Exam Taiyari Series

JEE (MAIN)

Unit Wise Practice Tests

PHYSICS

- Complete syllabus is divided into logical units
- Self-assessment Practice tests for each unit
- Prepared by subject experts
- As per the latest pattern of the examination
- Detailed explanatory solution of each test papers

10 Unit
+
2 Revision
+
1 Full Syllabus Test

CP PUBLICATION

JEE Main
Unit wise Practice Tests

PHYSICS

Preface

Competitive examination preparation takes enormous efforts & time on the part of a student to learn, practice and master each unit of the syllabus.

To check proficiency level in each unit, student must take self-assessment to identify his/her weak areas to work upon, that eventually builds confidence to win. Also performance of a student in exam improves significantly if student is familiar with the exact nature, type and difficulty level of the questions being asked in the Exam.

With this objective in mind, we are presenting before you this book containing unit tests. Some features of the book are -

a) The complete syllabus is divided into logical units and there is a self-assessment tests for each unit

b) Tests are prepared by subject experts who have decade of experience to prepare students for competitive exams

c) Tests are as per the latest pattern of the examination

d) Detailed explanatory solution of each test paper s also given

Student is advised to attempt these Tests once they complete the preparation/revision of unit. They should attempt these Test in exam like environment in a specified time. Student is advised to properly analyze the solutions and think of alternative methods & linkage to the solutions of identical problems also. We firmly believe that the book in this form will definitely help a genuine, hardworking student.

We have put our best efforts to make this book error free, still there may be some errors. We would appreciate if the same is brought to our notice.

We wish to utilize the opportunity to place on record our special thanks to all faculty members & editorial team for their efforts to make this book.

Best wishes

Career Point Team

JEE Main

Syllabus : Physics

The syllabus contains two Section-A and B, Section-A pertains to the Theory Part having 80% weightage, while Section-B contains Practical Component (Experimental Skills) having 20% weightage.

Section -A

Unit -1 : Physics and Measurement

Physics, technology and society, S.I. units, Fundamental and derived units. Least count, accuracy and precision of measuring instruments, Errors in measurement, Dimensions of Physical quantities, dimensional analysis and its applications.

Unit -2 : Kinematics

Frame of reference. Motion in a straight line; Position time graph, speed and velocity, Uniform and non-uniform motion, average speed and instantneous velocity Uniformly accelerated motion, velocity-time, position-time graphs, relations for uniformly acceleated motion. Scalars and Vector, Vector addition and Subtraction, Zero Vector, Scalar and Vector products, Unit vector, Resolution of a Vector, Relative Velocity, Motion in a plane, Projectile Motion, Uniform Circular Motion.

Unit -3 : Laws of Motion

Force and Inertia, Newton's First Law of motion; Momentum, Newton's Second Law of motion; Impulse; Newton's Third law of motion, Law of conservation of linear momentum and its applications, Equilibrium of concurrent forces.

Static and Kinetic Friction, Law of friction, rolling friction.

Dynamics of uniform circular motion : Centripetal force and its applications.

Unit -4 : Work, Energy and Power

Work done by a constant force and a variable force; Kinetic and potential energies, work energy theorem, power.

Potential energy of a spring, conservation of mechanical energy, conservative and non-conservative forces; Elastic and inelastic collisions in one and two dimensions.

Unit -5 : Rotational Motion

Centre of mass of a two-particle system, Centre of mass of a rigid body; Basic concepts of rotational motion; moment of a force, torque, angular momentum, conservation of angular momentum and its applications; moment of inertia, radius of gyration. Values of moments of inertia for simple geometrical Parallel objects, parallel and perpendicular axes theorems and their applications. Rigid body rotation, equation of rotational motion.

Unit 6 : Gravitation

The universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth. Kepler's laws of planetary motion, gravitational potential energy; gravitational potential, Escape velocity, Orbital velocity of a satellite. Geo-stationary satellites.

Units -7 : Properties of solids and liquids

Elastic behavior, Stress-strain relationship, Hooke's Law, Young's modulus, bulk modulus, modulus of rigidity. Pressure due to a fluid column; Pascal's law and its applications. Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow, Reynolds number. Bernoulli's principle and its applications. Surface energy and surface tension, angle of contact, application of surface tension - drops, bubbles and capillary rise. Heat temperature, thermal expansion; specific heat capacity, calorimetry; change of state, latent heat. Heats transfer conduction, convection and radiation, Newton's law of cooling.

Unit -8 : Thermodynamics

Thermal equilibrium, zeroth law of thermodynamics, concept of temperature. Heat, work and internal energy. First law of thermodynamics. Second law of thermodynamics; reversible and inreversible processes. Carnot engine and its efficiency.

Unit -9 : Kinetic Theory of gases

Equation of state of a perfect gas, work done on compressing a gas. Kinetic theory of gases assumptions, concept of pressure. Kinetic energy and temperature : rms speed of gas molecules; Degrees of freedom, Law of equipartition of energy, applications to specific heat capacities of gases; Mean free path, Avogadro's number.

Unit -10 : Oscillations and Waves

Periodic motion-period, frequency, displacement as a function of time, Periodic functions, Simple harmonic motion (S.H.M.) and its equation; phase; oscillations of a spring restoring force and force constant; energy in S.H.M.; kinetic and potential energies; Simple pendulum-derivation of expression for its time period; Free, forced and damped oscillations, resonance.

Wave motion, Longitudinal and transverse waves, speed of a wave. Displacement relation for a progressive wave, Principle of superposition of waves, reflection of waves, Standing waves in string and organ pipes, fundamental mode and harmonics, Beats, Doppler effect in sound.

Unit -11 : Electrostatics

Electric charges, Conservation of charge, Coulomb's law-forces between two point charges, forces between multiple charges; superposition principle and continuous charge distribution.

Electric field; Electric field due to point charge, Electric field lines, Electric dipole, Electric field due to a dipole, Torque on a dipole in a uniformly electric field.

Electric flux, Gauss's law and its applications to find field due to infinitely long uniformly charged straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical sheell. Electric potential and its calculation for a point charge, electric dipole and system of charges; Equipotential surface, Electrical potential energy of a system of two point charges in an electrostatic field.

Conductors and insulators, Dielectrics and electric polariztion, capacitor, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, Energy stored in capacitor.

Unit -12 : Current Electricity

Electric current, Drift velocity, Ohm's law, Electrical resistance, Resistances of different materials. V-I characteriics of Ohmic and nonohmic conductors, Electrical energy and power, Electrical resistivity. Colour code for resistors; Series and parallel combinations of resistors; Temperature dependence of resistance.

Electric Cell and its Internal resistance, potential difference and emf of a cell, combination of cells in series and in parallel. Kirchhoffs laws and their applications. Wheatstone bridge, Metre bridge. Potentiometer - principle and its applications.

Unit -13 : Magnetic Effect of Current and Magnetism

Biot - Savart law and its application to current carrying circular loop. Ampere's law and its applications to infinitely long current carrying straight wire and solenoid. Force on a moving charge in uniform magnetic and electric field, Cyclotron.

Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current carrying conductors definition of ampere. Torque experienced by a current loop in uniform magnetic field; Moving coil galvanometer, its current sensitivity and conversion to ammeter and voltmeter.

Current loop as a magnetic dipole and its magnetic dipole moment. Bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements. Para, dia and ferro magnetic substances.

Magnetic susceptibility and permeability. Hysteresis, Electromagnetic and permanent magnets.

Unit -14 : Electromagnetic Induction and Alternating currents

Electromagnetic induction; Faraday's law, induced emf and current; Lenz's Law, Eddy currents, Self and mutual inductance, Alternating currents, peak and rms value of alternating current / voltage; reactance and impedance; LCR series circuit, resonance; Quality factor, power in AC circuits, wattless current. AC generator and transformer.

Unit -15 : Electromagnetic waves

Electromagnetic waves and their characteristics, Transverse nature of electromagnetic waves.

Electromagnetic spectrum (radio waves, microwaves, infarared, visible, ultraviolet, X-rays, gamma rays). Applications of e.m. waves.

Unit -16 : Optics

Reflection and refraction of light at plane and spherical surface, mirror formula, Total internal reflection and its applications, Deviation and Dispersion of light by a prism, Lens Formula, Magnification, Power of a Lens, Combination of thin lenses in contact, Microscope and Astronomical Telescope (reflecting and refracting) and their magnifying powers.

Wave optics : Wave front and Huygens' principle, Laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light. Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescopes, Polarisation, plane polarized light; Brewster's law, uses of plane polarized light and Polaroids.

Unit -17 : Dual Nature of Matter and Radiation

Dual nature of radiation. Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation; particle nature of light. Matter waves-wave nature of particle, de Broglie relation. Davisson-Germer experiment.

Unit -18 : Atoms and Nuclei

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum. Composition and size of nucleus, atomic masses, isotopes, isobars; isotones. Radioactivity-alpha, beta and gamma particles / rays and their properties; radioactive decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number, nuclear fission and fusion.

Unit -19 : Electronic Devices

Semiconductors : semiconductor diode : I-V characteristics in forward and reverse bias; diode as a rectifier; I-V characteristics of LED, photodiode, solar cell and Zener diode; as a voltage regulator, Junction transistor, action, characteristics of a transistor; transistor as an amplifier (common emitter configuration) and oscillator. Logic gates (OR, AND, NOT, NAND and NOR). Transistor as a switch.

Unit -20 : Communications systems

Propagation of electromagnetic waves in the atmosphere; Sky and space wave propagation, Need for modulation, Amplitude and Frequency Modulation, Bandwidth of signals, Bandwidth of Transmission medium, Basic Elements of a Communication System (Block Diagram only).

Section -B

Unit -21 : Experimental Skills

Familiarity with the basic approach and observations of the experiments and activities :

1. Vernier callipers-its use to measure internal and external diameter and depth of a vessel.
2. Screw gauge-its use to determine thickness / diameter of thin sheet/wire.
3. Simple Pendulum-dissipation of energy by plotting a graph between square of amplitude and time.
4. Metre Scale-mass of a given object by principle of moments.
5. Young's modulus of elasticity of the material of a metallic wire.
6. Surface tension of water by capillary rise and effect of detergents.
7. Co-efficient of Viscosity of a given viscous liquid by measuring terminal velocity of a given spherical body.
8. Plotting a cooling curve for the relationship between the temperature of a hot body and time.
9. Speed of sound in air at room temperature using a resonance tube.
10. Specific heat capacity of a given (i) solid and (ii) liquid by method of mixtures.
11. Resistivity of the material of a given wire using metre bridge.
12. Resistance of a given wire using Ohm's law,
13. Potentiometer -
    (i) Comparison of emf of two primary cells.
    (ii) Determination of internal resistance of a cell.
14. Resistance and figure of merit of a galvanometer by half deflection method.
15. Focal length of :
    (i) Convex mirror
    (ii) Concave mirror and
    (iii) Convex lens
    using parallax method
16. Plot of angle of deviation vs angle of incidence for a triangular prism.
17. Refractive index of a glass slab using a traveling microscope.
18. Characteristic curves of a p-n junction diode in forward and reverse bias.
19. Characteristic curves of a Zener diode and finding reverse break down voltage.
20. Characteristic curves of a transistor and finding current gain and voltage gain.
21. Identification of Diode, LED, Transistor, IC, Resistor, Capacitor from mixed collection of such items.
22. Using millimeter to :
    (i) Identify base of a transistor
    (ii) Distinguish between npn and pnp type transistor.
    (iii) See the unidirectional flow of current in case of a diode and an LED.
    (iv) Check the corretness or otherwise of a given electronic component (diode, transistor or IC).

Practice Test Syllabus

PHYSICS

Test No	Chapters
Unit Test-1	Essential Mathematics and Vector, Unit & Dimension, Significant Figure and Error Analysis, Motion in One Dimension, Projectile Motion
Unit Test-2	NLM, Friction, Work, Power and Energy, Circular Motion
Unit Test-3	Conservation Laws, Rotational Motion
Unit Test-4	Gravitation, SHM, Properties of Matter, Fluid Mechanics
Unit Test-5	Transverse Wave, Sound Wave, Doppler Effect, KTG, Thermodynamics, Calorimetry, Heat Transfer, Thermal Expansion
Revision-1	Units 1 to 5
Unit Test-6	Electrostatics, Gauss Law
Unit Test-7	Capacitor, Electric Current
Unit Test-8	Magnetism & Matter, Magnetic Effect of Current, Electro-magnetic Induction, Alternating Current
Unit Test-9	Reflection at Plane and Curved Surface, Refraction at Plane Surface, Refraction at Curved Surface, Prism, Wave Optics, Interference, Diffraction, Polarisation
Unit Test-10	Nuclear Physics & Radioactivity, Photo-electric Effect, X-Rays, Atomic Structure, Matter wave, Semi conductors & Electronics
Revision-2	Units 6 to 10
Major	Full Syllabus

CONTENTS

Practice Test for JEE Main
Unit Test -1

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Essential Mathematics and Vector, Unit Dimension, Significant Figure and Error Analysis, Motion in One Dimension, Projectile Motion

IMPORTANT INSTRUCTIONS

GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 $x = a(\theta + \sin\theta)$; $y = a(1 - \cos\theta)$ then $\frac{dy}{dx}$

(1) $\frac{\sin\theta}{(1+\cos\theta)}$ (2) $\frac{\cos\theta}{1+\sin\theta}$

(3) $\frac{1+\cos\theta}{\sin\theta}$ (4) $\frac{\sin\theta}{1-\cos\theta}$

Q.2 Correct graph of $y - 1 = x^2$ is -

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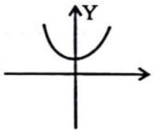

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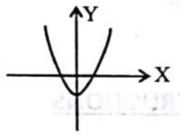

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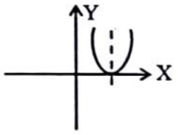

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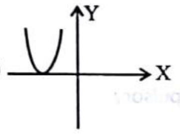


Q.3 $\int_2^5 \frac{1}{(2+3x)} dx$ is -

(1) $\frac{15}{2}$ (2) $\frac{7}{5}$

(3) $\frac{1}{3}\ell n\frac{17}{8}$ (4) $\ell n\frac{17}{8}$

Q.4 A truck travelling due north at 20 m/s turns west and travels at the same speed. The change in its velocity be

(1) 40 m/s N–W (2) $20\sqrt{2}$ m/s N–W

(3) 40 m/s S–W (4) $20\sqrt{2}$ m/s S–W

Q.5 The resultant of two vectors $\vec{P}$ & $\vec{Q}$ is $\vec{R}$. If the magnitude of $\vec{Q}$ is doubled, the new resultant vector becomes perpendicular to $\vec{P}$. Then, the magnitude of $\vec{R}$ is equal to.

(1) P + Q (2) P

(3) P – Q (4) Q

Q.6 In an equilateral ΔABC, AL, BM and CN are medians. Forces along BC and BA represented by them will have a resultant represented by -

(1) 2AL (2) 2BM

(3) 2CN (4) AC

Q.7 Write the dimensions of a/b in the relation $P = \frac{a - t^2}{bx}$, where P is the pressure, x is the distance and t is the time.

(1) $M^{-1}L^0T^{-2}$ (2) ML^0T^{-2}

(3) ML^0T^2 (4) MLT^{-2}

Q.8 If E, M, J and G, respectively, denote energy, mass, angular momentum and gravitational constant, then $\frac{EJ^2}{M^5G^2}$ has the dimensions of

(1) time (2) angle

(3) mass (4) length

Q.9 Out of the following, the only pair that does not have identical dimensions is -

(1) Angular momentum and Plank's constant

(2) Moment of inertia and force

(3) Work and torque

(4) Impulse and momentum

Q.10 The resistance $R = \frac{V}{i}$ where V = 100 ± 5 volts and i = 10 ± 0.2 amperes. What is the total error in R -

(1) 5% (2) 7%

(3) 5.2% (4) $\frac{5}{2}$%

Q.11 The period of oscillation of a simple pendulum in the experiment is recorded as 2.63 s, 2.56 s, 2.42 s, 2.71 s and 2.80 s respectively. The average absolute error is :

(1) 0.1 s (2) 0.11 s

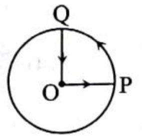
(3) 1.0 s (4) 0.01 s

Q.12 A body travels uniformly a distance of (10.0 ± 0.5 m) in a time (2.0 ± 0.1) sec. The velocity of the body within error limits is :

(1) (5.0 ± 0.6) m/s (2) (5.0 ± 0.5) m/s

(3) (5.0 ± 0.05) m/s (4) (5.0 ± 1.0) m/s

Q.13 A cyclist starts from the centre O of a circular park of radius one kilometre, reaches the edge P of the park, then cycles along the circumference and returns to the centre along QO as shown in figure. If the round trip takes ten minutes, the net displacement and average speed of the cyclist (in metre and kilometre per hour) is-



(1) 0, 1 (2) $\frac{\pi+4}{2}$, 0

(3) 21.4, $\frac{\pi+4}{2}$ (4) 0, 21.4

Q.14 A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15 S, then-

(1) $S = \frac{1}{2}ft^2$ (2) $S = \frac{1}{4}ft^2$

(3) $S = \frac{1}{72}ft^2$ (4) $S = \frac{1}{6}ft^2$

Q.15 A boat which has a speed of 5 km/h in still water crosses a river of width 1 km along the shortest possible path in 15 minutes. The velocity of river water in km/h is -

(1) 1 (2) 3

(3) 4 (4) $\sqrt{(41)}$

Q.16 Look at the graphs (a) to (d) carefully and indicate which of these possibly represents one dimensional motion of a particle ?

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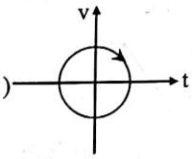

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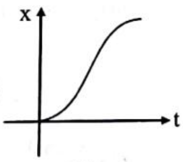

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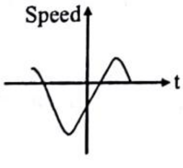

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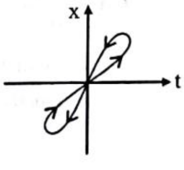


Q.17 A blind person after walking each 10 steps in one direction, each of length 80 cm, turns randomly to the left or to the right by 90°. After walking a total of 40 steps the maximum possible displacement of the person from his starting position could be -

(1) 320 m (2) 32 m

(3) $16/\sqrt{2}$ m (4) $16\sqrt{2}$ m

Q.18 From a balloon rising vertically upwards at 5 m/s, a stone is thrown up at 10 m/s relative to the balloon. Its velocity with respect to ground after 2 sec is - (assume g = 10 m/s^2)

(1) 0 (2) 20 m/s

(3) 10 m/s (4) 5 m/s

Q.19 A particle is released from rest from a tower of height 3h. The ratio of times to fall equal heights h, i.e., $t_1 : t_2 : t_3$ is :

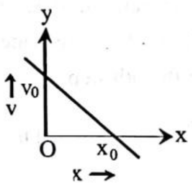
(1) $\sqrt{3}:\sqrt{2}:1$

(2) 3 : 2 : 1

(3) 9 : 4 : 1

(4) $1 : (\sqrt{2}-1) : (\sqrt{3}-\sqrt{2})$

Q.20 Depict the shown v-x graph in a-x graph :



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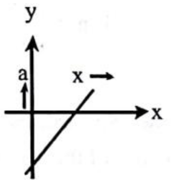

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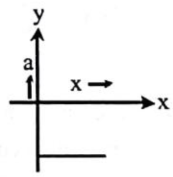

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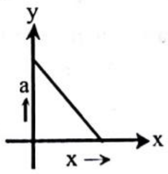

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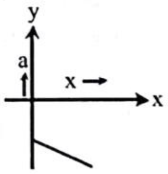
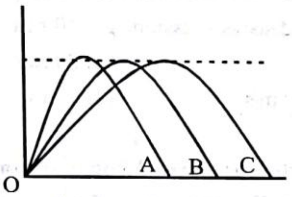


Q.21 A body A starts from rest with an acceleration a_1. After 2 second, another body B starts from rest with an acceleration a_2. If they travel equal distances in the 5^{th} second, after the starts of A, then the ratio $a_1 : a_2$ is equal to -

(1) 5 : 9 (2) 5 : 7
(3) 9 : 5 (4) 9 : 7

Q.22 Three projectile A, B and C are thrown from the same point in the same plane. Their trajectories are shown in the figure. Then which of the following statement is true-



(1) the time of flight is the same for all the three
(2) the launch speed is greatest for particle C
(3) the horizontal velocity component is greatest for particle C
(4) all of the above

Q.23 A ball rolls off the top of a staircase with a horizontal velocity u m/s. If the steps are h metre high and b metre wide, the ball will hit the edge of the nth step, if -

(1) $n = \frac{2hu}{gb^2}$ (2) $n = \frac{2hu^2}{gb}$
(3) $n = \frac{2hu^2}{gb^2}$ (4) $n = \frac{hu^2}{gb^2}$

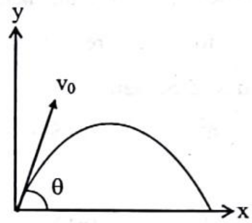
Q.24 The friction of the air causes a vertical retardation equal to 10% of the acceleration due to gravity. (Take g = 10 ms^{-2}). The maximum height will be decreased by in projectile motion -

(1) 11% (2) 10%
(3) 9% (4) 12%

Q.25 A particle is projected with a velocity v such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where g is acceleration due to gravity)

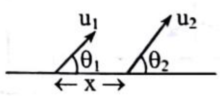
(1) $\frac{4v^2}{5g}$ (2) $\frac{4g}{5v^2}$
(3) $\frac{v^2}{g}$ (4) $\frac{4v^2}{\sqrt{5}g}$

Q.26 A small particle of mass m is projected at an angle θ with the x-axis with an initial velocity v_0 in the XY-plane as shown in the adjoining figure. At a time $t < \frac{v_0 \sin\theta}{g}$ the angular momentum of the particle is –



(1) $-mgv_0t^2 \cos\theta\ \hat{j}$
(2) $mgv_0t \cos\theta\ \hat{k}$
(3) $-\frac{1}{2} mgv_0t^2 \cos\theta\ \hat{k}$
(4) $\frac{1}{2} mgv_0t^2 \cos\theta\ \hat{i}$

Q.27 Two particles are projected simultaneously from the level ground as shown figure. They may collide after a time :



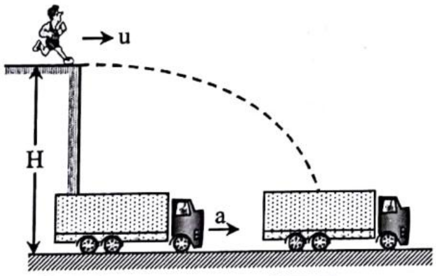
(1) $\frac{x\sin\theta_2}{u_1}$ (2) $\frac{x\cos\theta_2}{u_2}$
(3) $\frac{x\sin\theta_2}{u_1\sin(\theta_2-\theta_1)}$ (4) $\frac{x\sin\theta_1}{u_2\sin(\theta_2-\theta_1)}$

Q.28 The trajectory of a projectile in a vertical plane is $y = ax - bx^2$, where a and b are constants and x and y are respectively horizontal and vertical distances of the projectile from the point of projection. The maximum height attained by the particle and the angle of projection from the horizontal are -

(1) $\frac{b^2}{2a}$, $\tan^{-1}(b)$ (2) $\frac{a^2}{b}$, $\tan^{-1}(2a)$

(3) $\frac{a^2}{4b}$, $\tan^{-1}(a)$ (4) $\frac{2a^2}{b}$, $\tan^{-1}(a)$

Q.29 A stunt performer is to run and dive off a tall platform and land in a net in the back of a truck below. Originally the truck is directly under the plateform, it starts forward with a constant acceleration a at the same instant the performer leaves the plateform. If the platform is H above the net in the truck, then the horizontal velocity u that the performer must have as he leaves the platform is -



(1) $a\sqrt{2H/g}$ (2) $a\sqrt{H/2g}$

(3) $a\sqrt{g/2H}$ (4) None of the above

Q.30 A particle is projected from the ground with an initial speed u at an angle θ with horizontal. The average velocity of the particle between its point of projection and highest point of trajectory is-

(1) $u \cos\theta$ (2) $\frac{u}{2}\sqrt{1+\cos^2\theta}$

(3) $\frac{u}{2}\sqrt{1+2\cos^2\theta}$ (4) $\frac{u}{2}\sqrt{1+3\cos^2\theta}$

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

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Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

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SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -2

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : NLM, Friction, Work Power and Energy, Circular Motion

IMPORTANT INSTRUCTIONS

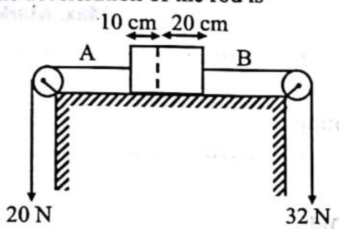
GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

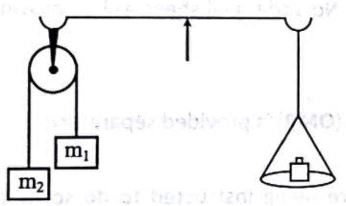
1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 Figure shows a uniform rod of mass 3 kg and of length 30 cm. The strings shown in figure are pulled by constant forces of 20 N and 32 N. The acceleration of the rod is-



(1) 2 m/s² (2) 3m/s²
(3) 4 m/s² (4) 6 m/s²

Q.2 A pulley is attached to one arm of a balance and a string passed round it carries two masses m_1 and m_2. The balance is counter poised and the pulley is clamped so that m_1 and m_2 do not move. How much counter weight is to be reduced or increased to restore balance if the clamp is released ?

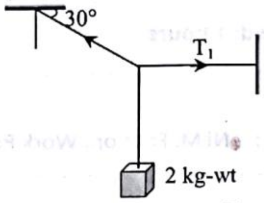


(1) $\frac{g(m_1 - m_2)^2}{(m_1 + m_2)}$ to be reduced
(2) $\frac{g(m_1 - m_2)^2}{(m_1 + m_2)}$ to be increased
(3) $\frac{g(m_1 - m_2)}{(m_1 + m_2)}$ to be reduced
(4) $\frac{g(m_1 - m_2)}{(m_1 + m_2)}$ to be increased

Q.3 A bullet is fired from a gun. The force on the bullet is given by :
$F = 600 - 2 \times 10^5 t$
Where F is in newton and t in second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet ?

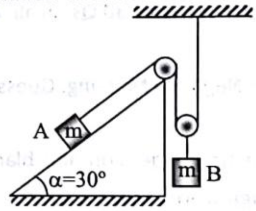
(1) 9 N-s (2) zero
(3) 0.9 N-s (4) 1.8 N-s

Q.4 A body of weight 2 kg is suspended as shown in the figure. The tension T_1 in the horizontal string (in kg wt) is -



(1) $2/\sqrt{3}$ (2) $\sqrt{3}/2$
(3) $2\sqrt{3}$ (4) 2

Q.5 In an arrangement shown in the figure, the acceleration of block A and B are given –

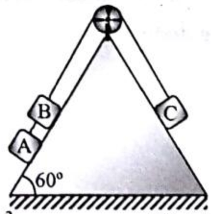


(1) g/3, g/6 (2) g/6, g/3
(3) g/2, g/2 (4) 0, 0

Q.6 The force exerted by the lift on the foot of a person standing in it, is more than his weight then the lift is -
(a) going up and slowing down
(b) going up and speeding up
(c) going down and slowing down
(d) going down and speeding up

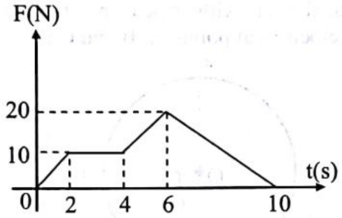
(1) a, c (2) b, c
(3) a, d (4) b, d

Q.7 As shown in figure A, B and C are 1 kg, 3 kg and 2 kg respectively. The acceleration of the system is -



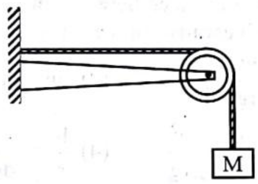
(1) 5 ms^{-2} (2) 4.11 ms^{-2}
(3) 4 ms^{-2} (4) 5.11 ms^{-2}

Q.8 A particle of mass 2 kg is initially at rest. A force acts on it whose magnitude changes with time. The force time graph is shown ahead. The velocity of the particle after 10 s is –



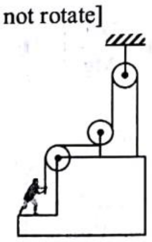
(1) 20 ms^{-1} (2) 10 ms^{-1}
(3) 75 ms^{-1} (4) 50 ms^{-1}

Q.9 A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by :



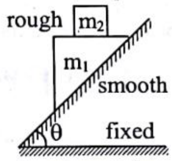
(1) $\sqrt{2}$ Mg
(2) $\sqrt{2}$ mg
(3) $\left(\sqrt{(M+m)^2+m^2}\right)g$
(4) $\left(\sqrt{(M+m)^2+M^2}\right)g$

Q.10 A system is shown in the figure. A man standing on the block is pulling the rope. Velocity of the point of string in contact with the hand of the man is 2m/s downwards. The velocity of the block will be [assume that the block does not rotate]



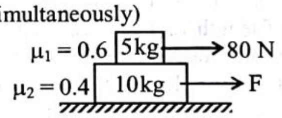
(1) 3 m/s (2) 2 m/s
(3) 1/2 m/s (4) 1 m/s

Q.11 A triangular prism of mass 'm_1' with a block of mass 'm_2' in placed on it is released from rest on a smooth inclined plane of inclination 'θ'. The block does not slip on the prism. Then-



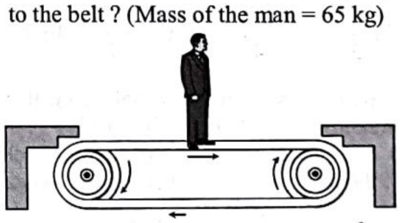
(1) the acceleration of the prism is g cos θ
(2) the acceleration of the prism is g tan θ
(3) the minimum coefficient of friction between the block and prism is $\mu_{min} = \cot\theta$
(4) the minimum coefficient of friction between block and prism is $\mu_{min} = \tan\theta$

Q.12 A system of two blocks is shown in figure. Friction coefficient between 5 kg and 10 kg block is $\mu = 0.6$ and between 10 kg and ground is $\mu = 0.4$. What will be the maximum value of force F applied at the lower block so that 5 kg block does not slip w.r.t. 10 kg. (g = 10 m/sec^2). The force applied at the upper block is having fixed magnitude of 80 N (both forces start to act simultaneously)



(1) 160 N (2) 250 N
(3) 210 N (4) 310 N

Q.13 Figure below shows a man standing stationary with respect to a horizontal conveyor belt that is accelerating with 1 ms^{-2}. If the coefficient of static friction between the man's shoes and the belt is 0.2, upto what acceleration of the belt can the man continue to be stationary relative to the belt ? (Mass of the man = 65 kg)



(1) 1.25 ms^{-2} (2) 1.96 ms^{-2}
(3) 2.5 ms^{-2} (4) 3.6 ms^{-2}

Q.14 A box of mass 8 kg is placed on a rough inclined plane of inclination θ. Its downward motion can be prevented by applying an upward pull F and it can be made to slide upwards by applying a force 2F. The coefficient of friction between the box and the inclined plane is -

(1) $\frac{1}{3}\tan\theta$ (2) $3\tan\theta$

(3) $\frac{1}{2}\tan\theta$ (4) $2\tan\theta$

Q.15 Starting from rest, a body slides down a 45° inclined plane in twice the time it takes to slide down the same distance in the absence of friction. The coefficient of friction between the body and the inclined plane is-

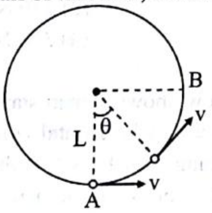
(1) 0.33 (2) 0.75 (3) 0.25 (4) 0.80

Q.16 A table which is rotating with speed ω. A groove is made on the surface along a radius. A particle is placed inside groove at a distance *a* from centre. Find the speed of the particle w.r.t. the table as its distance from the centre become ℓ-

(1) $v = \omega\ell$ (2) $v = \omega(\ell - a)$

(3) $v = \frac{\omega(\ell + a)}{2}$ (4) $v = \omega\sqrt{\ell^2 - a^2}$

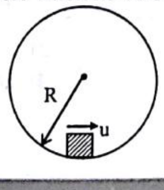
Q.17 A bob of mass M is suspended by a massless string of length L. The horizontal velocity v at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies –



(1) $\theta = \frac{\pi}{4}$ (2) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$

(3) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$ (4) $\frac{3\pi}{4} < \theta < \pi$

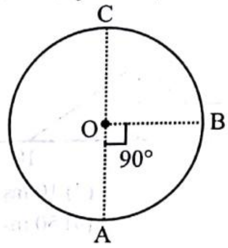
Q.18 A particle is given an initial speed u inside a smooth spherical shell of radius R = 1 m that it is just able to complete the circle. Acceleration of the particle when its velocity is vertical is -



(1) $g\sqrt{10}$ (2) g

(3) $g\sqrt{2}$ (4) 3g

Q.19 A particle crosses the topmost point C of a vertical circle with critical speed ; then the ratio of velocities at points A, B and C is



(1) 3 : 2 : 1 (2) 5 : 3 : 1

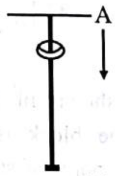
(3) $5^2 : 3^2 : 1^2$ (4) $\sqrt{5} : \sqrt{3} : \sqrt{1}$

Q.20 A rail track is banked for speed v by making the height of the outer rail h higher than that of inner. The distance between the rails is d. The radius of curvature of the track is r then -

(1) $\frac{h}{d} = \frac{v^2}{rg}$ (2) $\tan\left\{\sin^{-1}\frac{h}{d}\right\} = \frac{v^2}{rg}$

(3) $\tan^{-1}\frac{h}{d} = \frac{v^2}{rg}$ (4) $\frac{h}{r} = \frac{v^2}{dg}$

Q.21 An elastic cord of constant K and length L is hung from point A having a massless lock at the other end. A smooth ring of mass M falls from point A, the maximum elongation of cord is



(1) $\frac{Mg}{K}\left(1 + \frac{1+2KL}{Mg}\right)^{1/2}$

(2) $\frac{Mg}{K}\left(1 - \left(1 - \frac{2KL}{Mg}\right)^{1/2}\right)$

(3) $\frac{MgL}{K}$

(4) $\frac{Mg}{K}\left(1 + \left(1 + \frac{2KL}{Mg}\right)^{1/2}\right)$

Q.22 A hammer of mass M falls from height h to drive a pile of mass m into the ground. The hammer makes the pile pentrate in the ground to a distance d, opposition force of penetration is given by -

(1) $\frac{m^2gh}{M+md}$

(2) $\frac{M^2gh}{(M+m)d} + (M+m)\,g$

(3) $\frac{M^2gh}{M+md}$

(4) $\frac{m^2gh}{(m+M)d} - (M+m)\,g$

Q.23 A variable force, given by the 2-dimensional vector $\vec{F} = (3x^2\hat{i} + 4\hat{j})$, acts on a particle. The force is in newton and x is in metre. What is the change in the kinetic energy of the particle as it moves from the point with coordinates (2, 3) to (3, 0) (The coordinates are in metres)

(1) –7J (2) zero
(3) +7J (4) +19J

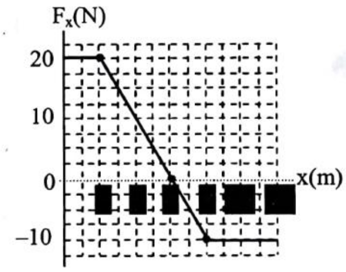
Q.24 A constant power P is applied to a car starting from rest. If v is the velocity of the car at time t, then -

(1) $v \propto t$ (2) $v \propto \frac{1}{t}$
(3) $v \propto \sqrt{t}$ (4) $v \propto \frac{1}{\sqrt{t}}$

Q.25 A particle is released from a height H. At certain height its kinetic energy is two times its potential energy. Height and speed of particle at that instant are -

(1) $\frac{H}{3}, \sqrt{\frac{2gH}{3}}$ (2) $\frac{H}{3}, 2\sqrt{\frac{gH}{3}}$
(3) $\frac{2H}{3}, \sqrt{\frac{2gH}{3}}$ (4) $\frac{H}{3}, \sqrt{2gH}$

Q.26 An object moving along the x axis is acted upon by a force F_x that varies with position as shown. How much work is done by this force as the object moves from $x = 2$ m to $x = 8$ m?



(1) –10 J (2) +10 J
(3) +30 J (4) –30 J

Q.27 A man is riding on a cycle with velocity 7.2 km/hr up a hill having a slope 1 in 20. The total mass of the man and cycle is 100 kg. The power of the man is – ($g = 9.8$ m/s^2)

(1) 200 W (2) 175 W
(3) 125 W (4) 98 W

Q.28 The PE between two atoms in a molecule is given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$ where a & b are +ve constant and x is the distance between the atoms. The atom is in stable equilibrium when -

(1) $x = \sqrt[6]{\frac{11a}{5b}}$ (2) $x = \sqrt[6]{\frac{a}{2b}}$
(3) $x = 0$ (4) $x = \sqrt[6]{\frac{2a}{b}}$

Q.29 If the KE of a body is increased by 300% it momentum will increased by -

(1) 100% (2) 150%
(3) $\sqrt{300}$ % (4) 175%

Q.30 A uniform chain has a mass m and length ℓ. It is held on a frictionless table with one-sixth of its length hanging over the edge. The work done in just pulling the hanging part back on the table is:

(1) $mg\frac{\ell}{72}$ (2) $\frac{mg\ell}{36}$
(3) $\frac{mg\ell}{12}$ (4) $\frac{mg\ell}{6}$

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

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Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

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SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -3

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Conservation Laws, Rotational Motion

IMPORTANT INSTRUCTIONS

GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

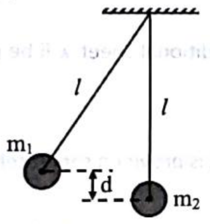
1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 A projectile is fired with a speed u at an angle θ above the horizontal field. The coefficient of restitution between the projectile and field is e. Find the position from the starting point when the projectile will land at its second collision

(1) $\frac{e^2u^2\sin 2\theta}{g}$ (2) $\frac{(1-e^2)u^2\sin 2\theta}{g}$

(3) $\frac{(1-e)u^2\sin\theta\cos\theta}{g}$ (4) $\frac{(1+e)u^2\sin 2\theta}{g}$

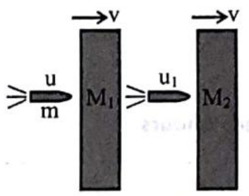
Q.2 Two pendulums each of length l are initially situated as shown in figure. The first pendulum is released and strikes the second. Assume that the collision is completely inelastic and neglect the mass of the string and any frictional effects. How high does the centre of mass rise after the collision ?



(1) $d\left[\frac{m_1}{(m_1+m_2)}\right]^2$ (2) $d\left[\frac{m_1}{(m_1+m_2)}\right]$

(3) $\frac{d(m_1+m_2)^2}{m_2}$ (4) $d\left[\frac{m_2}{(m_1+m_2)}\right]^2$

Q.3 A 20 g bullet pierces through a plate of mass M_1 = 1kg and then comes to rest inside a second plate of mass M_2 = 2.98 kg as shown in the figure. It is found that the two plates, initially at rest, now move with equal velocities. Find the percentage loss in the initial velocity of the bullet when it is between M_1 and M_2. Neglect any loss of material of the plates due to the action of bullet



(1) 50% (2) 25%

(3) 100% (4) 75%

Q.4 A body of mass m_1 moving at a constant speed undergoes an elastic head on collision with a body of mass m_2 initially at rest. The ratio of the kinetic energy of mass m_1 after the collision to that before the collision is -

(1) $\left(\frac{m_1-m_2}{m_1+m_2}\right)^2$ (2) $\left(\frac{m_1+m_2}{m_1-m_2}\right)^2$

(3) $\left(\frac{2m_1}{m_1+m_2}\right)^2$ (4) $\left(\frac{2m_2}{m_1+m_2}\right)^2$

Q.5 A body of mass 5 kg explodes at rest into three fragments with masses in the ratio 1 : 1 : 3. The fragments with equal masses fly in mutually perpendicular directions with speeds of 21 m/s. The velocity of the heaviest fragment will be -

(1) 11.5 m/s (2) 14.0 m/s

(3) 7.0 m/s (4) 9.89 m/s

Q.6 A bag (mass M) hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined (bag + bullet) system -

(1) Momentum is $\frac{mvM}{(M+m)}$

(2) KE is $\frac{mv^2}{2}$

(3) Momentum is $\frac{mv(M+m)}{M}$

(4) KE is $\frac{m^2v^2}{2(M+m)}$

Q.7 A uniform metal disc of radius R is taken and out of it a disc of diameter R is cut off from the end. The centre of the mass of the remaining part will be:

(1) $\frac{R}{4}$ from the centre

(2) $\frac{R}{3}$ from the centre

(3) $\frac{R}{5}$ from the centre

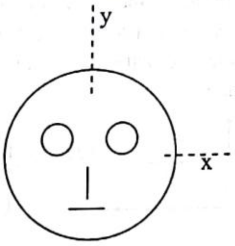
(4) $\frac{R}{6}$ from the centre

Q.8 A ball is dropped from a height h on the ground. If the coefficient of restitution is e, the height to which the ball goes up after it rebounds for the n^{th} time is-

(1) he^{2n} (2) $h e^{n}$

(3) $\frac{e^{2n}}{h}$ (4) $\frac{h}{e^{2n}}$

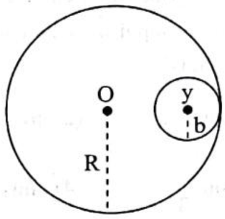
Q.9 Look at the drawing given in the figure which has been drawn with ink of uniform line-thickness. The mass of ink used to draw each of the two inner circles, and each of the two lines segments is m. The mass of the ink used to draw the outer circle is 6m. The coordinates of the centers of the different parts are : outer circle (0, 0), left inner circle (–a, a), right inner circle (a, a), vertical line (0, 0) and horizontal line (0, –a). The y-coordinate of the centre of mass of the ink in this drawing is-



(1) $\frac{a}{10}$ (2) $\frac{a}{8}$

(3) $\frac{a}{12}$ (4) $\frac{a}{3}$

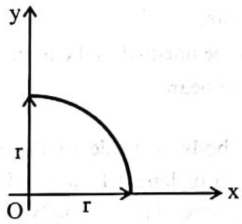
Q.10 A cavity of radius b is made in a disc of mass M, radius R, as shown in fig. Find the new COM –



(1) $\frac{-b^2}{R+b}$ (2) $\frac{-b^2}{R-b}$

(3) $\frac{-R}{2R+b}$ (4) $\frac{-R}{3R+b}$

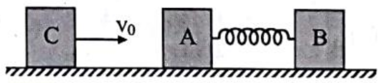
Q.11 The coordinates of centre of mass of the following quarter circular arc is -



(1) $\left(\frac{r}{2},\frac{r}{2}\right)$ (2) $\left(\frac{2r}{3},\frac{2r}{3}\right)$

(3) $\left(\frac{2r}{\pi},\frac{2r}{\pi}\right)$ (4) $\left(\frac{4r}{\pi},\frac{4r}{\pi}\right)$

Q.12 A block C of mass m is moving with velocity v_0 and collides elastically with block A of mass m which connected to another block B of mass 2m through a spring of spring constant k. What is k if x_0 is the compression of spring when velocity of A and B is same? (Initially spring is unstretched)



(1) $\frac{mv_0^2}{x_0^2}$ (2) $\frac{mv_0^2}{2x_0^2}$

(3) $\frac{3}{2}\frac{mv_0^2}{x_0^2}$ (4) $\frac{2}{3}\frac{mv_0^2}{x_0^2}$

Q.13 A particle of mass m is made to move with uniform speed v_0 along the perimeter of regular hexagon, inscribed in a circle of radius R. The magnitude of impulse applied at each corner of the hexagon is -

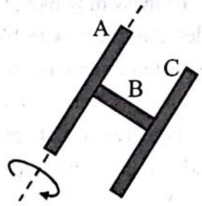
(1) $2mv_0 \sin\frac{\pi}{6}$ (2) $mv_0 \sin\frac{\pi}{6}$

(3) $mv_0 \sin\frac{\pi}{3}$ (4) $2mv_0 \sin\frac{\pi}{3}$

Q.14 Two men support a uniform horizontal beam at its two ends. If one of them suddenly lets go, the force exerted by the beam on the other man will -

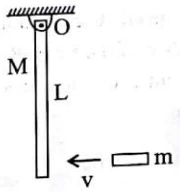
(1) remain unaffected
(2) increase
(3) decrease
(4) become unequal to the force exerted by him on the beam

Q.15 A rigid body is made of three identical thin rods, each of length L fastened together in the form of letter H. The body is free to rotate about a horizontal axis that runs along the length of one of the legs of the H. The body is allowed to fall from rest from a position in which the plane of H is horizontal. What is the angular speed of the body when the plane of H is vertical ?



(1) $\sqrt{\frac{g}{L}}$ (2) $\frac{1}{2}\sqrt{\frac{g}{L}}$ (3) $\frac{3}{2}\sqrt{\frac{g}{L}}$ (4) $2\sqrt{\frac{g}{L}}$

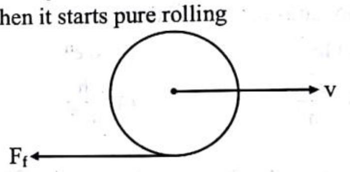
Q.16 A wooden log of mass M & length L is hinged by a frictionless of nail at O. A bullet of mass m strikes with velocity v & sticks to it. Find the angular velocity of the system immediately after collision –



(1) $\frac{mv}{M+m}$ (2) $\frac{3mv}{(M+m)L}$

(3) $\frac{3mv}{(M+3m)L}$ (4) $\frac{mv}{(M+3m)L}$

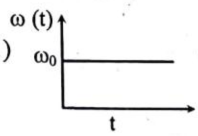
Q.17 A thin spherical shell lying on a rough horizontal surface is hit by a cue in such a way that line of action passes through the centre of the shell. As a result shell starts moving with a linear speed v without any initial angular velocity. Find the linear velocity to the shell when it starts pure rolling



(1) $\frac{3}{5}v$ (2) $\frac{2}{5}v$

(3) $\frac{4}{5}v$ (4) None of these

Q.18 A circular platform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the edge of the platform. Now, the platform is given an angular velocity ω_0. When the tortoise moves along a chord of the platform with a constant velocity (with respect to the platform), the angular velocity of the platform will vary with time t as -

(1)


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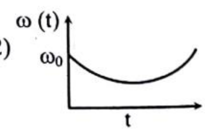

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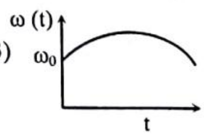

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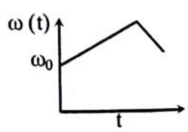
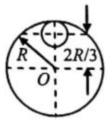


Q.19 The ratio of the time taken by a solid sphere and that taken by a disc of the same mass and radius to roll down a smooth inclined plane from rest from the same height -

(1) 15 : 14 (2) $\sqrt{15} : \sqrt{14}$

(3) 14 : 15 (4) $\sqrt{14} : \sqrt{15}$

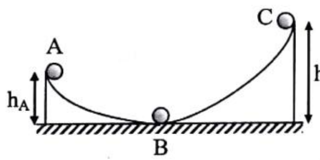
Q.20 A thin disc of mass $9M$ and radius R from which a disc of radius $R/3$ is cut as shown in figure. Then moment of inertia of the remaining disc about O, perpendicular to the plane of disc is -



(1) $4\,MR^2$ (2) $9\,MR^2$

(3) $\frac{37}{9}MR^2$ (4) $\frac{40}{9}MR^2$

Q.21 A ball moves over a fixed track as shown in figure. From A to B, the ball rolls without slipping. Surface BC is frictionless. K_A, K_B and K_C are kinetic energies of the ball at A, B and C respectively. Then –



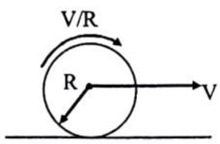
(a) $h_A > h_C$; $K_B > K_C$ (b) $h_A > h_C$; $K_C > K_A$

(c) $h_A = h_C$; $K_B = K_C$ (d) $h_A < h_C$; $K_B > K_C$

(1) a, b (2) a,c

(3) b,d (4) None of these

Q.22 A disc is performing pure rolling on a smooth stationary surface with constant angular velocity as shown in figure. At any instant, for the lower most point of the disc -



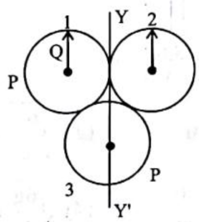
(1) Velocity is v, acceleration is zero

(2) Velocity is zero, acceleration is zero

(3) Velocity is v, acceleration is $\frac{v^2}{R}$

(4) Velocity is zero, acceleration is nonzero

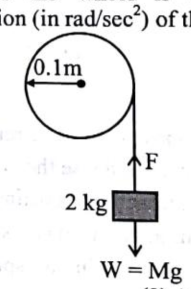
Q.23 Three rings, each of mass P and radius Q are arranged as shown in the figure. The moment of inertia of the arrangement about YY' axis will be



(1) $\frac{7}{2}PQ^2$ (2) $\frac{2}{7}PQ^2$

(3) $\frac{2}{5}PQ^2$ (4) $\frac{5}{2}PQ^2$

Q.24 The moment of inertia of a solid flywheel about its axis is 0.1 kg-m^2. A tangential force of 2 kg-wt. is applied round the circumference of the flywheel with the help of a string and mass arrangement as shown in the figure. If the radius of the wheel is 0.1 m, find the acceleration (in rad/sec^2) of the mass :



(1) 163.3 (2) 16.3

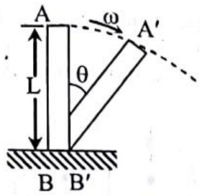
(3) 81.66 (4) 8.16

Q.25 A ladder of length ℓ and mass m is placed against a smooth vertical wall, but the ground is not smooth. Coefficient of friction between the ground and the ladder is μ. The angle θ at which the ladder will stay in equilibrium is -

(1) $\theta = \tan^{-1}(\mu)$ (2) $\theta = \tan^{-1}(2\mu)$

(3) $\theta = \tan^{-1}\left(\frac{\mu}{2}\right)$ (4) None of these

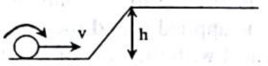
Q.26 A uniform rod of length L is free to rotate in a vertical plane about a fixed horizontal axis through B. The rod begins rotating from rest from its unstable equilibrium position. When it has turned through an angle θ its average angular velocity ω is given as:



(1) $\sqrt{\frac{6g}{L}}\sin\theta$ (2) $\sqrt{\frac{6g}{L}}\sin\frac{\theta}{2}$

(3) $\sqrt{\frac{6g}{L}}\cos\frac{\theta}{2}$ (4) $\sqrt{\frac{6g}{L}}\cos\theta$

Q.27 A sphere is rolling on a frictionless surface as shown in figure with a translational velocity v ms^{-1}. If it is to climb the inclined surface then v should be -



(1) $\geq \sqrt{\frac{10}{7}gh}$ (2) $\geq \sqrt{2gh}$

(3) 2gh (4) $\frac{10}{7}gh$

Q.28 A particle moves in a circular path with decreasing speed. Choose the correct statement.

(1) Angular momentum remains constant

(2) Acceleration ($\bar{a}$) is towards the centre

(3) Particle moves in a spiral path with decreasing radius

(4) The direction of angular momentum remains constant

Q.29 Two loops P and Q are made from a uniform wire. The radii of P and Q are r_1 and r_2 respectively, and their moments of inertia are I_1 and I_2 respectively. If $I_2 = 4I_1$, then $\frac{r_2}{r_1}$ equals –

(1) $4^{2/3}$ (2) $4^{1/3}$

(3) $4^{-2/3}$ (4) $4^{-1/3}$

Q.30 If the distance between H and Cl ions in HCl molecule is x, then its moment of inertia about an axis passing through the centre of mass and perpendicular to the bond length, is-

(1) $35x^2$ (2) $36x^2/35$

(3) $35x^2/36$ (4) $x^2/35$

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

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Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

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SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -4

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Gravitation, SHM, Properties of Matter, Fluid Mechanics

IMPORTANT INSTRUCTIONS

GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 The masses and the radii of earth and moon are respectively M_e, R_e and M_m, R_m. The distance between the centres is r. At what minimum velocity a particle of mass m be projected from the mid point of the distance between their centres so that it may escape into space ?

(1) $\sqrt{\frac{4G}{r}(M_e + M_m)}$

(2) $\frac{4G}{r}\sqrt{(M_e + M_m)}$

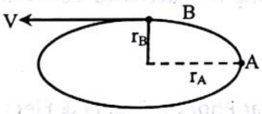
(3) $\sqrt{\frac{2G}{r}(M_e + M_m)}$

(4) $\frac{2G}{r}\sqrt{(M_e + M_m)}$

Q.2 The mass of a satellite is M/81 and radius is R/4 where M and R are the mass and radius of the planet. If zero gravitational field exist at a point between planet and satellite then the distance between the surfaces of planet and its satellite will be atleast greater than

(1) 1.25 R (2) 12.5 R
(3) 10.5 R (4) 5 R

Q.3 The orbital velocity of a satellite at point B with radius r_B is v. The radius of A is r_A. If the orbit is increased in radial distances so that r_A becomes $1.2r_A$, find the orbital velocity at $(1.2\ r_A)$



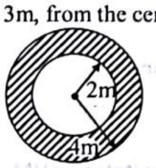
(1) $\frac{vr_B}{r_A\sqrt{1.2}}$ (2) $\frac{vr_A}{1.2r_B}$

(3) $\frac{vr_B}{1.2r_A}$ (4) $\frac{vr_A}{r_B\sqrt{1.2}}$

Q.4 Binary stars of comparable masses rotate under the influence of each other's gravity at a distance $2\left[\frac{G}{\omega^2}\right]^{1/3}$, where ω is the angular velocity of each of the star about centre of mass of the system. If difference between the masses of two stars is 6 units, find the ratio of the masses of smaller to bigger star -

(1) 4 : 10 (2) 1 : 7
(3) 2 : 8 (4) 3 : 9

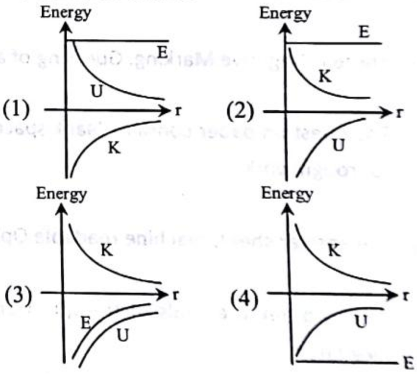
Q.5 Consider a uniform annular sphere of density ρ and internal radius 2m and external radius 4m. The gravitational field strength at a point at a distance r = 3m, from the centre of sphere is :



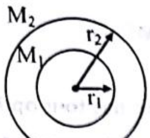
(1) $-\frac{32G\pi\rho}{9}$ (2) $-4G\pi$

(3) $-\frac{32}{27}G\pi\rho$ (4) $-\frac{76}{27}G\pi\rho$

Q.6 The correct graph representing the variation of total energy(E), kinetic energy(K) & potential energy (U) of a satellite with its distance from the centre of earth is -



Q.7 Two concentric shells of masses M_1 and M_2 are having radii r_1 and r_2. Which of the following is the correct expression for the gravitational field on a mass m ?



(1) $F = \frac{G(M_1 + M_2)}{r^2}$, for $r < r_1$

(2) $E = \frac{G(M_1 + M_2)}{r^2}$, for $r < r_2$

(3) $E = \frac{GM_2}{r^2}$, for $r_1 < r < r_2$

(4) $E = \frac{GM_1}{r^2}$, for $r_1 < r < r_2$

Q.8 Four particles of equal mass M along a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is :

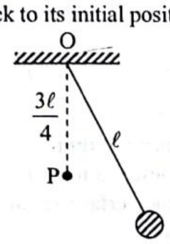
(1) $\frac{GM}{R}$

(2) $\sqrt{\left[2\sqrt{2}\frac{GM}{R}\right]}$

(3) $\sqrt{\left[\frac{GM}{R}(2\sqrt{2}+1)\right]}$

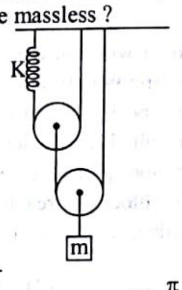
(4) $\sqrt{\left[\frac{GM}{R}\left(\frac{(2\sqrt{2}+1)}{4}\right)\right]}$

Q.9 A pendulum has time period T for small oscillations. An obstacle P is situated below the point of suspension O at a distance $\frac{3l}{4}$. The pendulum is released from rest. Through- out the motion the moving string makes small angle with vertical. Time after which the pendulum returns back to its initial position is-



(1) T (2) $\frac{3T}{4}$ (3) $\frac{3T}{5}$ (4) $\frac{4T}{5}$

Q.10 What is the period of small oscillations of the block of mass m if the springs are ideal and pulleys are massless ?



(1) $\frac{\pi}{2}\sqrt{\frac{m}{k}}$ (2) $\frac{\pi}{2}\sqrt{\frac{m}{2k}}$

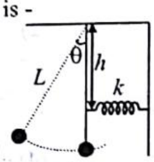
(3) $\frac{\pi}{2}\sqrt{\frac{2m}{k}}$ (4) $\pi\sqrt{\frac{m}{2k}}$

Q.11 A particle of mass m is located in a potential field given by $U(x) = U_0(1-\cos ax)$ where U_0 and a are constants and x is distance from origin. The period of small oscillations is-

(1) $2\pi\sqrt{\frac{U_0}{ma^2}}$ (2) $2\pi\sqrt{\frac{mU_0}{a^2}}$

(3) $2\pi\sqrt{\frac{a}{mU_0}}$ (4) $2\pi\sqrt{\frac{m}{U_0a^2}}$

Q.12 A pendulum of length L and bob of mass M has a spring of force constant K connected horizontally to it at a distance h below its point of suspension. The rod is in equilibrium in vertical position. The rod of length L used for vertical suspension is rigid and massless. The frequency of vibration of the system for small values of θ is -



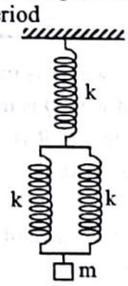
(1) $\frac{1}{2\pi L}\sqrt{gL+\frac{kh}{m}}$ (2) $\frac{1}{2\pi L}\sqrt{\frac{mgL+k}{m}}$

(3) $2\pi\sqrt{\frac{kL^2}{mgL+kh}}$ (4) $\frac{1}{2\pi L}\sqrt{gL+\frac{kh^2}{m}}$

Q.13 A particle is performing S.H.M. Its total energy is E. When the displacement of the particle is half of its amplitude, its K.E. will be

(1) E (2) 3 E/4 (3) E/2 (4) E/4

Q.14 A body of mass m = 2kg hangs from three springs, each of spring constant 1875 N/m, as shown in the figure. If the mass is slightly displaced and let go, the system will oscillate with time-period



(1) $\frac{\pi}{5}$ sec (2) $\frac{\pi}{25}$ sec

(3) $\frac{2\pi}{5}$ sec (4) $\frac{2\pi}{25}$ sec

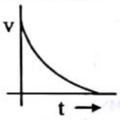
Q.15 The length of simple pendulum executing SHM is increased by 69%. The percentage increase in the time period of the pendulum is -

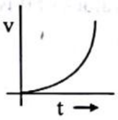
(1) 30% (2) 11%
(3) 21% (4) 42%

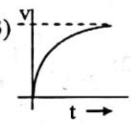
Q.16 If a spring has time period T, and is cut into n equal parts, then the time period of each part will be-

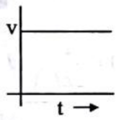
(1) $T\sqrt{n}$ (2) $T/\sqrt{n}$
(3) nT (4) T

Q.17 In viscosity experiment which one is the graph between, velocity of time for a ball falling in viscous fluid.

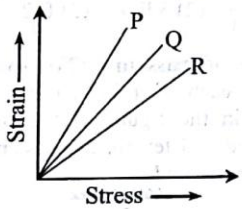
(1) 

(2) 

(3) 

(4) 

Q.18 The strain-stress curves of three wires of different materials are shown in the figure. P, Q and R are the elastic limits of the wires. The figure shows that :



(1) elasticity of wire P is maximum
(2) elasticity of wire Q is maximum
(3) tensile strength of R is maximum
(4) none of the above

Q.19 Two soap bubbles, each of radius r, coalesce in vacuum under isothermal conditions to form a bigger bubble of radius R. Then R is equal to

(1) $2^{-1/2}r$ (2) $2^{-1/3}r$
(3) $2^{1/2}r$ (4) 2r

Q.20 If the volume of a block of aluminium is decreased by 1%, the pressure (stress) on its surface is increased by (Bulk modulus of $Al = 7.5 \times 10^{10}\ Nm^{-2}$) -

(1) $7.5 \times 10^{10}\ Nm^{-2}$ (2) $7.5 \times 10^{8}\ Nm^{-2}$
(3) $7.5 \times 10^{6}\ Nm^{-2}$ (4) $7.5 \times 10^{4}\ Nm^{-2}$

Q.21 An air bubble of radius r in water is at a depth h below the water surface at some instant. If P is atmospheric pressure and d and T are the density and surface tension of water respectively, the pressure inside the bubble will be -

(1) $P + hdg - (4T/r)$ (2) $P + hdg + (2T/r)$
(3) $P + hdg - (2T/r)$ (4) $P + hdg + (4T/r)$

Q.22 The coefficient of apparent expansion of a liquid is C when heated in a copper vessel and it is S when heated in a silver vessel. If A is the coefficient of linear expansion of copper, then that of silver is :

(1) $\frac{C+S-3A}{3}$ (2) $\frac{C+3A-S}{3}$
(3) $\frac{S+3A-C}{3}$ (4) $\frac{C+S+3A}{3}$

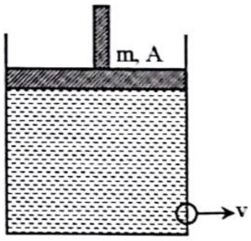
Q.23 Several spherical drops of a liquid each of radius r coalesce to form a single drop of radius R. If T is the surface tension, then the energy liberated will be -

(1) $4\pi R^3T\left(\frac{1}{r}-\frac{1}{R}\right)$ (2) $2\pi R^3T\left(\frac{1}{r}-\frac{1}{R}\right)$
(3) $\frac{4}{3}\pi r^2T\left(\frac{1}{r}-\frac{1}{R}\right)$ (4) $2\pi RT\left(\frac{1}{R}-\frac{1}{r}\right)$

Q.24 Two blocks of wood of masses m_1 and m_2 and each of specific gravity 0.5 are submerged at a depth of h_1 and h_2 in a vessel ($h_2 > h_1$) filled with water, which is accelerated upwards with an acceleration g/2. The difference in time taken by the blocks to reach the surface, when released with zero velocity is -

(1) zero (2) $2\sqrt{\frac{(h_2-h_1)}{2g}}$
(3) $\sqrt{\frac{(h_2-h_1)}{g}}$ (4) $2\sqrt{\frac{(h_2-h_1)}{3g}}$

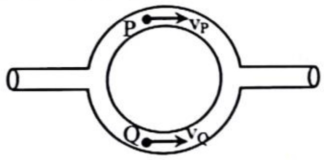
Q.25 A cylindrical vessel contains a liquid of density ρ up to height h. The liquid is closed by a piston of mass m and area of cross section A. There is a small hole at the bottom of the vessel. The speed v with which the liquid comes out of the hole is



(1) $\sqrt{2gh}$ (2) $\sqrt{2\left(gh+\frac{mg}{\rho A}\right)}$

(3) $\sqrt{2\left(gh+\frac{mg}{A}\right)}$ (4) $\sqrt{2gh+\frac{mg}{A}}$

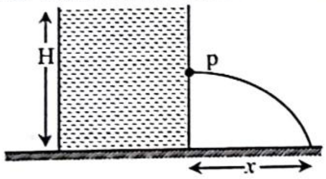
Q.26 Figure shows a liquid flowing through a tube at the rate of 0.1 m^3/s. The tube is branched into two semicircular tubes of cross sectional area A/3 and 2A/3. The velocity of liquid at Q is (the cross section of the main tube is $A = 10^{-2} m^2$ and $v_P = 20$ m/s)



(1) 5 m/s (2) 30 m/s
(3) 35 m/s (4) None of these

Q27 Water rises to a height *h* in a capillary tube of cross sectional area A, the height to which water will rise in a capillary tube of cross-sectional area 4A will be-
(1) h (2) h/2
(3) h/4 (4) 4h

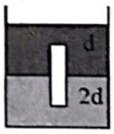
Q.28 A tank is filled with water upto a height H. Water is allowed to come out of a hole P in one of the walls at some depth below the surface of water. Then maximum horizontal distance x is :



(1) $\frac{H}{2}$ (2) $\frac{\sqrt{3}H}{2}$
(3) H (4) None of these

Q.29 The total weight of a piece of wood is 6 kg. In the floating state in water its 1/3 part remains inside the water. On this floating solid, what maximum weight is to be put such that the whole of the piece of wood is to be drowned in the water -
(1) 12 kg (2) 10 kg
(3) 14 kg (4) 15 kg

Q.30 A homogeneous solid cylinder of length L (L < H/2), cross-sectional area A/5 is immersed such that it floats with its axis vertical at the liquid-liquid interface with length L/4 in the denser liquid as shown in the figure. The lower density liquid is open to atmosphere having P_0. Then density D of solid is given by -



(1) $\frac{5}{4}d$ (2) $\frac{4}{5}d$
(3) $4d$ (4) $\frac{d}{5}$

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Test Date D D M M Y Y Y Y

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

1	① ② ③ ④		31	① ② ③ ④		61	① ② ③ ④
2	① ② ③ ④		32	① ② ③ ④		62	① ② ③ ④
3	① ② ③ ④		33	① ② ③ ④		63	① ② ③ ④
4	① ② ③ ④		34	① ② ③ ④		64	① ② ③ ④
5	① ② ③ ④		35	① ② ③ ④		65	① ② ③ ④
6	① ② ③ ④		36	① ② ③ ④		66	① ② ③ ④
7	① ② ③ ④		37	① ② ③ ④		67	① ② ③ ④
8	① ② ③ ④		38	① ② ③ ④		68	① ② ③ ④
9	① ② ③ ④		39	① ② ③ ④		69	① ② ③ ④
10	① ② ③ ④		40	① ② ③ ④		70	① ② ③ ④
11	① ② ③ ④		41	① ② ③ ④		71	① ② ③ ④
12	① ② ③ ④		42	① ② ③ ④		72	① ② ③ ④
13	① ② ③ ④		43	① ② ③ ④		73	① ② ③ ④
14	① ② ③ ④		44	① ② ③ ④		74	① ② ③ ④
15	① ② ③ ④		45	① ② ③ ④		75	① ② ③ ④
16	① ② ③ ④		46	① ② ③ ④		76	① ② ③ ④
17	① ② ③ ④		47	① ② ③ ④		77	① ② ③ ④
18	① ② ③ ④		48	① ② ③ ④		78	① ② ③ ④
19	① ② ③ ④		49	① ② ③ ④		79	① ② ③ ④
20	① ② ③ ④		50	① ② ③ ④		80	① ② ③ ④
21	① ② ③ ④		51	① ② ③ ④		81	① ② ③ ④
22	① ② ③ ④		52	① ② ③ ④		82	① ② ③ ④
23	① ② ③ ④		53	① ② ③ ④		83	① ② ③ ④
24	① ② ③ ④		54	① ② ③ ④		84	① ② ③ ④
25	① ② ③ ④		55	① ② ③ ④		85	① ② ③ ④
26	① ② ③ ④		56	① ② ③ ④		86	① ② ③ ④
27	① ② ③ ④		57	① ② ③ ④		87	① ② ③ ④
28	① ② ③ ④		58	① ② ③ ④		88	① ② ③ ④
29	① ② ③ ④		59	① ② ③ ④		89	① ② ③ ④
30	① ② ③ ④		60	① ② ③ ④		90	① ② ③ ④

SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -5

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Transverse Wave, Sound Wave, Doppler Effect, KTG, Thermodynamics, Calorimetry, Heat Transfer, Thermal Expansion

IMPORTANT INSTRUCTIONS

GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 Two tuning forks when sounded together, produce 3 beats/s. One of the fork is in unison with 27 cm length of sonometer wire and the other with 28 cm length of the same wire. The frequencies of the two tuning forks are -

(1) 87, 84 Hz (2) 42, 39 Hz
(3) 81, 78 Hz (4) 84, 81Hz

Q.2 A source of frequency 10 kHz when vibrated over the mouth of a closed organ pipe is in unison at 300 K. The beats produced when temperature rises by 1 K is -

(1) 30 Hz (2) 13.33 Hz
(3) 16.67 Hz (4) 40 Hz

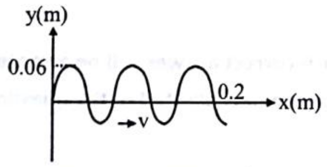
Q.3 The ratio of velocity of sound in hydrogen gas to that in helium gas at the same temperature -

(1) $\sqrt{\frac{21}{5}}$ (2) $\sqrt{\frac{42}{25}}$
(3) $\sqrt{\frac{42}{15}}$ (4) $\sqrt{\frac{42}{23}}$

Q.4 A transverse wave is described by the equation $Y = Y_0 \sin 2\pi(f\,t - x/\lambda)$. The maximum particle velocity is equal to four times the wave velocity if-

(1) $\lambda = \pi Y_0/4$ (2) $\lambda = \pi Y_0/2$
(3) $\lambda = \pi Y_0$ (4) $\lambda = 2\pi Y_0$

Q.5 For the wave shown in figure, write the equation of this wave if its position is shown at t = 0. Speed of wave is v = 300 m/s.



(1) $y = (0.06\text{ m})\sin[(78.5\text{ m}^{-1})x + (23562\text{ s}^{-1})t]$ m
(2) $y = (0.06\text{ m})\sin[(78.5\text{ m}^{-1})x - (23562\text{ s}^{-1})t]$ m
(3) $y = (0.06\text{ m})\sin[(78.5\text{ m}^{-1})x + (23562\text{ s}^{-1})t]$ m
(4) $y = (0.86\text{ m})\sin[(70.5\text{ m}^{-1})x - (28562\text{ s}^{-1})t]$ m

Q.6 In an experiment for the determination of the speed of sound in air using the resonance column method, length of air-column that resonates in the fundamental mode, with a tuning fork is 0.1 m. When this length is changed to 0.35 m, the same tuning fork resonates with the first overtone. The end correction is-

(1) 0.05 m (2) 0.012 m
(3) 0.018 m (4) 0.025 m

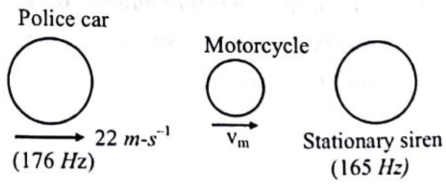
Q.7 When a source of sound of frequency f crosses a stationary observer with a speed v_s (<< speed of sound v), the apparent change in frequency Δf is given by -

(1) $\frac{2fv_s}{v}$ (2) $2fvv_s$
(3) $\frac{2fv}{v_s}$ (4) $\frac{fv_s}{v}$

Q.8 The frequency of a radar is 780 MHz. The frequency of the reflected wave from an aeroplane is increased by 2.6 kHz. The velocity of aeroplane is -

(1) 0.25 km/sec (2) 0.5 km/sec
(3) 1 km/sec (4) 2 km/sec

Q.9 A police car moving at 22 $m\text{-}s^{-1}$, chases a motorcyclist. The police man sounds his horn at 176 *Hz*, while both of them move towards a stationary siren of frequency 165 *Hz*. The speed of the motorcycle, if he does not observe any beat, is



(1) 11 $m\text{-}s^{-1}$ (2) 22 $m\text{-}s^{-1}$
(3) 33 $m\text{-}s^{-1}$ (4) 44 $m\text{-}s^{-1}$

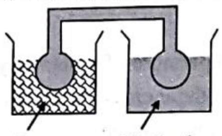
Q.10 A body of mass 25 kg is dragged on a rough horizontal floor for one hour with a speed of 2 kmh^{-1}. The coefficient of friction for the surface in contact is 0.5 and half the heat produced is absorbed by the body. If specific heat of body is 0.1 cal g^{-1} ($°C^{-1}$) and g = 9.8 ms^{-2}, then the rise in temperature of body is:
(1) 39 K (2) 59.5 K
(3) 84.5 K (4) 11.6 K

Q.11 The Fahrenheit and Kelvin scales of temperature will give the same reading at -
(1) –40 (2) 313
(3) 574.25 (4) 732.75

Q.12 If 70 cals of heat is required to raise the temperature of 2 moles of an ideal gas at constant pressure from 30°C to 35°C, then the amount of heat required to raise the temperature of same gas through same range at constant volume is
(1) 50 cals (2) 70 cals
(3) 60 cals (4) 65 cals

Q.13 2 kg of ice at –20° C is mixed with 5 kg of water at 20°C in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water and ice are 1 kcal/kg-°C and 0.5 kcal/kg-°C. While the latent heat of fusion of ice = 80 kcal/kg
(1) 7 kg (2) 6 kg
(3) 4 kg (4) 2 kg

Q.14 Two identical glass bulbs are interconnected by a thin glass tube. A gas is filled in these bulbs at N.T.P. If one bulb is placed in ice and another bulb is placed in hot bath, then the pressure of the gas becomes 1.5 times. The temperature of hot bath will be



Ice Hot bath
(1) 100°C (2) 182°C
(3) 256°C (4) 546°C

Q.15 Work done by a system under isothermal change from a volume V_1 to V_2 for a gas which obeys Vander Waal's equation

$$(V-\beta n)\left(P+\frac{\alpha n^2}{V}\right)=nRT$$

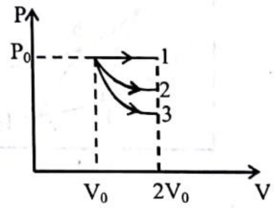
(1) $nRT\log_e\left(\frac{V_2-n\beta}{V_1-n\beta}\right)+\alpha n^2\left(\frac{V_1-V_2}{V_1V_2}\right)$
(2) $nRT\log_{10}\left(\frac{V_2-\alpha\beta}{V_1-\alpha\beta}\right)+\alpha n^2\left(\frac{V_1-V_2}{V_1V_2}\right)$
(3) $nRT\log_e\left(\frac{V_2-n\alpha}{V_1-n\alpha}\right)+\beta n^2\left(\frac{V_1-V_2}{V_1V_2}\right)$
(4) $nRT\log_e\left(\frac{V_1-n\beta}{V_2-n\beta}\right)+\alpha n^2\left(\frac{V_1V_2}{V_1-V_2}\right)$

Q.16 If one mole of monoatomic gas (γ = 5/3) is mixed with one mole of a diatomic gas (γ = 7/5), the value of γ for the mixture is -
(1) 1.40 (2) 1.50
(3) 1.53 (4) 3.07

Q.17 For a gas at a temperature T the root mean square velocity V_{rms} and the most probable speed V_{mp}, and the average speed V_{av} obey the relationship -
(1) $V_{av}>V_{rms}>V_{mp}$ (2) $V_{rms}>V_{av}>V_{mp}$
(3) $V_{mp}>V_{av}>V_{rms}$ (4) $V_{mp}>V_{rms}>V_{av}$

Q.18 At constant temperature on increasing the pressure of a gas by 5% will decrease its volume by -
(1) 5% (2) 5.26%
(3) 4.26% (4) 4.76%

Q.19 A gas is expanded from volume V_0 to $2V_0$ under three different processes. Process 1 is isobaric process 2 is isothermal and process 3 is adiabatic. Let ΔU_1, ΔU_2 and ΔU_3 be the change in internal energy of the gas in these three processes. Then –



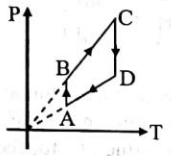
(1) $\Delta U_1>\Delta U_2>\Delta U_3$ (2) $\Delta U_1<\Delta U_2<\Delta U_3$
(3) $\Delta U_2<\Delta U_1<\Delta U_3$ (4) $\Delta U_2<\Delta U_3<\Delta U_1$

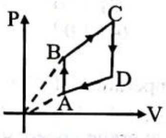
Q.20 A gas is expanded to double its volume by two different processes. One is isobaric and the other is isothermal. Let W_1 and W_2 be the respective work done, then -

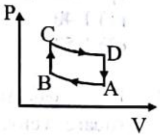
(1) $W_2 = W_1 \ell n(2)$ (2) $W_2 = \dfrac{W_1}{\ell n(2)}$

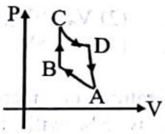
(3) $W_2 = \dfrac{W_1}{2}$ (4) data is insufficient

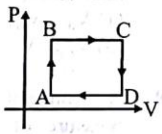
Q.21 Pressure versus temperature graph of an ideal gas is as shown in figure corresponding pressure (P) versus volume (V) graph will be



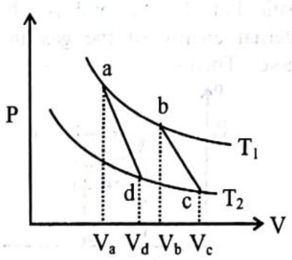
(1) 

(2) 

(3) 

(4) 

Q.22 Two different adiabatic paths for the same gas intersects two isothermals at T_1 and T_2 as shown in the P-V diagram. Then $\dfrac{V_a}{V_d}$ is equal to-



(1) $\dfrac{V_c}{V_b}$ (2) $V_C V_b$

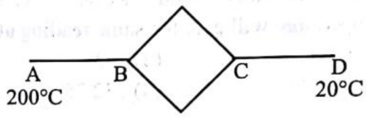
(3) $\dfrac{V_b}{V_c}$ (4) $\dfrac{V_c V_b}{V_c + V_b}$

Q.23 An ideal heat engine has an efficiency η. The coefficient of performance of the engine when driven backward will be.

(1) $1-(1/\eta)$ (2) $\eta/(1-\eta)$

(3) $(1/\eta)-1$ (4) $1/(1-\eta)$

Q.24 Six identical conducting rods are joined as shown in figure. Points A and D are maintained at temperatures 200°C and 20° C respectively. The temperature of junction B will be -

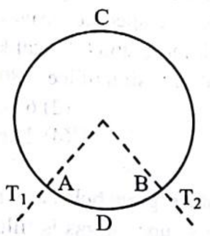


(1) 120°C (2) 100°C

(3) 140°C (4) 80° C

Q.25 A ring consisting of two parts ADB and ACB of same thermal conductivity K carries an amount of heat H. The ADB part is now replaced with another metal keeping the temperatures T_1 and T_2 constant. The heat carried increases to 2H. What should be the conductivity of the new ADB part ?

(Given $\dfrac{ACB}{ADB} = 3$)



(1) $\dfrac{7}{3}K$ (2) 2 K

(3) $\dfrac{5}{2}K$ (4) 3 K

Q.26 If the temperature of a hot body is increased by 50% then the increase in the quantity of emitted heat radiation will be -

(1) 125% (2) 200%

(3) 300% (4) 400%

Q.27 A body cools from 60°C to 50°C in 10 minutes when kept in air at 30°C. In the next 10 minutes its temperature will be -

(1) Below 40°C (2) 40 °C

(3) Above 40°C (4) Cannot be predicted

Q.28 A pendulum clock is 5 sec. slow at a temperature 30°C and 10 sec. fast at a temperature of 15°C. At what temperature does it give the correct time -

(1) 18°C (2) 20°C

(3) 25°C (4) None of these

Q.29 Driver of a truck gets his steel petrol tank filled with 75 L of petrol at 10°C. If a α_{steel} is $12 \times 10^{-6}/\ °C$ and γ_{pet} is $9.5 \times 10^{-4}/°C$ the overflow of petrol at 30°C is -

(1) 7.31 L (2) 1.37 L

(3) 13.7 L (4) 1.73 L

Q.30 The coefficient of linear expansion of crystal in one direction is α_1 and that in every direction perpendicular to it is α_2. The coefficient of cubical expansion is -

(1) $\alpha_1 + \alpha_2$ (2) $2\alpha_1 + \alpha_2$

(3) $\alpha_1 + 2\alpha_2$ (4) None of these

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

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4	4	4	4	4	4
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6	6	6	6	6	6
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Test Date | D | D | M | M | Y | Y | Y | Y |

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

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SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Revision Test -1

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Units 1 to 5

IMPORTANT INSTRUCTIONS

GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 If $\vec{P} + \vec{Q} = \vec{R}$ & $\vec{R}$ is perpendicular to $\vec{P}$, define angle between $\vec{P}$ & $\vec{Q}$ if $|\vec{P}| = |\vec{R}|$ -

(1) $\frac{3\pi}{4}$ (2) $\frac{\pi}{4}$ (3) π (4) $\frac{\pi}{2}$

Q.2 Let nth division of main scale coincides with $(n + 1)^{th}$ division of vernier scale. $1MSD = L$ units. Vernier Constant is -

(1) $\frac{L}{(n+1)} unit$ (2) $(n+1)L\,unit$

(3) $\left(\frac{L}{n-1}\right) unit$ (4) $\left(\frac{nL}{n+1}\right) unit$

Q.3 In the formula, $a = 3bc^2$, a and c have dimensions of electric capacitance and magnetic induction respectively. What are dimensions of b in *MKS* system ?

(1) $[M^{-3}L^{-2}T^4Q^4]$ (2) $[M^{-3}T^4Q^4]$

(3) $[M^{-3}T^3Q]$ (4) $[M^{-3}L^2T^4Q^{-4}]$

Q.4 Four marbles are dropped from the top of a tower one after the other with an interval of one second. The first one reaches the ground after 4 seconds. When the first one reaches the ground the distances between the first and second, and the third and fourth will be respectively -

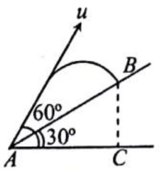
(1) 35, 25 and 15 m (2) 30, 20 and 10 mS

(3) 20, 10 and 5 m (4) 40, 30 and 20 m

Q.5 A bullet losses 1/20 of its velocity after penetrating a plank. How many planks are required to stop the bullet ?

(1) 6 (2) 9 (3) 11 (4) 13

Q.6 In figure the time taken by the projectile to reach from *A* to *B* is *t*. Then the distance *AB* is equal to-



(1) $\frac{ut}{\sqrt{3}}$ (2) $\frac{\sqrt{3}ut}{2}$ (3) $\sqrt{3}\ ut$ (4) $2ut$

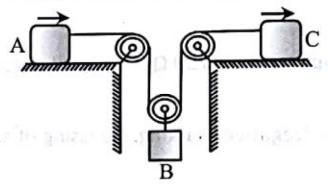
Q.7 A chain consisting of 5 links each of mass 0.1 kg is lifted vertically with a constant acceleration of 2.5 m/s^2. The force of interaction between the top link and the link immediately below it, will be –

($g = 9.8$ m/s^2)

(1) 6.15 N (2) 4.92 N

(3) 3.69 N (4) 2046 N

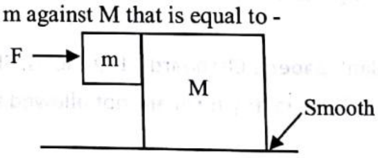
Q.8 Blocks A and C start from rest and move to the right with acceleration $a_A = 12t$ m/s^2 and $a_C = 3$ m/s^2. Here t is in seconds. The time when block B acceleration is zero.



(1) 2s (2) 1s

(3) 3/2s (4) 1/4 s

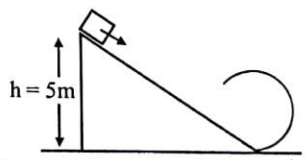
Q.9 The two blocks, m = 10 kg and M = 50 kg are free to move as shown. The coefficient of static friction between the blocks is 0.5 and there is no friction between M and the ground. A minimum horizontal force F is applied to hold m against M that is equal to -



(1) 100 N (2) 50 N

(3) 240 N (4) 180 N

Q.10 In given figure to complete the circular loop what should be the radius if initial height is 5 m.



(1) 4m (2) 3m

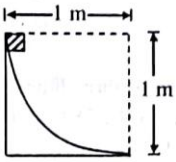
(3) 2.5m (4) 2m

Q.11 A car (treat it as particle) of mass 'm' is accelerating on a level smooth road under the action of single force F. The power delivered to the car is constant and equal to P. If the velocity of the car at an instant is v, then after travelling how much distance it becomes double ?

(1) $\frac{7mv^3}{3P}$ (2) $\frac{4mv^3}{3P}$

(3) $\frac{mv^3}{P}$ (4) $\frac{18mv^3}{7P}$

Q.12 A body of mass 2kg slides down a curved track which is quadrant of a circle of radius 1 m. All the surfaces are frictionless. If the body starts from rest, its speed at the bottom of the track is -



(1) 4.43 m s^{-1} (2) 2 ms^{-1}

(3) 0.5 m s^{-1} (4) 19.6 m s^{-1}

Q.13 A uniform chain of length L and mass M overhangs a horizontal table with its two third part on the table. The friction coefficient between the table and the chain is μ. The work done by the friction during the period the chain slips off the table is -

(1) $-\frac{1}{4}\mu MgL$ (2) $-\frac{2}{9}\mu MgL$

(3) $-\frac{4}{9}\mu MgL$ (4) $-\frac{6}{7}\mu MgL$

Q.14 A moving body with a mass m_1 strikes a stationary body of mass m_2. The masses m_1 and m_2 should be in the ratio m_1/m_2 so as to decrease the velocity of the first body 1.5 times assuming a perfectly elastic impact. Then the ratio m_1/m_2 is

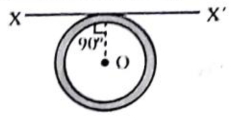
(1) 5 (2) 1/5 (3) 1/25 (4) 25

Q.15 Consider a system of two particles having masses m_1 and m_2. If the particle of mass m_1 is pushed towards the mass centre of particles through a distance d, by what distance would the particle of mass m_2 move so as to keep the mass centre of particles at the original position?

(1) $\frac{m_1 d}{m_2}$ (2) d

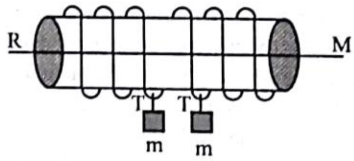
(3) $\frac{m_2 d}{m_1}$ (4) $\frac{m_1}{m_1+m_2}d$

Q.16 A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX′ is



(1) $\frac{\rho L^3}{8\pi^2}$ (2) $\frac{\rho L^3}{16\pi^2}$ (3) $\frac{5\rho L^3}{16\pi^2}$ (4) $\frac{3\rho L^3}{8\pi^2}$

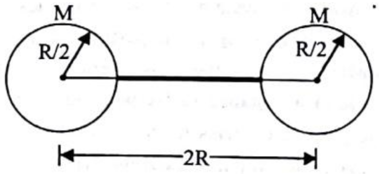
Q.17 In the arrangement shown in figure two equal masses (each m) hung from light cords wrapped around a uniform solid cylinder of mass M and radius R. The cylinder is free to roate about a horizontal axis. If the system is released from rest then, the tension in each cord is -



(1) $\frac{Mmg}{4m+M}$ (2) $\frac{Mmg}{m+M}$

(3) $\frac{Mmg}{M+3m}$ (4) $\frac{Mmg}{(2m+M)}$

Q.18 Two sphere each of mass M and radius $\frac{R}{2}$ are connected with a massless rod of length 2R as shown in the figure. What will be the moment of inertia of the system about an axis passing through the centre of one of the spheres and perpendicular to the rod :



(1) $\frac{21}{5}MR^2$ (2) $\frac{2}{5}MR^2$

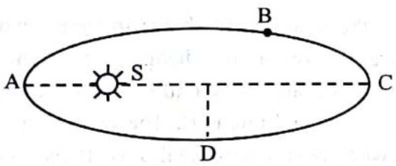
(3) $\frac{5}{2}MR^2$ (4) $\frac{5}{21}MR^2$

Q.19 A tunnel is dug along a diameter of the planet. A particle is dropped into it at the surface. The particle reaches the centre of the planet with speed v. If v_e is the escape velocity from the surface of the planet, then -

(1) $\sqrt{2}\,v = v_e$ (2) $v = v_e$

(3) $v_e = \sqrt{3}v$ (4) $v_e = \sqrt{5}v$

Q.20 A planet revolves in elliptical orbit around the sun. The linear speed of the planet will be maximum at :



(1) A (2) B (3) C (4) D

Q.21 A particle at the end of a spring executes simple harmonic motion with a period t_1, while the corresponding period for another spring is t_2. If the period of oscillation with the two springs in series is T, then -

(1) $T = t_1 + t_2$ (2) $T^2 = t_1^2 + t_2^2$

(3) $T^{-1} = t_1^{-1} + t_2^{-1}$ (4) $T^{-2} = t_1^{-2} + t_2^{-2}$

Q.22 The metallic bob of a simple pendulum has the relative density ρ. The time period of this pendulum is T. If the metallic bob is immersed in water, then the new time period is given by

(1) $T\frac{\rho-1}{\rho}$ (2) $T\frac{\rho}{\rho-1}$

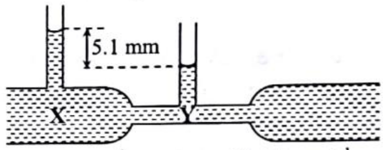
(3) $T\sqrt{\frac{\rho-1}{\rho}}$ (4) $T\sqrt{\frac{\rho}{\rho-1}}$

Q.23 A block of mass M is suspended from a wire of length L, area of cross-section A and Young's modulus Y. The elastic potential energy stored in the wire is :

(1) $\frac{1}{2}\frac{M^2g^2L}{AY}$ (2) $\frac{1}{2}\frac{Mg}{ALY}$

(3) $\frac{1}{2}\frac{M^2g^2A}{YL}$ (4) $\frac{1}{2}\frac{MgY}{AL}$

Q.24 The diagram shows a venturimeter through which water is flowing. The speed of water at X is 2 cm s^{-1}. The speed of water at Y is : (taking g = 1000 cm s^{-2})



(1) 23 cm s^{-1} (2) 32 cm s^{-1}

(3) 101 cm s^{-1} (4) 1024 cm s^{-1}

Q.25 Equal masses of three liquids A, B and C have temperatures 10°C, 25°C and 40°C respectively. If A and B are mixed, the mixture has a temperature of 15°C. If B and C are mixed, the mixture has a temperature of 30°C. If A and C are mixed, the mixture will have a temperature of

(1) 16°C (2) 20°C

(3) 25°C (4) 29°C

Q.26 The density of carbon dioxide gas at 0°C and at a pressure of 1×10^5 N/m^2 is 1.98 kg/m^3. Find the root mean square velocity of its molecules at 50°C, pressure is constant -

(1) 423 m/s (2) 300 m/s

(3) 100 m/s (4) 500 m/s

Q.27 Find the amount of work done to increase the temperature of one mole of ideal gas by 30°C, if it is expanding under the condition $V \propto T^{2/3}$ ($R = 8.31$ J /*mol-k*)

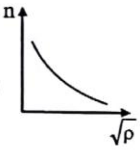
(1) 16.62 *J* (2) 166.2 *J*

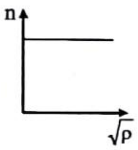
(3) 1662 *J* (4) 1.662 *J*

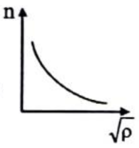
Q.28 One end of a copper rod of length 1m and area of cross section $10^{-3}m^2$ is immersed in boiling water and the other and in ice. If the coefficient of thermal conductivity of copper is 92 cal/m-s °C and the latent heat of ice is 8×10^4 cal/kg, then the amount of ice which will melt in one minute is -

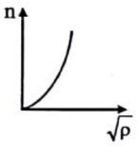
(1) 9.2×10^{-3} kg (2) 8×10^{-3} kg
(3) 6.9×10^{-3} kg (4) 5.4×10^{-3} kg

Q.29 The correct graph between the frequency n and square root of density (ρ) of a wire, keeping its length, radius and tension constant, is

(1) 

(2) 

(3) 

(4) 

Q.30 A siren placed at a railway platform is emitting sound of frequency 5 kHz. A passenger sitting in a moving train A records a frequency of 5.5 kHz, while the train approaches the siren. During his return journey in a different train B he records a frequency of 6.5 kHz while approaching the same siren. The ratio of the velocity of train B to that train A is-

(1) 242/252 (2) 2
(3) 3 (4) 11/6

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Test Date D D M M Y Y Y Y

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

Q					Q					Q				
1	①	②	③	④	31	①	②	③	④	61	①	②	③	④
2	①	②	③	④	32	①	②	③	④	62	①	②	③	④
3	①	②	③	④	33	①	②	③	④	63	①	②	③	④
4	①	②	③	④	34	①	②	③	④	64	①	②	③	④
5	①	②	③	④	35	①	②	③	④	65	①	②	③	④
6	①	②	③	④	36	①	②	③	④	66	①	②	③	④
7	①	②	③	④	37	①	②	③	④	67	①	②	③	④
8	①	②	③	④	38	①	②	③	④	68	①	②	③	④
9	①	②	③	④	39	①	②	③	④	69	①	②	③	④
10	①	②	③	④	40	①	②	③	④	70	①	②	③	④
11	①	②	③	④	41	①	②	③	④	71	①	②	③	④
12	①	②	③	④	42	①	②	③	④	72	①	②	③	④
13	①	②	③	④	43	①	②	③	④	73	①	②	③	④
14	①	②	③	④	44	①	②	③	④	74	①	②	③	④
15	①	②	③	④	45	①	②	③	④	75	①	②	③	④
16	①	②	③	④	46	①	②	③	④	76	①	②	③	④
17	①	②	③	④	47	①	②	③	④	77	①	②	③	④
18	①	②	③	④	48	①	②	③	④	78	①	②	③	④
19	①	②	③	④	49	①	②	③	④	79	①	②	③	④
20	①	②	③	④	50	①	②	③	④	80	①	②	③	④
21	①	②	③	④	51	①	②	③	④	81	①	②	③	④
22	①	②	③	④	52	①	②	③	④	82	①	②	③	④
23	①	②	③	④	53	①	②	③	④	83	①	②	③	④
24	①	②	③	④	54	①	②	③	④	84	①	②	③	④
25	①	②	③	④	55	①	②	③	④	85	①	②	③	④
26	①	②	③	④	56	①	②	③	④	86	①	②	③	④
27	①	②	③	④	57	①	②	③	④	87	①	②	③	④
28	①	②	③	④	58	①	②	③	④	88	①	②	③	④
29	①	②	③	④	59	①	②	③	④	89	①	②	③	④
30	①	②	③	④	60	①	②	③	④	90	①	②	③	④

SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -6

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Electrostatics, Gauss Law

IMPORTANT INSTRUCTIONS

GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

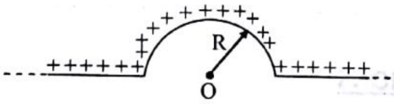
MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 If a charge q is placed at the centre of the line joining two equal like charges Q, the system of three will be in equilibrium if q is :

(1) $-\frac{Q}{2}$ (2) $-\frac{Q}{4}$ (3) $-4Q$ (4) $+\frac{Q}{2}$

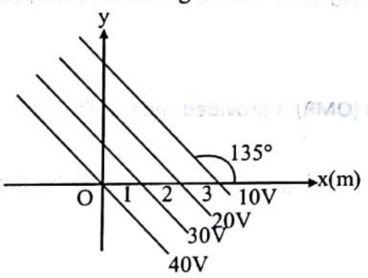
Q.2 The electric field intensity due to a thin infinity long straight wire of uniform linear charge density λ at O is –



(1) $\frac{\lambda}{2\pi\varepsilon_0 R}$ (2) $\frac{\lambda\sqrt{2}}{2\pi\varepsilon_0 R}$

(3) $\frac{\lambda\sqrt{5}}{2\pi\varepsilon_0 R}$ (4) zero

Q.3 Figure shows a set of equipotential surfaces. The magnitude and direction of electric field that exists in the region is –



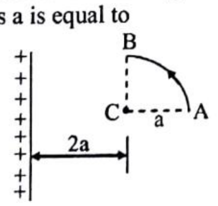
(1) $10\sqrt{2}$ V/m at 45° with x-axis

(2) $10\sqrt{2}$ V/m at 135° with x-axis

(3) $5\sqrt{2}$ V/m at 45° with x-axis

(4) $5\sqrt{2}$ V/m at 135° with x-axis

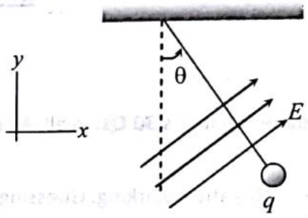
Q.4 The arc AB with the centre C and the infinitely long wire having linear charge density λ are lying in the same plane. The minimum amount of work to be done to move a point charge q_0 from point A to B through a circular path AB of radius a is equal to



(1) $\frac{q_0^2}{2\pi\varepsilon_0}\log\left(\frac{2}{3}\right)$ (2) $\frac{q_0\lambda}{2\pi\varepsilon_0}\log\left(\frac{3}{2}\right)$

(3) $\frac{q_0\lambda}{2\pi\varepsilon_0}\log\left(\frac{2}{3}\right)$ (4) $q_0\lambda/\sqrt{2}\,\pi\varepsilon_0$

Q.5 A charged cork ball of mass m is suspended on a light string in the presence of a uniform electric field as shown in figure. When $E = (A\hat{i} + B\hat{j})\,NC^{-1}$, where A and B are positive numbers, the ball is in equilibrium at the angle θ. Find the charge on the ball -



(1) $q = \frac{mg}{A + B\tan\theta}$ (2) $q = \frac{mg\tan\theta}{A+B}$

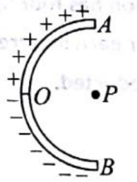
(3) $q = \frac{mg\tan\theta}{A + B\tan\theta}$ (4) $q = \frac{Amg}{A+B}$

Q.6 An electric field is expressed as $E = 2\hat{i} + 3\hat{j}$. Find the potential difference $(V_A - V_B)$ between two points A and B whose position vectors are given by $r_A = \hat{i} + 2\hat{j}$ and $r_B = 2\hat{i} + \hat{j} + 3\hat{k}$ -

(1) $-1V$ (2) $1V$

(3) $2V$ (4) $3V$

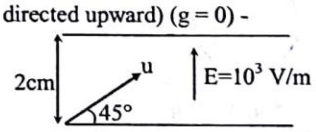
Q.7 A thin glass rod is bent into a semicircle of radius r. A charge +Q is uniformly distributed along the upper half and a charge –Q is uniformly distributed along the lower half, as shown in figure. Calculate electric field E at P, the center of semicircle –



(1) $\frac{Q}{\pi^2\varepsilon_0 r^2}$ (2) $\frac{2Q}{\pi^2\varepsilon_0 r^2}$

(3) $\frac{4Q}{\pi^2\varepsilon_0 r^2}$ (4) $\frac{Q}{4\pi^2\varepsilon_0 r^2}$

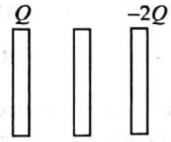
Q.8 A particle having charge that of an electron and mass 1.6×10^{-30} kg is projected with an initial speed u at an angle 45° to the horizontal from the lower plate of a parallel plate capacitor as shown in figure. The plates are sufficiently long and have separation 2 cm. The maximum value of velocity of particle for it not to hit the upper plate. (Electric field between plates = 10^3V/m directed upward) (g = 0) -



(1) 2×10^6 m/s (2) $2\sqrt{2} \times 10^6$ m/s

(3) $\sqrt{2} \times 10^6$ m/s (4) $\frac{1}{\sqrt{2}} \times 10^6$ m/s

Q.9 Three identical metal plates with large surface areas are kept parallel to each other as shown. The left most is given a charge Q, the right most part a charge $-2Q$ and the middle one remains neutral. Then which is wrong –



(1) The charge appearing on outer surface of right most plate is $-\frac{Q}{2}$

(2) The charge appearing on outer surface of left most plate is $-\frac{Q}{2}$

(3) The charge appearing on left surface of middle plate is $-\frac{3Q}{2}$

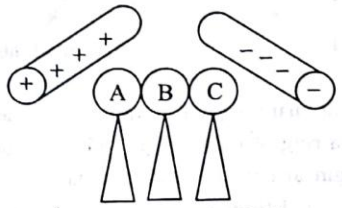
(4) The charge appearing on right surface of middle plate is $\frac{3Q}{4}$

Q.10 Three concentric spherical shells have radii a, b and c (a < b < c) and have surface charge densities σ, $-\sigma$ and σ respectively. If V_A, V_B and V_C denote the potentials of the three shells, then, for $V_A = V_C$, we get -

(1) $c = \frac{a+b}{2}$ (2) $c = b - a$

(3) $c = 2(a + b)$ (4) $c = a + b$

Q.11 Three metal spheres A, B and C are mounted on insulating stands. The spheres are touching one another, as shown in the diagram. A strong positively charged object is brought near sphere A and a strong negative charge is brought near sphere C. While the charged objects remain near spheres A and C, sphere B is removed by means of its insulating stand. After the charged objects are removed, sphere B is first touched to sphere A and then to sphere C. The resulting charge on B would be -



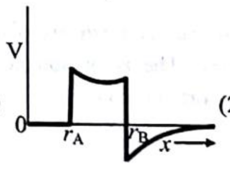
(1) the same sign but 1/2 the magnitude as originally on sphere A.

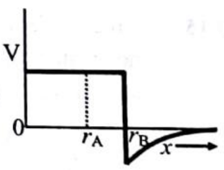
(2) the opposite sign but 1/2 the magnitude as originally on sphere A.

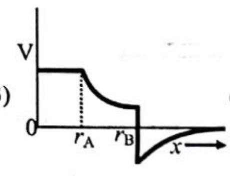
(3) the opposite sign but 1/4 the magnitude as originally on sphere A.

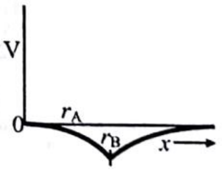
(4) the same sign but 1/2 the magnitude as originally on sphere C

Q.12 Two concentric conducting thin spherical shells A, and B having radii r_A and r_B ($r_B > r_A$) are charged to Q_A and $-Q_B$ ($|Q_B| > |Q_A|$). The electric potential along a line, (passing through the centre) is

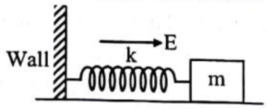
(1)


(2)


(3)


(4)


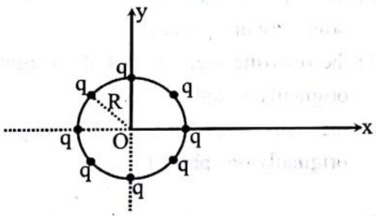
Q.13 A point mass m and charge q is connected with massless spring of natural length L. Initially spring is in its natural length. If a horizontal uniform electric field E is switched on as shown in figure, then the maximum separation between the point mass and the wall is : (Assume all surfaces are frictionless)



(1) $L + \frac{2qE}{K}$ (2) $L + \frac{qE}{K}$

(3) L (4) None of these

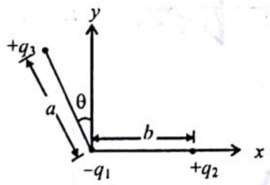
Q.14 Eight charges each of value q each are placed on a ring of radius R placed in x-y plane with origin at centre. –q charge having mass m is projected from z = ∞ towards the centre of the ring with velocity v. The velocity of –q when it reaches the centre of ring is (neglect gravity) -



(1) $\sqrt{\frac{8kq^2}{mR}}$ (2) $\sqrt{\frac{8kq^2}{mR}+v}$

(3) $\sqrt{\frac{16kq^2}{mR}+v^2}$ (4) $\sqrt{\frac{16kq^2}{mR}+v}$

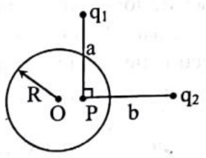
Q.15 Three charges $-q_1$, $+q_2$ and $+q_3$ are placed as shown in the figure. The x-component of the force on $-q_1$ is proportional to -



(1) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\sin\theta$ (2) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\cos\theta$

(3) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\sin\theta$ (4) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\cos\theta$

Q.16 In the given figure, two point charges q_1 and q_2 are placed at distances a and b from a point p inside the metallic sphere having charge Q. The electric field due to metallic sphere at the point P is –



(1) $\frac{1}{4\pi\varepsilon_0}\sqrt{\left(\frac{q_1}{a^2}\right)^2+\left(\frac{q_2}{b^2}\right)^2}$

(2) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2}$

(3) $\frac{1}{4\pi\varepsilon_0}\sqrt{\left(\frac{Q}{R^2}\right)^2+\left(\frac{q_1}{a^2}+\frac{q_2}{b^2}\right)^2}$

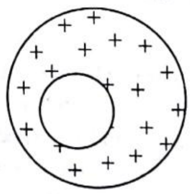
(4) None of the above

Q.17 Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r) = \rho_0\left(\frac{5}{4}-\frac{r}{R}\right)$ upto r = R, and $\rho(r) = 0$ for r > R, where r is the distance from the origin. The electric field at a distance r(r < R) from the origin is given by -

(1) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{4}-\frac{r}{R}\right)$ (2) $\frac{4\pi\rho_0 r}{3\varepsilon_0}\left(\frac{5}{3}-\frac{r}{R}\right)$

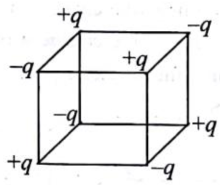
(3) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{3}-\frac{r}{R}\right)$ (4) $\frac{4\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4}-\frac{r}{R}\right)$

Q.18 A spherical portion has been removed from a solid sphere having a charge distributed uniformly it its volume as shown in figure. The electric field inside the emptied space is



(1) zero everywhere
(2) nonzero and uniform
(3) non-uniform
(4) zero only at its centre

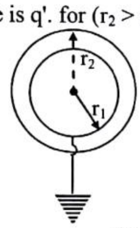
Q.19 Eight point charges are placed at the corners of a cube of edge a as shown in figure. The work done in disassembling this system of charges will be –



(1) $\frac{q^2}{4\pi\varepsilon_0 a}$ (2) $\frac{q^2\sqrt{3}}{4\pi\varepsilon_0 a}$

(3) $\frac{12q^2}{4\pi\varepsilon_0 a}$ (4) $\frac{5.824q^2}{4\pi\varepsilon_0 a}$

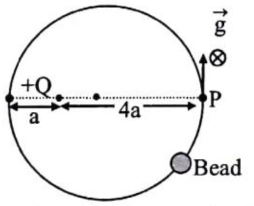
Q.20 Charge on the outer sphere is q, and the inner sphere is grounded. Then the charge q' on the inner sphere is q'. for ($r_2 > r_1$)



(1) zero (2) q' = q

(3) $q' = -\frac{r_1}{r_2}q$ (4) $q' = \frac{r_1}{r_2}q$

Q.21 The diagram shows a small bead of mass m carrying charge q. The bead can freely move on the smooth fixed ring placed on a smooth horizontal plane. In the same plane a charge +Q has also been fixed as shown. The potential at the point P due to +Q is V. The velocity with which the bead should projected from the point P so that it can complete a circle should be greater than -



(1) $\sqrt{\frac{6qV}{m}}$ (2) $\sqrt{\frac{qV}{m}}$

(3) $\sqrt{\frac{3qV}{m}}$ (4) None of these

Q.22 Point charges q, – q, 2Q and Q are placed in order at the corners A, B, C, D, of a square of side 2b. If the field at the midpoint of CD is zero, then $\frac{q}{Q}$ is -

(1) 1 (2) 2

(3) $\frac{2\sqrt{2}}{5}$ (4) $\frac{5\sqrt{5}}{2}$

Q.23 Three charges $+Q_1$, $+Q_2$ and q are placed on a straight line such that q is somewhere in between $+Q_1$ and $+Q_2$. If this system of changes is in equilibrium, what should be the magnitude and sign of charge q ?

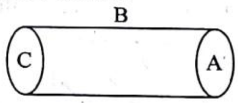
(1) $\frac{Q_1Q_2}{(\sqrt{Q_1}+\sqrt{Q_2})}$, positive

(2) $\frac{Q_1+Q_2}{2}$, positive

(3) $\frac{Q_1Q_2}{(\sqrt{Q_1}+\sqrt{Q_2})^2}$, negative

(4) $\frac{Q_1+Q_2}{2}$, negative

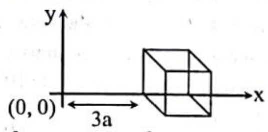
Q.24 A hollow cylinder has a charge q coulomb at the centre. If ϕ is the electric flux in units of voltmeter associated with the curved surface B, the flux linked with the plane surface A in units of voltmeter will be :



(1) $\frac{q}{2\varepsilon_0}$ (2) $\frac{\phi}{3}$

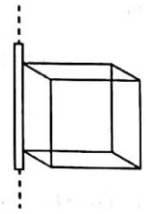
(3) $\frac{q}{\varepsilon_0} - \phi$ (4) $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$

Q.25 A cube of edge a is kept on x-axis in a region where electric field varies with distance as $E = kx\hat{i}$. Total electric flux associated with the cube is-



(1) ka^3 (2) $-3ka^3$ (3) $4ka^3$ (4) zero

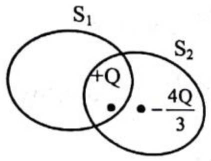
Q.26 An infinite wire having charge density λ passes through one of the edges of a cube having length ℓ. Find the total flux passing through the cube



(1) $\frac{\lambda\ell}{\varepsilon_0}$ (2) $\frac{\lambda\ell}{4\varepsilon_0}$

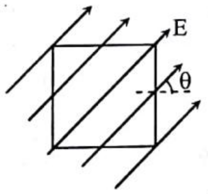
(3) $\frac{\lambda\ell}{6\varepsilon_0}$ (4) None of these

Q.27 The ratio of ϕ_E passing through the surfaces S_1 and S_2 is -



(1) 1 : 1 (2) –2 : 1
(3) –3 :1 (4) –1 : 3

Q.28 A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt/m is-

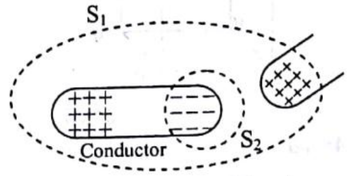


(1) EL^2 (2) $EL^2 \cos\theta$
(3) $EL^2 \sin\theta$ (4) zero

Q.29 The inward and outward electric flux for a close surface in units of Nm^2/C are respectively 8×10^3 and 4×10^3. Then the total charge inside the surface is (where ε_0 = permittivity constant):
(1) $4\times10^3 C$ (2) $-4\times10^3 C$

(3) $\frac{(-4\times10^3)}{\varepsilon_0} C$ (4) $-4\times10^3 \varepsilon_0 C$

Q.30 Charge on an originally uncharged conductor is separated by holding a positively charged rod very close nearby as in the figure. Assume that the induced negative charge on the conductor is equal to the positive charge q on the rod. Then flux through the surface S_1 is :



(1) zero (2) q / ε_0
(3) $-q / \varepsilon_0$ (4) none of these

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ⊘
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Test Date | D | D | | M | M | | Y | Y | Y | Y |

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

1	①	②	③	④	31	①	②	③	④	61	①	②	③	④
2	①	②	③	④	32	①	②	③	④	62	①	②	③	④
3	①	②	③	④	33	①	②	③	④	63	①	②	③	④
4	①	②	③	④	34	①	②	③	④	64	①	②	③	④
5	①	②	③	④	35	①	②	③	④	65	①	②	③	④
6	①	②	③	④	36	①	②	③	④	66	①	②	③	④
7	①	②	③	④	37	①	②	③	④	67	①	②	③	④
8	①	②	③	④	38	①	②	③	④	68	①	②	③	④
9	①	②	③	④	39	①	②	③	④	69	①	②	③	④
10	①	②	③	④	40	①	②	③	④	70	①	②	③	④
11	①	②	③	④	41	①	②	③	④	71	①	②	③	④
12	①	②	③	④	42	①	②	③	④	72	①	②	③	④
13	①	②	③	④	43	①	②	③	④	73	①	②	③	④
14	①	②	③	④	44	①	②	③	④	74	①	②	③	④
15	①	②	③	④	45	①	②	③	④	75	①	②	③	④
16	①	②	③	④	46	①	②	③	④	76	①	②	③	④
17	①	②	③	④	47	①	②	③	④	77	①	②	③	④
18	①	②	③	④	48	①	②	③	④	78	①	②	③	④
19	①	②	③	④	49	①	②	③	④	79	①	②	③	④
20	①	②	③	④	50	①	②	③	④	80	①	②	③	④
21	①	②	③	④	51	①	②	③	④	81	①	②	③	④
22	①	②	③	④	52	①	②	③	④	82	①	②	③	④
23	①	②	③	④	53	①	②	③	④	83	①	②	③	④
24	①	②	③	④	54	①	②	③	④	84	①	②	③	④
25	①	②	③	④	55	①	②	③	④	85	①	②	③	④
26	①	②	③	④	56	①	②	③	④	86	①	②	③	④
27	①	②	③	④	57	①	②	③	④	87	①	②	③	④
28	①	②	③	④	58	①	②	③	④	88	①	②	③	④
29	①	②	③	④	59	①	②	③	④	89	①	②	③	④
30	①	②	③	④	60	①	②	③	④	90	①	②	③	④

SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -7

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Capacitor, Electric Current

IMPORTANT INSTRUCTIONS

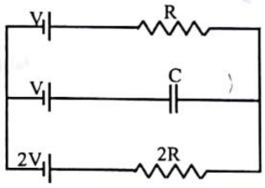
GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

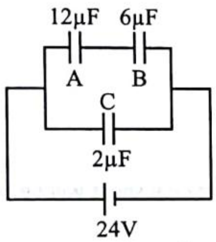
1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 In the given circuit, with steady current, the potential drop across the capacitor must be



(1) V (2) V/2
(3) V/3 (4) 2V/3

Q.2 For the circuit shown in figure the charges on three capacitors A, B and C are respectively -

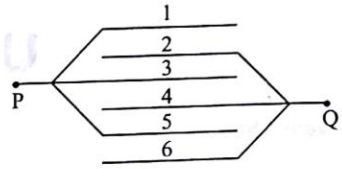


(1) 96 μC, 96 μC and 48 μC
(2) 32 μC, 64 μC and 48 μC
(3) 64 μC, 32 μC and 48 μC
(4) 32 μC, 32 μC and 48 μC

Q.3 A capacitor of 2 μF is charged to a potential of 4V using a battery, and then the battery is disconnected and the charged capacitor is connected to an uncharged capacitor of 4 μF capacitance. When the equilibrium is established the total energy stored in the capacitors is -

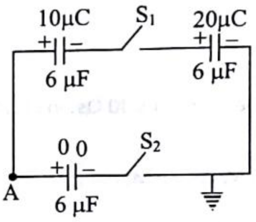
(1) 16 μJ (2) $\frac{16}{3}$ μJ
(3) $\frac{32}{3}$ μJ (4) $\frac{32}{9}$ μJ

Q.4 Six metallic plates each with a surface area of one side A, are placed at a distance d from each other. The alternate plates are connected to points P and Q as shown in figure :



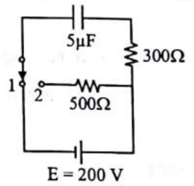
The capacitance of the system is :
(1) $\varepsilon_0 A/d$ (2) $5\varepsilon_0 A/d$
(3) $6\varepsilon_0 A/d$ (4) $\varepsilon_0 A/5d$

Q.5 In the given circuit when S_1 & S_2 are closed. The potential of point A will be –



(1) $\frac{5}{3}$V (2) $-\frac{5}{3}$V
(3) $\frac{10}{3}$V (4) $-\frac{10}{3}$V

Q.6 The amount of heat generated in 500 Ω resistance, when the key is thrown over from contact 1 to 2, as shown in figure, is -

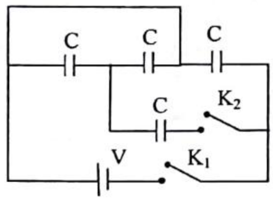


(1) 6.25×10^{-2} J (2) 6.25×10^{-3} J
(3) 3.75×10^{-3} J (4) 3.75×10^{-2} J

Q.7 Capacity of an isolated sphere is increased n times when it is enclosed by an earthed concentric sphere. The ratio of their radii is –

(1) $\frac{n^2}{n-1}$ (2) $\frac{n}{n-1}$
(3) $\frac{2n}{n+1}$ (4) $\frac{2n+1}{n+1}$

Q.8 Initially K_1 is closed, now if K_2 is also closed, find the heat dissipated in the circuit after the switch K_2 is closed



(1) $\frac{1}{2}CV^2$ (2) $\frac{2}{3}CV^2$

(3) $\frac{1}{3}CV^2$ (4) $\frac{1}{4}CV^2$

Q.9 The capacity of a parallel plate condenser is C_0. If a dielectric of relative permittivity ε_r and thickness equal to one fourth the plate separation is placed between the plates, then its capacity becomes C. Then value of $\frac{C}{C_0}$ will be-

(1) $\frac{5\varepsilon_r}{4\varepsilon_r+1}$ (2) $\frac{4\varepsilon_r}{3\varepsilon_r+1}$

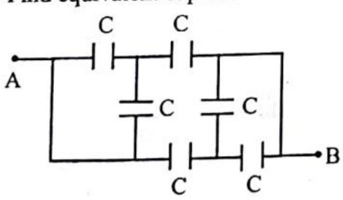
(3) $\frac{3\varepsilon_r}{2\varepsilon_r+1}$ (4) $\frac{2\varepsilon_r}{\varepsilon_r+1}$

Q.10 A fully charged capacitor has a capacitance 'C'. It is discharged through a small coil of resistance wire embedded in a thermally insulated block of specific heat capacity 's' and mass 'm'. If the temperature of the block is raised by 'ΔT', the potential difference 'V' across the capacitance is–

(1) $\sqrt{\frac{2mC\Delta T}{s}}$ (2) $\frac{mC\Delta T}{s}$

(3) $\frac{ms\Delta T}{C}$ (4) $\sqrt{\frac{2ms\Delta T}{C}}$

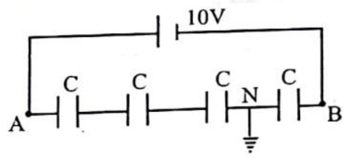
Q.11 Find equivalent capacitance between A& B -



(1) $\frac{C}{4}$ (2) $\frac{3C}{4}$

(3) $\frac{3C}{2}$ (4) $\frac{4C}{3}$

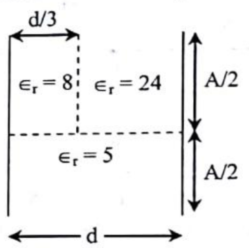
Q.12 The potential at point A in the circuit is - (N point is grounded. Grounding means that potential of that point is zero.)



(1) 10 V (2) 7.5 V

(3) 5 V (4) 2.5 V

Q.13 Equivalent dielectric constant of given arrangement is -



(1) 7.2 (2) 9.7

(3) 2.5 (4) None of these

Q.14 A parallel plate capacitor having capacitance C Farad is connected with a battery of emf V volts. Keeping the capacitor connected with the battery, a dielectric slab of dielectric constant K is inserted between the plates. The dimensions of the slab are such that it fills the space between the capacitor plates, consider the following statements

(i) Potential difference between the capacitor plates remains the same

(ii) The capacitance increases by a factor K

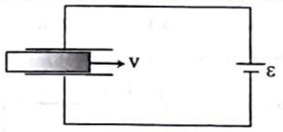
(iii) The energy stored increases by a factor K

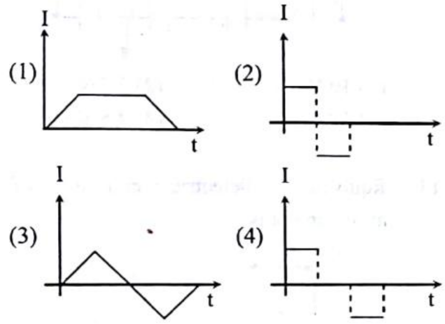
Then the correct statements are -

(1) (i), (ii) (2) (ii), (iii)

(3) (i), (ii), (iii) (4) none of these

Q.15 A dielectric slab of area A and thickness d is inserted between the plates of capacitor of area 2A and distance between the plates d with a constant speed v as shown in figure. The capacitor is connected to a battery of emf ε. The current in the circuit varies with time as -



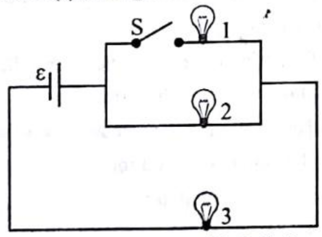


Q.16 n identical cells, each of e.m.f. ε and internal resistance r, are joined in series to form a closed circuit. One cell A is joined with reversed polarity. The potential difference across each cell, except A, is -

(1) $\frac{2\varepsilon}{n}$ (2) $\frac{n-1}{n}\varepsilon$

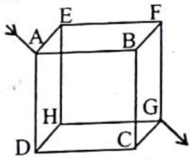
(3) $\frac{n-2}{n}\varepsilon$ (4) $\frac{2n}{n-2}\varepsilon$

Q.17 The three light bulbs in the circuit below are identical, and the battery has zero internal resistance. When switch S is closed to cause bulb 1 to light, which of the other two bulbs increase(s) in brightness ?



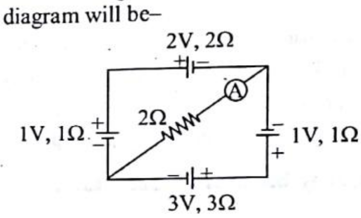
(1) Neither bulb (2) Bulb 2 only
(3) Bulb 3 only (4) Both bulbs

Q.18 Twelve wires each of resistance 6Ω are connected to form a cube as shown in the adjoining figure. The current enters at a corner A and leaves at the diagonally opposite corner G. The equivalent resistance across the corners A and G is –



(1) 12 Ω (2) 6 Ω (3) 3 Ω (4) 5 Ω

Q.19 The reading of ammeter in the adjoining diagram will be–



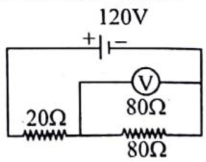
(1) $\frac{2}{17}$ A (2) $\frac{3}{11}$ A

(3) $\frac{1}{13}$ A (4) $\frac{4}{15}$ A

Q.20 If a given volume of water in a 220 V heater is boiled in 5 min, then same volume of water in 110 V heater of same resistace can be boiled in what time interval ?
(1) 20 min (2) 30 min
(3) 25 min (4) 40 min

Q.21 The temperature co-efficient of resistance of a wire is 0.00125°C. At 300 K, its resistance is 1Ω. The resistance of the wire will be 2Ω at -
(1) 1154 K (2) 1100 K
(3) 1400 K (4) 1127 K

Q.22 In figure, the e.m.f. of the cell is 120V and internal resistance is negligible. The resistance of the voltmeter is 80 ohm. The % error in reading of voltmeter will be -



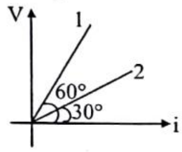
(1) 20 % (2) 16.7 %
(3) 21.2 % (4) 12.8 %

Q.23 The charge supplied by source varies with time t as $Q = at - bt^2$. The total heat produced in resistor R is (Assume direction of current is not changing)-

(1) $\frac{a^3R}{6b}$ (2) $\frac{a^2R}{27b}$

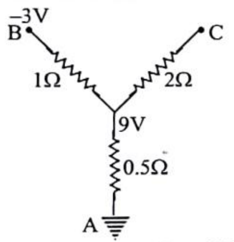
(3) $\frac{a^3R}{3b}$ (4) None of these

Q.24 The V-i graph is given for two conductors of same area and length. If σ_1 and σ_2 are the conductivities of the conductors 1 and 2 respectively, $\frac{\sigma_1}{\sigma_2} =$



(1) 2 : 1 (2) 3 : 1 (3) $1 : \sqrt{2}$ (4) 1 : 3

Q.25 The potential of C is :

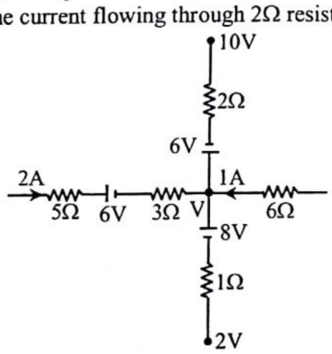


(1) 51 V (2) 0 (3) + 3V (4) 69 V

Q.26 If a copper wire is stretched so that its length increases by 20 % , then what is the percentage increase in its resistance (assuming its volume remains constant) ?

(1)10 % (2) 21 % (3) 44 % (4) 120 %

Q.27 For the part of the circuit gives in figure, find the current flowing through 2Ω resistor:



(1) 1 A

(2) 3A

(3) 4 A

(4) information insufficient

Q.28 Twelve cells, each having emf E volt are connected in series and are kept in a closed box. Some of these cells are wrongly connected with positive and negative terminals reversed. This 12 cell battery is connected in series with an ammeter, an external resistance R ohm and a two-cell battery (two cells of the same type used earlier, connected perfectly in series). The current in the circuit when the 12-cell battery and 2-cell battery aid each other is 3A and is 2A when they oppose each other. Then the number of cell is 12-cell battery that are connected wrongly is:

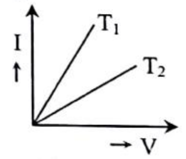
(1) 4 (2) 3 (3) 2 (4) 1

Q.29 The current density varies with radial distance r as $J = ar^2$, in a cylindrical wire of radius R. The current passing through the wire between radial distance $R/3$ and $R/2$ is -

(1) $\frac{65\pi aR^4}{2592}$ (2) $\frac{25\pi aR^4}{72}$

(3) $\frac{65\pi a^2R^3}{2938}$ (4) None of these

Q.30 The current voltage graph for a given metallic wire at two different temperatures T_1 and T_2 are shown in figure. Which is true -



(1) $T_1 = T_2$ (2) $T_1 > T_2$

(3) $T_1 < T_2$ (4) None of these

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

⓪	⓪	⓪	⓪	⓪	⓪
①	①	①	①	①	①
②	②	②	②	②	②
③	③	③	③	③	③
④	④	④	④	④	④
⑤	⑤	⑤	⑤	⑤	⑤
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Test Date D D M M Y Y Y Y

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

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SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -8

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Magnetism & Matter, Magnetic Effect of Current, Electro-magnetic Induction, Alternate Current

IMPORTANT INSTRUCTIONS

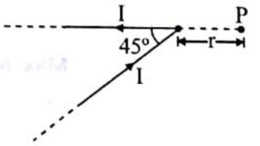
GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

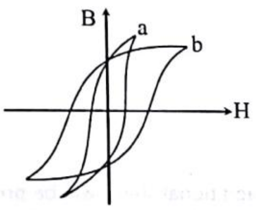
Q.1 Magnetic induction at point P from shown current-carrying long conductors is given by-



(1) $\frac{5\mu_0 I}{2\sqrt{2}\,\pi r}(\sqrt{2}-1)$ (2) $\frac{\mu_0 I}{\sqrt{2}\,\pi r}(\sqrt{2}-1)$

(3) $\frac{8\mu_0 I}{2\pi r}(\sqrt{2}-1)$ (4) $\frac{\mu_0 I}{4\pi r}(\sqrt{2}-1)$

Q.2 The B-H curves (a) and (b) drawn below are associated with :



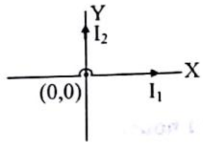
(1) a diamagnetic and a ferromagnetic substance respectively
(2) a paramagnetic and a ferromagnetic substance respectively
(3) soft iron and steel respectively
(4) steel and soft iron respectively

Q.3 A long straight wire along the z-axis carries a current I in the negative z-direction. The magnetic vector field $\vec{B}$ at a point having coordinates (x, y) in the z = 0 plane is -

(1) $\frac{\mu_0 I(y\hat{i}-x\hat{j})}{2\pi(x^2+y^2)}$ (2) $\frac{\mu_0 I(x\hat{i}+y\hat{j})}{2\pi(x^2+y^2)}$

(3) $\frac{\mu_0 I(x\hat{j}-y\hat{i})}{2\pi(x^2+y^2)}$ (4) $\frac{\mu_0 I(x\hat{i}-y\hat{j})}{2\pi(x^2+y^2)}$

Q.4 Two long straight conductors with currents I_1 and I_2 are placed along X and Y axes. The equation of locus of points of zero magnetic induction is :



(1) $Y = X$ (2) $Y = \frac{I_2 X}{I_1}$

(3) $Y = \frac{I_1}{I_2}X$ (4) $Y = \frac{X}{I_1 I_2}$

Q.5 An iron rod of length L and magnetic moment M is bent in the form of a semicircle. Now its magnetic moment will be -

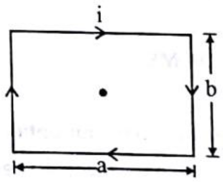
(1) M (2) $\frac{2M}{\pi}$

(3) $\frac{M}{\pi}$ (4) $M\pi$

Q.6 The time of vibration of a dip needle vibration in the vertical plane in the magnetic meridian is 3s. When the same magnetic needle is made to vibrate in the horizontal plane, the time of vibration is $3\sqrt{2}$ s. Then angle of dip will be -

(1) 90° (2) 60°
(3) 45° (4) 30°

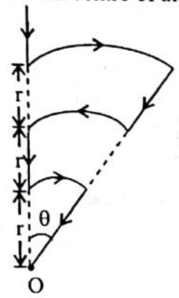
Q.7 Shown in the figure is a rectangular loop of conductor carrying a current *i*. The length and breath of the loop are respectively *a* and *b*. The magnetic field at the centre of loop is -



(1) $\frac{\mu_0 i(a+b)}{2\pi\sqrt{a^2+b^2}}$ (2) $\frac{\mu_0 iab}{2\pi\sqrt{a^2+b^2}}$

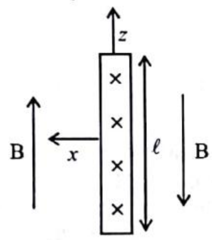
(3) $\frac{\mu_0 i(a+b)}{\pi\sqrt{a^2+b^2}}$ (4) $\frac{2\mu_0 i\sqrt{a^2+b^2}}{\pi ab}$

Q.8 Shown in the figure is a conductor carrying a current I. The magnetic field intensity at the point O(common centre of all the three arcs) is:



(1) $\frac{5\mu_0 I\theta}{24\pi r}$ (2) $\frac{\mu_0 I\theta}{24\pi r}$ (3) $\frac{11\mu_0 I\theta}{24\pi r}$ (4) zero

Q.9 A thin infinitely large sheet lying in yz plane carries a current of linear current density λ. The current is in negative y direction and λ represents current per unit length measured along z-axis. Find the magnetic field near the sheet : (Magnetic field due to the sheet will be parallel to sheet)

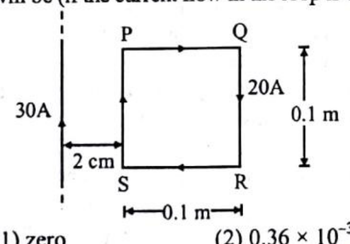


(Long sheet with $\lambda = \frac{\text{current}}{\text{length}}$)

(1) $B = \frac{\mu_0 \lambda}{2}$ (2) $B = \mu_0 2\lambda$

(3) $B = \mu_0 \lambda$ (4) $B = \frac{\mu_0 \lambda}{4}$

Q.10 The resultant force on a square current loop PQRS due to a long current carrying conductor will be (if the current flow in the loop is clockwise)



(1) zero (2) 0.36×10^{-3}N

(3) 2.5×10^{-3} N (4) 5×10^{-4} N

Q.11 The real angle of dip, if a magnet is suspended at an angle of 30° to the magnetic meridian and the dip needle makes an angle of 45° with horizontal is :

(1) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (2) $\tan^{-1}(\sqrt{3})$

(3) $\tan^{-1}\left(\sqrt{\frac{3}{2}}\right)$ (4) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$

Q.12 The relative permeability is represented by μ_r and the susceptibility by χ for a magnetic substance. Then for a paramagnetic substance.

(1) $\mu_r > 1, \chi < 0$ (2) $\mu_r > 1, \chi > 0$

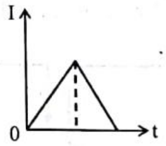
(3) $\mu_r < 1, \chi < 0$ (4) $\mu_r < 1, \chi > 0$

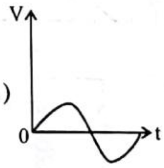
Q.13 In a uniform magnetic field of induction B a wire in the form of a semicircle of radius r rotates about the diameter of the circle with angular frequency ω. The axis of rotation is perpendicular to the field. If the total resistance of the circuit is R, the mean power generated per period of rotation is :

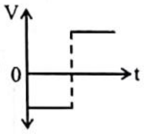
(1) $\frac{B\pi r^2\omega}{2R}$ (2) $\frac{(B\pi r^2\omega)^2}{8R}$

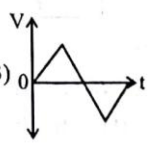
(3) $\frac{(B\pi r\omega)^2}{2R}$ (4) $\frac{(B\pi r\omega^2)^2}{8R}$

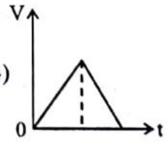
Q.14 The current I in an inductance coil varies with time t according to the following graph :
Which one of the following plots shows the variations of the voltage in the coil?



(1) 

(2) 

(3) 

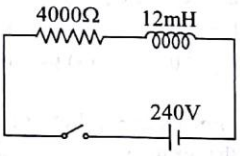
(4) 

Q.15 The self-inductance of a long solenoid (length = ℓ, total number of turn = N, face area = A) is :

(1) $\mu_0 N\ell$ (2) $\mu_0 NA\ell$

(3) $\mu_0 \frac{NA}{\ell}$ (4) $\mu_0 \frac{N^2A}{\ell}$

Q.16 In the inductive circuit given in the figure, the current rises after the switch is closed. At instant when the current is 15 mA, then potential difference across the inductor will be -



(1) Zero (2) 240 V

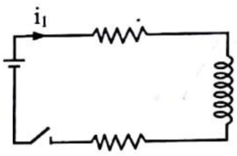
(3) 180 V (4) 60 V

Q.17 A current I = 10 sin(100π t) amp. is passed in first coil, which induces a maximum e.m.f of 5π volt in second coil. The mutual inductance between the coils is -

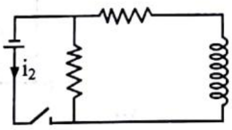
(1) 10 mH (2) 15 mH

(3) 25 mH (4) 5 mH

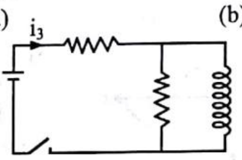
Q.18 The figure shows three circuits with identical batteries, inductors and resistance. Rank the circuits according to the currents through the battery just after the switch is closed, greatest first:



(a)



(b)

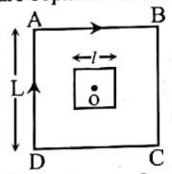


(c)

(1) $i_2 > i_3 > i_1$ (2) $i_2 > i_1 > i_3$

(3) $i_1 > i_2 > i_3$ (4) $i_1 > i_3 > i_2$

Q.19 A small square loop of wire of side l is placed inside a large square loop of wire of side $L >> l$. The loops are coplanar and their centers coincide.

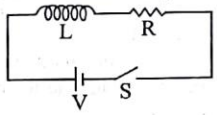


The mutual inductance of system is :

(1) $\mu_0 L^2 l$ (2) $2\sqrt{2}\frac{\mu_0 l^2}{\pi L}$

(3) $2\sqrt{2}\frac{\mu_0 L^2}{\pi l}$ (4) $\mu_0 l^2 L$

Q.20 In adjacent circuit, switch S is closed at t = 0. The time at which current in the circuit becomes half of the steady current is



(1) $\tau\, \ell n\, 2$ (2) $\frac{\ell n\, 2}{\tau}$

(3) $2\,\tau\, \ell n\, 2$ (4) $\frac{\tau}{2}\ell n\, 2$

Q.21 A generator at a utility company produces 100 A of current at 4000 V. The voltage is stepped upto 240000 V by an ideal transformer before it is sent on a high voltage transmission line. The current in transmission line is -

(1) 3.67 A (2) 2.67 A

(3) 1.67 A (4) 2.40 A

Q.22 One 10 V, 60 W bulb is to be connected to 100 V line. The required induction coil has self inductance of value (f = 50 Hz) -

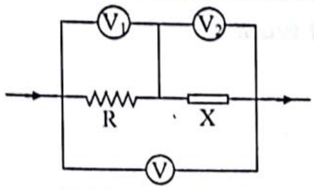
(1) 0.052 H (2) 2.42 H

(3) 16.2 mH (4) 1.62 mH

Q.23 An ac source of angular frequency ω is fed across a resistor r and a capacitor C in series. The current registered is I. If the frequency of source is changed to ω/3 (maintaining the same voltage), the current in the circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency ω -

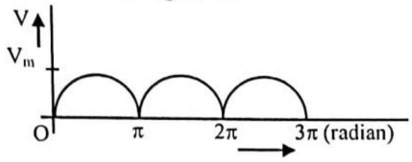
(1) $\sqrt{\frac{3}{5}}$ (2) $\sqrt{\frac{2}{5}}$ (3) $\sqrt{\frac{1}{5}}$ (4) $\sqrt{\frac{4}{5}}$

Q.24 If the reading of the voltmeters vary with time as $V_1 = 20 \sin \omega t$ and $V_2 = -20 \cos (\omega t + \pi/6)$, then the unknown circuit element x is a :



(1) pure (or ideal) inductor
(2) practical inductor
(3) pure (or ideal) capacitor
(4) practical capacitor

Q.25 The average and effective value for the wave shape shown in the figure are -



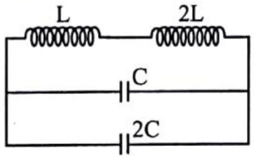
(1) $\frac{2}{\pi} V_m$ and $\frac{V_m}{2}$ (2) $\frac{V_m}{\pi}$ and $\frac{V_m}{\sqrt{2}}$

(3) $\frac{2}{\pi} V_m$ and $\frac{V_m}{\sqrt{2}}$ (4) $\frac{V_m}{\pi\sqrt{2}}$ and $\frac{V_m}{\sqrt{2}}$

Q.26 An alternating current is given by $(\sqrt{3} \sin \omega t + \cos \omega t)$. The rms current is :

(1) 2 (2) $\sqrt{2}$ (3) $2\sqrt{2}$ (4) 4

Q.27 The frequency of oscillation of current in the inductance is –



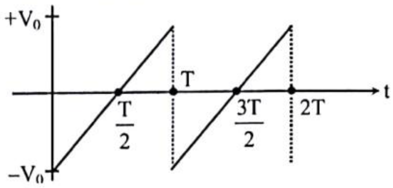
(1) $\frac{1}{3\sqrt{LC}}$ (2) $\frac{1}{6\pi\sqrt{LC}}$

(3) $\frac{1}{\sqrt{LC}}$ (4) $\frac{1}{2\pi\sqrt{LC}}$

Q.28 A coil has an inductance of 0.7 H and is joined in series with a resistance of 220 Ω. When an alternating e.m.f. of 220 V at 50 cps is applied to it, then the wattless component of the current in the circuit is-

(1) 5 ampere (2) 0.5 ampere
(3) 0.7 ampere (4) 7 ampere

Q.29 Rms value of the saw-tooth voltage of peak value V_0 as shown in -



(1) $\frac{V_0}{2}$ (2) $\frac{V_0}{\sqrt{2}}$

(3) $\frac{V_0}{3}$ (4) $\frac{V_0}{\sqrt{3}}$

Q.30 A $2.5/\pi$ μF capacitor and a 3000 ohm resistance are joined in series to an a.c. source of 200 volt and 50 sec^{-1} frequency. The power factor of the circuit and the power dissipated in it will respectively be–

(1) 0.6, 0.06W (2) 0.06, 0.6W
(3) 0.6, 4.8W (4) 4.8, 0.6W.

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

0	0	0	0	0	0
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2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
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8	8	8	8	8	8
9	9	9	9	9	9

Test Date | D | D | M | M | Y | Y | Y | Y |

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

1	①	②	③	④	31	①	②	③	④	61	①	②	③	④
2	①	②	③	④	32	①	②	③	④	62	①	②	③	④
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30	①	②	③	④	60	①	②	③	④	90	①	②	③	④

SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Unit Test -9

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Reflecton at Plane and Curved Surface, Refraction at Plane Surface, Refraction at Curved Surface, Prism, Wave Optics, Interference, Differaction, Polarisation

IMPORTANT INSTRUCTIONS

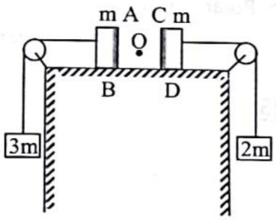
GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 Two blocks each of mass m lie on a smooth table. They are attached to two other masses as shown in the figure. The pulleys and strings are light. An object O is kept at rest on the table. The sides AB & CD of the two blocks are made reflecting. The acceleration of two images formed in those two reflecting surfaces w.r.t. each other is :



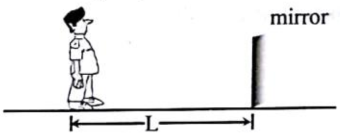
(1) 5g/6 (2) 5g/3 (3) g/3 (4) 17g/6

Q.2 An object is approaching a fixed plane mirror with velocity 5 m/s making an angle of 45° with the normal. The speed of image with respect to mirror is-

(1) 5 m/s (2) $\frac{5}{\sqrt{2}}$ m/s

(3) $5\sqrt{2}$ m/s (4) 10 m/s

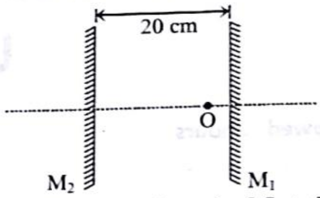
Q.3 A boy of height H is standing in front of a mirror, which has been fixed on the ground as shown in figure. What length of his body can the man see in the mirror ? The length of the mirror is (H/2).



(1) H (2) $H^2/(H^2 + L^2)^{1/2}$

(3) Zero (4) $2H^2/L$

Q.4 Two plane mirror M_1 and M_2 are placed parallel to each other 20 cm apart. A luminous point object 'O' is placed between them at 5 cm from M_1 as shown in figure -



(a) The distances (in cm) of first three nearest images from mirror M_1 are 5, 35 and 45 respectively

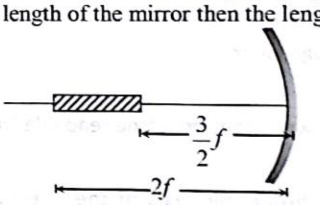
(b) The distances (in cm) of first three nearest images from mirror M_2 are 5, 35 and 45 respectively

(c) The distances (in cm) of first three nearest images from mirror M_1 are 15, 25 and 55 respectively

(d) The distances (in cm) of first three nearest images from mirror M_2 are 15, 25 and 55 respectively

(1) a, b (2) b, c (3) a, d (4) c, d

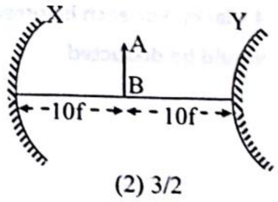
Q.5 A linear object is placed along the axis of a mirror as shown in figure. If 'f ' is the focal length of the mirror then the length of image is-



(1) $\frac{2f}{3}$ (2) f

(3) $\frac{f}{3}$ (4) None of these

Q.6 Concave mirror and convex mirror having equal focal lengths 2f are placed on same principal axis. If the object AB is placed between these mirrors, find the height ratio of the images of this object on two mirrors H_x/H_y = ?



(1) 1/2 (2) 3/2

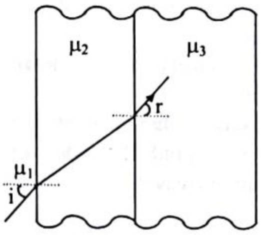
(3) 4/3 (4) 1/1

Q.7 An infinitely long rod lies along the axis of a concave mirror of focal length f. The near end of the rod is at a distance $u > f$ from the mirror. Its image will have a length -

(1) $\frac{f^2}{u-f}$ (2) $\frac{uf}{u-f}$

(3) $\frac{f^2}{u+f}$ (4) $\frac{uf}{u+f}$

Q.8 In the figure shown $\frac{\sin i}{\sin r}$ is equal to :



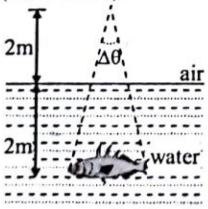
(1) $\frac{\mu_2^2}{\mu_3\mu_1}$ (2) $\frac{\mu_3}{\mu_1}$

(3) $\frac{\mu_3\mu_1}{\mu_2^2}$ (4) None of the above

Q.9 The refracting angle of a prism is A and the refractive index of the material of the prism is $\cot\frac{A}{2}$. The angle of minimum deviation is :

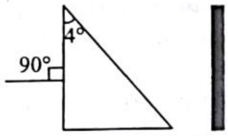
(1) $180° - 3A$ (2) $180° + 2A$
(3) $90° - A$ (4) $180° - 2A$

Q.10 A man looks down on a fish of length 20 cm. His eye is 2m above the surface of the water ($\mu = 4/3$) and the fish is 2m below the surface as shown in the figure the ratio of angular width $\Delta\theta$ of the fish as seen by the man in presence of water to the $\Delta\theta$ in the absence of water is ($\Delta\theta$ is small)



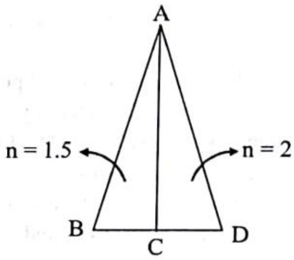
(1) 6/5 (2) 5/6
(3) 7/8 (4) 8/7

Q.11 A prism having an apex angle 4° and refractive index 1.5 is located in front of a vertical plane mirror as shown in figure. Through what total angle is the ray deviated after reflection from the mirror :



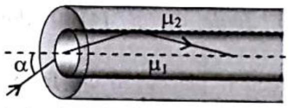
(1) 176° (2) 4°
(3) 178° (4) 2°

Q.12 A ray of light is incident on a prism as shown in fig. Find the total deviation suffered by the ray if $\angle BAC = 1°$ and $\angle CAD = 2°$ -



(1) 1° (2) 1.5° (3) 2.5° (4) 2°

Q.13 An optical fiber consists of core of μ_1 surrounded by a cladding of $\mu_2 < \mu_1$. A beam of light enters from air at an angle α with axis of fiber. The highest α for which ray can be travelled through fiber is -



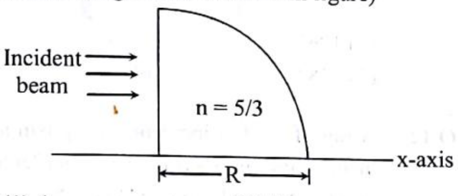
(1) $\cos^{-1}\sqrt{\mu_2^2 - \mu_1^2}$ (2) $\sin^{-1}\sqrt{\mu_1^2 - \mu_2^2}$

(3) $\tan^{-1}\sqrt{\mu_1^2 - \mu_2^2}$ (4) $\sec^{-1}\sqrt{\mu_1^2 - \mu_2^2}$

Q.14 Two identical glass (μ_g = 3/2) equiconvex lenses of focal length f are kept in contact. The space between the two lenses is filled with water (μ_w = 4/3). The focal length of the combination is -

(1) f (2) $\frac{f}{2}$ (3) $\frac{4f}{3}$ (4) $\frac{3f}{4}$

Q.15 A uniform, horizontal parallel beam of light is incident upon a prism as shown. The prism is in the shape of a quarter cylinder of radius R = 5 cm, and has the index of refraction n = 5/3. The width of the region at which the incident rays, after normal incidence on plane surface and subsequent refraction at curved surface, intersect on x-axis is (Neglect the ray which travels along x-axis as shown in figure)



(1) 4 cm (2) 5/4 cm
(3) 9/4 cm (4) 25/4 cm

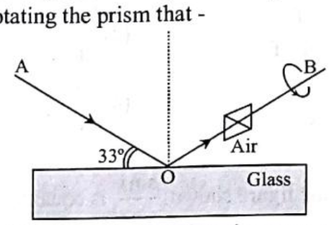
Q.16 Two thin lens have a combined power of 10 D in contact. When separated by 20 cm their equivalent power is 6.25 D. Find their in dividual powers in dioptres -
(1) 3.5 and 6.5 (2) 5 and 5
(3) 7.5 and 2.5 (4) 9 and 1

Q.17 A beam of plane polarized light falls normally on a polarizer of cross sectional area $3 \times 10^{-4}\ m^2$. Flux of energy of incident ray in $10^{-3}\ W$. The polarizer rotates with an angular frequency of 31.4 *rad/s*. The energy of light passing through the polarizer per revolution will be -
(1) 10^{-4} *Joule* (2) 10^{-3} *Joule*
(3) 10^{-2} *Joule* (4) 10^{-1} *Joule*

Q.18 A screen is placed 50 cm from a single slit, which is illuminated with 6000 Å light. If distance between the first and third minima in the diffraction pattern is 3.00 mm, what is the width of the slit ?
(1) 0.1 mm (2) 0.2 mm
(3) 0.3 mm (4) 0.4 mm

Q.19 A slit of width a is illuminated by red light (λ = 6500 Å). The first minima for red light will fall at $\theta = 30°$, when a will be -
(1) 3250 Å (2) 6.5×10^{-4} cm
(3) 1.3 micron (4) 2.6×10^{-4} cm

Q.20 A beam of light AO is incident on a glass slab (μ = 1.54) in a direction making an angle with its base as shown in figure. If the reflected light OB is passed through a Nicol-prism, we find on rotating the prism that -



(1) the intensity is reduced to zero and remains zero
(2) the intensity reduces down somewhat and rises again
(3) there is no change in intensity
(4) intensity gradually reduces to zero and then again increases

Q.21 Magnification produced by astronomical telescope for normal adjustment is 10 and length of telescope is 1.1 m. The magnification when the image is formed at least distance of distinct vision (D = 25 cm) is -
(1) 14 (2) 6 (3) 16 (4) 18

Q.22 In a compound microscope the focal lengths of two lenses are 1.5 cm and 6.25 cm. If an object is placed at 2 cm from objective and final image is formed at 25 cm from eye lens, the distance between the two lenses is -
(1) 6.00 cm (2) 7.75 cm
(3) 9.25 cm (4) 11.00 cm

Q.23 A telescope of objective lens diameter 2m uses light of wavelength 5000 Å for viewing stars. The minimum angular separation between two stars whose image is just resolved by telescope -
(1) 4×10^{-4} rad (2) 0.25×10^{-6} rad
(3) 0.31×10^{-6} rad (4) 5×10^{-3} rad

Q.24 In a young's double slit experiment, let s_1 & s_2 be the two slit and c be the centre of the screen if $\angle s_1cs_2 = \theta$ and λ is the wavelength, the fringe width will be -
(1) $\frac{\lambda}{\theta}$ (2) $\lambda\theta$ (3) $\frac{2\lambda}{\theta}$ (4) $\frac{\lambda}{2\theta}$

Q.25 In Young's double-slit experiment, the intensity of light in front of one of the slits on a screen is $I_0/2$ where I_0 is the maximum intensity. The distance between the slits is 5λ where λ is the wavelength of monochromatic light. How far away is the screen from the slit ?

(1) 20λ (2) 25λ (3) 40λ (4) 50λ

Q.26 In Young's double slit experiment the intensity of light at a point on the screen where path difference λ is I. If intensity at a point is I/4, then possible path differences at this point are -

(1) $\lambda/2, \lambda/3$ (2) $\lambda/3, 2\lambda/3$
(3) $\lambda/3, \lambda/4$ (4) $2\lambda/3, \lambda/4$

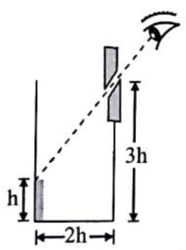
Q.27 In the ideal double-slit experiment, when a glass-plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wave-length λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass-plate is -

(1) 2λ (2) $2\lambda/3$ (3) $\lambda/3$ (4) λ

Q.28 If ratio of maximum to minimum intensity in an interference experiment is 16:1 then ratio of amplitudes of individual waves is -

(1) 4 : 1 (2) 16 : 1
(3) 5 : 3 (4) 25 : 9

Q.29 An observer can see through a pin-hole the top end of a thin rod of height h, placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid upto a height 2h, he can see the lower end of the rod. Then, the refractive index of the liquid is -



(1) $\frac{5}{2}$ (2) $\sqrt{\frac{5}{2}}$ (3) $\sqrt{\frac{3}{2}}$ (4) $\frac{3}{2}$

Q.30 If white light traveling in air incidents over glass and undergoes refraction then which colour light deviates maximum -

(1) Red
(2) Yellow
(3) Violet
(4) All colours deviates by same angle

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

0	0	0	0	0	0
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8	8	8	8	8	8
9	9	9	9	9	9

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Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

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30	1	2	3	4	60	1	2	3	4	90	1	2	3	4

SIGNATURE OF CANDIDATE

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Practice Test for JEE Main
Unit Test -10

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Nuclear Physics & Radioactivity, Photo-electric Effect, X-Rays, Atomic Structure, Matter wave, Semi conductors & Electronics

IMPORTANT INSTRUCTIONS

GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

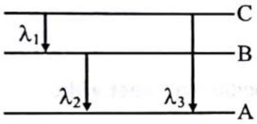
1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 If the wavelength of photon emitted due to transition of electron from third orbit to first orbit in a hydrogen atom is λ, then the wavelength of photon emitted due to transition of electron from fourth orbit to second orbit will be -

(1) $\frac{128}{27}\lambda$ (2) $\frac{25}{9}\lambda$

(3) $\frac{36}{7}\lambda$ (4) $\frac{125}{11}\lambda$

Q.2 Energy levels A, B, C of a certain atom corresponds to increasing values of energy, i.e., $E_A < E_B < E_C$. If λ_1, λ_2 and λ_3 are the wavelengths of radiations corresponding to the transitions, C to B, B to A and C to A respectively, which of the following statement is correct ?

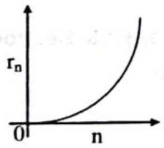


(1) $\lambda_3 = \lambda_1 + \lambda_2$ (2) $\lambda_3 = \frac{\lambda_2\lambda_1}{\lambda_1 + \lambda_2}$

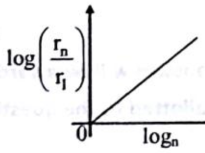
(3) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (4) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Q.3 If in hydrogen atom r_n = radius of nth Bohr orbit, f_n = frequency of revolution of electron in nth orbit and A_n = Area enclosed by nth orbit. Which of the following graphs is/are correct ?

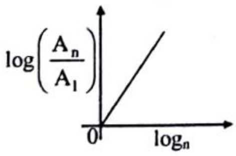
(a)



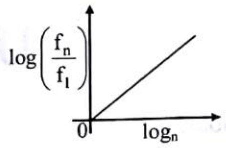
(b)



(c)



(d)



(1) a, b (2) a, b, c

(3) a, b, c, d (4) None of these

Q.4 A particle of mass m moves around in a circular orbit in a centro symmetric potential field $u(r) = \frac{Kr^2}{2}$. Using Bohr's quantization rule, find the permissible energy levels.

(1) $\frac{nh}{2\pi}\sqrt{\frac{K}{m}}$ (2) $\frac{2nh}{\pi}\sqrt{\frac{K}{m}}$

(3) $\frac{nh}{2}\sqrt{\frac{K}{m}}$ (4) None of these

Q.5 In Rutherford's experiment, the number of α-particles scattered through an angle of 90° is 28 per minute. Then, the number of particles scattered through an angle of 60° per minute by the same nucleus is :

(1) 28 per minute (2) 112 per minute

(3) 12.5 per minute (4) 7 per minute

Q.6 A hydrogen atom and a Li^{++} ion are both in the second excited state. If l_H and l_{Li} are their respective electronic angular momenta and E_H and E_{Li} their respective energies, then -

(1) $l_H > l_{Li}$ and $|E_H| > |E_{Li}|$

(2) $l_H = l_{Li}$ and $|E_H| < |E_{Li}|$

(3) $l_H = l_{Li}$ and $|E_H| > |E_{Li}|$

(4) $l_H < l_{Li}$ and $|E_H| < |E_{Li}|$

Q.7 An e-m wave of wavelength λ is incident on a photo sensitive surface of negligible work function. If the photoelectrons emitted from this surface have the de-Broglie wavelength λ_1. Find relation between 'λ' and 'λ_1' -

(1) $\lambda = \left(\frac{2mc}{h}\right)\lambda_1^2$ (2) $\lambda = \left(\frac{mc}{2h}\right)\lambda_1^2$

(3) $\lambda_1 = \left(\frac{2mc}{h}\right)\lambda^2$ (4) None of these

Q.8 A 100 W light bulb is placed at the centre of a spherical chamber of radius 20 cm. Assume that 60% of the energy supplied to the bulb is converted into light and that the surface of the chamber is perfectly absorbing. Find the pressure exerted by the light on the surface of the chamber.

(1) 4.0×10^{-6}Pa (2) 4.0×10^{-7}Pa
(3) $2.0 \times 10^{+7}$Pa (4) $4.0 \times 10^{+7}$Pa

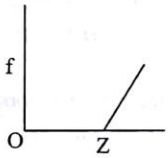
Q.9 In Davisson-Germer experiment, the correct relation between angle of diffraction ϕ and glancing angle θ is -

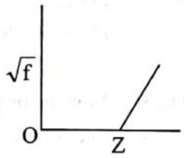
(1) $\theta = 90° - \frac{\phi}{2}$ (2) $\theta = 90° + \frac{\phi}{2}$
(3) $\theta = \frac{\phi}{2}$ (4) $\theta = \phi$

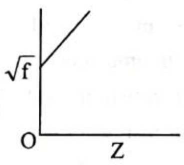
Q.10 The longest wavelength that can be analysed by a sodium chloride crystal of spacing d = 2.82 Å in the second order is -

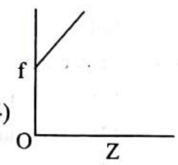
(1) 2.82 Å (2) 5.64 Å
(3) 8.46 Å (4) 11.28 Å

Q.11 Identify the graph which correctly represent the Moseley's law -

(1) 

(2) 

(3) 

(4) 

Q.12 In X-ray tube when the accelerating voltage V is halved, the difference between the wavelength of K_a line and minimum wavelength of continuous X-ray spectrum -

(1) remain constant (2) increases
(3) becomes half (4) decreases

Q.13 Light of wavelength λ strikes a photoelectric surface and electron are ejected with K.E. 'K'. If 'K' is to be increased to exactly twices its original value, the wavelength must be changed to λ' such that

(1) $\lambda' < \lambda/2$ (2) $\lambda' > \lambda/2$
(3) $\lambda > \lambda' > \lambda/2$ (4) $\lambda' = \lambda/2$

Q.14 Photo electric emission is observed from a metallic surface for frequencies ν_1 & ν_2 of the incident light ($\nu_1 > \nu_2$). If the maximum kinetic energy of the photo electrons emitted in two cases are in ratio 1 : n, then the threshold frequency of the metallic surface is -

(1) $\frac{\nu_1 - \nu_2}{n-1}$ (2) $\frac{n\nu_1 - \nu_2}{n-1}$
(3) $\frac{n\nu_2 - \nu_1}{n-1}$ (4) $\frac{\nu_1 - \nu_2}{n}$

Q.15 If K_1 and K_2 are the maximum kinetic energies of photoelectrons emitted when lights of wavelength λ_1 and λ_2 respectively incident on a metallic surface and $\lambda_1 = 3\lambda_2$, then -

(1) $K_1 > \frac{K_2}{3}$ (2) $K_1 < \frac{K_2}{3}$
(3) $K_1 = 3K_2$ (4) $K_2 = 3K_1$

Q.16 Given that a photon of light of wavelength 10,000 angstrom has an energy equal to 1.23 eV. When light of wavelength 5000 angstrom and intensity I_0 falls on a photoelectric cell, the saturation current is 0.40×10^{-6} ampere and the stopping potential is 1.36 volt, then the work function is -

(1) 0.43 eV (2) 1.10 eV
(3) 1.36 eV (4) 2.47 eV

Q.17 In an α-decay the kinetic energy of α-particle is 48 MeV and Q-value of the reaction is 50 MeV. The mass number of the mother nucleus is -
(Assume that daughter nucleus is in ground state)

(1) 96 (2) 100
(3) 104 (4) none of these

Q.18 Carbon-14 decay with a half life of about 5,800 year. In a sample of bone, the ratio of carbon-14 to carbon-12 is found to be 1/4 of what it is in free air. This bone may belong to period about x centuries ago, where x is

(1) 2×58 (2) 58
(3) 58/2 (4) 3×58

Q.19 A radioactive element decays by β-emission. A detector records n beta particles in 2s and in next 2s it records 0.75n beta particle. Find mean life correct to nearest whole number. Given $\ell n\, 2 = 0.6931$, $\ell n\, 3 = 1.0986$

(1) 17 s (2) 7 s
(3) 5 s (4) 15 s

Q.20 When Lithium (^7Li) is bombarded by a proton, two alpha particles (^4He) are produced. The masses of ^7Li, ^1H and ^4He are 7.016004 u, 1.007825 u and 4.002603 u respectively. The reaction energy is nearly -

(1) 17 eV (2) 17 keV
(3) 17 MeV (4) 170 MeV

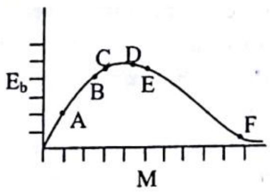
Q.21 A nuclear fission is represented by the following reaction :

$$U^{236} = X^{111} + Y^{122} + 3n$$

If the binding energies per nucleon of X^{111}, Y^{122} and U^{236} are 8.6MeV, 8.5 MeV and 7.6 MeV respectively, then the energy released in the reaction will be -

(1) 200 MeV (2) 202 MeV
(3) 195 MeV (4) 198 MeV

Q.22 Below Shows is a plot of binding energy per nucleon E_b, against the nuclear mass M; A, B, C, D, E, F correspond to different nuclei. Consider four reactions

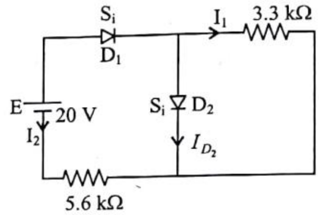


(i) $A + B \rightarrow C + \varepsilon$ (ii) $C \rightarrow A + B + \varepsilon$
(iii) $D + E \rightarrow F + \varepsilon$ (iv) $F \rightarrow D + E + \varepsilon$

Where ε is the energy released ? In which reactions is ε positive -

(1) i and iv (2) i and iii
(3) ii and iv (4) ii and iii

Q.23 In the circuit shown in figure I_1, I_2 and I_{D_2} are respectively -



(1) 0.212 mA, 3.32 mA, 3.108 mA
(2) 2.12 mA, 3.32 mA, 3.108 mA
(3) 0.212 mA, 0.332 mA, 3.108 mA
(4) None of these

Q.24 In a common emitter amplifier, using output resistance of 5000 ohm and input resistance of 2000 ohm, if the input signal voltage is 10 mV and $\beta = 50$, calculate output voltage & power gain

(1) 1.25 V,6250 (2) 3V, 6250
(3) 1.5V, 3050 (4) None of these

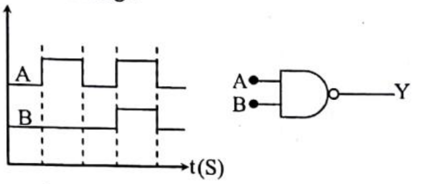
Q.25 In semiconductor the concentrations of electrons and holes are $8 \times 10^{18}/m^3$ and $5 \times 10^{18}/m^3$ respectively. If the mobilities of electrons and holes are 2.3 m^2/V-s and 0.01 m^2/V–s respectively, then semiconductor is :

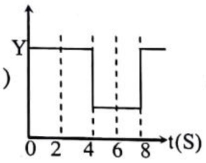
(1) n-type and its resistivity is 0.34 Ω-m
(2) p-type and its resistivity is 0.034 Ω-m
(3) n-type and its resistivity is 0.034 Ω-m
(4) p-type and its resistivity is 3.4 Ω-m

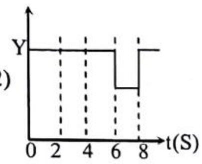
Q.26 If $\alpha = 0.98$ and current though emitter $i_e = 20$ mA, the value of β is -

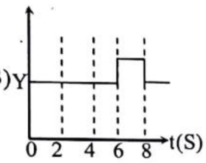
(1) 4.9 (2) 49
(3) 96 (4) 9.6

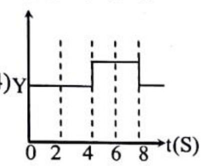
Q.27 The real time variation of input signals A & B are as shown below. If the inputs are into NAND gate, then select the output signals from the following : -



(1) 

(2) 

(3) 

(4) 

Q.28 Which of the following is forward biased ?

(1) −5V ▶| 5V (2) 0V ▶| 2V

(3) −1V ▶| −1.5V (4) None of these

Q.29 If α and β are the current gain in the CB and CE configurations respectively of the transistor circuit, then $(\beta - \alpha)/\alpha\beta = ...$

(1) ∞ (2) 1 (3) 2 (4) 0.5

Q.30 A screw gauge has a least count of 0.005 mm and its head scale is divided into 200 equal division. The distance between consecutive threads on the screw is :

(1) 0.25 mm (2) 0.5 mm

(3) 1.00 mm (4) 2.00 mm

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Test Date | D | D | M | M | Y | Y | Y | Y |

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

1	① ② ③ ④		31	① ② ③ ④		61	① ② ③ ④
2	① ② ③ ④		32	① ② ③ ④		62	① ② ③ ④
3	① ② ③ ④		33	① ② ③ ④		63	① ② ③ ④
4	① ② ③ ④		34	① ② ③ ④		64	① ② ③ ④
5	① ② ③ ④		35	① ② ③ ④		65	① ② ③ ④
6	① ② ③ ④		36	① ② ③ ④		66	① ② ③ ④
7	① ② ③ ④		37	① ② ③ ④		67	① ② ③ ④
8	① ② ③ ④		38	① ② ③ ④		68	① ② ③ ④
9	① ② ③ ④		39	① ② ③ ④		69	① ② ③ ④
10	① ② ③ ④		40	① ② ③ ④		70	① ② ③ ④
11	① ② ③ ④		41	① ② ③ ④		71	① ② ③ ④
12	① ② ③ ④		42	① ② ③ ④		72	① ② ③ ④
13	① ② ③ ④		43	① ② ③ ④		73	① ② ③ ④
14	① ② ③ ④		44	① ② ③ ④		74	① ② ③ ④
15	① ② ③ ④		45	① ② ③ ④		75	① ② ③ ④
16	① ② ③ ④		46	① ② ③ ④		76	① ② ③ ④
17	① ② ③ ④		47	① ② ③ ④		77	① ② ③ ④
18	① ② ③ ④		48	① ② ③ ④		78	① ② ③ ④
19	① ② ③ ④		49	① ② ③ ④		79	① ② ③ ④
20	① ② ③ ④		50	① ② ③ ④		80	① ② ③ ④
21	① ② ③ ④		51	① ② ③ ④		81	① ② ③ ④
22	① ② ③ ④		52	① ② ③ ④		82	① ② ③ ④
23	① ② ③ ④		53	① ② ③ ④		83	① ② ③ ④
24	① ② ③ ④		54	① ② ③ ④		84	① ② ③ ④
25	① ② ③ ④		55	① ② ③ ④		85	① ② ③ ④
26	① ② ③ ④		56	① ② ③ ④		86	① ② ③ ④
27	① ② ③ ④		57	① ② ③ ④		87	① ② ③ ④
28	① ② ③ ④		58	① ② ③ ④		88	① ② ③ ④
29	① ② ③ ④		59	① ② ③ ④		89	① ② ③ ④
30	① ② ③ ④		60	① ② ③ ④		90	① ② ③ ④

SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Revision Test -2

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Units 6 to 10

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5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

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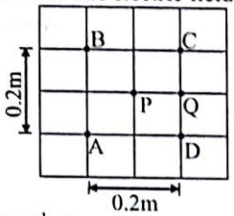
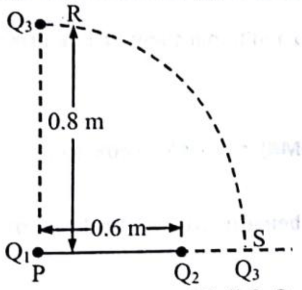
Q.1 A, B, C, D, P and Q are points in a uniform electric field. The potentials at these points are V (1) = 2 volt, V (P) = V (2) = V (4) = 5 volt, V (3) = 8 volt. The electric field at P is



(1) 10 V m^{-1} along PQ
(2) 5 V m^{-1} along PC
(3) $15\sqrt{2}$ V m^{-1} along PA
(4) 5 V m^{-1} along PA

Q.2 Two charges Q_1 and Q_2 coulombs are shown in figure. A third charge Q_3 coulomb is moved from points R to S along a circular path. Change in potential energy of the charge is -

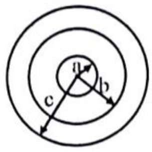


(1) $kQ_1Q_2Q_3$ (2) $4kQ_1Q_2$
(3) $4kQ_2Q_3$ (4) $\frac{2}{3}kQ_2Q_3$

Q.3 A drop of water of mass m falls away from the bottom of charged conducting sphere of radius R, carrying with it a charge q_1 and leaving the sphere a uniformly distributed charge q_2. The kinetic energy of the drop after it has fallen height h is -

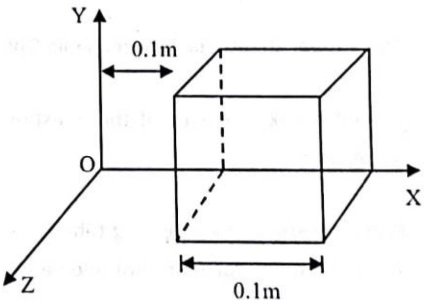
(1) $\frac{1}{4\pi\varepsilon_0} q_1q_2 \left(\frac{h}{R(R+h)}\right)$
(2) mgh
(3) $\frac{1}{4\pi\varepsilon_0} q_1q_2 \left(\frac{h}{R(R+h)}\right) + mgh$
(4) $\frac{1}{4\pi\varepsilon_0} \frac{q_1q_2}{h} + mgh$

Q.4 A solid conducting sphere of radius a has a net positive charge 2Q. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge –Q. The surface charge density on the inner and outer surface of the spherical shell will be -



(1) $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$ (2) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$
(3) $0, \frac{Q}{4\pi c^2}$ (4) None of these

Q.5 Due to a charge inside the cube, the electric field is: $E_x = 600x$, $E_y = 0$, $E_z = 0$. The charge inside the cube is nearly -

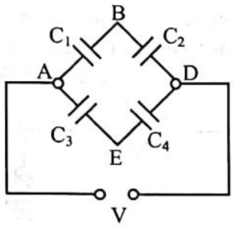


(1) 600μC (2) 60μC
(3) 53 μμC (4) 6 μμC

Q.6 Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium, the value of q is -

(1) $-\frac{Q}{2}(1+2\sqrt{2})$ (2) $\frac{Q}{4}(1+2\sqrt{2})$
(3) $-\frac{Q}{4}(1+2\sqrt{2})$ (4) $\frac{Q}{2}(1+2\sqrt{2})$

Q.7 Potential difference between the points B and E of the circuit is -



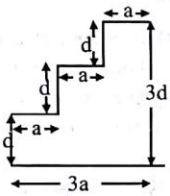
(1) $\frac{(C_2 - C_1)}{V}$

(2) $\frac{(C_4 - C_3)}{V}$

(3) $\left\{\frac{C_2C_3 - C_1C_4}{C_1 + C_2 + C_3 + C_4}\right\} V$

(4) $\left\{\frac{C_1C_4 - C_2C_3}{(C_1 + C_2)(C_3 + C_4)}\right\} V$

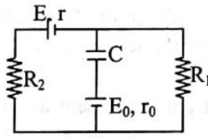
Q.8 The expression for the equivalent capacitance of the system shown is : (A is the cross-sectional area of one of the plates)



(1) ε_0 A/3d (2) $\frac{3\varepsilon_0 A}{d}$

(3) ε_0 A/6d (4) none of the above

Q.9 In steady state, find energy stored in the capacitor–



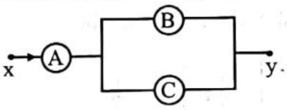
(1) $\frac{1}{2}C\left[\frac{ER_1}{r + R_1 + R_2}\right]^2$

(2) $\frac{1}{2}C\left[E_0 + \left(\frac{ER_1}{r + R_1 + R_2}\right).R_1\right]^2$

(3) $\frac{1}{2}CE_0^2$

(4) none of the above

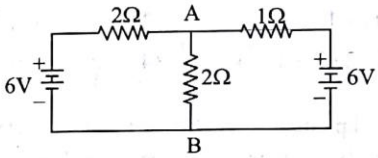
Q.10 A, B and C are voltmeters of resistances R, 1.5R and 3R respectively. When same potential difference is applied between x and y, the voltmeter readings are V_A, V_B and V_C. Then -



(1) $V_A = V_B = V_C$ (2) $V_A \neq V_B = V_C$

(3) $V_A = V_B \neq V_C$ (4) $V_A + V_B = V_C$

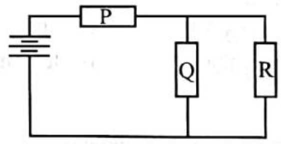
Q.11 The potential difference between the points A and B in the following circuit will be–



(1) zero (2) 2 V

(3) 3.5 V (4) 4.5 V

Q.12 The resistance P, Q and R in the circuit have equal resistance.



The battery of negligible resistance, supplies a total power of 12W. What is the power dissipated by heating in resistor R–

(1) 2W (2) 4W

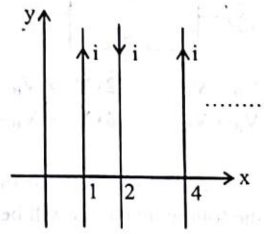
(3) 3W (4) 6W

Q.13 A particle of charge per unit mass α is released from origin with a velocity $\vec{v} = v_0\hat{i}$ in a uniform magnetic field $\vec{B} = -B_0\hat{k}$. If the particle passes through (0, y, 0), then y is equal to -

(1) $-\frac{2v_0}{B_0\alpha}$ (2) $\frac{v_0}{B_0\alpha}$

(3) $\frac{2v_0}{B_0\alpha}$ (4) $-\frac{v_0}{B_0\alpha}$

Q.14 Equal currents i = 1 A are flowing through the wires parallel to y-axis located at x = +1 m, x = +2 m, x = +4 m, etc. but in opposite directions as shown in fig. The magnetic field (in tesla) at origin would be -



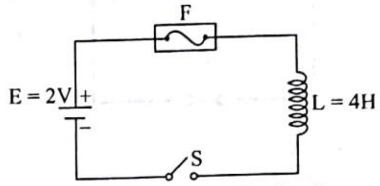
(1) $-1.33 \times 10^{-7}\hat{k}$ (2) $1.33 \times 10^{-7}\hat{k}$
(3) $2.67 \times 10^{-7}\hat{k}$ (4) $-2.67 \times 10^{-7}\hat{k}$

Q.15 A dip circle is so set that the dip needle moves freely in the magnetic meridian. In this position the angle of dip is 39°. Now, the dip circle is rotated so that the plane in which the needle moves makes an angle of 30° with the magnetic meridian. In this position, the needle will dip by an angle -
(1) exactly 39° (2) 30°
(3) more than 39° (4) less than 39°

Q.16 A coil having an inductance of $\frac{1}{\pi}$ henry is connected in series with 300 Ω .If 20 V from a 200 cycle source is impressed across the combination, then the phase angle between, V and I is–
(1) $\tan^{-1}\left(\frac{5}{4}\right)$ (2) $\tan^{-1}\left(\frac{4}{5}\right)$
(3) $\tan^{-1}\left(\frac{3}{4}\right)$ (4) $\tan^{-1}\left(\frac{4}{3}\right)$

Q.17 A transformer with efficiency 80 % works at 4 kW and 100 V. If the secondary voltage is 200 V, then the primary and secondary currents are respectively–
(1) 40 A, 16 A (2) 16 A, 40 A
(3) 20 A, 40 A (4) 40 A, 20 A

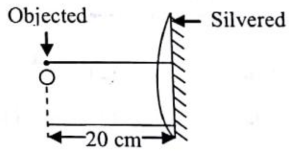
Q.18 In the circuit shown, the cell is ideal. The coil has an inductance of 4 H and zero resistance. F is a fuse of zero resistance and will blow when the current through it reaches 5 A. The switch is closed at t = 0. The fuse will blow -



(1) after 1 s (2) after 2s
(3) after 5s (4) after 10 s

Q.19 A square wire frame of side 3.0 cm is placed 25cm away from a concave mirror of focal length 10 cm. The centre of the wire frame is on the axis of the mirror, with its two sides normal to the mirror. The area enclosed by the image of the wire frame is –
(1) 2 cm^2 (2) 4 cm^2
(3) 8 cm^2 (4) 16 cm^2

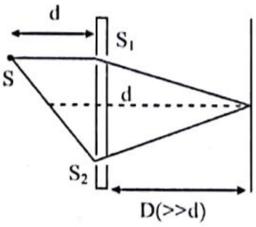
Q.20 An object O is placed at a distance of 20 cm from a thin plano-convex lens of focal length 15 cm. The plane surface of the lens is silvered as shown in fig. The image is formed at a distance of



(1) 60 cm to the right of the lens
(2) 30 cm to the left of the lens
(3) 24 cm to the right of the lens
(4) 12 cm to the left of the lens

Q.21 A ray of light is incident at an angle of 60° on one face of a 30° prism . The emergent ray from the prism makes an angle of 30° with the incident ray. The angle of emergence and refractive index of the material of the prism are-
(1) 90°, $\sqrt{3}$ (2) 0°, $\sqrt{3}$
(3) 0°, $\sqrt{2}$ (4) 90°, $\sqrt{2}$

Q.22 To obtain the central maximum at the centre, a mica sheet of refractive index 1.5 is introduced. Which of the following is correct?



(1) The thickness of sheet is $2(\sqrt{2}-1)$ d in front of S_1

(2) The thickness of sheet $(\sqrt{2}+1)$d in front of S_2

(3) The thickness of sheet is $(2\sqrt{2}\,d-1)$ in front of S_2

(4) The thickness of sheet is $(2\sqrt{2}-1)$ d in front of S_1

Q.23 Green light of wavelength 5000 Å from a narrow slit is incident on a double slit. If the overall separation of 10 fringes on a screen 200 cm away is 2 cm, the slit separation is-

(1) 5×10^{-4} m (2) 2.5×10^{-2} m
(3) 2.5×10^{-4} m (4) 5×10^{-2} m

Q.24 A person is not able to see objects farther than 80 cm clearly, while another person is not able to see objects beyond 120 cm, clearly. The powers of the lenses used by them for correct vision are in the ratio -

(1) 2 : 3 (2) 3 : 2 (3) 1 : 2 (4) 2 : 1

Q.25 Radiation coming from transitions n = 2 to n = 1 of hydrogen atoms falls on helium ions n = 1 and n = 2 states. What are the possible transitions of helium ions as they absorb energy from the radiation ?

(1) n = 1 to n = 2 and n = 2 to n = 3
(2) n = 1 to n = 3 and n = 2 to n = 4
(3) n = 2 to n = 3 and n = 2 to n = 4
(4) n = 1 to n = 2 and n = 2 to n = 4

Q.26 An electron with speed v and a photon with speed c have the same de-Broglie wavelength. If the kinetic energy and momentum of electron is E_e and P_e and that of photon is E_{ph} and P_{ph} respectively, then correct statement is -

(1) $\frac{E_e}{E_{ph}}=\frac{2c}{v}$ (2) $\frac{E_e}{E_{ph}}=\frac{v}{2c}$

(3) $\frac{P_e}{P_{ph}}=\frac{2c}{v}$ (4) $\frac{P_e}{P_{ph}}=\frac{v}{2c}$

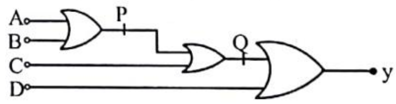
Q.27 A radioactive element X converts into another stable element Y. Half life of X is 2hrs. Initially only X is present. After time t, the ratio of atoms of X and Y is found to be 1 : 4, then t in hours is -

(1) 2 (2) 4
(3) between 4 and 6 (4) 6

Q.28 If mass of U^{235} = 235.12142 amu, mass of U^{236} = 1.008665 amu, then the energy required to remove one neutron from the nucleus U^{236} is nearly about -

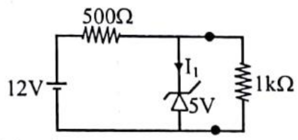
(1) zero (2) 6.5 MeV
(3) 75 MeV (4) 1 eV

Q.29 The expression of y in the given circuit is



(1) ABCD (2) A + BCD
(3) A + B + C + D (4) AB + CD

Q.30 The current flowing through the zener diode in figure is -



(1) 2 mA (2) 7 mA
(3) 9 mA (4) 5 mA

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

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②	②	②	②	②	②
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④	④	④	④	④	④
⑤	⑤	⑤	⑤	⑤	⑤
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Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

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5	①	②	③	④
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90	①	②	③	④

SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Practice Test for JEE Main
Major Test

Time allowed: 1 hours **Max. Marks : 120**

SYLLABUS

Physics : Full Syllabus

IMPORTANT INSTRUCTIONS

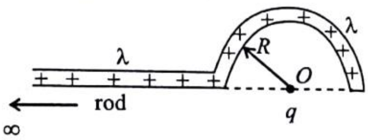
GENERAL :

1. This paper contains **30 Qs.** in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
4. The answer sheet, machine readable Optical Mark Recognition (**OMR**) is provided separately.
5. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
6. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers & Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct & Each correct answer will be awarded 4 Marks. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

Q.1 A charge particle of charge q is kept at the centre of the semicircular charged ring. If linear charge density is λ every where, as shown in the figure. Then net electrostatic force on the particle is –



(1) $\frac{\lambda q}{4\pi\varepsilon_0 R}$ (2) $\frac{\sqrt{5}\lambda q}{4\pi\varepsilon_0 R}$

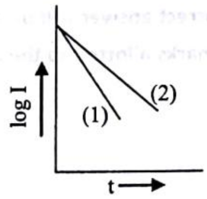
(3) $\frac{3\lambda q}{4\pi\varepsilon_0 R}$ (4) $\frac{\sqrt{2}\lambda q}{4\pi\varepsilon_0 R}$

Q.2 Two points are at distances a and b (a < b) from a long string of charge per unit length λ. The potential difference between the points is proportional to -

(1) b/a (2) b^2/a^2

(3) $\sqrt{b/a}$ (4) log(b/a)

Q.3 A capacitor of capacitance C is charged to a constant potential difference V and then connected in series with an open key and a pure resistor R. At time t = 0, the key is closed. If I is current at time t = 0, a plot of log I against t is shown as in the graph (1). Later one of the parameters, i.e. V, R and C is changed, keeping the other two constant and graph (2) is recorded. Then –



(1) C is reduced (2) C is increased

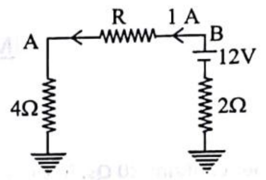
(3) R is reduced (4) R is increased

Q.4 Resistivity of iron is 1×10^{-7} ohm-metre. The resistance of the given wire of a particular thickness and length is 1 Ω. If the diameter and length of the wire both are doubled, the resistivity will be -

(1) 1×10^{-7} (2) 2×10^{-7}

(3) 4×10^{-7} (4) None of these

Q.5 In the circuit shown



(1) R = 8 ohms

(2) R = 6 ohms

(3) R = 10 ohms

(4) Potential difference between A and B is 2V

Q.6 An electron having kinetic energy T is moving in a circular orbit of radius R perpendicular to a uniform magnetic field induction $\vec{B}$. If kinetic energy is doubled and magnetic field induction is triple, the radius will become :

(1) $R\sqrt{\frac{9}{4}}$ (2) $R\sqrt{\frac{3}{2}}$

(3) $R\sqrt{\frac{2}{9}}$ (4) $R\sqrt{\frac{4}{3}}$

Q.7 A train is moving towards north with a speed of 180 kilometre per hour. If the vertical component of the earth's magnetic field is 0.2×10^{-4} T, the emf induced in the axle 1.5 m long is -

(1) 5.4 mV (2) 54 mV

(3) 15 mV (4) 1.5 mV

Q.8 A plane electromagnetic waves,
$E_z = 100 \cos (6 \times 10^8 t + 4x)$ V/m
Propagates in a medium of dielectric constant :

(1) 1.5 (2) 2.0

(3) 2.4 (4) 4.0

Q.9 A piece of n-type semiconductor is subjected to an electric field E_x. The left end of the semiconductor is exposed to a radiation so that electron-hole pairs are generated continuously. Let n be the number density of electrons. The electron current density J_e, is given by $J_e = en\mu_e E_x + eD_e \dfrac{dn}{dx}$. The dimensions of electron drift mobility (μ_e) and electron diffusion coefficient (D_e) are respectively.

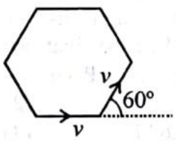
(1) $[M^{-1}T^{-2}I^{1}]$ and $[L^2T^{-1}]$
(2) $[M^{1}T^{-2}I^{-1}]$ and $[M^1L^2T^{-1}]$
(3) $[M^{-1}T^{2}I^{1}]$ and $[L^2T^{-1}]$
(4) $[M^{-1}T^{2}I^{2}]$ and $[L^1T^{-2}I^1]$

Q.10 An elevator of mass M is accelerated upwards by applying a force F. A mass m initially situated at a height of 1m above the floor of the elevator is falling freely. It will hit the floor of the elevator after a time equal to

(1) $\sqrt{\dfrac{2M}{F+mg}}$ (2) $\sqrt{\dfrac{2M}{F-mg}}$

(3) $\sqrt{\dfrac{2M}{F}}$ (4) $\sqrt{\dfrac{2M}{F+Mg}}$

Q.11 A particle of mass m is made to move with uniform speed v along the perimeter of a regular hexagon. Magnitude of impulse applied at each corner of the hexagon is



(1) mv (2) $mv\sqrt{3}$

(3) $\dfrac{mv}{2}$ (4) zero

Q.12 A force (F) acting on a body is dependent on its displacement s as $F \propto s^{-1/3}$. Therefore, the power delivered by the force varies with its displacement as

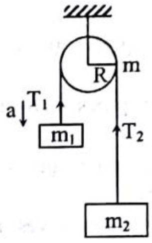
(1) $s^{2/3}$ (2) $s^{1/2}$
(3) $s^{-5/3}$ (4) s^{0}

Q.13 The maximum tension in the string of a simple pendulum is 1.2 times the minimum tension. If θ_0 is the angular amplitude, then θ_0 is

(1) $\cos^{-1}\left(\dfrac{4}{5}\right)$ (2) $\cos^{-1}\left(\dfrac{3}{4}\right)$

(3) $\cos^{-1}\left(\dfrac{15}{16}\right)$ (4) $\cos^{-1}\left(\dfrac{7}{8}\right)$

Q.14 Two bodies of masses m_1 and m_2 are attached to the two ends of a string. The string passes over a pulley of mass m and radius R. If $m_1 > m_2$, the acceleration of the system will be-



(1) $\dfrac{m_1 - m_2}{m_1 + m_2}g$ (2) $\dfrac{m_1 + m_2}{m_1 - m_2}g$

(3) $\dfrac{m_1 - m_2}{m_1 + m_2 + (1/2)m}$ (4) $\dfrac{m_1 - m_2 + m}{m_1 + m_2 + m}$

Q.15 Let A and B be the points respectively above and below the earth's surface each at a distance equal to half the radius of the earth. If the acceleration due to gravity at these points be g_A and g_B respectively, then $g_B : g_A$

(1) 1 : 1 (2) 9 : 8
(3) 8 : 9 (4) zero

Q.16 Four functions given below describe motion of a particle.

(I) $y = \sin \omega t - \cos \omega t$, (II) $y = \sin^3 \omega t$,

(III) $y = 5\cos\left(\dfrac{3\pi}{4} - 3\omega t\right)$, (IV) $y = 1 + \omega t + \omega^2 t^2$.

Therefore, simple harmonic motion is represented by

(1) only (I) (2) (I), (II) and (III)
(3) (I) and (III) (4) (I) and (II)

Q.17 A vibratory motion is represented by

$$x = 2A\cos\omega t + A\cos\left(\omega t + \frac{\pi}{2}\right) + A\cos(\omega t + \pi) + \frac{A}{2}\cos\left(\omega t + \frac{3\pi}{2}\right).$$

The resultant amplitude of the motion is

(1) $\frac{9A}{2}$ (2) $\frac{\sqrt{5}A}{2}$

(3) $\frac{5A}{2}$ (4) $2A$

Q.18 There are two organ pipes of the same length and the same material but of different radii. When they are emitting fundamental notes -

(1) broader pipe gives note of smaller frequency

(2) both the pipes give notes of the same frequency

(3) narrower pipe gives note of smaller frequency

(4) either of them gives note of smaller or larger frequency depending on the wavelength of the wave.

Q.19 A container of volume 0.1 m^3 is filled with nitrogen at a temperature of 47°C and a gauge pressure of 4.0×10^5 Pa. After some time, due to leakage, the gauge pressure drops to 3.0×10^5 Pa and the temperature to 27°C. The mass of nitrogen that has leaked out is about -

(1) 128 g (2) 84 g

(3) 154 g (4) 226 g

Q.20 Ninety percent of a radioactive sample is left over after a time interval t. The percentage of initial sample that will disintegrate in an interval $2t$ is -

(1) 38% (2) 19%

(3) 9% (4) 62%

Q.21 The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength 400 nm is 500 mV. When the incident wavelength is changed to a new value, the stopping potential is found to be 800 mV. New wavelength is about -

(1) 365 nm (2) 250 nm

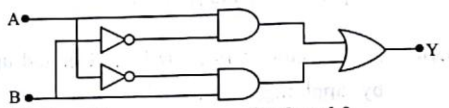
(3) 640 nm (4) 340 nm

Q.22 Two identical particles move at right angles to each other, possessing de Broglie wavelengths λ_1 and λ_2. The de Broglie wavelength of each of the particles in their centre of mass frame will be -

(1) $\sqrt{\frac{\lambda_1^2 + \lambda_2^2}{2}}$ (2) $\frac{\lambda_1 + \lambda_2}{2}$

(3) $\frac{2\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$ (4) $\frac{2\lambda_1\lambda_2}{\sqrt{\lambda_1^2 + \lambda_2^2}}$

Q.23 for the logic circuit given below, the outputs Y for A = 0, B = 0 and A = 1, B = 1 are -



(1) 0 and 1 (2) 0 and 0

(3) 1 and 0 (4) 1 and 1

Q.24 In a Young's double slit experiment sources of equal intensities are used. Distance between slits is d and wavelength of light used is λ($\lambda << d$). Angular separation of the nearest points on either side of central maximum where intensities become half of the maximum value is -

(1) $\frac{\lambda}{d}$ (2) $\frac{\lambda}{2d}$ (3) $\frac{\lambda}{4d}$ (4) $\frac{\lambda}{6d}$

Q.25 A certain quantity of oxygen (γ = 7/5) is compressed isothermally until its pressure is doubled (P_2). The gas is then allowed to expand adiabatically until its original volume is restored. Then the final pressure (P_3) in terms of initial pressure (P_1) is

(1) $P_3 = 0.55\ P_1$ (2) $P_3 = 0.76\ P_1$

(3) $P_3 = 0.68\ P_1$ (4) $P_3 = 2.55\ P_1$

Q.26 In a meter bridge experiment the resistance to be measured is connected in the right gap and a known resistance in the left gap has value of $50 \pm 0.2\ \Omega$ when the null points is judged to be at 60 ± 0.2 cm. The students notes that the ends of the bridge wire are not at 0.0 cm and 100.0 cm of the scale and makes a guess that they may be somewhere within 0.2 cm beyond the scale ends. The value of the unknown resistance should be expressed as

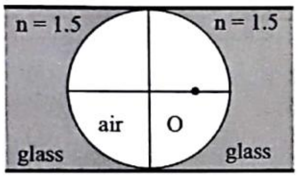
(1) $33.33 \pm 1\ \Omega$ (2) $75 \pm 1\ \Omega$

(3) $75.0 \pm 0.9\ \Omega$ (4) $33.4 \pm 0.5\ \Omega$

Q.27 Hot coffee in a mug cools from 90°C to 70°C in 4.8 minutes. the room temperature is 20°C. Applying Newton's law of cooling the time needed to cool it further by 10°C should be nearly -

(1) 4.2 min (2) 3.8 min
(3) 3.2 min (4) 2.4 min

Q.28 Two concave refracting surfaces of equal radii of curvature face each other in air as shown in figure. A point object O is placed midway between the centre and one of the poles. Then the separation between the images of O formed by each refracting surface is



(1) 11.4 R (2) 1.14R
(3) 0.114R (4) 0.0114 R

Q.29 The Th_{90}^{232} atom has successive alpha and beta decays to the end product Pb_{82}^{208}. The numbers of alpha and beta particles emitted in the process respectively are -

(1) 4, 6 (2) 4, 4
(3) 6, 2 (4) 6, 4

Q.30 In Fraunhroffer diffraction pattern due to a single slit, the screen is at distance of 100 cm from the slit and slit is illuminated by $\lambda = 5893Å$. The width of the slit is 0.1 mm. Then separation between central maxima and the first secondary minima

(1) 0.5893 cm (2) 5.893 cm
(3) 0.2946 cm (4) 2.946 cm

Practice Test for JEE Main

OMR SHEET

Use only HB pencils to darken the ovals and black pen for all other entries selection procedure

Incorrect	● ⊗ ✓
Correct	●

Do Not make any stray marks in the form Damaged form is liable to be rejected

Enrolment No.

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Test Date D D M M Y Y Y Y

Name of the Candidate (in Capital Letters)

Father Name (in Capital Letters)

Course

Examination Centre (In Capital Letters)

1	①	②	③	④	31	①	②	③	④	61	①	②	③	④
2	①	②	③	④	32	①	②	③	④	62	①	②	③	④
3	①	②	③	④	33	①	②	③	④	63	①	②	③	④
4	①	②	③	④	34	①	②	③	④	64	①	②	③	④
5	①	②	③	④	35	①	②	③	④	65	①	②	③	④
6	①	②	③	④	36	①	②	③	④	66	①	②	③	④
7	①	②	③	④	37	①	②	③	④	67	①	②	③	④
8	①	②	③	④	38	①	②	③	④	68	①	②	③	④
9	①	②	③	④	39	①	②	③	④	69	①	②	③	④
10	①	②	③	④	40	①	②	③	④	70	①	②	③	④
11	①	②	③	④	41	①	②	③	④	71	①	②	③	④
12	①	②	③	④	42	①	②	③	④	72	①	②	③	④
13	①	②	③	④	43	①	②	③	④	73	①	②	③	④
14	①	②	③	④	44	①	②	③	④	74	①	②	③	④
15	①	②	③	④	45	①	②	③	④	75	①	②	③	④
16	①	②	③	④	46	①	②	③	④	76	①	②	③	④
17	①	②	③	④	47	①	②	③	④	77	①	②	③	④
18	①	②	③	④	48	①	②	③	④	78	①	②	③	④
19	①	②	③	④	49	①	②	③	④	79	①	②	③	④
20	①	②	③	④	50	①	②	③	④	80	①	②	③	④
21	①	②	③	④	51	①	②	③	④	81	①	②	③	④
22	①	②	③	④	52	①	②	③	④	82	①	②	③	④
23	①	②	③	④	53	①	②	③	④	83	①	②	③	④
24	①	②	③	④	54	①	②	③	④	84	①	②	③	④
25	①	②	③	④	55	①	②	③	④	85	①	②	③	④
26	①	②	③	④	56	①	②	③	④	86	①	②	③	④
27	①	②	③	④	57	①	②	③	④	87	①	②	③	④
28	①	②	③	④	58	①	②	③	④	88	①	②	③	④
29	①	②	③	④	59	①	②	③	④	89	①	②	③	④
30	①	②	③	④	60	①	②	③	④	90	①	②	③	④

SIGNATURE OF CANDIDATE

SIGNATURE OF INVIGILATOR

Answers

With

Solutions

Practice Test for JEE Main

Answer Key

• Unit Test -1 •

1. (1)	**2.** (1)	**3.** (3)	**4.** (4)	**5.** (4)	**6.** (2)	**7.** (2)
8. (2)	**9.** (2)	**10.** (2)	**11.** (2)	**12.** (2)	**13.** (4)	**14.** (3)
15. (2)	**16.** (2)	**17.** (4)	**18.** (4)	**19.** (4)	**20.** (1)	**21.** (1)
22. (4)	**23.** (3)	**24.** (3)	**25.** (1)	**26.** (3)	**27.** (3)	**28.** (3)
29. (2)	**30.** (4)					

• Unit Test -2 •

1. (3)	**2.** (1)	**3.** (3)	**4.** (3)	**5.** (4)	**6.** (2)	**7.** (2)
8. (4)	**9.** (4)	**10.** (2)	**11.** (4)	**12.** (4)	**13.** (2)	**14.** (1)
15. (2)	**16.** (4)	**17.** (2)	**18.** (1)	**19.** (4)	**20.** (1)	**21.** (4)
22. (2)	**23.** (3)	**24.** (3)	**25.** (2)	**26.** (3)	**27.** (4)	**28.** (4)
29. (1)	**30.** (1)					

• Unit Test -3 •

1. (4)	**2.** (1)	**3.** (2)	**4.** (1)	**5.** (4)	**6.** (4)	**7.** (4)
8. (1)	**9.** (1)	**10.** (1)	**11.** (4)	**12.** (4)	**13.** (1)	**14.** (3)
15. (3)	**16.** (3)	**17.** (2)	**18.** (3)	**19.** (4)	**20.** (1)	**21.** (1)
22. (4)	**23.** (1)	**24.** (2)	**25.** (4)	**26.** (2)	**27.** (1)	**28.** (4)
29. (2)	**30.** (3)					

• Unit Test -4 •

1. (1)	**2.** (1)	**3.** (1)	**4.** (2)	**5.** (4)	**6.** (3)	**7.** (3)
8. (4)	**9.** (2)	**10.** (1)	**11.** (4)	**12.** (4)	**13.** (2)	**14.** (4)
15. (1)	**16.** (2)	**17.** (3)	**18.** (3)	**19.** (3)	**20.** (2)	**21.** (2)
22. (2)	**23.** (1)	**24.** (4)	**25.** (2)	**26.** (1)	**27.** (2)	**28.** (3)
29. (1)	**30.** (1)					

UNIT TEST -5

1. (4)	**2.** (3)	**3.** (2)	**4.** (2)	**5.** (2)	**6.** (4)	**7.** (1)
8. (2)	**9.** (2)	**10.** (4)	**11.** (3)	**12.** (1)	**13.** (2)	**14.** (4)
15. (1)	**16.** (2)	**17.** (2)	**18.** (4)	**19.** (1)	**20.** (1)	**21.** (2)
22. (3)	**23.** (3)	**24.** (3)	**25.** (1)	**26.** (4)	**27.** (3)	**28.** (3)
29. (2)	**30.** (3)					

REVISION TEST -1

1. (1)	**2.** (1)	**3.** (1)	**4.** (1)	**5.** (3)	**6.** (1)	**7.** (2)
8. (4)	**9.** (3)	**10.** (4)	**11.** (1)	**12.** (1)	**13.** (2)	**14.** (1)
15. (1)	**16.** (4)	**17.** (4)	**18.** (1)	**19.** (1)	**20.** (1)	**21.** (2)
22. (4)	**23.** (1)	**24.** (2)	**25.** (1)	**26.** (1)	**27.** (2)	**28.** (3)
29. (3)	**30.** (3)					

UNIT TEST -6

1. (2)	**2.** (1)	**3.** (1)	**4.** (2)	**5.** (3)	**6.** (1)	**7.** (1)
8. (2)	**9.** (4)	**10.** (4)	**11.** (3)	**12.** (3)	**13.** (1)	**14.** (3)
15. (1)	**16.** (1)	**17.** (3)	**18.** (2)	**19.** (4)	**20.** (3)	**21.** (1)
22. (4)	**23.** (3)	**24.** (4)	**25.** (1)	**26.** (2)	**27.** (3)	**28.** (4)
29. (4)	**30.** (2)					

UNIT TEST -7

1. (3)	**2.** (1)	**3.** (2)	**4.** (2)	**5.** (1)	**6.** (1)	**7.** (2)
8. (3)	**9.** (2)	**10.** (4)	**11.** (4)	**12.** (2)	**13.** (2)	**14.** (3)
15. (4)	**16.** (1)	**17.** (3)	**18.** (4)	**19.** (3)	**20.** (1)	**21.** (4)
22. (2)	**23.** (1)	**24.** (4)	**25.** (4)	**26.** (3)	**27.** (1)	**28.** (4)
29. (1)	**30.** (3)					

UNIT TEST -8

1. (4)	**2.** (3)	**3.** (1)	**4.** (3)	**5.** (2)	**6.** (2)	**7.** (4)
8. (1)	**9.**(1)	**10.** (4)	**11.** (1)	**12.** (2)	**13.** (2)	**14.** (2)
15. (4)	**16.** (3)	**17.** (4)	**18.** (1)	**19.** (2)	**20.** (1)	**21.** (3)
22. (1)	**23.** (1)	**24.** (4)	**25.** (3)	**26.** (2)	**27.** (2)	**28.** (2)
29. (4)	**30.** (3)					

UNIT TEST -9

1. (2)	**2.** (3)	**3.** (3)	**4.** (3)	**5.** (2)	**6.** (2)	**7.** (1)
8. (2)	**9.** (4)	**10.** (4)	**11.** (3)	**12.** (3)	**13.** (2)	**14.** (4)
15. (4)	**16.** (3)	**17.** (1)	**18.** (2)	**19.** (3)	**20.** (4)	**21.** (1)
22. (4)	**23.** (3)	**24.** (1)	**25.** (4)	**26.** (2)	**27.** (1)	**28.** (3)
29. (2)	**30.** (1)					

UNIT TEST -10

1. (1)	**2.** (2)	**3.** (2)	**4.** (1)	**5.** (2)	**6.** (2)	**7.** (1)
8. (2)	**9.** (1)	**10.** (1)	**11.** (2)	**12.** (2)	**13.** (3)	**14.** (2)
15. (2)	**16.** (2)	**17.** (2)	**18.** (1)	**19.** (2)	**20.** (3)	**21.** (4)
22. (1)	**23.** (1)	**24.** (2)	**25.** (1)	**26.** (2)	**27.** (2)	**28.** (3)
29. (2)	**30.** (3)					

REVISION TEST -2

1. (3)	**2.** (3)	**3.** (3)	**4.** (1)	**5.** (3)	**6.** (2)	**7.** (4)
8. (4)	**9.** (2)	**10.** (1)	**11.** (4)	**12.** (1)	**13.** (3)	**14.** (2)
15. (3)	**16.** (4)	**17.** (1)	**18.** (4)	**19.** (2)	**20.** (4)	**21.** (2)
22. (1)	**23.** (1)	**24.** (2)	**25.** (3)	**26.** (2)	**27.** (3)	**28.** (2)
29. (3)	**30.** (3)					

MAJOR TEST

1. (2)	**2.** (4)	**3.** (2)	**4.** (1)	**5.** (2)	**6.** (3)	**7.** (3)
8. (2)	**9.** (3)	**10.** (4)	**11.** (1)	**12.** (4)	**13.** (3)	**14.** (3)
15. (2)	**16.** (3)	**17.** (2)	**18.** (1)	**19.** (2)	**20.** (2)	**21.** (1)
22. (4)	**23.** (2)	**24.** (2)	**25.** (2)	**26.** (4)	**27.** (3)	**28.** (3)
29. (4)	**30.** (1)					

Unit Test-1

Hints & Solutions

1. **[1]**

$$\frac{dx}{d\theta} = a(1+\cos\theta)\ ;\ \frac{dy}{d\theta} = a(0+\sin\theta)$$

$$\frac{dy}{dx} = \frac{dy}{d\theta} \Big/ \frac{d\theta}{dx} = \frac{a\sin\theta}{a(1+\cos\theta)}$$

2. **[1]**

At $y = 1, x = 0$

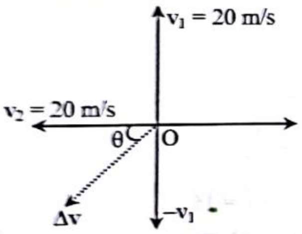
3. **[3]**

$$\left[\frac{\log(2+3x)}{3}\right]_2^5$$

$$\frac{1}{3}(\log 17 - \log 8) = \frac{1}{3}\ \ell n\frac{17}{8}$$

4. **[4]**

From figure



$\vec{v}_1 = 20\hat{j}$ and $\vec{v}_2 = -20\hat{i}$

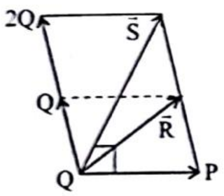
$\Delta\vec{v} = \vec{v}_2 - \vec{v}_1 = -20(\hat{i}+\hat{j})$

$|\Delta\vec{v}| = 20\sqrt{2}$ and direction

$\theta = \tan^{-1}(1) = 45°$ i.e. S–W

5. **[4]**

$$\tan 90° = \frac{2Q\sin\theta}{p+2Q\cos\theta}$$



$\Rightarrow P + 2Q\cos\theta = 0$

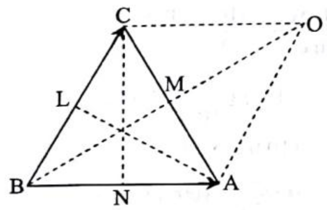
$\&\ R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$= Q^2 + P(P + 2Q\cos\theta)$

$= Q^2 + 0$

$\Rightarrow R = Q$

6. **[2]**



$\because\ \overrightarrow{BO} = \overrightarrow{BA} + \overrightarrow{BC}$

$= 2\overrightarrow{BM}$

7. **[2]**

$P = F/A = MLT^{-2}/L^2 = ML^{-1}T^{-2}$

$$b = \frac{t^2}{Px} = \frac{T^2}{ML^{-1}T^{-2}L} = M^{-1}T^4$$

$a = Pbx = T^2$

$$\frac{a}{b} = M^1L^0T^{-2}$$

8. **[2]**

$$\frac{EJ^2}{M^5G^2} = M^0L^0T^0$$

9. **[2]**

Moment of inertia and force

10. **[2]**

$$\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I} = \frac{5}{100} + \frac{0.2}{10}$$

$$\frac{\Delta R}{R} \times 100 = 7\,\%$$

11. [2]

Average value $= \dfrac{2.63+2.56+2.42+2.71+2.80}{5}$

$= 2.62$ sec.

Now $|\Delta T_1| = 2.63 - 2.62 = 0.01$

$|\Delta T_2| = 2.62 - 2.56 = 0.06$

$|\Delta T_3| = 2.62 - 2.42 = 0.20$

$|\Delta T_4| = 2.71 - 2.62 = 0.09$

$|\Delta T_5| = 2.80 - 2.62 = 0.18$

Mean absolute error

$$\Delta T = \frac{|\Delta T_1|+|\Delta T_2|+|\Delta T_3|+|\Delta T_4|+|\Delta T_5|}{5}$$

$$\Delta T = \frac{0.54}{5} = 0.108 = 0.11 \text{ sec.}$$

12. [2]

$$v = \frac{\text{distance}}{\text{time}} = \frac{(10.0 \pm 0.5)}{(2.0 \pm 0.1)} \frac{\text{m}}{\text{s}}$$

$$\text{distance} = \left(10.0 \pm \frac{0.5}{10.0} \times 100\%\right)$$

$= (10.0 \pm 5\%)$

$$\text{time} = \left(2.0 \pm \frac{0.1}{2.0} \times 100\%\right)$$

$= (2.0 \pm 5\%)$

velocity $= 5.0 \pm 10\% = 5.0 \pm (5.0 \times 10\%)$

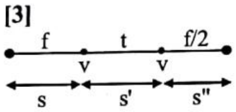
13. [4]

Net disp. = 0

$$\text{and } V_{avg} = \frac{2 + \frac{\pi r}{2}}{\left(\frac{1}{6}\right)}$$

$$= 21.4 \frac{\text{km}}{\text{hr}}$$

14. [3]



$$s'' = \frac{v^2}{2(f/2)}$$

but $s = \dfrac{v^2}{2f}$ $\therefore s'' = 2s$

and $s' = 12s$

and $12s = vt$ ....(1)

and $v^2 = 2fs$ ....(2)

from (1) and (2)

$144 s^2 = (2fs).t^2$

$$\therefore s = \frac{ft^2}{72}$$

15. [2]

$$t = \frac{d}{\sqrt{v^2 - u^2}}$$

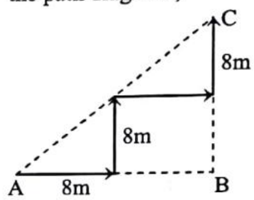
$$\frac{15}{60} = \frac{1}{\sqrt{5^2 - 4^2}}$$

$$v_r = \sqrt{5^2 - 4^2} = 3 \text{ km/h}$$

16. [2]

17. [4]

Maximum possible displacement is only when he will turns, left & right alternatively. According to the path diagram ;



The displacement $AC = \sqrt{AB^2 + BC^2}$

$= \sqrt{(16)^2 + (16)^2}$

$= 16\sqrt{2}$ m

18. [4]

$\because \vec{v}_{S,B} = \vec{v}_S - \vec{v}_B$

$\because \vec{v}_S = \vec{v}_{S,B} + \vec{v}_B$

$= 10\hat{j} + 5\hat{j} = 15\hat{j}$

Velocity of stone w.r.t. ground = 15 m/s upward

$\because v = u + at$

$= 15 - gt = 15 - 20 = -5$ m/s

19. [4]

$$h = \frac{1}{2}gt_1^2$$

$$\& \ 2h = \frac{1}{2}g(t_1 + t_2)^2$$

$$\& \ 3h = \frac{1}{2}g(t_1 + t_2 + t_3)^2$$

$\therefore t_1 : t_1 + t_2 : t_1 + t_2 + t_3 = 1 : \sqrt{2} : \sqrt{3}$

$\therefore t_1 : t_2 : t_3 = 1 : (\sqrt{2} - 1) : (\sqrt{3} - \sqrt{2})$

20. [1]

$a = V\dfrac{dv}{dx}$

21. [1]

For A

$S_5 = \dfrac{a_1}{2}(2\times5-1)$

For B

$S_3 = \dfrac{a_2}{2}(2\times3-1)$

Given that

$\dfrac{a_1}{2}(2\times5-1) = \dfrac{a_2}{2}(2\times3-1)$

$9a_1 = 5a_2$

22. [4]

Reason of (A) $\rightarrow$ because $t \propto \sqrt{h}$ not speed

Reason of (B) $\rightarrow$ because range is greatest of C

Reason of (C) $\rightarrow$ same as (B)

or

(i) $H = \dfrac{u_y^2}{2g}$ or $u_y = \sqrt{2Hg}$

(ii) $T = \dfrac{2u_y}{g}$

$\therefore$ T is same for all

(iii) $R = u_xT$

Or $u_x \propto R$

$\therefore$ horizontal velocity component is greatest for particle C

(iv) $u = \sqrt{u_x^2 + u_y^2}$

$\therefore$ launch speed is greatest for particle C

23. [3]

$R = u\sqrt{\dfrac{2H}{g}} \Rightarrow nb = u\sqrt{\dfrac{2nh}{g}}$

24. [3]

$H = \dfrac{u_y^2}{2g}$

$H' = \dfrac{u_y^2}{2\left(\dfrac{11g}{10}\right)}$

$\dfrac{H}{H'} = \dfrac{11}{10}$

$H' = \dfrac{10}{11}H$

% decrease in height

$= \dfrac{H-H'}{H}\times100$

$= \dfrac{100}{11} \cong 9\%$

25. [1]

$R = 2H$ given

Let θ = angle of projection

$\dfrac{2v_xv_y}{g} = 2.\dfrac{{v_y}^2}{2g}$

$\dfrac{v_y}{v_x} = 2$

$\tan\theta = 2$

From triangle we can say that

$\sin\theta = \dfrac{2}{\sqrt5}, \cos\theta = \dfrac{1}{\sqrt5}$

$\therefore$ Range of projectile $R = \dfrac{2v^2\sin\theta\cos\theta}{g}$

$= \dfrac{2v^2}{g}\times\dfrac{2}{\sqrt5}\times\dfrac{1}{\sqrt5} = \dfrac{4v^2}{5g}.$

26. [3]

$\vec{L} = \vec{r}\times(m\vec{v})$

$\vec{r} = v_0\cos\theta t\ \hat{i} + (v_0\sin\theta t - \dfrac{1}{2}gt^2)\ \hat{j}$

$\vec{v} = v_0\cos\theta\ \hat{i} + (v_0\sin\theta - gt)\ \hat{j}$

$\vec{L} = mv_0\cos\theta t\left(-\dfrac{1}{2}gt\right)\hat{k}$

$= -\dfrac{1}{2}mg\,v_0t^2\cos\theta\ \hat{k}$

27. [3]

$t = \dfrac{x}{u_1\cos\theta_1 - u_2\cos\theta_2}$ ...(i)

And $u_1\sin\theta_1 .t - \dfrac{1}{2}gt^2 = u_2\sin\theta_2.t - \dfrac{1}{2}gt^2$

$\therefore\ u_1 \sin\theta_1 = u_2 \sin\theta_2$ ...(ii)

from equation no. (i) & (ii)

$$t = \frac{x}{u_1 \cos\theta_1 - \frac{u_1 \sin\theta_1 . \cos\theta_2}{\sin\theta_2}}$$

$$\therefore\ t = \frac{x \sin\theta_2}{u_1 \sin(\theta_2 - \theta_1)}$$

28. [3]

$y = ax - bx^2$

for y to be maximum (H)

$$\frac{dy}{dx} = 0$$

$a - 2bx = 0$

$$x = \frac{a}{2b}$$

$$y_{max} = a\left(\frac{a}{2b}\right) - v\left(\frac{a}{2b}\right)^2 = \frac{a^2}{4b}$$

$$\left(\frac{dy}{dx}\right)_{x=0} = a = \tan\theta_0$$

where θ_0 is the angle of projectile

$\theta_0 = \tan^{-1}(a)$

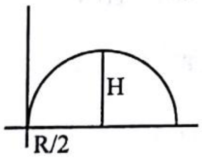
29. [2]

$$\frac{1}{2}at^2 = ut$$

$$u = \frac{a}{2}\sqrt{\frac{2H}{g}}$$

$$u = a\sqrt{\frac{H}{2g}}$$

30. [4]



$$v = \frac{\text{displacement}}{\text{time}} = \frac{\sqrt{\left(\frac{R}{2}\right)^2 + H^2}}{T/2}$$

$$= \frac{\sqrt{\left(\frac{u_0^2 \sin 2\theta}{2g}\right)^2 + \left(\frac{u_0^2 \sin^2\theta}{2g}\right)^2}}{\frac{u_0 \sin\theta}{g}}$$

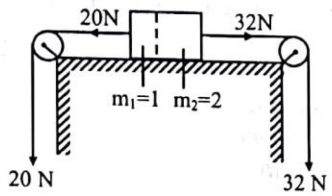
$$= \frac{\frac{u_0^2 \sin\theta}{2g}\sqrt{4\cos^2\theta + \sin^2\theta}}{\frac{u_0 \sin\theta}{g}}$$

$$= \frac{u_0}{2}\sqrt{1 + 3\cos^2\theta}$$

Unit Test-2

Hints & Solutions

1. [3]

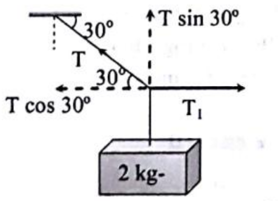


$32 - 20 = 3a$
$12 = 3a$
$a = 4\ m/s^2$

2. [1]
When m_1 & m_2 not moving
Then $W_1 = (m_1 + m_2)\ g$
When m_1 & m_2 are moving
$$W_2 = \frac{4m_1m_2g}{m_1 + m_2}$$
$\therefore$ Reduced wt $= W_1 - W_2$

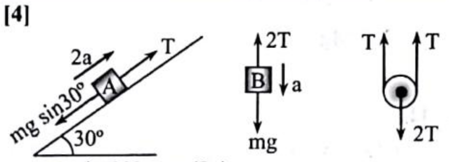
3. [3]
$F = 600 - 2 \times 10^5\ t = 0$
$$t = \frac{600}{2\times 10^5} = 3 \times 10^{-3}\ s$$
$$\text{Impulse} = \int_0^t F dt$$

4. [3]
$T \sin 30 = 2 kg\ wt \Rightarrow T = 4\ kg\ wt$



$T_1 = T\cos 30° = 4\cos 30° = 2\sqrt{3}$
and $T\sin30° = 2g$

5. [4]



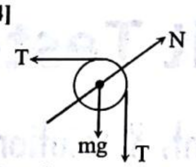
$T - mg \sin 30° = m (2a)$
or $T - \frac{mg}{2} = 2ma$ ...(1)
and $mg - 2T = ma$ ...(2)
Solving equation (1) and (2) we get
$a = 0$

6. [2]
in upward acceleration or downward deceleration
$N = mg + ma$
$N > mg$
in downward acceleration or upward deceleration
$N = mg - ma$
$N < mg$

7. [2]
Net during force
$= m_A g \sin 60° + m_B g \sin 60° - m_C g \sin 30°$
$= 1 \times 10 \frac{\sqrt{3}}{2} + 3 \times 10 \frac{\sqrt{3}}{2} - 2 \times 10 \times \frac{1}{2}$
$= 24.64$ N
Total mass being pulled $= 1 + 3 + 2 = 6$ kg
$\therefore$ Acceleration of the system
$$a = \frac{24.66}{6} = 4.11\ ms^{-2}$$

8. [4]
Area enclosed by F - t curve given change in momentum
$\Delta P = P_f - P_i = m(V_f - V_i) = \int Fdt = 100$
$mv_f = 100$
$$v_f = \frac{100}{2} = 50\ m/sec$$

9. [4]

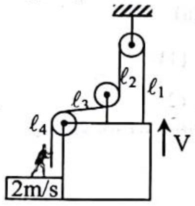


$N^2 = T^2 + (mg + T)^2$

put $T = Mg$

10. [2]

$\ell_1 + \ell_2 + \ell_3 = C$

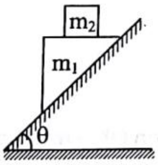


$\frac{d\ell_1}{dt} + \frac{d\ell_2}{dt} + \frac{d\ell_3}{dt} + \frac{d\ell_4}{dt} = 0$

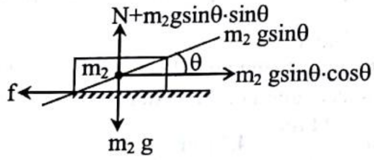
$-v - v + 0 + v + 2 = 0$

$v = 2$ m/s

11. [4]



Both blocks have acceleration g sin θ



(In frame of m_1)

$N = m_2g - m_2g\sin^2\theta = m_2g\cos^2\theta$

$f = \mu N$

$\Rightarrow f = \mu m_2 g\cos^2\theta$ ...(1)

$f = m_2 g\sin\theta\cdot\cos\theta$ ...(2)

comparing equ^n (1) & (2)

$\mu m_2 g\cos^2\theta = m_2 g\sin\theta\cos\theta$

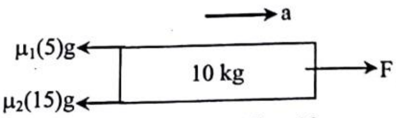
$\mu\cos\theta = \sin\theta$

$\tan\theta = \mu$

12. [4]

$(F + 80N) - \mu_2(5\text{ kg} + 10\text{ kg})g = (15\text{ kg})a$

$\frac{F+80-60}{15} = a$ ...(1)



$F - \mu_2(15)\times 10 - \mu_1(5\times 10) = 10\times a$

$\frac{F-90}{10} = a$ ...(2)

So, we can write

$\frac{F+20}{15} = \frac{F-90}{10}$

$F = 310$ N

13. [2]

As the man is standing stationary w.r.t. the horizontal conveyor belt, he is also accelerating at 1 ms^{-2}, the acceleration of the belt. Thus,

Acceleration of the man, $a = 1\ ms^{-2}$

Mass of the man, M = 65 kg

Therefore, net force on the man, $Ma = 65 \times 1 = 65$ N

The limiting friction between the shoes of the man and the belt is given by

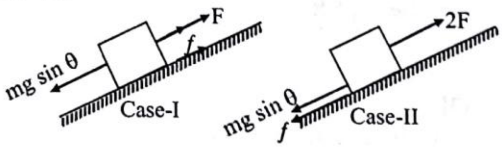
$F = \mu Mg = 0.2 \times 65 \times 9.8$ N

If, the man can remain stationary upto an acceleration say a', then

$Ma' = F$

or $a' = \frac{F}{M} = \frac{0.2\times 65\times 9.8}{65} = 1.96\ ms^{-2}$

14. [1]



Case (1), $F + f = mg\sin\theta$

Case (2), $2F = f + mg\sin\theta$

$2(mg\sin\theta - f) = f + mg\sin\theta$

$mg\sin\theta = 3f$

$mg\sin\theta = 3\mu mg\cos\theta$

$\mu = \frac{1}{3}\tan\theta$

15. [2]

On smooth surface

$a_1 = g\sin\theta$

On rough surface

$a_2 = g\sin\theta - \mu g\cos\theta$

$S = \frac{1}{2}at^2 \Rightarrow t \propto \frac{1}{\sqrt{a}}$

$\frac{t}{2t} = \sqrt{\frac{g\sin\theta - \mu g\cos\theta}{g\sin\theta}}$

$\frac{1}{4} = 1 - \mu\cot\theta$

$\mu = \frac{3}{4} = .75$

16. [4]

$a = \omega^2 x$ or $\frac{vdv}{dx} = \omega^2 x$

$\int_0^v vdv = \int_a^\ell \omega^2 x dx$

$v = \omega\sqrt{\ell^2 - a^2}$

17. [2]

$v = \sqrt{2gL}$

Let at angle θ $\quad v' = \frac{v}{2} = \sqrt{\frac{gL}{2}}$

$\frac{1}{2}mv^2 = \frac{1}{2}mv'^2 + mgR(1 - \cos\theta)$

$\cos\theta = \frac{1}{4}$

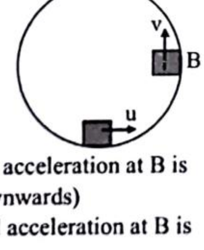
$\frac{\pi}{4} < \theta < \frac{\pi}{2}$

18. [1]

$u^2 = 5gR$

$\therefore v^2 = u^2 - 2gR$

$= 5gR - 2gR = 3gR$



Tangential acceleration at B is

$a_t = g$ (downwards)

Centripetal acceleration at B is

$a_C = \frac{v^2}{R} = 3g$

$\therefore$ Total acceleration will be

$a = \sqrt{a_C^2 + a_t^2} = g\sqrt{10}$

19. [4]

$v_c = \sqrt{g}R$; $v_A = \sqrt{5}gR$; $v_B = \sqrt{3}gR$

$v_A : v_B : v_C :: \sqrt{5} : \sqrt{3} : 1$

20. [1]

$\tan\theta = \frac{h}{d} = \frac{v^2}{rg}$

21. [4]

Let extension in cord is x

$Mg(L + x) = \frac{1}{2}Kx^2$

$\Rightarrow Kx^2 - 2Mgx - 2MgL = 0$

$x = \frac{2Mg \pm \sqrt{4M^2g^2 + 8KMgL}}{2K}$

$= \frac{Mg}{K}\left\{1 + \sqrt{1 + \frac{2KL}{Mg}}\right\}$

22. [2]

$P_i = P_f \Rightarrow (M + m)v = M\sqrt{2gh}$

$W = \Delta k + \Delta U$

$\Rightarrow f.d = \frac{1}{2}(M + m)\left\{\frac{M^2(2gh)}{(M + m)^2}\right\} + (M + m)gd$

23. [3]

$W = \int_2^3 3x^2dx + \int_3^0 4dy$

24. [3]

Power, $\quad P = m \times a \times v$

$P = m \times \frac{v^2}{t}$

If P is constant, then for a given body $v^2 \propto t$

or $v \propto \sqrt{t}$

25. [2]

$\because K + U = mgH$ & $K = 2U$

$\therefore 2U + U = mgH$

$\Rightarrow U = \frac{mgH}{3} \Rightarrow mgh = \frac{mgH}{3} \Rightarrow h = H/3$

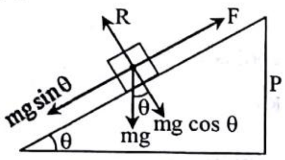
$\therefore \frac{1}{2} mv^2 = 2U = \frac{2mgH}{3} \Rightarrow v = 2\sqrt{\frac{gH}{3}}$

26. [3]

$W = \frac{1}{2} \times 20 \times 4 - \frac{1}{2} \times 10 \times 2$

$= 30$ J

27. [4]



$v = 7.2$ km/h $= 7.2 \times \frac{5}{18} = 2$ m/s

slope is given 1 in 20

$\sin\theta = \frac{1}{20}$

$\Rightarrow F = mg\sin\theta$

So power of the man $P = F \times v = mg\sin\theta \times v$

$= 100 \times 9.8 \times \frac{1}{20} \times 2$

$= 98$ Watt

28. [4]

Condition for stable equilibrium

$\Rightarrow F = -\frac{dU}{dx} = 0$

$\Rightarrow -\frac{d}{dx}\left[\frac{a}{x^{12}} - \frac{b}{x^6}\right] = 0$

$\Rightarrow -12ax^{-13} + 6bx^{-7} = 0$

$\Rightarrow \frac{12a}{x^{13}} = \frac{6b}{x^7} \Rightarrow \frac{2a}{b} = x^6 \Rightarrow x = \sqrt[6]{\frac{2a}{b}}$

29. [1]

Let initial energy $E_1 = E$

final KE; $E_2 = E + 300\%$ of $E = 4E$

As $P \propto \sqrt{E} \Rightarrow \frac{P_2}{P_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4E}{E}} = 2$

$\Rightarrow P_2 = 2P_1 \Rightarrow P_2 = P_1 + 100\%$ of P_1

i.e. momentum will increase by 100%

30. [1]

Weight of overhanging part of chain $= \frac{mg}{6}$

The weight acts at the centre of gravity of the overhanging part,

i.e., $\frac{\ell}{12}$ below the surface of table.

Gain in potential energy $= \frac{mg}{6} \times \frac{\ell}{12} = \frac{mg\ell}{72}$

$\therefore$ Work done = gain in potential energy $= \frac{mg\ell}{72}$

Hints & Solutions

1. **[4]**

Vertical velocity after collision = e u sinθ

$$\text{So } x = R + R' = \frac{u^2 \sin 2\theta}{g} + \frac{2u\cos\theta(eu\sin\theta)}{g}$$

$$= \frac{u^2 \sin 2\theta}{g}(1+e)$$

2. **[1]**

By conservation of momentum

$m_1v_1 = (m_1 + m_2)v$

or $m_1\sqrt{2gd} = (m_1 + m_2)v$

let centre of mass rise through a height h

$$\frac{1}{2}(m_1 + m_2)v^2 = (m_1 + m_2)gh$$

$$h = d\left\{\frac{m_1}{m_1 + m_2}\right\}^2$$

3. **[2]**

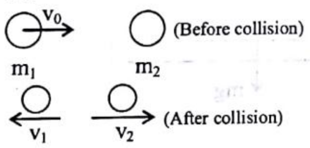
$mu + M_1 \times 0 = M_1V + mu_1$ (for I[st] plate)

$mu_1 + M_2 \times 0 = (m + M_2)V$ (for II[nd] plate)

from I[st] & II[nd] equation $\frac{u_1}{u} = \frac{3}{4}$

$$\text{so \% loss} = \frac{u_1 - u}{u} \times 100\% = 25\%$$

4. **[1]**



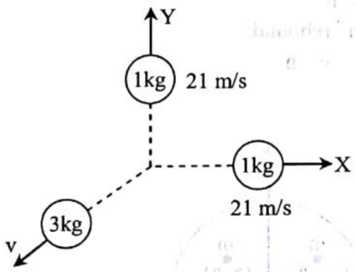
$m_1v_0 = m_2v_2 - m_1v_1$ ....(1)

$e = \frac{v_1 + v_2}{v_0} = 1$ ....(2)

Solving (1) and (2)

$$\left(\frac{v_1}{v_0}\right)^2 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$$

5. **[4]**



$P_x = mv_x = 21$ kg m/s

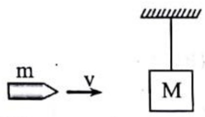
$P_y = mv_y = 21$ kg m/s

Resultant $= \sqrt{P_x^2 + P_y^2} = 21\sqrt{2}$ kg m/s

$3 \times v = \sqrt{P_x^2 + P_y^2} = 21\sqrt{2}$

$\Rightarrow v = 7\sqrt{2} = 9.89$ m/s

6. **[4]**



Initial momentum = mv

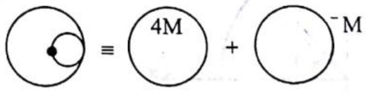
final momentum = (m + M) V

mv = (m + M) V

$$\Rightarrow V = \frac{mv}{(M+m)}$$

$$KE = \frac{1}{2}(m+M)V^2 = \frac{1}{2}\frac{m^2v^2}{(M+m)}$$

7. **[4]**



$$X_{cm} = \frac{4M(0) - M(R/2)}{4M - M} \Rightarrow X_{cm} = -\frac{R}{6}$$

at a distance $\frac{R}{6}$ from centre.

8. [1]

$\downarrow v = \sqrt{2gh}$ $\quad \uparrow v' = e\sqrt{2gh} = \sqrt{2gh'}$

$v' = ev$

$v' = ev$

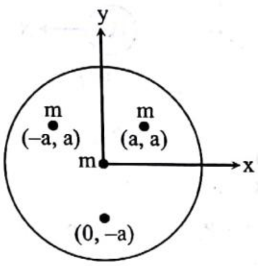
$\sqrt{2gh'} = e\sqrt{2gh}$

$h' = e^2 h$

For n^{th} rebound

$h'_{n^{th}} = e^{2n} h$

9. [1]



$$y_{cm} = \frac{6m \times 0 + ma + ma + m \times 0 + m(-a)}{10m}$$

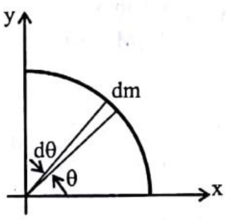
$$y_{cm} = \frac{a}{10}$$

10. [1]

$$x_{CM} = \frac{M(0) - \frac{Mb^2}{R^2}(R-b)}{M - \frac{Mb^2}{R^2}}$$

$$= -\frac{b^2}{R+b}$$

11. [4]



$$dm = \lambda R d\theta = \frac{2m}{\pi} d\theta$$

$$\therefore\ x_{cm} = \frac{1}{m}\int x\,dm$$

$$= \frac{1}{m}\int_0^{\pi/2} R\cos\theta \frac{2m}{\pi} d\theta$$

Similarly $y_{cm} = \dfrac{1}{m}\displaystyle\int_0^{\pi/2} R\sin.\theta \frac{2m}{\pi} d\theta$

12. [4]

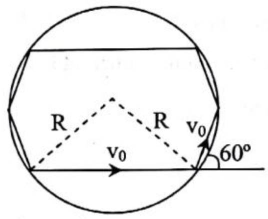
$mv_0 = mv + mv$

$$v = \frac{v_0}{2}$$

$k_I + v_i = k_f + v_f$

$$\frac{1}{2}mv_0^2 + 0 = \frac{1}{2}\mu\left(\frac{v_0}{2}\right)^2 \times 2 + \frac{1}{2}kx_0^2$$

13. [1]



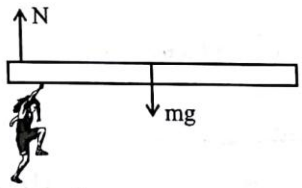
I = change in momentum

$$= \sqrt{(mv_0)^2 + (mv_0)^2 - 2(mv_0)^2 - 2(mv_0)^2\cos 60^\circ}$$

$$= mv_0\sqrt{2 - 2\cos(\pi/3)} = 2\ mv_0 \sin\frac{\pi}{6}$$

14. [3]

When both support, the force exerted by each $= \dfrac{mg}{2}$



when one leave

$$\tau = mg\left\{\frac{\ell}{2}\right\} = I\alpha = \frac{m\ell^2}{3}\alpha$$

$$\alpha = \frac{3g}{2\ell} \Rightarrow a_{CM} = \left(\frac{\ell}{2}\right) \times \frac{3g}{2\ell} = \frac{3g}{4}$$

$$\text{So } mg - N = m\left\{\frac{3g}{4}\right\} \Rightarrow N = \frac{mg}{4}$$

15. [3]

$$I = 0 + \frac{mL^2}{3} + mL^2 = \frac{4}{3}mL^2$$

from energy conservation

$$\frac{1}{2}I\omega^2 = 0 + mg\frac{L}{2} + mgL$$

$$\text{So } \omega = \frac{3}{2}\sqrt{\frac{g}{L}}$$

16. [3]

$$mvL = \left(\frac{ML^2}{3} + mL^2\right)\omega$$

$$\omega = \frac{3mv}{(M+3m)L}$$

17. [2]

$$v_f = v - \frac{f}{m}t \quad .....(1)$$

$$fr = I\alpha = \frac{2}{3}mr^2\alpha \quad \text{So} \quad \alpha = \frac{3}{2}\frac{f}{mr}$$

$$\omega_f = 0 + \alpha t \quad .....(2)$$

for pure rolling $v_f = r\omega_f \Rightarrow v_f = \frac{2}{5}v$

18. [3]

Thoery $I\omega = \text{constant}$

$$\omega \propto \frac{1}{I}$$

19. [4]

$$t = \sqrt{\frac{2s}{g\sin\theta}\left(1+\frac{K^2}{R^2}\right)}$$

$$\frac{t_1}{t_2} = \sqrt{\frac{1+\frac{2}{5}}{1+\frac{1}{2}}} = \sqrt{\frac{14}{15}}$$

20. [1]

$$I = \frac{9M(R^2)}{2} - \left\{M\left(\frac{R}{3}\right)^2 + M\left(\frac{2R}{3}\right)^2\right\}$$

$$= 4\ MR^2$$

21. [1]

$TE._A = T.E_B = T.E_C$

$$0 + Mgh_A = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + mgr$$

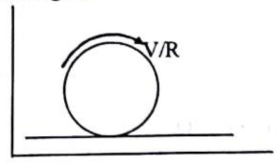
$$= \frac{1}{2}I\omega^2 + MghC$$

So $k_B > k_C > k_A$

So $h_A > h_c$

22. [4]

From figure



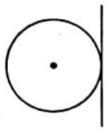
V=Rω

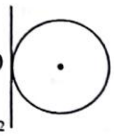
V_{net} (for lowest point) $= v - R\omega = v - v = 0$

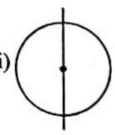
and Acceleration $= \frac{v^2}{R} + 0 = \frac{v^2}{R}$

(Since linear speed is constant)

23. [1]

(i)  $I_1 = \frac{3}{2}PQ^2$

(ii)  $I_2 = \frac{3}{2}PQ^2$

(iii)  $I_3 = \frac{PQ^2}{2}$

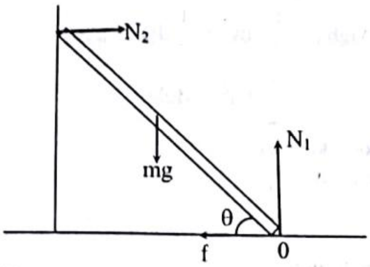
$$I = I_1 + I_2 + I_3 = \frac{7}{2}PQ^2$$

24. [2]

$$a = \frac{mg}{m + I/r^2} = \frac{19.6}{12}$$

$$\alpha = \frac{a}{R} = 16.33\ \text{rad/s}^2$$

25. [4]



$N_1 = mg$ ....(1)

$N_2 = f = \mu N_1$

$N_2 = \mu N_1$

$N_2 = \mu mg$

torque about point 'O'

$$Mg\left(\frac{1}{2}\cos\theta\right) = N_2\, \ell \sin\theta$$

$$Mg\,\frac{1}{2}\cos\theta = \mu mg\, \ell \sin\theta$$

$$\tan\theta = \frac{1}{2\mu}$$

$$\theta = \tan^{-1}\left(\frac{1}{2\mu}\right)$$

$$\vec{\tau}_{\text{anticlockwise}} = \vec{\tau}_{\text{clockwise}}$$

26. [2]

$$\frac{1}{2}I\omega^2 = mg\,\frac{\ell}{2}(1-\cos\theta)$$

$$\frac{1}{2}\times\frac{m\ell^2}{3}\times\omega^2 = mg\,\frac{\ell}{2}\times 2\sin^2\frac{\theta}{2}$$

$$\omega = \sqrt{\left(\frac{6g}{\ell}\right)}\left(\sin\frac{\theta}{2}\right)$$

27. [1]

$$\frac{1}{2}MV^2 + \frac{1}{2}I\omega^2 \ge Mgh$$

$$V \ge \sqrt{\frac{10}{7}gh}$$

28. [4]

Magnitude of angular momentum will decrease as L = mvr and v is decreasing

⇒ direction of acceleration will not be towards centre due tangential retardation.

29. [2]

$I = MR^2 = (2\pi RAd)R^2$

or $I \propto R^3$

or $R \propto I^{1/3}$

or $\frac{R_2}{R_1} = \left(\frac{I_2}{I_1}\right)^{1/3} = \left(\frac{4}{1}\right)^{1/3}$

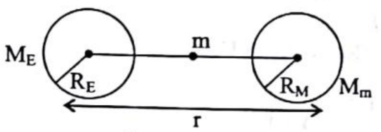
30. [3]

$$I = \frac{m_1 m_2}{m_1 + m_2}.x^2$$

$$I = \frac{m_H m_{Cl}}{m_H + m_{Cl}}.x^2$$

$$I = \frac{35x^2}{36}$$

1. [1]



$u_i + k_i = u_f + k_f$

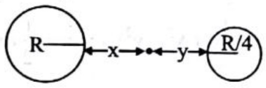
$$-\frac{GmM_E}{r/2} - \frac{GmM_M}{r/2} + \frac{1}{2}mv^2 = 0$$

2. [1]

At null point

$$\frac{GMm}{(R+x)^2} = \frac{GMm}{81\left(\frac{R}{4}+y\right)^2}$$

$$R + x = 9\left(\frac{R}{4}+y\right)$$



$x + y = r$

$$R + (r - y) = 9\left(\frac{R}{4}+y\right)$$

$$y = \frac{1}{10}\left[r - \frac{5}{4}R\right]$$

Since $y > 0$

$$r > \frac{5}{4}R$$

3. [1]

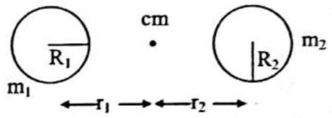
Using principle of angualr momentum

$L = mv_A r_A = mv\, r_B$

$$v_A = \frac{vr_B}{r_A} \;; v = \sqrt{\frac{GM}{r}}$$

$$\frac{v_0}{v_A} = \left(\frac{r_A}{1.2r_A}\right)^{\frac{1}{2}} \Rightarrow v_0 = \frac{vr_B}{r_A\sqrt{1.2}}$$

4. [2]



$m_1 r_1 = m_2 r_2$

$$m_1 r_1 \omega^2 = \frac{Gm_1 m_2}{r^2}$$

on solving

$$r = \left[\frac{G(m_1+m_2)}{\omega^2}\right]^{1/3}$$

on comparing

$$r = 2\left[\frac{G}{\omega^2}\right]^{1/3}$$

$(m_1 + m_2)^{1/3} = 2$

$m_2 - m_1 = 6$

$$\frac{m_1}{m_2} = \frac{1}{7}$$

5. [4]

$$E = \frac{GM}{r^2}$$

$$Eg = \frac{GM}{9}$$

Where M $\Rightarrow \rho \times \left[\frac{4\pi}{3}[3^3 - 2^3]\right]$

$$\Rightarrow \frac{\rho \times 4\pi \times 19}{3}$$

$$\Rightarrow \frac{G\pi\rho 76}{27}$$

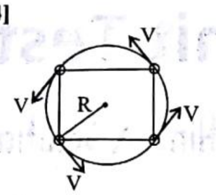
6. [3]

$$U = -\frac{GMm}{r};\ K = \frac{GMm}{2r};\ E = \frac{-GMm}{2r}$$

7. [3]

field at internal point of the shell is zero but at external point shell behave as if its whole mass at centre.

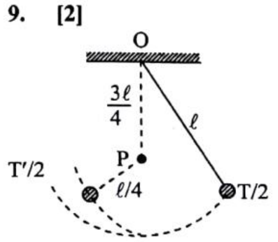
8. [4]



$$\frac{mv^2}{R} = F_{net}$$

$$v = \sqrt{\frac{GM}{R}\left[\frac{2\sqrt{2}+1}{4}\right]}$$

9. [2]



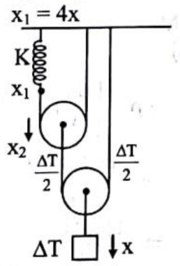
$$\begin{cases} T = 2\pi\sqrt{\dfrac{\ell}{g}} \\ T' = 2\pi\sqrt{\dfrac{\ell/4}{g}} \\ \Rightarrow 2\pi\sqrt{\dfrac{\ell}{4g}} \\ = \dfrac{T}{2} \end{cases}$$

$$t = \frac{T'}{2} + \frac{T}{2} = \frac{T}{4} + \frac{T}{2} \quad \Rightarrow \quad t = \frac{3T}{4}$$

10. [1]

Constrain

$$-x_2 + 2x = 0$$
$$x_2 = 2x$$
$$-x_1 + x_2 + x_2$$
$$x_1 = 2x_2$$
$$x_1 = 4x$$



$$2Kx_1 = \frac{\Delta T}{2}$$

$$\Delta T = 4\,Kx_1$$
$$\Rightarrow 16\,Kx$$

$$a = \frac{16\,Kx}{m}$$

$$\omega = G\sqrt{\frac{K}{m}}$$

$$T = \frac{2\pi}{4}\sqrt{\frac{m}{K}} = \frac{\pi}{2}\sqrt{\frac{m}{K}}$$

11. [4]

$$U = U_0\{1 - \cos ax\}$$

$$F = -\frac{dU}{dx}$$

$$= -U_0\{a \sin ax\}$$

$\{\because$ for small oscillation $\because \sin ax \approx ax\}$

$$= -aU_0(ax)$$

$$F = -a^2U_0x$$

effective $k = a^2U_0$

$$T = 2\pi\sqrt{\frac{m}{a^2U_0}}$$

12. [4]

$$T = -[mgL\sin\theta + kh^2\theta]$$

For small angle $\sin\theta \approx \theta$

$$T = I\alpha = -(mgL + kh^2)\,\theta$$

$$\alpha = -(mgL + kh^2)\theta/mL^2$$

$$\text{So } f = \frac{1}{2\pi L}\sqrt{gL + \frac{kh^2}{m}}$$

13. [2]

$$KE = \frac{1}{2}m\omega^2(A^2 - y^2)$$

$$KE = \frac{E}{A^2}(A^2 - y^2)\ \left(\because E = \frac{1}{2}m\omega^2A^2\right)$$

$$EA = \frac{E}{A^2}\left(A^2 - \frac{A^2}{4}\right)$$

$$= \frac{3E}{4}$$

14. [4]

$$K_{eq} = \frac{(2K)K}{(2K)+K} = \frac{2K}{3} = \frac{2\times1875}{3} = 1250$$

$$\therefore T = 2\pi\sqrt{\frac{m}{K}} = 2\pi\sqrt{\frac{2}{1250}} = \frac{2\pi}{25}\text{ sec}$$

15. [1]

$$\frac{T'}{T} = \sqrt{\frac{169}{100}}\,; \qquad T' = \frac{13}{10}T$$

$$\left(\frac{T'}{T} - 1\right)\times 100\% = \left(\frac{13}{10} - 1\right)\times 100\% = 30\%$$

16. [2]
When spring in cut in n equal parts
Its new force constant is nK

$\because\ T = 2\pi\sqrt{\frac{m}{K}}$

$T' = 2\pi\sqrt{\frac{m}{nK}}$

$\therefore\ T' = \frac{T}{\sqrt{n}}$

17. [3]
It increase and at terminal velocity it becomes constant.

18. [3]

$\text{Slope} = \tan\theta = \frac{\text{Strain}}{\text{Stress}} = \frac{1}{E}$

*(Slope) $\Rightarrow P > Q > R$
$E_P < E_Q < E_R$

19. [3]
$4\pi r_1^2 + 4\pi r_2^2 \Rightarrow 4\pi R^2$
$R = \sqrt{2}r$

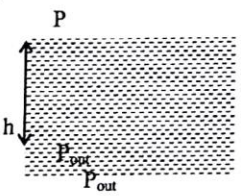
20. [2]

Given, $\frac{\Delta V}{V} = 1\% = \frac{1}{100}$

Bulk modulus, $B = \frac{P}{\Delta V/V} = \frac{PV}{\Delta V}$

or $P = \frac{B\Delta V}{V} = 7.5 \times 10^{10} \times \frac{1}{100}$
$= 7.5 \times 10^{8}\ Nm^{-2}$

21. [2]



$\because\ P' = P_{out} + \frac{2T}{r}$

$= P + hdg + \frac{2T}{r}$

22. [2]
$\gamma_a = \gamma_R - \gamma_C$
$C = \gamma_R - 3A$ .... (1)
$S = \gamma_R - 3\alpha_S$ .... (2)
$C - S = 3\alpha_S - 3A$

$\alpha_S = \frac{C - S + 3A}{3}$

23. [1]

$n\left(\frac{4}{3}\pi r^3\right) = \frac{4}{3}\pi R^3$

$R = n^{1/3} r$
$U_1 = nT\,4\pi r^2$
$U_1 = T\,4\pi R^2 n^{1/3}$
$U_2 = T\,4\pi R^2$
$W = U_1 - U_2$
$W = T\,4\pi R^2 \{n^{1/3} - 1\}$

$W = T\,4\pi R^3 \left\{\frac{1}{r} - \frac{1}{R}\right\}$

24. [4]

$a_1 = \frac{\text{upthrust} - \text{weight}}{m} = 2g$

similarity $a_2 = 2g$
Acceleration relative to water = 3g/2

$t_1 = 2\sqrt{\frac{h_1}{3g}}$

$t_2 = 2\sqrt{\frac{h_2}{3g}}$

$\therefore\ t_2 - t_1 = 2\sqrt{\frac{(h_2 - h_1)}{3g}}$

25. [2]

$\rho gh + \frac{mg}{A} + 0 + 0 = 1/2\ \rho v^2$

26 [1]
$A_1v_1 + A_2v_2 = Av$

27 [2]

$h = \frac{2S\cos\theta}{r\rho g}$.

Cross-sectional area increases 4 times, which means radius gets doubled. Therefore,

$h' = \frac{2S}{2(r\rho g)} = \frac{h}{2}$

28. [3]

speed of efflux × $u = \sqrt{2gh}$

$\therefore$ Range $x = u\sqrt{\frac{2(H-h)}{g}}$

$$x = \sqrt{2gh}\sqrt{\frac{2(H-h)}{g}}$$

$$x^2 = 4(H-h)h = 4\,[Hh - h^2]$$

$$\frac{dx^2}{dh} = 4[H-2h] = 0$$

$\Rightarrow h = H/2$

$$\therefore\ x_{max} = \sqrt{2g\times\frac{H}{2}}\sqrt{\frac{2(H-H/2)}{g}}$$

$$= H$$

29. [1]

upthrust = weight

$\Rightarrow$ Th. = mg

$\Rightarrow v_{in}\rho_w g = mg$

$\Rightarrow \frac{V}{3}\ \rho_w g = 6g \qquad ...(1)$

and $(M+6)\,g = V\,\rho_w g \qquad ...(2)$

from equation (1) and (2)

$(M+6)\,g = 18\,g$

$\Rightarrow M = 12$ kg

30. [1]

In Floating condition W = B

or $\left(\frac{A}{5}L\right)Dg = \left(\frac{A}{5}.\frac{L}{4}\right)2dg + \left(\frac{A}{5}.\frac{3L}{4}\right)dg$

$\Rightarrow\ D = \frac{5d}{4}$

Unit Test-5

Hints & Solutions

1 **[4]**

$n_1 - n_2 = 3$ ...(1)

$n \propto \frac{1}{\ell}$

$n_1\ell_1 = n_2\ell_2$

$\frac{n_1}{n_2} = \frac{28}{27}$ ...(2)

Solving these two equation

$n_1 = 84;\ n_2 = 81$

2 **[3]**

Initially frequency of vibrations of closed organ pipe = 10 kHz.

$$f = \frac{v}{4\ell} = \frac{\sqrt{\gamma RT/M}}{4\ell}$$

or $f \propto \sqrt{T}$

$$\frac{f'}{f} = \sqrt{\frac{T'}{T}} = \left(1+\frac{1}{300}\right)^{1/2} \approx 1 + \frac{1}{600}$$

or $f' = f\left(1+\frac{1}{600}\right)$

or $\Delta f = f' - f = \frac{f}{600}$

$$= \frac{10\times10^3}{600} = 16.67 \text{ Hz.}$$

$\therefore$ Number of beats produced = 16.67 Hz.

3. **[2]**

$$V = \sqrt{\frac{\gamma RT}{M_w}}$$

$$\frac{V_{H_2}}{V_{He}} = \sqrt{\frac{\gamma_{H_2}}{\gamma_{He}} \times \frac{M_{He}}{M_{H_2}}}$$

$$= \sqrt{\frac{7}{5}\times\frac{4}{\frac{5}{3}\times 2}} = \sqrt{\frac{42}{25}}$$

4. **[2]**

$$v = \frac{dY}{dt} = Y_0 \cos\left[2\pi\left(ft - \frac{x}{\lambda}\right)\right] \times 2\pi f$$

or $v = 2\pi f Y_0 \cos\left[2\pi\left(ft - \frac{x}{\lambda}\right)\right]$

The particle velocity is maximum, when

$$\cos\left[2\pi\left(ft - \frac{x}{\lambda}\right)\right] = 1$$

$\therefore v_{max} = 2\pi f Y_0$ ....(1)

We know that, $Y = a \sin(\omega t - kx)$

The wave velocity V is given by

$$V = \frac{\omega}{k} = \frac{2\pi f}{2\pi/\lambda} = f\lambda \quad ....(2)$$

Given that $v_{max} = 4V$

$\therefore 2\pi f Y_0 = 4f\lambda$

or $\lambda = \frac{\pi Y_0}{2}$

5. **[2]**

The amplitude, A = 0.06 m

$\frac{5}{2}\lambda = 0.2\text{ m}$

$\therefore \lambda = 0.08$ m

$$f = \frac{v}{\lambda} = \frac{300}{0.08} = 3750 \text{ Hz}$$

$k = \frac{2\pi}{\lambda} = 78.5\text{m}^{-1}$ and $\omega = 2\pi f = 23562$ rad/s

At t= 0, x = 0, $\frac{dy}{dx}$ = positive

and the given curve is a sine curve.

Hence, equation of wave traveling in positive x-direction should have the form,

$y(x, t) = A \sin(kx - wt)$

Substituting the values, we have

$y = (0.06\text{m}) \sin[(78.5\text{m}^{-1})x - (23562\text{ s}^{-1})t]\text{m}$

6. **[4]**

Given :

Initial length of air-column (l_1) = 0.1 m and final length of air-column (l_2) = 0.35 m. We know that frequency of fundamental mode

$$(v_1) = \frac{v}{4(l_1+e)} = \frac{v}{4(0.1+e)} \quad ....(i)$$

Similarly, frequency of first overtone

$$(\nu_2) = \frac{3v}{4(l_2+e)} = \frac{3v}{4(0.35+e)} \quad ....(ii)$$

Since these frequencies are equal, therefore

$$\frac{v}{4(0.1+e)} = \frac{3v}{4(0.35)+e}$$

or $0.35 + e = 0.3 + 3e$

or $2e = 0.35 - 0.3 = 0.05$

or $e = 0.025$ m

(Where e = End correction of air column)

7. **[1]**

$\Delta f = f_1 - f_2$

$$\underset{s}{\bullet}\xrightarrow{v_s} \quad \overset{O}{\bullet} \quad \underset{s}{\bullet}\xrightarrow{v_s}$$

$$= f\left(\frac{v}{v-v_s}\right) - f\left(\frac{v}{v+v_s}\right)$$

$$= f\left[\left(1-\frac{v_s}{v}\right)^{-1} - \left(1+\frac{v_s}{v}\right)^{-1}\right]$$

$$= f\left[\left(1+\frac{v_s}{v}\right) - \left(1-\frac{v_s}{v}\right)\right] = \frac{2fv_s}{v}$$

8. **[2]**

$$n' - n'' = \Delta n = \frac{2v_s}{v} \times n$$

$\Delta n = 2.6$ kHz $= 2.6 \times 10^3$Hz

and $n = 780$ MHz $= 780 \times 10^6$ Hz

$$\therefore 2.6 \times 10^3 = \frac{2v_s}{3\times10^8} \times 780 \times 10^6$$

$$\text{or } v_s = \frac{(2.6\times10^3)(3\times10^8)}{2\times(780\times10^6)} = 500 \text{ m/s}$$

$= 0.5$ km/sec.

9. **[2]**

Given : Frequency of police horn (ν_h) = 176 Hz

Velocity of police car (v_p) = 22 m-s^{-1}

Velocity of motorcycle = v_m

Frequency of stationary siren (ν_s) = 165 Hz

We know from the Doppler's effect that apparent frequency heard by the motorcyclist from the police car, when both are moving in the same direction

$$(\nu_1) = \left(\frac{v-v_m}{v-v_p}\right) \times \nu_h = \frac{330-v_m}{330-22} \times 176 = \frac{330-v_m}{308} \times 176$$

Similarly, apparent frequency heard by motorcyclist from the stationary siren, when he is moving towards it

$$(\nu_2) = \left(\frac{v+v_m}{v-v_s}\right) \times \nu_s = \left(\frac{330+v_m}{330-0}\right) \times 165 = \frac{330+v_m}{330} \times 165$$

Since the motorcyclist does not observe any beat, therefore $\nu_1 - \nu_2 = 0$ or $\nu_1 = \nu_2$

$$\text{or } \frac{330-v_m}{308} \times 176 = \left(\frac{330+v_m}{330}\right) \times 165$$

$$\text{or } \frac{300-v_m}{330+v_m} = \frac{165}{176} \times \frac{308}{330} = \frac{7}{8}$$

or $2640 - 8\,v_m = 2310 + 7\,v_m$

or $15v_m = 2640 - 2310 = 330$

or $v_m = \frac{330}{15} = 22$ m-s^{-1}

10. **[4]**

$0.5 \times \mu Mg \times (V \times 60 \times 60) = MS\Delta T$

$$\Delta T = \frac{0.5\times0.5\times9.8\times2\times\frac{5}{18}\times60\times60}{0.1\times4.186\times10^3}$$

11. **[3]**

Let F = K = x

$$\text{As } \frac{F-32}{9} = \frac{K-273}{5} \therefore \frac{x-32}{9} = \frac{x-273}{5}$$

$$x = \frac{2297}{4} = 574.25°$$

12. **[1]**

From $\Delta Q = mC_p(\Delta T)$

$70 = 2 \times C_p \times (35 - 30)$,

$\therefore C_p = 70/10 = 7$ cals/mole/°C

$C_V = C_p - R = 7 - 2 = 5$ cals/mole/°C

$\Delta Q' = mC_V(\Delta T) = 2 \times 5 \times 5 = 50$ cals

13. **[2]**

Heat released by 5 kg of water when its temperature falls from 20°C to 0°C is

$Q_1 = cm\,(\Delta T) = 10^3 \times 5 \times 20 = 0.2 \times 10^5$ cals

Heat energy taken by 2 kg of ice at –20°C in coming to 0°C is

$Q_2 = cm\,(\Delta T) = 500 \times 2 \times 20 = 0.2 \times 10^5$ cals

The remaining heat

$Q = Q_1 - Q_2 = 0.8 \times 10^5$ cal

Mass of ice melted, $m' = \frac{Q}{L}$

$$= \frac{0.8\times10^5}{80\times10^3} = 1 \text{ kg}$$

$\therefore$ Temperature of mixture will become 0°C
Mass of water in it = 5 + 1 = 6 kg
Mass of ice = 2 – 1 = 1 kg

14. [4]
Quantity of gas in these bulbs is constant i.e. initial no. of moles in both bulb = Final number of moles

$\mu_1 + \mu_2 = \mu_1 + \mu_2$

$$\frac{PV}{R(273)} + \frac{PV}{R(273)} = \frac{1.5\ PV}{R(273)} + \frac{1.5\ PV}{R(T)}$$

$$\Rightarrow \frac{2}{273} = \frac{1.5}{273} + \frac{1.5}{T} \Rightarrow T = 819\ K = 546°C$$

15. [1]
According to given Vander Waal's equation

$$P = \frac{nRT}{V - n\beta} - \frac{\alpha n^2}{V^2}$$

Work done, $W = \int_{V_1}^{V_2} PdV$

$$= nRT \int_{V_1}^{V_2} \frac{dV}{V - n\beta} - \alpha n^2 \int_{V_1}^{V_2} \frac{dV}{V^2}$$

$$= nRT [\log_e (V - n\beta)]_{V_1}^{V_2} + \alpha n^2 \left[\frac{1}{V}\right]_{V_1}^{V_2}$$

$$= nRT \log_e \frac{V_2 - n\beta}{V_1 - n\beta} + \alpha n^2 \left(\frac{V_1 - V_2}{V_1 V_2}\right)$$

16. [2]

$\gamma_1 = \frac{5}{3}$ means gas is monoatomic or

$C_{v_1} = \frac{3}{2}R$

$\gamma_2 = \frac{7}{5}$ means gas is diatomic or

$C_{v_2} = \frac{5}{2}R$

C_v (of the mixture)

$$= \frac{n_1 C_{v_1} + n_2 C_{v_2}}{n_1 + n_2} = \frac{(1)\left(\frac{3}{2}R\right) + (1)\left(\frac{5}{2}\right)R}{1+1} = 2R$$

C_p (of the mixture) $= C_v + R = 3R$

$$\therefore\ \gamma_{mixture} = \frac{C_p}{C_v} = \frac{3R}{2R} = 1.5$$

17. [2]

$$v_{rms} = \sqrt{\frac{3RT}{M_w}}$$

$$v_{mp} = \sqrt{\frac{2RT}{M_w}}$$

$$v_{avg} = \sqrt{\frac{8RT}{\pi M_w}}$$

So $v_{rms} > v_{avg} > v_{mp}$

18. [4]
T = constant
PV = constant

$$PV = \left(P + \frac{5}{100}P\right)V'$$

$$V' = \frac{V}{1.05}$$

$$\%\text{ change in volume} = \frac{\frac{V}{1.05} - V}{V} \times 100$$

$$= \frac{-0.05}{1.05} \times 100 = -\frac{5}{1.05} = -4.76\%$$

19. [1]
(i) isobaric (ii) isothermal
$V \propto T, \Delta U = +ve \quad \Delta U = 0$
$V \uparrow, T, \Delta W = +ve$
(iii) $\Delta U < 0, \Delta W > 0$
$(\Delta U)_I > (\Delta U)_{II} > (\Delta U)_{III}$

20. [1]
$W_1 = PdV = P(V_2 - V_1)$

$$\Rightarrow W_1 = PV_1 \left(\frac{V_2}{V_1} - 1\right)$$

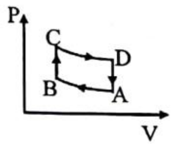
$= nRT(2 - 1) = nRT$

$W_2 = nRT\ \ell n \frac{V_2}{V_1}\ nRT\ \ell n2$

$W_2 = W_1\ \ell n2$

21. [2]

<u>A – B</u>	T → const	<u>BC</u>	V → Const.
	P ∝ V		P ∝ T
<u>C – D</u>	T → const.	<u>DA</u>	V → Const.
	P ∝ V		P ∝ T



22. [3]

For curve bc

$TV^{\gamma-1}$ = constant

$T_1 V_b^{\gamma-1} = T_2 V_c^{\gamma-1}$ ...(1)

For curve ad

$T_1 V_a^{\gamma-1} = T_2 V_d^{\gamma-1}$ ...(2)

eq. (1) / (2) $\left(\frac{V_b}{V_a}\right)^{\gamma-1} = \left(\frac{V_c}{V_d}\right)^{\gamma-1}$

$\Rightarrow \frac{V_b}{V_a} = \frac{V_c}{V_d}$

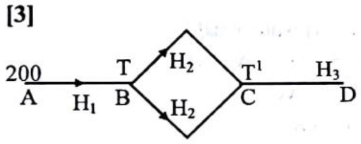
$\Rightarrow \frac{V_a}{V_d} = \frac{V_b}{V_c}$

23. [3]

$\eta = 1 - \frac{T_2}{T_1}$

$\omega = \frac{T_2}{T_1 - T_2} = \frac{T_2/T_1}{1-(T_2/T_1)} = \frac{(1-\eta)}{\eta} = \frac{1}{\eta} - 1$

24. [3]



$H_1 = 2H_2$

$\frac{KA}{\ell}(200 - T) = 2\frac{KA}{2\ell}(T - T')$

$200 = 2T - T'$ .... (1)

$2H_2 = H_3$

$2\frac{KA}{2\ell}(T - T') = (T' - 20)\frac{KA}{\ell}$

$2T' - T = 20$ .... (2)

By solving (1) & (2)

T = 140

25. [1]

$H_1 + H_2 = \frac{KA(T_1 - T_2)}{3l} + \frac{KA(T_1 - T_2)}{l}$

$= \frac{4}{3l} KA (T_1 - T_2)$

In later case

$H_2 = 2H - H_1$

$= \frac{7KA}{3l}(T_1 - T_2) = \frac{K'A}{l}(T_1 - T_2)$

$\Rightarrow K' = \frac{7}{3}K$

26. [4]

$\because \frac{E_2}{E_1} = \left(\frac{1.5T}{T}\right)^4 \Rightarrow \frac{E_2 - E_1}{E_1} = \left(\frac{3}{2}\right)^4 - 1$

$= \frac{81}{16} - 1 = \frac{65}{16}$

$\Rightarrow \left(\frac{E_2 - E_1}{E_1}\right) \times 100 = \frac{65}{16} \times 100 = 406\%$

27. [3]

$\frac{60-50}{10} = K\left[\frac{60+50}{2} - 30\right]$ ...(1)

$\frac{50-\theta}{10} = K\left[\frac{50+\theta}{2} - 30\right]$ ...(2)

By (2) / (1)

$\frac{50-\theta}{10} = \frac{\theta - 10}{50} \Rightarrow \theta = 43.3°C$

28. [3]

Let correct time at θ°C & $15° < \theta < 30°$

apply $\Delta t = \frac{1}{2}\alpha\Delta\theta \cdot t$

for slow :

$5 = \frac{1}{2}\alpha \times (30° - \theta) \cdot t$ ...(1)

for fast :

$10 = \frac{1}{2}\alpha \times (\theta - 15)\, t$ ...(2)

By (1)/(2) : $\theta = 25°C$

29. [2]

$\gamma_{steel} = 3\alpha_{steel}$

$= 3 \times 12 \times 10^{-6} /°C$

$= 36 \times 10^{-6} /°C$

$\gamma_{ob} = \gamma_{Pet} - \gamma_{steel}$

$= 950 \times 10^{-6} - 36 \times 10^{-6}$

$= 912 \times 10^{-6} /°C$

Overflow petrol

$\Delta V = V_I \gamma_{ob} \Delta t$

$= 75 \times 912 \times 10^{-6} \times 20$

$= 1.500 \times 912 \times 10^{-6} = 1.37$ L

30. [3]

$V = V_0(1 + \gamma\Delta\theta)$

or $L^3 = L_0(1\ \alpha_1 \Delta\theta) L_0^2(1 + \alpha_2\Delta\theta)^2$

$L_0^3(1 + \alpha_1\Delta\theta)(1 + \alpha_2\Delta\theta)^2$

Since $L_0^3 = V_0$, hence

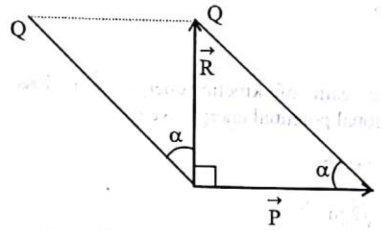
$1 + \gamma\Delta\theta = (1 + \alpha_1\Delta\theta)(1 + \alpha_2\Delta\theta)^2$

$\cong (1 + \alpha_1\Delta\theta)(1 + 2\alpha_2\Delta\theta)$

$\cong 1 + \alpha_1\Delta\theta + 2\alpha_2\Delta\theta$

$\therefore \quad \gamma = \alpha_1 + 2\alpha_2$

1. **[1]**



If $|\vec{P}| = |\vec{R}|$
then $\alpha = 45°$

So angle between $\vec{P}$ & $\vec{Q}$.

$= 90° + 45° = 135° = \frac{3\pi}{4}$

2. **[1]**

$1\ VSD = \left(\frac{n}{n+1}\right) MSD$

$V.C. = 1\ MSD - 1\ VSD = \left(1 - \frac{n}{n+1}\right) MSD$

$= \frac{L}{(n+1)}$ unit

3. **[1]**

$a = 3bc^2$

or $b = \frac{a}{3c^2}$

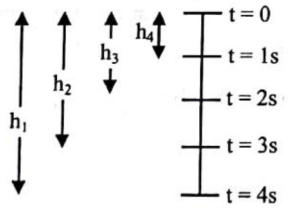
writing dimension of for a and c, we have

$[b] = \frac{[Q/V]}{[B]^2} = \frac{[Q]}{[ML^2T^{-2}Q^{-1}][MT^{-1}Q^{-1}]^2}$

$= [M^{-3}L^{-2}T^4Q^4]$

4. **[1]**

For first marble, $h_1 = \frac{1}{2} g \times 16 = 8g$



For second marble, $h_2 = \frac{1}{2} g \times 9 = 4.5\ \Omega$

For third marble, $h_3 = \frac{1}{2} g \times 4 = 2g$

For fourth marble, $h_4 = \frac{1}{2} g \times 1 = 0.5\ g$

$\therefore\ h_1 - h_2 = 8\ g - 4.5\ g = 3.5\ g = 35$ m.
$h_2 - h_3 = 4.5\ g - 2g = 2.5\ g = 25$ m and
$h_3 - h_4 = 2g - 0.5\ g = 1.5\ g = 15$ m.

5. **[3]**

Final velocity after passing through a plank

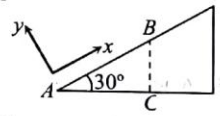
$v = \frac{19u}{20}$

So, $v^2 = u^2 + 2as$; $2as = -\frac{39}{400}u^2$

if bullet passes through n planks and stopped.
$0 = u^2 + 2as$; $u^2 + 2a(ns)$

$n = -\frac{u^2}{2as} = \frac{400}{39} = 10.3$ So, $\boxed{n = 11}$

6. **[1]**



$(V_0)_x = u \cos 30°$; $a_x = -g \sin 30°$

$AB = (u \cos 30°)\, t - \frac{1}{2} g \sin 30.t^2$

$AB = (u \cos 30°)\, .\, t - \frac{1}{2} g \sin 30°\, .\, t^2$

$AB = \frac{\sqrt{3}ut}{2} - \frac{gt^2}{4}$

but $t = \frac{2u \sin(60° - 30°)}{g \cos 30°} = \frac{2u}{\sqrt{3}g}$

$\therefore\ AB = \frac{\sqrt{3}ut}{2} - (gt)\frac{t}{4}$

$= \frac{\sqrt{3}ut}{2} - \left(\frac{2u}{\sqrt{3}}\right)\frac{t}{4}$

$= \frac{ut}{2}\left(\sqrt{3} - \frac{1}{\sqrt{3}}\right) = \frac{ut}{\sqrt{3}}$

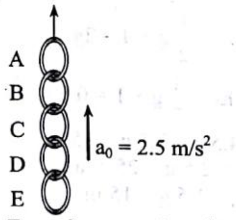
Alternate method :

horizontal distance in time t = AC
$= u \cos 60°. t$

$$AC = \frac{ut}{2}$$

and $AB = \frac{AC}{\cos 30°} = \frac{ut/2}{\sqrt{3}/2} = \frac{ut}{\sqrt{3}}$

7. [2]



Let Force between A and B = T
$T = (B + C + D + E)(g + a_0)$
$T = 4\,m(g + a_0)$
$= 4(0.1)(12.3) = 4.92$ N

8. [4]
From constraint relations, we can see that the acceleration of block B in upward direction is

$a_B = \left(\frac{a_C + a_A}{2}\right)$ with proper signs.

So, $a_B = \left(\frac{3 - 12t}{2}\right) = 1.5 - 6t$

(i) or $\frac{dv_B}{dt} = 1.5 - 6t$

(ii) or $\int_0^{v_B} dv_B = \int_0^{t} (1.5 - 6t)dt$

or $v_B = 1.5t - 3t^2$
or $v_B = 0$ at $t = ½$ s

9. [3]
Limiting condition for m to not slip in vertical downward direction, $mg = \mu N$

$\Rightarrow N = \frac{mg}{\mu} = \frac{100}{0.5} = 200$ N

Same normal force would accelerate M, thus

$a_M = \frac{200}{50} = 4$ m/s^2

Taking m + M as system
$F = (m + M).\,4 = 240$ N

10. [4]

$\sqrt{2gh} = \sqrt{5gr}$

$r = \frac{2h}{5} = \frac{2\times 5}{5} = 2$m

11. [1]

$P = m\frac{vdv}{ds}.v$

$\int_v^{2v} mv^2 dv = \int_0^r P ds$

$s = \frac{7mv^3}{3P}$

12. [1]
Equating gain of kinetic energy with loss of gravitational potential energy, we get

$\frac{1}{2}mv^2 = mgh$

or $v = \sqrt{2gh}$

or $v = \sqrt{2 \times 9.8 \times 1}$ ms^{-1}

$= \sqrt{19.6}$ ms^{-1} = 4.43 ms^{-1}

13. [2]

$W = \int_0^{2L/3} -\frac{\mu Mg}{L}\ell\, d\ell = -\frac{2}{9}\mu MgL$

14. [1]

$m_1 u = m_1\frac{2u}{3} + m_2 v$

or $\frac{1}{3}m_1 u = m_2 v$

Using Newton's experimental law of impact,

$v - \frac{2u}{3} = u$ or $v = \frac{5}{3}u$

From equation (1), $\frac{1}{3}m_1 u = \frac{5}{3}m_2 u$

or $\frac{m_1}{m_2} = 5$

15. [1]

$CM = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$

Again, $CM = \frac{m_1(x_1 - d) + m_2(x_2 + d_2)}{m_1 + m_2}$

or $\frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{m_1 x_1 - m_1 d + m_2 x_2 + m_2 d_2}{m_1 + m_2}$

or $m_2 d_2 = m_1 d$ or $d_2 = \frac{m_1}{m_2}d$

16. [4]

Mass per unit length of the wire = ρ

Mass of L length, $M = \rho L$

and since the wire of length L is bent in a form of circular loop therefore $2\pi R = L \Rightarrow R = L/2\pi$

Moment of inertia of loop about given axis

$$= \frac{3}{2}MR^2 = \frac{3}{2}\rho L\left(\frac{L}{2\pi}\right)^2 = \frac{3\rho L^3}{8\pi^2}$$

17. [4]

$mg - T = ma$ ...(1)

$2T \times R = I\alpha = MR^2 \times \frac{a}{R}$

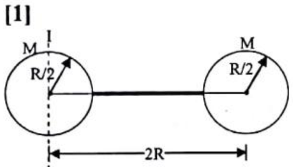
$Ma = 2T$

$T = \frac{Ma}{2}$ ...(2)

$mg - \frac{Ma}{2} = ma \Rightarrow mg = \left(\frac{Ma}{2} + m\right)a$

$a = \dfrac{mg}{\frac{M}{2}+m}$ $\quad \therefore T = \dfrac{mMg}{2\left(\frac{M}{2}+m\right)}$

18. [1]



$I_1 = \frac{2}{5}M(R/2)^2$

$I_2 = I_0 + Md^2 = \frac{2}{5}M(R/2)^2 + M(2R)^2$

$\therefore I = I_1 + I_2 = \frac{21}{5}MR^2$

19. [1]

$\frac{1}{2}mv^2 = \left[-\frac{GMm}{R}\right] - \left[-\frac{3GMm}{2R}\right]$

or $\frac{1}{2}mv^2 = \frac{3GMm}{2R} - \frac{GMm}{R}$

or $\frac{v^2}{2} = \frac{3GM}{2R} - \frac{GM}{R}$

$\frac{v^2}{2} = \frac{GM}{R} \times \frac{1}{2}$

or $v = \sqrt{\frac{GM}{R}}$

Also, $v_e = \sqrt{\frac{2GM}{R}} = \sqrt{2}\,v$.

20. [1]

Here, angular momentum is conserved, i.e. $L = I\omega$ constant. At A. the moment of inertia I is least. So angular speed and therefore the linear speed of planet at A is maximum.

21. [2]

$t_1 = 2\pi\sqrt{\frac{m}{k_1}}$ ....(1),

$t_2 = 2\pi\sqrt{\frac{m}{k_2}}$ ....(2)

when springs are in series then

$$T = 2\pi\sqrt{\frac{m}{\frac{k_1k_2}{k_1+k_2}}} = 2\pi\sqrt{\frac{m(k_1+k_2)}{k_1k_2}}$$

squaring and adding (1) and (2) we get

$t_1^2 + t_2^2 = 4\pi^2\frac{m}{k_1} + 4\pi^2\frac{m}{k_2}$

$= 4\pi^2 m\left(\frac{k_1+k_2}{k_1k_2}\right)$

or $t_1^2 + t_2^2 = T^2$

22. [4]

When the bob is immersed in water its effective weight $= \left(mg - \frac{m}{\rho}g\right) = mg\left(\frac{\rho-1}{\rho}\right)$

$\therefore g_{eff} = g\left(\frac{\rho-1}{\rho}\right);\ \frac{T'}{T} = \sqrt{\frac{g}{g_{eff}}}$

$\Rightarrow T' = T\sqrt{\frac{\rho}{(\rho-1)}}$

23. [1]

$\because kx = mg$

by using $E = \frac{1}{2}kx^2$

we get $U = \frac{1}{2}\frac{M^2g^2L}{AY}$

24. [2]

$\frac{1}{2}\rho v_1^2 + P_1 = \frac{1}{2}\rho v_2^2 + P_2$

$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2)$

$hdg = \frac{1}{2}\rho(v_2^2 - v_1^2)$

$v_2 = 32$ m/sec.

25. [1]

When system of masses $m_1, m_2, \ldots,$ specific heat capacities $s_1, s_2, \ldots$ and initial temperature $\theta_1, \theta_2, \ldots$ are mixed, the temperature of the mixture is

$$\theta = \frac{\sum ms\theta}{\sum ms} = \frac{m_1s_1\theta_1 + m_2s_2\theta_2 + \ldots.}{m_1s_1 + m_2s_2 + \ldots..}$$

For systems of equal mass, $\theta = \frac{\sum s\theta}{\sum s}$.

Let s_1, s_2 and s_3 be the specific heat capacities of A, B and C respectively.

For A + B, $15 = \frac{10s_1 + 25s_2}{s_1 + s_2}$

or $5s_1 = 10s_2$ or $s_1 = 2s_2$

26. [1]

$$v_{rms} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3RT_f}{M_W}}$$

From I.G. equation

$$P.\frac{M}{\rho} = \frac{M}{M_W}RT_I$$

$$M_W = \frac{\rho RT_I}{P}$$

$$v_{rms} = \sqrt{\frac{3RT_f}{\rho RT_I} \times P}$$

$$= \sqrt{\frac{3 \times 10^5 \times (273 + 50)}{1.98 \times 273}}$$

$= 423$ m/s

27. [2]

$PV = nRT \quad T$

Process $V \propto T^{2/3}$ or $T \propto V^{3/2}$

For PV^x = constant $PV \propto V^{3/2}$

$PV^{-1/2}$ = constant

$$W = \frac{nR}{x-1}(dT)$$

$$= \frac{1R}{-1-\frac{1}{2}}(-30) = \frac{60R}{3} = 20R = 166.2$$

28. [3]

$$H = \frac{\Delta Q}{\Delta t} = \frac{KA(\theta_H - \theta_L)}{l}$$

$\Delta Q = mL$

$$\therefore \frac{mL}{\Delta t} = \frac{KA(\theta_H - \theta_L)}{l}$$

$$\therefore m = \frac{KA(\theta_H - \theta_L)\Delta t}{lL}$$

$$= \frac{92 \times 10^{-3} \times 100 \times 60}{1 \times 80 \times 10^3}$$

$= 6.9 \times 10^{-3}$ kg

29. [3]

We know frequency $n = \frac{p}{2\ell}\sqrt{\frac{T}{\pi r^2 \rho}}$

$$\Rightarrow n \propto \frac{1}{\sqrt{\rho}}$$

i.e., graph between n and $\sqrt{\rho}$ will be hyperbola.

30. [3]

$$n' = n\left(\frac{V + V_0}{V}\right)$$

$n'V = nV + nV_0$

$$V\frac{(n' - n)}{n} = V_0$$

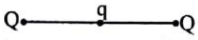
$V_0 \propto (n' - n)$

$$\frac{V_2}{V_1} = \frac{6.5 - 5}{5.5 - 5} = 3$$

Unit Test-6

Hints & Solutions

1. [2]



$$F = \frac{kQq}{\left(\frac{r}{2}\right)^2} + \frac{kQQ}{r^2} = 0$$

$$q = -\frac{Q}{4}$$

2. [1]

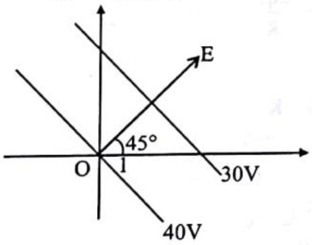
$$E_{arc} = \frac{2k\lambda}{r}\sin\frac{\theta}{2}$$

$$= \frac{2k\lambda}{r}\sin\frac{180^\circ}{2}$$

$$= \frac{\lambda}{2\pi\varepsilon_0 R}$$

3. [1]

$$E = \frac{\Delta v}{\Delta r} = \frac{10}{1\cos 45^\circ} = 10\sqrt{2}$$



at 45° with 'x' axis because electric field should be perpendicular to equipotential surface and directed form high potential to low potential

4. [2]

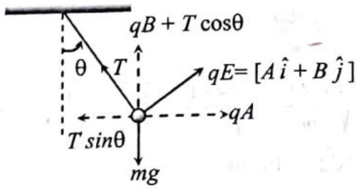
$$W_{A\to B} = q\,(V_B - V_A)$$

$$= q\int_B^A E.dr$$

$$= q_0\int_{2a}^{3a}\frac{\lambda}{2\pi\varepsilon_0 r}.dr$$

$$= \frac{\lambda q_0}{2\pi\varepsilon_0}\,\ell n\,\frac{3}{2}$$

5. [3]



$$qA = T\sin\theta \quad \text{.......(1)}$$

$$qB + T\cos\theta = mg \quad \text{........(2)}$$

$$qB + \frac{qA\cos\theta}{\sin\theta} = mg$$

$$q\left[B + \frac{A}{\tan\theta}\right] = mg$$

$$q = \frac{mg\tan\theta}{A + B\tan\theta}$$

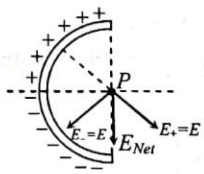
6. [1]

$$V_A - V_B = \int_{x_A}^{x_B} E_x dx + \int_{y_A}^{y_B} E_y dy + \int_{z_A}^{z_B} E_z dz$$

$$= \int_1^2 2dx + \int_2^1 3dy + \int odz$$

$$= 2(2-1) + 3(1-2) = 2 - 3 = -1 \text{ volt}$$

7. [1]



$$E_{Net} = 2E\cos 45^\circ = \sqrt{2}\,E$$

$$= \sqrt{2}\,\frac{2K\lambda}{r}\sin 45^\circ$$

$$= \frac{2\sqrt{2}\lambda}{4\pi\varepsilon_0 r} \times \frac{1}{\sqrt{2}} = \frac{\lambda}{2\pi\varepsilon_0 r}$$

$$= \frac{Q}{2\pi\varepsilon_0 r\left(\frac{\pi r}{2}\right)} = \frac{Q}{\pi^2\varepsilon_0 r^2}$$

8. [2]

$V_y^2 = u_y^2 - 2a_y s_y$

At the highest point V_y should be 0.

$u_y^2 = 2a_y s_y$

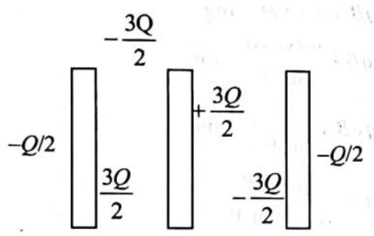
$(u \sin 45°)^2 = \frac{2 \times qE}{m} \times h$

$\frac{u^2}{2} = \frac{2qEh}{m}$

$u = \sqrt{\frac{4qEh}{m}} = \sqrt{\frac{4 \times 1.6 \times 10^{-19} \times 10^3 \times 2 \times 10^{-2}}{1.6 \times 10^{-30}}}$

$= 2\sqrt{2} \times 10^6$ m/s

9. [4]



10. [4]

$V_A = k\left[\frac{q_A}{a} + \frac{q_B}{b} + \frac{q_c}{c}\right]$

$= \frac{1}{4\pi \epsilon_0}\left(\frac{\sigma 4\pi a^2}{a} + \frac{-\sigma 4\pi b^2}{b} + \frac{\sigma 4\pi c^2}{c}\right)$

$= \frac{\sigma}{\epsilon_0}[a - b + c]$

$V_C = k\left[\frac{q_A}{c} + \frac{q_B}{c} + \frac{q_C}{c}\right]$

$= \frac{1}{4\pi \epsilon_0}\left[\frac{\sigma.4\pi a^2}{c} + \frac{-\sigma.4\pi b^2}{c} + \frac{\sigma.4\pi c^2}{c}\right]$

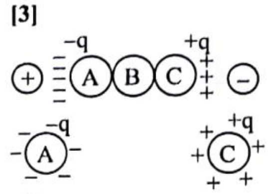
$= \sigma\left[\frac{a^2 - b^2 + c^2}{c}\right]$

$V_A = V_C$

$\frac{\sigma}{\epsilon_0}(a - b + c) = \frac{\sigma}{\epsilon_0}\left(\frac{a^2 - b^2}{c} + c\right)$

$\boxed{c = a + b}$

11. [3]



B in neutral

A B $\Rightarrow$ charge on B $= \frac{-q + 0}{2} = -\frac{q}{2}$

B C $\Rightarrow$ charge on B $= \frac{-\frac{q}{2} + q}{2} = \frac{q}{4}$

12. [3]

$E_A = 0 \qquad r < r_A$

$E_A = \frac{KQ}{r^2} \qquad r_A < r < r_B$

$E_B = \frac{KQ_A}{r^2} - \frac{KQ_B}{r^2} \qquad r > r_A > r_B$

13. [1]

$\frac{1}{2} Kx^2 = (qE)\, x$

$x = \frac{2qE}{K}$

$\therefore x_{max} = L + \frac{2qE}{K}$

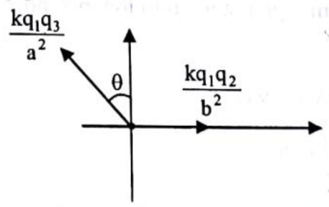
14. [3]

$U_i + K_i = U_f + K_f$

$0 + \frac{1}{2} mv^2 = \frac{-k8q^2}{R} + \frac{1}{2} mv'^2$

$\therefore v' = \sqrt{\frac{16kq^2}{mR} + v^2}$

15. [1]



$F_x = \frac{kq_1q_2}{b^2} - \frac{kq_1q_3}{a^2}\sin\theta$

$= kq_1\left[\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta\right] \propto \left[\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta\right]$

16. [1]

The net electric field at P is zero.

$\vec{E}_P = \vec{E}_1 + \vec{E}_2 + \vec{E}_{sphere}$

$0 = \vec{E}_1 + \vec{E}_2 + \vec{E}_{sphere}$

$\therefore\ \vec{E}_{sphere} = -(\vec{E}_1 + \vec{E}_2)$

$$|\vec{E}_{sphere}| = \sqrt{E_1^2 + E_2^2}$$

$$= \sqrt{\left(\frac{q_1}{4\pi\varepsilon_0 a^2}\right)^2 + \left(\frac{q_2}{4\pi\varepsilon_0 b^2}\right)^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\sqrt{\left(\frac{q_1}{a^2}\right)^2 + \left(\frac{q_2}{b^2}\right)^2}$$

17. [3]

$$\oint \vec{E}.d\vec{A} = \frac{\Sigma q}{\varepsilon_0}$$

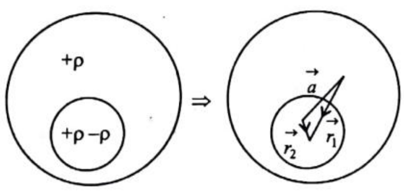
$$E\,(4\pi r^2) = \frac{1}{\varepsilon_0}\int \rho\, dV$$

$$\Sigma q = \int_0^r \rho\, dV = \int_0^r \rho_0\left(\frac{5}{4} - \frac{r}{R}\right) 4\pi r^2 dr$$

$$\Sigma q = 4\pi\rho_0\left[\frac{5}{4}\left(\frac{r^3}{3}\right) - \frac{1}{R}\left(\frac{r^4}{4}\right)\right]$$

$$E\,(4\pi r^2) = \frac{4\pi\rho_0}{\varepsilon_0}\left[\frac{5}{4}\left(\frac{r^3}{3}\right) - \frac{r^4}{4R}\right]$$

18. [2]



$$E_p = \vec{E_1} + \vec{E_2}$$

$$= \frac{\rho \vec{r_1}}{3\epsilon_0} + \frac{(-\rho)\vec{r_2}}{3\epsilon_0}$$

$$= \frac{\rho}{3\epsilon_0}(\vec{r_1} - \vec{r_2}) = \frac{\rho}{3\epsilon_0}\vec{a}$$

19. [4]

$$U = \frac{k(q)(-q)}{a} \times 12 + \frac{kq^2}{a\sqrt{2}} \times 12 + \frac{k(q)(-q)}{a\sqrt{3}} \times 4$$

$$= \frac{5.824q^2}{4\pi\varepsilon_0 a}$$

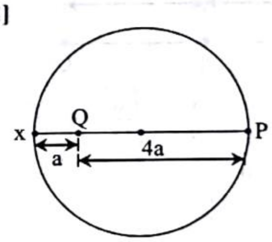
20. [3]

Potential at the surface of inner sphere = 0 (grounded)

$$\frac{1}{4\pi\varepsilon_0}\frac{q}{r_2} + \frac{1}{4\pi\varepsilon_0}\frac{q'}{r_1} = 0$$

$$\Rightarrow q' = \frac{-qr_1}{r_2}$$

21. [1]



$$V_p = V = \frac{kQ}{4a}$$

$$V_x = \frac{kQ}{a}$$

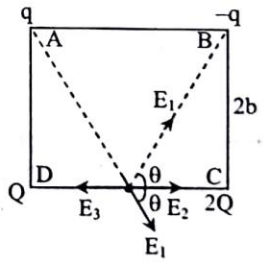
$$\frac{1}{2}mv^2 = \frac{kQ}{a} - \frac{kQ}{4a}$$

$$= \frac{3kQ}{4a}$$

$$\frac{1}{2}mv^2 = 3\left[\frac{kQ}{4a}\right].q = 3Vq$$

$$v = \sqrt{\frac{6qV}{m}}$$

22. [4]



$$E_1 = \frac{kq}{(\sqrt{5}b)^2} = \frac{kq}{5b^2}$$

$$E_2 = \frac{kQ}{b^2}, E_3 = \frac{2kQ}{5b^2}$$

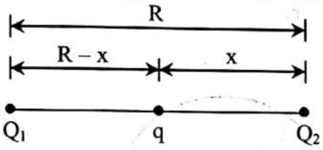
$$E_{net} = 2E_1 \cos\theta + E_2 - E_3$$

$$0 = \frac{2kq}{5b^2} \times \frac{1}{\sqrt{5}} + \frac{kQ}{b^2} - \frac{2kQ}{b^2}$$

$$\frac{q}{Q} = \frac{5\sqrt{5}}{2}$$

23. [3]

Force on Q_2 is zero (q should be negative)



$$\frac{kQ_1Q_2}{R^2} = \frac{kqQ_2}{x^2} \text{ or } \frac{x}{R} = \sqrt{\frac{q}{Q_1}}$$

Force on q is zero :

$$\frac{kQ_1q}{(R-x)^2} = \frac{kqQ_2}{x^2}$$

$$\text{or } \frac{R-x}{x} = \sqrt{\frac{Q_1}{Q_2}}$$

$$\Rightarrow \frac{R}{x} = \frac{\sqrt{Q_1}+\sqrt{Q_2}}{\sqrt{Q_3}} \text{ or } \frac{\sqrt{Q_1}}{\sqrt{q}} = \frac{\sqrt{Q_1}+\sqrt{Q_3}}{\sqrt{Q_2}}$$

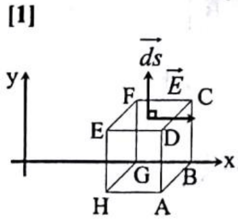
$$\text{or } q = \frac{Q_1Q_2}{(\sqrt{Q_1}+\sqrt{Q_2})^2}$$

24. [4]

$$\phi + 2\phi' = \frac{q}{\varepsilon_0}$$

$$\phi' = \frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$$

25. [1]



$$\phi_{ABCDA} = (4ka)\hat{i}.a^2\hat{i}$$

$$\phi_{ABCDA} = 4ka^3$$

$$\phi_{EFGE} = (3ka)\hat{i}.a^2\hat{i} = -3ka^3$$

$$\phi_{cube} = 4ka^3 - 3ka^3$$

$$\phi_{cube} = ka^3$$

26. [2]

Total flux from line charge

$$= \frac{q}{\varepsilon_0} = \frac{\lambda\ell}{\varepsilon_0}$$

Flux through cube $= \frac{1}{4}$ th of total flux

$$= \frac{1}{4} \times \frac{\lambda\ell}{\varepsilon_0} = \frac{\lambda\ell}{4\varepsilon_0}$$

27. [3]

$$\frac{\phi_1}{\phi_2} = \frac{\Sigma q_1}{\Sigma q_2} = \frac{Q}{Q - \frac{4Q}{3}} = \frac{-3}{1}$$

28. [4]

$$\phi = EA\cos 90°$$

29. [4]

$$\Sigma q = \epsilon_0 (\phi_o - \phi_i)$$

30. [2]

$$\phi = \frac{q_{in}}{\varepsilon_0}$$

Unit Test-7

Hints & Solutions

1. [3]

$V + V_R = V_C + V$

$\Rightarrow V_C = V_R$

$iR = \left(\dfrac{2V - V}{2R + R}\right) R = \dfrac{V}{3}$

2. [1]

P.D at $2\mu F = 24$ V; $Q = 48\ \mu C$

P.D at $6\mu F = 16$ V; $Q = 96\ \mu C$

P.D at $12\mu F = 8$ V; $Q = 96\ \mu C$

3. [2]

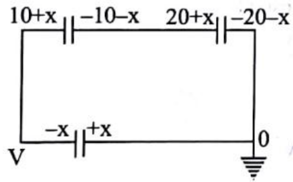
$V = \dfrac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$U_F = \dfrac{1}{2}(C_1 + C_2)V^2$

4. [2]

$C_{PQ} = (n - 1)C = (6 - 1)C = 5C = \dfrac{5\epsilon_0 A}{d}$

5. [1]



$\dfrac{10 + x}{6} + \dfrac{20 + x}{6} + \dfrac{x}{6} = 0$

$x = -10$

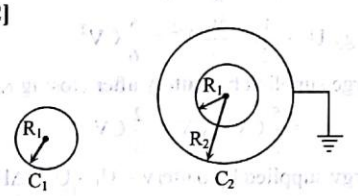
$V - 0 = -\dfrac{x}{C}$

$V = -\dfrac{(-10)}{6} = \dfrac{10}{6} = \dfrac{5}{3}$ volt

6. [1]

$H_{500} = \left(\dfrac{500}{300 + 500}\right)\dfrac{1}{2}CV^2 = \dfrac{5}{8}\left(\dfrac{1}{2}CV^2\right)$

7. [2]



$C_1 = 4\pi\varepsilon_0 R_1$

and $C_2 = 4\pi\varepsilon_0\left(\dfrac{R_1R_2}{R_2 - R_1}\right)$

Given that $C_2 = nC_1$

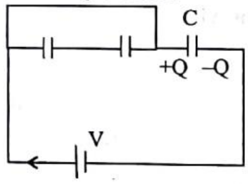
or $\dfrac{R_2R_1}{R_2 - R_1} = nR_1$

or $\dfrac{R_2/R_1}{R_2/R_1 - 1} = n$

or $\dfrac{R_2}{R_1} = \dfrac{n}{n-1}$

8. [3]

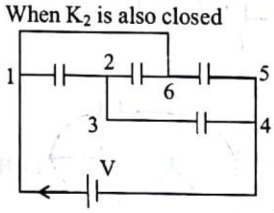
When K_1 is closed



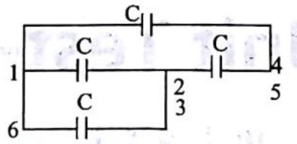
$Q = CV$

energy $U_i = \dfrac{1}{2}CV^2$

When K_2 is also closed



Equivalent circuit



$$C_{eq} = C + \frac{2C}{3} = \frac{5C}{3}$$

Energy $U_f = \frac{1}{2} \times \frac{5C}{3} V^2 = \frac{5}{6} CV^2$

Charge supplied by battery after closing K_2

$$= \frac{5}{3}CV - CV = \frac{2}{3}CV$$

Energy supplied by battery = $U_f - U_i + \Delta H$

$$\frac{2}{3}CV^2 = \frac{5}{6}CV^2 - \frac{1}{2}CV^2 + \Delta H$$

$$\therefore \Delta H = \frac{1}{3}CV^2$$

9. [2]

$$C_0 = \frac{\varepsilon_0 A}{d}, \; C = \frac{\varepsilon_0 A}{d - \frac{d}{4} + \frac{d}{4\varepsilon_r}} = \frac{\varepsilon_0 A}{\frac{3d}{4} + \frac{d}{4\varepsilon_r}}$$

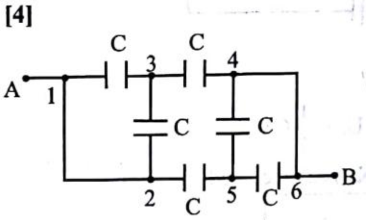
$$= \left(\frac{4\varepsilon_r}{3\varepsilon_r + 1}\right) C_0$$

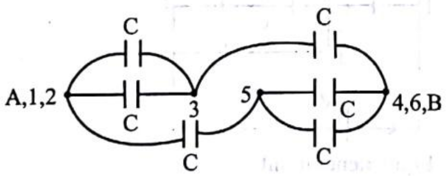
10. [4]

$$\text{Heat} = \frac{1}{2}CV^2 = ms\,\Delta T$$

$$V = \sqrt{\frac{2mS\Delta T}{C}}$$

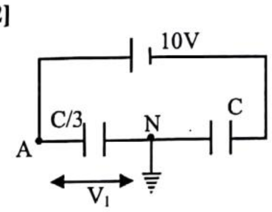
11. [4]





$$C_{eq} = \frac{2C}{3} + \frac{2C}{3} \Rightarrow C_{eq} = \frac{4C}{3}$$

12. [2]



$$V_A - V_N = \frac{10 \times C}{C + \frac{C}{3}} = \frac{30C}{4C} = 7.5$$

$V_A - 0 = 7.5$

$V_A = 7.5$ V

13. [2]

$$C_8 = \frac{\epsilon_0 (8)\left(\frac{A}{2}\right)}{d/3} = 12\,C$$

$$C_{24} = \frac{\epsilon_0 (24)\left(\frac{A}{2}\right)}{2d/3} = 18\,C$$

$$C_5 = \frac{\epsilon_0 (5)\left(\frac{A}{2}\right)}{d} = 2.5\,C$$

$C_{eq} = 7.2\,C + 2.5\,C$

$= 9.7\,C$

14. [3]

$\because$ Battery is connected

$\therefore$ V = constant

$$C = \frac{\varepsilon_0 KA}{d}$$

$C \propto K$

$$U = \frac{1}{2}CV^2$$

$U \propto C$

$U \propto K$

15. [4]

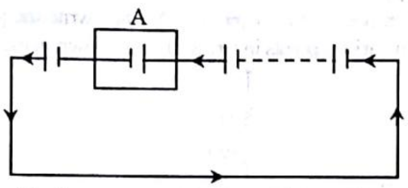
$$C(t) = \frac{\varepsilon_0 A}{d} = K\frac{(vt \times b)\varepsilon_0}{d} + \frac{(\ell - vt)b\varepsilon_0}{d}$$

$$Q(t) = CV = \frac{Kvb\varepsilon_0}{d}t + \frac{b\varepsilon_0 \ell}{d} - \frac{b\varepsilon_0 vt}{d}$$

$$I = \frac{dq}{dt} = \frac{Kvb\varepsilon_0}{d} - \frac{b\varepsilon_0 v}{d}$$

$$I = \frac{(K-1)vb\varepsilon_0}{d} = \text{const}$$

16. [1]

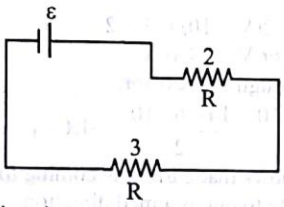


$V_T = E - Ir$

$V_T = E - \dfrac{(n-2)E}{nr} \times r$

$V_T = E - \dfrac{nE}{n} + \dfrac{2E}{n} = \dfrac{2E}{n}$

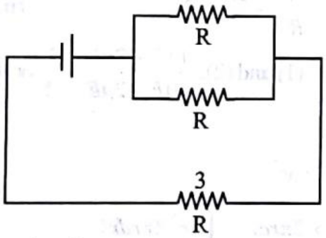
17. [3]



Old situation

$P_2 = \left(\dfrac{\varepsilon}{2}\right)^2 \dfrac{1}{R} = \dfrac{\varepsilon^2}{4R}$

$P_3 = \left(\dfrac{\varepsilon}{2}\right)^2 \dfrac{1}{R} = \dfrac{\varepsilon^2}{4R}$

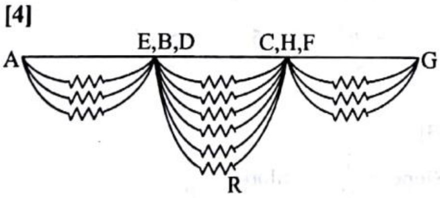


New situation

P_2 will be lasser than $\dfrac{\varepsilon^2}{4R}$

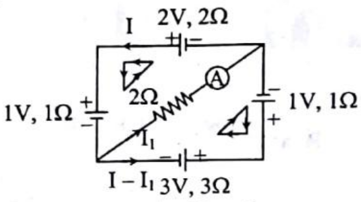
P_3 will be more than $\dfrac{\varepsilon^2}{4R}$

18. [4]



$R_{AG} = \dfrac{R}{3} + \dfrac{R}{6} + \dfrac{R}{3} = \dfrac{5R}{6} = \dfrac{5}{6} \times 6\,\Omega = 5\,\Omega$

19. [3]



$I \times 2 - 2 + 1 + I \times 1 + 2I_1 = 0$

$3I + 2I_1 = 2$ ....(1)

$-1 - (I - I_1) \times 4 + 3 + 2I_1 = 0$

$-4I + 4I_1 + 2 + 2I_1 = 0$

$-4I + 6I_1 = -2$

$-2I + 3I_1 = -1$ ....(2)

$6I + 4I_1 = 4$ ....(1)

$-6I + 9I_1 = -3$ ....(2)

$13I_1 = 1 \quad \therefore I_1 = 1/13$ A

20. [1]

$H = \dfrac{V^2}{R}t \quad \because H = \text{same};\ R = \text{same}$

$\Rightarrow t \propto \dfrac{1}{V^2} \quad \Rightarrow t' = 4t = 20$ min.

21. [4]

$1\Omega = R_{2T} = R_0(1 + \alpha\, 2T)$ .... (i)

$2\Omega = R_T = R_0(1 + \alpha T)$ ..... (ii)

$2 = \dfrac{1+\alpha T}{1+2T\alpha},\ \dfrac{2+54\alpha-1}{\alpha} = T,$

$\dfrac{1}{\alpha} + 54 = T;\ \dfrac{100000}{125} + 54 = T,\ T = 854°C$

$\therefore T = 854 + 273;\ T = 1127K$

22. [2]

Ideal voltmeter should measure (V)

$= \dfrac{120 \times 80}{100} = 96$ Volt

Voltmeter will measure (V') $= \dfrac{120 \times 40}{60}$

$= 80$ volt

$\therefore$ % error $= \dfrac{96-80}{96} \times 100$

$= \dfrac{16}{96} \times 100 = \dfrac{50}{3} = 16.7\%$

23. [1]

$I = \dfrac{dQ}{dt} = a - 2bt$

$I = 0$ at $t = \dfrac{a}{2b}$

$$\therefore \text{Heat} = \int_0^{\frac{a}{2b}} I^2 R dt = \int_0^{\frac{a}{2b}} (a-2bt)^2 R dt$$

$$= R\left[a^2 t + \frac{4b^2t^3}{3} - \frac{4abt^2}{2}\right]_0^{\frac{a}{2b}}$$

$$= R\left[\frac{a^2 \times a}{2b} + \frac{4b^2 \times a^3}{24b^3} - \frac{4aba^2}{8b^2}\right]$$

$$= R\left[\frac{a^3}{2b} + \frac{a^3}{6b} - \frac{a^3}{2b}\right] = \frac{Ra^3}{6b}$$

24. [4]

$\sigma \propto \frac{1}{R}$ when ℓ and A = same

$R \propto \tan\theta$, $\sigma \propto \frac{1}{\tan\theta}$

$$\frac{\sigma_1}{\sigma_2} = \frac{\tan 30^\circ}{\tan 60^\circ} = \frac{1}{3}$$

25. [4]

By KVL in each branch

$$V_0 = \frac{\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$9 = \frac{-\frac{3}{1} + \frac{V_C}{2} + 0}{1 + \frac{1}{2} + \frac{1}{0.5}}$$

$$\frac{V_C}{2} - 3 = 9\left(1 + \frac{1}{2} + 2\right)$$

$$\frac{V_C}{2} - 3 = 9\left[\frac{7}{2}\right]$$

$$\frac{V_C}{2} = \frac{63}{2} + 3$$

$V_C = 69$ V

26. [3]

$$\frac{R}{R_0} = \left(\frac{\ell}{\ell_0}\right)^2 = \left(\frac{1.2\ell}{\ell}\right)^2$$

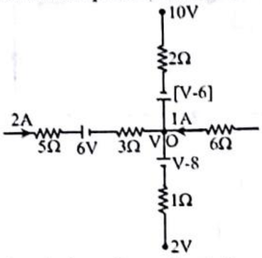
$R_f = 1.44\ R_0$

$$\therefore \% \text{ Changing in resistance} = \frac{1.44R_0 - R_0}{R_0} \times 100$$

$$= 0.44 \times 100 = 44\ \%.$$

27. [1]

Let potential of point O be V, then write the potential of various points in terms of V as shown in the figure



Apply junction rule at O.

$$\frac{V-6-10}{2} + \frac{V-8-2}{1} = 3$$

or $V - 16 + 2(V - 10) = 3 \times 2$

or $3V = 42$ or $V = 14$ volt

Current through 2Ω resistor,

$$I = \frac{V-6-10}{2} = \frac{14-6-10}{2} = -1A$$

–ve sign shows that current is coming towards O, i.e., opposite to our assumed direction.

28. [4]

When 'n' cells are reversely connected

$$i_1 = \frac{(12-2n)E + 2E}{R} = 3 \quad \text{...(i)}$$

$$i_2 = \frac{(12-2n)E - 2E}{R} = 2 \quad \text{...(ii)}$$

From eqns. (1) and (2); $\frac{14E - 2nE}{10E - 2nE} = \frac{3}{2}$ or $n = 1$

29. [1]

Given ; $J = ar^2$.

$$i = \int_1^2 J \times 2\pi r dr = \int_{R/3}^{R/2} ar^2 2\pi r dr$$

$$= 2\pi a \int_{R/3}^{R/2} r^3 dr = 2\pi a \left|\frac{r^4}{4}\right|_{R/3}^{R/2}$$

$$= \frac{\pi a}{2}\left[\left(\frac{R}{2}\right)^4 - \left(\frac{R}{3}\right)^4\right]$$

$$= \frac{\pi a R^4}{2} \times \frac{65}{81 \times 16} = \frac{65\pi a R^4}{2592}$$

30. [3]

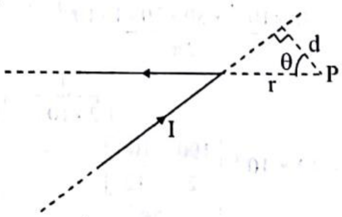
$\text{Slope} = \frac{I}{V} \Rightarrow \text{Slope} \propto \frac{1}{R}$

Hence $T_2 > T_1$

Unit Test-8

Hints & Solutions

1. **[4]**



$$B = \frac{\mu_0 i}{4\pi d}[\sin 90° - \sin\theta]$$

$\theta = 45°$

$$\sin 45° = \frac{d}{r}$$

$$B = \frac{\mu_0 i\sqrt{2}}{4\pi r}\left[1 - \frac{1}{\sqrt{2}}\right]$$

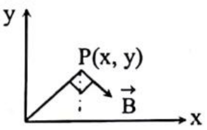
$$= \frac{\mu_0 i}{4\pi r}(\sqrt{2} - 1)$$

2. **[3]**

a $\rightarrow$ for soft iron

b $\rightarrow$ for steel

3. **[1]**

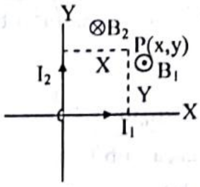


$$|B| = \frac{\mu_0}{2\pi}\frac{i}{\sqrt{x^2 + y^2}}$$

unit vector perpendicular to the position vector is $\dfrac{y\hat{i} - x\hat{j}}{\sqrt{x^2 + y^2}}$

$$\vec{B} = \frac{\mu_0 i}{2\pi(x^2 + y^2)}(y\hat{i} - x\hat{j})$$

4. **[3]**



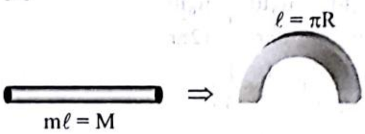
$B_{net} = 0$

$B_1 = B_2$

$$\frac{\mu_0 I_1}{2\pi Y} = \frac{\mu_0}{2\pi}\frac{I_2}{X}$$

$$Y = \frac{I_1}{I_2}X$$

5. **[2]**



$$M' = (2R)\,m = \frac{2m\ell}{\pi} = \frac{2M}{\pi}$$

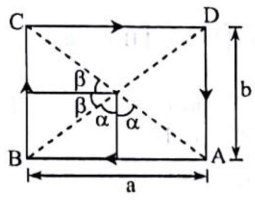
6. **[2]**

In magnetic meridian $3 = 2\pi\sqrt{\dfrac{I}{MB_e}}$ ...(1)

In horizontal plane, $3\sqrt{2} = 2\pi\sqrt{\dfrac{I}{MH}}$ ...(2)

$$\therefore \frac{3}{3\sqrt{2}} = \sqrt{\frac{H}{B_e}} = \sqrt{\frac{B_e\cos\theta}{B_e}} \Rightarrow \theta = 60°$$

7. **[4]**



$$B_{AB} = \frac{\mu_0 I}{4\pi b/2}\left[2\times\frac{a}{2\sqrt{\frac{a^2+b^2}{4}}}\right]$$

$$B_{AB} = \frac{\mu_0 I}{2\pi b}\,\frac{2a}{\sqrt{a^2+b^2}}$$

$$B_{BC} = \frac{\mu_0 I}{4\pi\frac{a}{2}}\times 2\times\frac{b}{2\sqrt{\frac{b^2+a^2}{4}}} = \frac{\mu_0 I b}{\pi a\sqrt{a^2+b^2}}$$

$$B_{net} = 2B_{AB} + 2B_{BC}$$

$$= \frac{2\mu_0 I a}{b\pi\sqrt{a^2+b^2}} + \frac{2\mu_0 I b}{\pi a\sqrt{a^2+b^2}}$$

$$= \frac{2\mu_0 I}{\pi\sqrt{a^2+b^2}}\left(\frac{a}{b}+\frac{b}{a}\right)$$

$$= \frac{2\mu_0 I}{\pi\sqrt{a^2+b^2}}\,\frac{a^2+b^2}{ab} = \frac{2\mu_0 I}{\pi}\,\frac{\sqrt{a^2+b^2}}{ab}$$

8. [1]

$$B = B_1 - B_2 + B_3$$

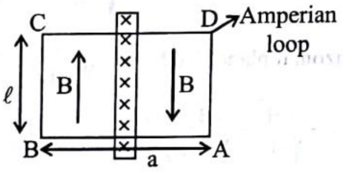
$$= \frac{\mu_0 I\theta}{4\pi r} - \frac{\mu_0 I\theta}{8\pi r} + \frac{\mu_0 I\theta}{12\pi r}$$

$$= \frac{\mu_0 I\theta}{4\pi r}\left(1-\frac{1}{2}+\frac{1}{3}\right)$$

$$= \frac{\mu_0 I\theta}{4\pi r}\left(\frac{6-3+2}{6}\right)$$

$$= \frac{\mu_0 I\theta}{4\pi r}\times\frac{5}{6}$$

9. [1]



$$\oint B.dl = \mu_0 I_{en}$$

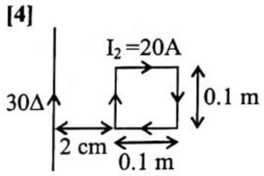
$$\int_{AB} B.dl + \int_{BC} B.dl + \int_{CD} B.dl + \int_{DA} B.dl = \mu_0 I$$

$$0 + B.l + 0 + B.l = \mu_0\lambda l$$

$$2Bl = \mu_0\lambda l$$

$$B = \frac{\mu_0\lambda}{2}$$

10. [4]



$$F_{loop} = \frac{\mu_0 I_1 I_2\times l}{2\pi}\left[\frac{1}{d}-\frac{1}{d+l}\right]$$

$$= \frac{4\pi\times10^{-7}\times30\times20\times1\times10^{-1}}{2\pi}\left[\frac{1}{2\times10^{-2}}-\frac{1}{0.12}\right]$$

$$= 12\times10^{-6}\left[\frac{100}{2}-\frac{100}{12}\right]$$

$$= 12\times10^{-6}\left[50-\frac{25}{3}\right]$$

$$= 12\times10^{-6}\left[\frac{125}{3}\right]$$

$$= 500\times10^{-6} = 5\times10^{-4}\,N$$

11. [1]

let θ = dip angle

H = horizontal component of the Earth's field

V = vertical component of the Earth's field

Also. $\tan\theta = \frac{V}{H}$

but $\tan45^\circ = \frac{V}{H\cos30^\circ}$

$\therefore\ \frac{\tan\theta}{\tan45^\circ} = \cos30^\circ$

or $\theta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

12. [2]

$2 > \mu_r > 1,\ 1 > \chi_m > 0$

13. [2]

$e = NAB\omega\sin\omega t$

$$P = \frac{e^2}{R} = \frac{(AB\omega)^2\sin^2\omega t}{R}$$

$$\langle P\rangle = \frac{(AB\omega)^2}{R}\langle\sin^2\omega t\rangle$$

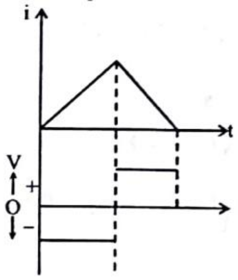
$$= \frac{\left(\frac{\pi r^2}{2}B\omega\right)^2\times\frac{1}{2}}{R} = \frac{(\pi r^2 B\omega)^2}{8R}$$

14. [2]

$$V = -L\frac{di}{dt}$$

From graph we can see that $\frac{di}{dt}$ = constant but its value is initally negative & then it become positive

∴ in graph V first remain negative and then become positive.



15. [4]

$$B = \mu_0 ni = \frac{\mu_0 Ni}{\ell}$$

$$\phi = NB \times A$$

$$= \frac{\mu_0 N^2 Ai}{\ell}$$

$$L = \frac{\phi}{3} = \frac{\mu_0 N^2 A}{\ell}$$

16. [3]

At any instant

$V_R + V_L = 240$

$iR + V_L = 240$

$V_L = 240 - iR$

$= 240 - 15 \times 10^{-3} \times 400 = 180$ V

17. [4]

Let $I = I_0 \sin\omega t$,

where $I_0 = 10$, $\omega = 100\,\pi$

then $\varepsilon = M\frac{dI}{dt}$

$= M\frac{d}{dt} I_0 \sin\omega t$

$= M I_0 \omega \cos\omega t$

∴ $\varepsilon_{max} = MI_0\omega$

$5\pi = M \times 10 \times 100\pi$

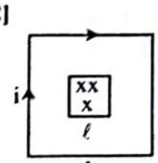
$M = 5$mH

18. [1]

At $t = 0$, current through inductor is zero

At $t = \infty$, inductor behave like a conductor

19. [2]



L

$\phi = BA = Mi$

$$M = \frac{BA}{i}$$

$$B = \frac{\mu_0 i}{4\pi\left(\frac{L}{2}\right)}(\sin 45° + \sin 45°) \times 4 = \frac{\mu_0 i}{\pi L}\frac{4}{\sqrt{2}}$$

$$M = \frac{\mu_0 i 4 \times \ell^2}{\pi L\sqrt{2}}$$

$$= \frac{2\sqrt{2}\mu_0\ell^2}{\pi L}$$

20. [1]

$i = i_0(1 - e^{-t/\tau})$

$\frac{i_0}{2} = i_0(1 - e^{-t/\tau})$

$e^{t/\tau} = 2$

$t = \tau \ln 2$.

21. [3]

$\boxed{V_p i_p = V_s i_s}$

$4000 \times 100 = 240000 \times i_s$

$i_s = 1.67$ A

22. [1]

$$R = \frac{V_R^2}{P_R}$$

$V_R I_R = P_R$

$$I_R = \frac{P_R}{V_R} = \frac{P_S}{Z} \Rightarrow Z = \frac{100}{\frac{60}{10}} = \frac{100}{6}$$

$$\sqrt{R^2 + X_L^2} = \left(\frac{100}{6}\right)^2$$

23. [1]

$$I = \frac{V}{\sqrt{R^2 + \frac{1}{\omega^2 C^2}}} = \frac{V}{\sqrt{R^2 + X_C^2}} \quad ...(1)$$

$$I/2 = \frac{V}{\sqrt{R^2 + \frac{9}{\omega^2 C^2}}} = \frac{V}{\sqrt{R^2 + (9X_C^2)}} \quad ...(2)$$

24. [4]

$$i = \frac{20}{R}\sin\omega t$$

$$V_2 = -20\sin\left(\frac{\pi}{2} - \left(\omega t + \frac{\pi}{6}\right)\right)$$

$$\Rightarrow -20\sin\left(\frac{\pi}{3} - \omega t\right) \Rightarrow 20\sin\left(\omega t - \frac{\pi}{3}\right)$$

V is lagging behind i by $\frac{\pi}{3}$

x as practical capacitor not the ideal because phase diff. between V and i $\neq \frac{\pi}{2}$

25. [3]

$$V_{average} = \frac{\int_0^{T/2}(V_{ac})dt}{T/2} = \frac{\int_0^{T/2}(V_0\sin\omega t)dt}{T/2}$$

$$= \frac{2V_0}{T}\int_0^{T/2}\sin(\omega t)\,dt$$

$$= \frac{2V_0}{T}(-\cos\omega t)_0^{T/2}$$

$$= \frac{2V_0}{T}\left(\cos 0 - \cos\frac{2\pi}{T}\times\frac{T}{2}\right)$$

$$= \frac{2V_0}{T}(1+1) = \frac{4V_0}{2\pi} = \frac{2V_0}{\pi}$$

$$V_{rms} = \sqrt{\frac{\int_0^{T/2}(V_{ac})^2dt}{T/2}} = \sqrt{\frac{V_0^2\int_0^{T/2}(\sin^2\omega t)\,dt}{T/2}}$$

$$= \sqrt{\frac{V_0^2\int_0^{T/2}(1-\cos 2\omega t)\,dt}{T}} = \sqrt{\frac{V_0^2}{T}\left(\frac{T}{2}\right)} = \frac{V_0}{\sqrt{2}}$$

26. [2]

$$I_{rms} = \sqrt{\frac{\int_0^1\left[(\sqrt{3}\sin wt) + (\cos wt)\right]^2 dt}{T}}$$

$$= \sqrt{\frac{\int_0^T 3\sin^2 wt\,dt + \int\cos^2 wt\,dt + \int\sqrt{3}\sin 2wt\,dt}{T}}$$

$$= \sqrt{\frac{\frac{3}{2}T + \frac{1}{2}T + 0}{T}} = \sqrt{2} = \sqrt{2}\text{ Amp.}$$

27. [2]

$$f = \frac{1}{2\pi\sqrt{L_{eq}C_{eq}}} = \frac{1}{2\pi\sqrt{3L\times 3C}} = \frac{1}{6\pi\sqrt{LC}}$$

28. [2]

$L = 0.7$ H, $R = 220\ \Omega$, $V_{rms} = 220$ volt

$$X_L = 2\pi f L = 2\times\frac{22}{7}\times 50\times 0.7 = 220\ \Omega$$

$$I_{rms} = \frac{V_{rms}}{\sqrt{X_L^2 + R^2}} = \frac{220}{\sqrt{2}\times 220} = \frac{1}{\sqrt{2}}$$

hence $I_0 = 1$ A

wattless current $= I_0\sin\phi$

$$= I_0\sqrt{I - \cos^2\phi}$$

$$= I_0\sqrt{1 - \frac{R^2}{Z^2}} = \frac{I_0}{\sqrt{2}} = 0.7\text{ A}$$

29. [4]

$$V(t) = -V_0 + \frac{2V_0}{T}\times t$$

$$V_{rms} = \sqrt{\frac{\int_0^T V^2 dt}{\int_0^T dt}} = \sqrt{\frac{\int_0^T\left(V_0^2 + \frac{4V_0^2t^2}{T^2} - \frac{4V_0^2t}{T}\right)dt}{\int_0^T dt}}$$

$$= \sqrt{\frac{V_0^2T + \frac{4V_0^2T}{3} - 2V_0^2T}{T}} = \frac{V_0}{\sqrt{3}}$$

30. [3]

The capacitive reactance is

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

$$= \frac{1}{2\pi\times 50\times\left(\frac{25}{\pi}\times 10^{-6}\right)} = 4000\text{ ohm.}$$

The impedance of the circuit is

$$Z = \sqrt{(R^2 + X_C^2)} = \sqrt{[(3000)^2 + (4000)^2]} = 500\text{ ohm}$$

Power factor, $\cos\phi = \frac{R}{Z} = \frac{3000}{5000} = 0.6$

Power dissipation, $\overline{p} = V_{rms}\times i_{rms}\times\cos\phi.$

$$= V_{rms}\times\frac{V_{rms}}{Z}\times\cos\phi.$$

$$= 200\times\frac{2000}{5000}\times 0.6$$

$= 4.8$ watt.

Unit Test-9

Hints & Solutions

1. [2]

acc. of block A

$\Rightarrow a_A = \frac{3m - m}{4m} \times g = g/2$

$\therefore$ acc of image in A mirror $= -2g/2\,\hat{i} = -g\,\hat{i}$

Similary acc of block C

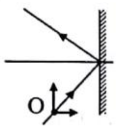
$a_C = \frac{2m - m}{3m} \times g = g/3$

$\therefore$ acc. of image in C mirror $= 2 \times (g/3\,\hat{i}) = 2g/3\,\hat{i}$

Image acceleration w.r.t to each other

$\therefore |\vec{a}_{A/C}| = |\vec{a}_A - \vec{a}_C| = |-g\hat{i} - 2g/3\,\hat{i}| = 5g/3$

2. [3]

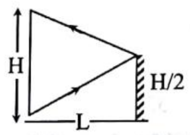


$\vec{v}_O = \frac{5}{\sqrt{2}}\hat{i} + \frac{5}{\sqrt{2}}\hat{j}$

$\vec{v}_I = -\frac{5}{\sqrt{2}}\hat{i} + \frac{5}{\sqrt{2}}\hat{j}$

$\vec{v}_{I/O} = -\frac{10}{\sqrt{2}}\hat{i}$; $|\vec{v}_{I/O}| = 5\sqrt{2}$ m/s

3. [3]



Can see only feet so zero

4. [3]

M_1	M_2
5	15
$5 + 2 \times 15$	$15 + 2 \times 5$
$3 \times 5 + 2 \times 15$	$3 \times 15 + 2 \times 5$

5. [2]

$$\frac{L_i}{L_o} = \frac{-(-f)^2}{\left(-\frac{3}{2}f + f\right)(-2f + f)}$$

$$= \frac{-f^2}{\left(-\frac{f}{2}\right)(-f)} = 2$$

$$L_i = 2L_o = 2\left(2f - \frac{3}{2}f\right) = f$$

6. [2]

We use following equation to find height of the object.

H_{image}/H_{object} = f/d, where d_f is the distance between object and focal point of the mirror.

Distance between object and focal point to the mirror x is d_{fx} = 8 f and distance between object and focal point of the mirror y is d_{fy} = 12f.

Let height of the object is h;

$H_{image}/h = 2f/8f$

$H_{imageX} = h/4$

$H_{imageY}/h = 2f/12f$

$H_{imageY} = h/6$

$H_{imageX}/H_{imageY} = 3/2$

7. [1]

$u_1 = -u,\ v_1 = -\left(\frac{uf}{u-f}\right)$

$u_2 = \infty,\ v_2 = -f$

$|v_2| - |v_1| = \frac{uf}{u-f} - f = \frac{uf - uf + f^2}{u-f} = \frac{f^2}{u-f}$

8. [2]

$\mu_1 \sin i = \mu_3 \sin r$ so $\frac{\sin i}{\sin r} = \frac{\mu_3}{\mu_1}$

9. [4]

$$\cot\frac{A}{2} = \frac{\sin\left(\frac{\delta_{min} + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\cos\frac{A}{2} = \sin\left(\frac{\delta_{min}+A}{2}\right)$$

$$\sin\left(\frac{\pi}{2}-\frac{A}{2}\right) = \sin\left(\frac{\delta_{min}+A}{2}\right)$$

$$\Rightarrow \frac{\pi}{2}-\frac{A}{2} = \frac{\delta_{min}}{2}+\frac{A}{2}$$

$$= \frac{\pi}{2} - A = \frac{\delta_{min}}{2}$$

$$\Delta_{min} = \pi - 2A$$

10. [4]

$$\theta = \frac{\text{Arc}}{\text{radius}}$$

$$\frac{\Delta\theta_w}{\Delta\theta_a} = \frac{r_a}{r_w} = \frac{2+2}{2+\frac{2}{4/3}} = \frac{4}{\frac{7}{2}} = \frac{8}{7}$$

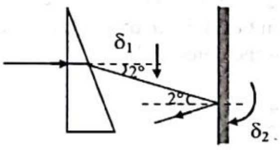
11. [3]

$\delta_1 = 4\,(1.5-1) = 2°$ Cw

$\delta_2 = 180 - 2 \times 2 = 176°$ Cw

$\delta = \delta_1 + \delta_2$

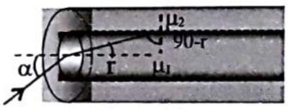
$\delta = 178$ Cw



12. [3]

$$\delta_{net} = \delta_1 + \delta_2$$
$$= (\mu - 1)\,A_1 + (\mu_2 - 1)\,A_2$$
$$= (1.5-1)\,1° + (2-1) \times 2°$$
$$= 2.5°$$

13. [2]



$90 - r > \theta_c$ where $\sin\theta_c = \dfrac{\mu_2}{\mu_1}$

So that TIR take place at core and cladding interface

$90 - \theta_c > r$

$\sin(90 - \theta_c) > \sin r$ .....(1)

Using snell law

$\sin\alpha = \mu_1 \sin r$ .....(2)

from (1) & (2)

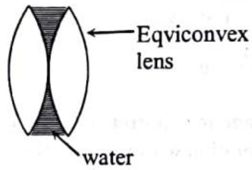
$$\cos\theta_c > \frac{\sin\alpha}{\mu_1}$$

$$\sin\alpha < \mu_1 \cos\theta_c$$

$$\sin\alpha < \sqrt{\mu_1^2 - \mu_2^2}$$

$$\therefore \alpha_{max} = \sin^{-1}\sqrt{\mu_1^2 - \mu_2^2}$$

14. [4]



$$\frac{1}{f} = \frac{\mu_{g-1}}{1}\left[\frac{2}{R}\right]$$

$$\frac{1}{f} = \frac{\frac{3}{2}-1}{1}\left[\frac{2}{R}\right]$$

$$\frac{1}{f} = \frac{1}{R} \quad \text{.... (1)}$$

Combination is a combination of three lens, where two lens each is eqviconex of focal length & and another one is equiconcave of water. Let focal length of this lens is f'

$$\frac{1}{f'} = \frac{\frac{4}{3}-1}{1}\left[\frac{-2}{R}\right]$$

$$\frac{1}{f'} = \frac{-2}{3R}$$

From (1) $\dfrac{1}{f'} = \dfrac{-2}{3f}$

Focal length of combination is f_{eq}

$$\frac{1}{f_{eq}} = \frac{1}{f} + \frac{1}{f} + \frac{1}{f'}$$

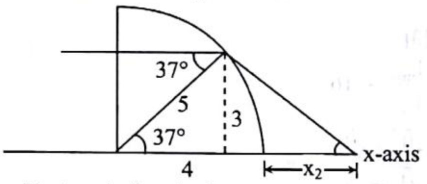
$$\frac{1}{f_{eq}} = \frac{2}{f} - \frac{2}{3f}$$

$$f_{eq} = \frac{3f}{4}$$

15. [4]

The ray fist above x-axis shale after refraction at cured surface intersect x-axis at A at a distance x_1 from O where

$$\frac{1}{24} = \frac{\mu - 1}{R} \text{ or } x_1 = \frac{R}{\mu - 1} = \frac{15}{2}\text{ cm}$$



critical angle for air glass

$\theta = \sin^{-13/5} = 37°$

$$\frac{3}{1 + x_2} = \tan 53° \Rightarrow x = \frac{5}{4}$$

$$\therefore \text{ Range width} = x_1 - x_2 = \frac{15}{2} - \frac{5}{4} = \frac{25}{4}\text{ cm}$$

16. [3]

$$P = P_1 + P_2 \Rightarrow 10 = \frac{1}{f_1} + \frac{1}{f_2}$$

$$P = P_1 + P_2 - d\,P_1P_2$$

$$\Rightarrow 6.25 = \frac{1}{f_1} + \frac{1}{f_2} - \frac{20}{f_1f_2}$$

On solving (3) option is obtained

17. [1]

Using malus law,

$I = I_0 \cos^2\theta$

$$\therefore I_{av} = \frac{1}{2\pi}\int_0^{2\pi} Id\theta = \frac{1}{2\pi}\int_0^{2\pi} I_0 \cos^2\theta d\theta$$

$$I_{av'} = \frac{I_0}{2}$$

$$\text{where } I_0 = \frac{P}{A} = \frac{10^{-3}}{3\times10^{-4}} = \frac{10}{3}\frac{\text{watt}}{\text{m}^2}$$

$$\therefore T = \frac{2\pi}{\omega} = \frac{2\times3.14}{31.4} = \frac{1}{5}\text{sec}$$

Energy passes per revolution

$= I_{av} \times \text{area} \times T$

$$= \frac{5}{3} \times 3 \times 10^{-4} \times \frac{1}{5} = 10^{-4}\text{ J}$$

18. [2]

$d\sin\theta = n\lambda$

$dx/D = n\lambda$

$$\therefore x_3 - x_1 = \frac{3\lambda D}{d} - \frac{\lambda D}{d} = \frac{2\lambda D}{d} = 0.2\text{mm}$$

19. [3]

$$\sin\theta = \frac{n\lambda}{a}, \text{ for } n = 1, \sin\theta = \frac{\lambda}{a}$$

$$\therefore a = \frac{\lambda}{\sin\theta} = \frac{6500\times10^{-10}}{\sin 30°}$$

$a = 13000 \times 10^{-10}$ m

$a = 1.3 \times 10^{-6}$ m

$a = 1.3$ micron

20. [4]

Intensity gradually increases and than decreases upto zero

21. [1]

$$\frac{f_o}{f_e} = 10$$

$f_o + f_e = 1.1$

$\therefore f_o = 100$ cm and $f_e = 10$ cm

$$\text{Final magnification} = f_o\left(\frac{1}{D} + \frac{1}{f_e}\right)$$

$$= 100\left[\frac{1}{25} + \frac{1}{10}\right] = 14$$

22. [4]

$$v_0 = \frac{f_o u_o}{u_o - f_o} = \frac{1.5\times2}{2 - 1.5} = 6\text{ cm}$$

$$u_e = \frac{f_e D}{f_e + D} = \frac{6.25\times25}{25 + 6.25} = 5\text{ cm}$$

$L = v_o + u_e = 6 + 5 = 11$ cm

(Distance between the lens is the length of tube)

23. [3]

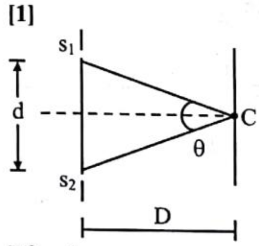
$$\Delta\theta = \frac{1.22\lambda}{a}$$

$$\therefore \Delta\theta = \frac{1.22\times5000\times10^{-10}}{2}$$

$= 3050 \times 10^{-10} = 3.05 \times 10^{-7}$ rad.

$\approx 0.31 \times 10^{-6}$ rad.

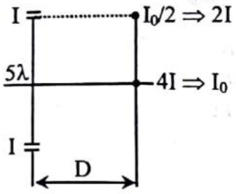
24. [1]



$D\theta = d$

$$\beta = \frac{\lambda D}{d} = \frac{\lambda D}{D\theta} = \frac{\lambda}{\theta}$$

25. [4]



$$\frac{dx}{D} = \Delta x$$

$2I = I + I + 2I\cos\phi$

$\cos\phi = 0$

$\phi = \pi/2$

$$\frac{2\pi}{\lambda}\Delta x = \frac{\pi}{2}$$

$$\Delta x = \frac{\lambda}{4}$$

$$\frac{d \times x}{D} = \frac{\lambda}{4}$$

$$\frac{5\lambda}{D} \times \frac{5\lambda}{2} = \frac{\lambda}{4}$$

$D = 50\,\lambda$

26. [2]

For path difference = Δ

phase difference $\phi = \frac{\Delta}{\lambda} \times 2\pi$

$\therefore$ for $\Delta = \lambda$ $\quad \phi = 2\pi$

$\therefore I = 4I_0\cos^2\frac{\phi}{2} = 4I_0$

for $I' = I/4$

$\therefore 4I_0\cos^2\frac{\phi}{2} = \frac{4I_0}{4}$

$\cos\frac{\phi}{2} = \pm\frac{1}{2}$

$\frac{\phi}{2} = 60°, 120$

$\phi = 120°, 240° = \frac{2\pi}{3}, 4\pi/3$

$\therefore \Delta = \frac{\phi}{2\pi} \times \lambda = \frac{2\pi}{3 \times 2\pi} \times \lambda = \lambda/3$

and $\Delta = \frac{4\pi}{3 \times 2\pi} \times \lambda = 2\lambda/3$

27. [1]

Path difference due to slab

$\Delta = (\mu - 1)t = n\lambda$ (for B-fringe)

Here $n = 1$ $\; t = \frac{\lambda}{\mu - 1} = \frac{\lambda}{(3/2 - 1)} = 2\lambda$

28. [3]

$$\frac{I_{max}}{I_{min}} = 16$$

$$\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}} = 4$$

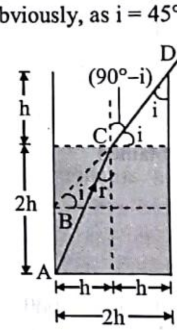
$$\sqrt{I_1} + \sqrt{I_2} = 4\sqrt{I_1} - 4\sqrt{I_2}$$

$$3\sqrt{I_1} = 5\sqrt{I_2}$$

$$\frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{5}{3} = \frac{A_1}{A_2}$$

29. [2]

Obviously, as $i = 45°$



$AC = \sqrt{(2h)^2 + h^2}$
$= h\sqrt{5}$

and $\sin r = h/AC = h/h\sqrt{5} = \frac{1}{\sqrt{5}}$,

$$\mu = \frac{\sin i}{\sin r} = \frac{1/\sqrt{2}}{1/\sqrt{5}} = \sqrt{\frac{5}{2}}$$

30. [1]

$V > I > B > G > Y > O > R$

$\therefore$ Violet deviates maximum

Unit Test-10

Hints & Solutions

1. **[1]**

$$13.6\,z^2\left(\frac{1}{1^2}-\frac{1}{3^2}\right)=\frac{hc}{\lambda}$$

$$13.6\,z^2\left(\frac{1}{2^2}-\frac{1}{4^2}\right)=\frac{hc}{\lambda_1}$$

On division ; $\dfrac{\frac{8}{9}}{\frac{3}{16}}=\dfrac{\lambda_1}{\lambda}$

$$\therefore \lambda_1=\frac{128}{27}\lambda$$

2. **[2]**

$$E_C-E_B=\frac{hc}{\lambda_1}$$

$$E_C-E_A=\frac{hc}{\lambda_3}$$

$$E_B-E_A=\frac{hc}{\lambda_3}$$

Solving the equations and get the answer.

3. **[2]**

$A_n=n^4A$

$\log\dfrac{A_n}{A}=4\log n$

$r_n=n^2r$

$\ln\dfrac{r_n}{r}=2\log n$

4. **[1]**

$$F=\frac{d}{dr}u(r)=Kr=\frac{mv^2}{r}$$

or $mv=\sqrt{Kr^2m}$ and $mvr=\dfrac{nh}{2\pi}$

$$\therefore\ r\sqrt{kr^2m}=\frac{nh}{2\pi}\ \text{ or }\ r=\left(\frac{nh}{2\pi\sqrt{Km}}\right)^{\frac{1}{2}}$$

and

$$mv^2=Kr^2=K\left(\frac{nh}{\sqrt{Km}}\right)$$

$$=r\sqrt{mKr}=\left(\frac{nh}{2\pi/mk}\right)^{\frac{1}{2}}$$

TE = KE + PE

$$=\frac{1}{2\pi}K\left[\frac{nh}{\sqrt{Km}}\right]+\frac{K}{2\pi}\left[\frac{nh}{\sqrt{Km}}\right]=\frac{nh}{2\pi}\sqrt{\frac{K}{m}}$$

5. **[2]**

$$N\propto\frac{1}{\sin^4\left(\frac{\theta}{2}\right)}$$

$$\frac{N_1}{N_2}=\left(\frac{\sin\theta_2/2}{\sin\theta_1/2}\right)^4=\left(\frac{\sin30^\circ}{\sin45^\circ}\right)^4=\frac{1}{4}$$

$N_2=4N_1=112$ per minute ($N_1=28$ per minute).

6. **[2]**

$l=\dfrac{nh}{2\pi}=\dfrac{3h}{2\pi}=l_H=l_{Li}$, $|E|\propto Z^2$ as $Z_H<Z_{Li}$

$\Rightarrow |E_H|<|E_{Li}|$

7. **[1]**

$$\frac{1}{2}mv^2=h\nu$$

or $\dfrac{p^2}{2m}=\dfrac{hc}{v}$

$$\lambda_1=\frac{h}{p}=\frac{h}{\sqrt{\frac{(2mhc)}{\lambda}}}=\sqrt{\frac{h\lambda}{2mc}}$$

or $\lambda_1^2=\dfrac{h\lambda}{2mc}$

$$\lambda=\left(\frac{2mc}{h}\right)\lambda_1^2$$

8. **[2]**

$$P=n\frac{hc}{\lambda}$$

number of photon $=n\times\dfrac{60}{100}=\dfrac{p\lambda}{hc}\times\dfrac{60}{100}$

force $=\dfrac{n\times\frac{h}{\lambda}}{4\pi r^2}=\dfrac{\frac{p}{c}\times\frac{60}{100}}{4\pi r^2}$

9. [1]

$\theta + \phi + \theta = 180°$

$\boxed{\theta = \dfrac{180-\phi}{2}}$

10. [1]

$2d \sin \phi = n \lambda$

$n = \dfrac{2d}{\lambda} \sin\phi$, $n = 2$

$\lambda = \dfrac{2d}{2} \sin \phi$

for λ_{max} , $\sin \phi = 1$

$\lambda = \dfrac{2d}{2} = d = 2.8$ Å

11. [2]

Mosley law

$\sqrt{f} = a(z - b)$

12. [2]

$\Delta\lambda = \lambda_{K\alpha} - \lambda_{min}$

When V is halved Δ_{min} becomes two times but $\lambda_{K\alpha}$ remains the same.

$\Delta\lambda' = \lambda_{K\alpha} - 2\lambda_{min} = 2(\Delta\lambda) - \lambda_{K\alpha}$ $\Delta\lambda' < 2(\Delta\lambda)$

13. [3]

$\dfrac{hc}{\lambda'} = 2\varepsilon + \phi$

$\dfrac{hc}{\lambda} = \varepsilon + \phi$

dividing then, $\dfrac{\lambda'}{\lambda} = \dfrac{\varepsilon + \phi}{2\varepsilon + \phi}$ or $\dfrac{\lambda'}{\lambda} < 1$, so, $\lambda' < \lambda$

Also, $\dfrac{\lambda'}{\lambda} = \dfrac{1}{2}\left[\dfrac{\varepsilon + \phi}{\varepsilon + \dfrac{\phi}{2}}\right]$

$\dfrac{\lambda'}{\lambda} > \dfrac{1}{2}$ or $\lambda < \lambda' < \dfrac{\lambda}{2}$

14. [2]

$E_1 = h(\nu_1 - \nu_0)$

$E_2 = h(\nu_2 - \nu_0)$

$\dfrac{E_1}{E_2} = \dfrac{\nu_2 - \nu_0}{\nu_1 - \nu_0} \Rightarrow n = \dfrac{\nu_2 - \nu_0}{\nu_1 - \nu_0}$

15. [2]

$K_1 = \dfrac{hc}{\lambda_1} - \phi$ or $\dfrac{hc}{\lambda_1} = K_1 + \phi$

$K_2 = \dfrac{hc}{\lambda_2} - \phi$ or $\dfrac{hc}{\lambda_2} = K_2 + \phi$

$\lambda_1 = 3\lambda_2$, $\dfrac{hc}{3\lambda_2} = K_1 + \phi$

$\left(\dfrac{K_2 + \phi}{3}\right) = K_1 + \phi$

$\dfrac{K_2}{3} = K_1 + \dfrac{2\phi}{3}$ $\therefore \dfrac{K_2}{3} > K_1$

16. [2]

$E = h\nu = \dfrac{hc}{\lambda}$

$\therefore \dfrac{E}{E'} = \dfrac{\lambda'}{\lambda}$ or $\dfrac{E}{1.23} = \dfrac{10,000}{5,000}$

$\therefore E = 2.46$ eV

Now $h\nu - w = \dfrac{1}{2} m(v_{max.})^2$

or $h\nu - w = eV$,

or $2.46\text{ eV} - w = e(1.36)$ volt

$\therefore w = (2.46 - 1.36)\text{eV} = 1.1$ eV

17. [2]

$K_\alpha = \left(\dfrac{A-4}{A}\right) Q$

$48 = \left(\dfrac{A-4}{A}\right) 50$

$48A = 50A - 200 \Rightarrow 200 = 2A \Rightarrow A = 100$

18. [1]

$T_{Half} = 5,800$ yr.

$\dfrac{C^{14}}{C^{12}} = \dfrac{1}{4}$

$\dfrac{N}{N_0} = \dfrac{C^{14}}{C^{14} + C^{12}} = \dfrac{1}{5} = \dfrac{1}{2^n}$

$5 = 2^n = 2^{x/5800}$

n is about 2

$x = 2 \times 5800$ yr. $= 2 \times 58$ centuries

{100 yr. = 1 centuries}

19. [2]

Let N_0 = initial number of nuclei

$n = N_0 - N_0 e^{-\lambda \times 2}$

$1.75\, n = N_0 - N_0 e^{-4\lambda}$

$$\frac{1}{1.75} = \frac{1-e^{-2\lambda}}{1-e^{-4\lambda}}$$

$$1 + e^{-2\lambda} = 1.75$$

$$e^{2\lambda} = \frac{1}{0.75} = 1.33$$

$$2\lambda = \ell n\,(1.33)$$

$$\tau = \frac{1}{\lambda} = \frac{2}{\ell n(1.33)} = 7s$$

20. [3]

$${}_{3}^{7}Li + {}_{1}^{1}H \longrightarrow {}_{2}^{4}He + {}_{2}^{4}He$$

Mass defect, $\Delta m = m\left({}_{3}^{7}Li\right) + m\left({}_{1}^{1}H\right) - 2m\left({}_{2}^{4}He\right)$

$= 7.016004\ u + 1.007825\ u - 2(4.002603)\ u$

$= 0.018623\ u$

$Q = (0.018623)\,(931.5)\ MeV \simeq 17\ MeV$

21. [4]

Energy released

= BE of products – BE of reactants

$= 111 \times 8.6 + 122 \times 8.5 - 236 \times 7.6$

$= 954.6 + 1037.0 - 1793.6 = 198\ MeV$

22. [1]

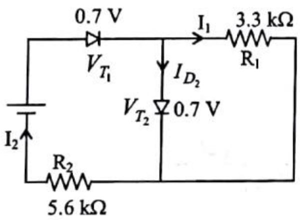
BE/A increases only in (i) & (iv) so only in these reactions, energy will emit.

23. [1]

$$I_1 = \frac{V_1}{R_1} = 0.212\ mA$$

By KVL;

$$-V_{T_1} - V_{T_2} - V_2 + E = 0$$



$\therefore\ V_2 = 20 - 0.7 - 0.7 = 18.6\ V$

$$I_2 = \frac{V_2}{R_2} = 3.32\ mA$$

24. [2]

$$\text{Voltage gain} = \beta\ \frac{R_{out}}{R_{in}}$$

$$\text{power gain} = \beta^2\ \frac{R_{out}}{R_{in}}$$

25. [1]

$n_e >>> n_h$

$\therefore$ N type semiconductor

$$P = \frac{1}{e[\mu_h n_h + \mu_e n_e]}$$

$$= \frac{1}{1.6\times10^{-19}[2.3\times8\times10^{18} + 0.01\times5\times10^{18}]}$$

$$= \frac{1}{0.16[18.4+0.05]} = \frac{1}{0.16\times18.45}$$

$$= \frac{1}{520} = 0.34\ \Omega - m$$

26. [2]

$$\alpha = \frac{I_C}{I_E} \Rightarrow I_C = \alpha I_E$$

$$I_B = I_E - I_C$$

$$\beta = \frac{I_C}{I_B}$$

27. [2]

A	B	A NAND B
0	0	1
1	0	1
0	0	1
1	1	0
0	0	1

28. [3]

As p-type is at higher potential than n-type.

29. [2]

$$\beta = \frac{\alpha}{1-\alpha} \Rightarrow \alpha - \beta = \frac{\alpha^2}{1-\alpha}$$

$$\beta - \alpha = \frac{\alpha}{1-\alpha} - \alpha = \frac{\alpha^2}{1-\alpha}$$

$$\therefore\ \frac{\beta-\alpha}{\alpha\beta} = 1$$

30. [3]

$$LC = \frac{\text{Pitch}}{\text{No of CSD}}$$

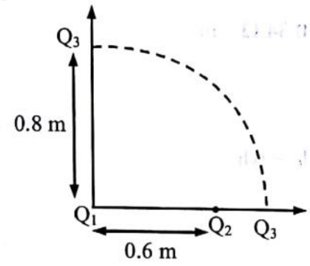
so pitch $= 0.005 \times 200 = 1.00$ mm

Revision Test-2

Hints & Solutions

1. **[3]**
Electric field is higher voltage to lower voltage.

2. **[3]**



$$U_i = \frac{KQ_1Q_3}{0.8} + \frac{KQ_2Q_3}{1} + \frac{KQ_1Q_2}{0.6}$$

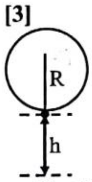
$$U_f = \frac{KQ_1Q_3}{0.8} + \frac{KQ_2Q_3}{0.2} + \frac{KQ_1Q_2}{0.6}$$

$$\Delta U = U_f - U_i = \frac{KQ_2Q_3}{1} - \frac{KQ_2Q_3}{0.2}$$

$$= K\,Q_2Q_3\left(1 - \frac{1}{0.2}\right)$$

$$|U| = 4K\,Q_2Q_3$$

3. **[3]**

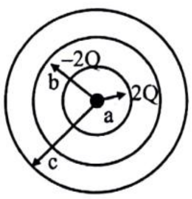


$$U_i + K_i = U_f + K_f$$

$$\frac{Kq_1q_2}{R} = -mgh + \frac{Kq_1q_2}{R+h} + K_f$$

$$\frac{Kq_1q_2}{R} - \frac{Kq_1q_2}{R+h} + mgh = K_f$$

4. **[1]**



At inner surface $\sigma = \dfrac{-2Q}{4\pi b^2}$

and at outer surface $\sigma = \dfrac{2Q}{4\pi c^2}$

5. **[3]**

$q = \varepsilon_0 (Q_2 - Q_1)$,

$\phi_2 = E_2 . A$

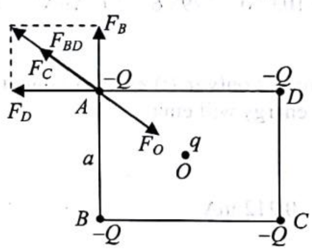
$\phi_2 = 600 \times 0.2 \times 0.01 = 1.2$

$\phi_1 = 600 \times 0.1 \times 0.01 = 0.6$

$q = 8.85 \times 10^{-12} \times 0.6$

$q = 53.10 \times 10^{-12}$

6. **[2]**



Consider the equilibrium of charge – Q at A.

$$F_B = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}$$

$$F_D = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}$$

$$F_{BD} = \sqrt{2}F_B = \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}Q^2}{a^2}$$

$$F_C = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(\sqrt{2}a)^2} = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2}$$

$$F_O = \frac{1}{4\pi\varepsilon_0}\frac{qQ}{\left(\frac{\sqrt{2}a}{2}\right)^2} = \frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a^2}$$

For equilibrium, $F_{BD} + F_C = F_O$

$$\frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}Q^2}{a^2} + \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2} = \frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a^2}$$

or $\sqrt{2}Q + \dfrac{Q}{2} = 2q$

or $2q = \frac{Q}{2}(2\sqrt{2}+1)$

or $q = \frac{Q}{4}(1+2\sqrt{2})$

7. [4]

Charge on C_1 and C_2

$$Q_1 = Q_2 = \left(\frac{C_1C_2}{C_1+C_2}\right)V$$

and charge on C_3 and C_4

$$Q_3 = Q_4 = \left(\frac{C_3C_4}{C_3+C_4}\right)V$$

$$\text{so } V_B - V_E = \frac{Q_2}{C_2} - \frac{Q_4}{C_4}$$

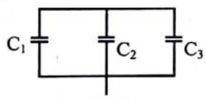
$$= \frac{C_1V}{C_1+C_2} - \frac{C_3V}{C_3+C_4}$$

$$= \left\{\frac{C_1C_4 - C_2C_3}{(C_1+C_2)(C_3+C_4)}\right\}V$$

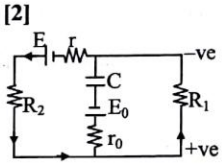
8. [4]

$$C = C_1 + C_2 + C_3 = \frac{\varepsilon_0 A}{d} + \frac{\varepsilon_0 A}{2d} + \frac{\varepsilon_0 A}{3d}$$

$$= \frac{11}{6}\frac{\varepsilon_0 A}{d}$$



9. [2]



In steady state current in capacitor branch is zero hence r_0 can be removed

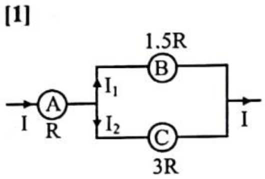
Voltage across R_1 : $IR_1 = \frac{ER_1}{r+R_1+R_2}$

$\therefore$ Voltage across capacitor $= \frac{ER_1}{r+R_1+R_2} + E_0$

$\therefore$ Energy stored in capacitor

$$= \frac{1}{2}C\left(E_0 + \frac{ER_1}{r+R_1+R_2}\right)^2$$

10. [1]



$I_1 + I_2 = I \quad I_1 = \frac{2I}{3}$

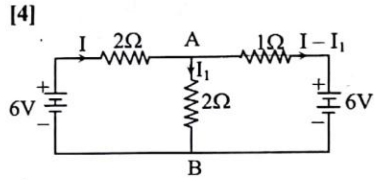
$I_1 \times 1.5\,R = I_2 \times 3R \quad I_2 = \frac{I}{3}$

$V_B = \frac{2I}{3} \times 1.5\,R = IR$

$V_C = \frac{I}{3} \times 3R = IR$

$V_A = V_B = V_C$

11. [4]



$2I + 2I_1 - 6 = 0$

$I + I_1 = 3$ ....(1)

$(I - I_1)\,1 + 6 - 2I_1 = 0$

$I - 3I_1 = -6$ ....(2)

from (1) & (2)

$I + I_1 = 3$

$\underline{\overset{-}{}I \overset{+}{-} 3I_1 = \overset{+}{-}6}$

$4I_1 = 9$ $\qquad \therefore I_1 = 9/4$

$V_A - V_B = IR$

$= 9/4 \times 2$

$= 9/2 = 4.5$

12. [1]

Let the resistances of P, Q and R be r :

The total resistances across the battery is

$$R_{Total} = \frac{r \times r}{r+r} + r = \frac{3}{2}r$$

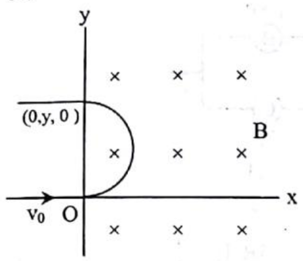
Current through P $I = \sqrt{\frac{\text{power}}{R_{Total}}} = \sqrt{\frac{12}{\frac{3r}{2}}} = \sqrt{\frac{8}{r}}$

Current through R, $I' = \frac{I}{2} = \sqrt{\frac{2}{r}}$

$\therefore$ Power dissipated in R

$P_R = (I')^2 r = \frac{2}{r} \times r = 2 = 2$ watt

13. [3]



$$y = 2r = \frac{2mv_0}{B_0 q}$$

$$\therefore \frac{q}{m} = \alpha \Rightarrow y = \frac{2v_0}{B_0\alpha}$$

14. [2]

$$B_1 = \frac{\mu_0 i}{2\pi} \odot \quad B_2 = \frac{\mu_0 i}{4\pi} \otimes \quad B_3 = \frac{\mu_0 i}{8\pi} \odot$$

$$B_{net} = \frac{\mu_0 i}{2\pi} + \frac{\mu_0 i}{8\pi} - \frac{\mu_0 i}{4\pi} \ldots\ldots$$

$$= \frac{\mu_0 i}{2\pi}\left[1 - \frac{1}{2} + \frac{1}{4} \ldots\ldots\ldots \infty\right]$$

$$= \frac{\mu_0 i}{2\pi}\left[\frac{1}{1+\frac{1}{2}}\right] = \frac{\mu_0 i}{3\pi} = \frac{4}{3} \times 10^{-7} = 1.33 \times 10^{-7} \odot$$

15. [3]

$$\tan\theta' = \frac{\tan\theta}{\cos\alpha}$$

$$\therefore \theta' > \theta$$

16. [4]

$$\tan\phi = \frac{X_L}{R} = \frac{2\pi f L}{R} = \frac{2\pi \times 200 \times \frac{1}{\pi}}{300} = \frac{4}{3}$$

$$\text{or } \phi = \tan^{-1}\frac{4}{3}$$

17. [1]

$$n\,\% = \frac{E_s I_s}{E_p I_p} \times 100 \quad \text{Now } E_p I_p = 4 \times 10^3$$

$$80 = \frac{200 \times I_s}{4 \times 10^3} \qquad I_p = \frac{4 \times 10^3}{E_p} = 40\text{A}$$

$$\therefore I_s = 16\text{A}$$

18. [4]

$$E = \frac{L\,di}{dt} \Rightarrow di = \frac{\varepsilon}{L}\,dt \Rightarrow i = \frac{\varepsilon}{L}t$$

$$5 = \frac{2}{4}t \Rightarrow t = 10 \text{ sec}$$

19. [2]

As $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\therefore \frac{1}{v} + \frac{1}{-25} = \frac{1}{-10}$$

$$\text{or } \frac{1}{v} = \frac{-1}{10} + \frac{1}{25} = \frac{-3}{50}$$

$$\text{or } v = \frac{-50}{3} \text{ cm}$$

As image is real,

$$m = \frac{-I}{O} = \frac{v}{u} \quad \text{or} \quad I = -O \times \frac{v}{u}$$

$$\text{or } I = -3 \times \frac{\frac{-50}{3}}{-25} = -2 \text{ cm (inverted)}$$

$\therefore$ Area of frame image $= (2)^2 = 4\text{cm}^2$

20. [4]

The effective focal length of the silvered lens is given by

$$\frac{1}{F} = \frac{2}{f} + \frac{1}{f_m} = \frac{2}{15} + \frac{1}{\infty} = \frac{2}{15}$$

which gives $F = \frac{15}{2}$ cm. The silvered lens behaves like a concave mirror. Using the spherical mirror formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{F}$, we have

($\because u = -20$ cm and $F = -15/2$ cm)

$$\frac{1}{v} + \frac{1}{-20} = \frac{2}{-15}$$

which gives $v = -12$ cm. The negative sign indicates that the image is formed to the left of the lens.

21. [2]

Here $i = 60^\circ$, $A = 30^\circ$, $\delta = 30^\circ$

As $\delta = (i + e) - A$

$\therefore 30 = (60 + e) - 30^\circ$

or $e = 0^\circ$

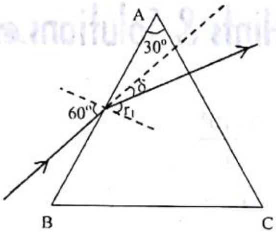
As $e = 0^\circ$, so $r_2 = 0^\circ$

But $A = r_1 + r_2$

or $30^\circ = r_1 + 0^\circ$

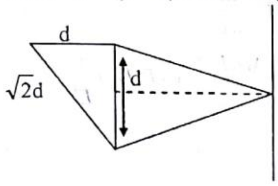
$\therefore r_1 = 30^\circ$

$$\therefore \mu = \frac{\sin i_1}{\sin r_1} = \frac{\sin 60^\circ}{\sin 30^\circ} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \sqrt{3}$$



22. [1]

$$\sqrt{2}\,d - d = (\mu - 1)\,t \Rightarrow t = 2\,(\sqrt{2} - 1)\,d$$



23. [1]

$$\beta = \frac{2}{10}\text{ cm} = 2 \times 10^{-3}\text{ m}$$

As $\beta = \dfrac{\lambda D}{d}$

$$\therefore\ d = \frac{\lambda D}{\beta} = \frac{5000\times10^{-10}\times200\times10^{-2}}{2\times10^{-3}}$$

$$= 5 \times 10^{-4}\text{ m}$$

24. [2]

$$\frac{1}{f_1} = \frac{1}{80} - \frac{1}{-\infty}$$

$$\frac{1}{f_2} = \frac{1}{-120} - \frac{1}{-\infty}$$

$$\frac{1}{f_2} \times \frac{f_1}{1} = -\frac{1}{120}\left(\frac{-80}{1}\right)$$

$$\frac{f_1}{f_2} = \frac{2}{3}$$

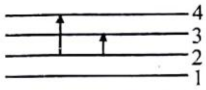
$$\frac{P_1}{P_2} = \frac{3}{2}$$

25. [3]

ΔE for hydrogen atom

$$\Delta E = 13.6\,(1)^2\left(1 - \frac{1}{4}\right) = 10.2\text{ eV}$$

for He^+ ion



$$\Delta E_{n=2\rightarrow n=4} = 10.2\text{ eV}$$

$$\Delta E_{n=2\rightarrow n=3} = 7.56\text{ eV}$$

26. [2]

$$\frac{E_e}{E_p} = \frac{\frac{1}{2}mv^2}{h\upsilon} = \frac{1}{2}v \times \frac{mv}{h}.\frac{h}{h\upsilon}$$

But $\dfrac{h}{mv} = \dfrac{h}{h\upsilon}$

$$\therefore\ \frac{E_e}{E_{ph}} = \frac{1}{2}v\left[\frac{mv}{h}.\frac{h}{h\upsilon}.\frac{c}{c}\right] = \frac{v}{2c}$$

27. [3]

Let N_2 be the number of atoms of X at time t = 0.
Then at t = 4hrs (two half lives)

$N_x = \dfrac{N_0}{4}$ and $N_y = \dfrac{3N_0}{4}$

$\therefore N_x/N_y = 1/3$ and at t = 6 hrs (three half lives)

$N_x = \dfrac{N_0}{8}$ and $N_y = \dfrac{7N_0}{8}$ or $\dfrac{N_x}{N_y} = \dfrac{1}{7}$

The given ratio $\dfrac{1}{4}$ lies between $\dfrac{1}{3}$ and $\dfrac{1}{7}$

Therefore, t lies between 4 hrs and 6 hrs.

28. [2]

Given, $m(U^{235}) = 235.121420$ amu
$m({}_0n^1) = 1.008665$ amu
$m(U^{236}) = 236.123050$ amu

Mass defect $\Delta m = m(U^{235}) + m({}_0n^1) - m(U^{236})$
$= 235.121420 + 1.008665 - 236.123050$
$\Delta m = 0.007$ amu

Energy required to remove one neutron
$= 0.007 \times 931$ MeV
$= 6.517$ MeV $= 6.5$ MeV

29. [3]

P = A + B
Q = P + Q = A + B + C
Y = A + B + C + D

30. [3]

Current in 1 kΩ is $= \dfrac{5}{1K\Omega} = 5$ mA

Current in 500 Ω $= \dfrac{12-5}{500} = 14$ mA

Current in zener = 14 – 5 = 9 mA

1. [2]

Due to rod only

$$\vec{F_1} = \frac{\lambda q}{4\pi\varepsilon_0 R}$$

Due to semicircle only

$$\vec{F_2} = \frac{\lambda q}{2\pi \in_0 R}$$

$$F_{net} = \sqrt{F_1^2 + F_2^2} \Rightarrow \boxed{F_{net} = \frac{\sqrt{5}\lambda q}{4\pi\varepsilon_0 R}}$$

2. [4]

$$E = \frac{2K\lambda}{r},\ dV = -Edr,\ V = -\int_a^b E\ dr$$

$$V_{ab} \propto \log\left(\frac{b}{a}\right)$$

3. [2]

It is discharging of capacitor

$$I = \frac{E}{R}e^{-t/RC}$$

$$\log I = \log\frac{E}{R} - \frac{t}{RC}$$

Intercept is constant $\Rightarrow$ E & R constant

|Slope| decrease $\Rightarrow C\uparrow$

4. [1]

Resistivity does not depend on length & cross section area.

5. [2]

$$I = \frac{V}{Req.}$$

$$1 = \frac{12}{6+R}$$

$$R = 6\Omega$$

6. [3]

$$R\sqrt{\frac{2mk}{qB}}$$

7. [4]

$e = Blv$

8. [2]

$$v = \omega/k \quad \Rightarrow v = \frac{6\times10^8}{4}$$

$$\mu = \frac{c}{v} \Rightarrow \frac{3\times10^8}{6\times10^8}\times 4 = 2$$

9. [3]

$$J_e = en\mu_e E_x + eD_e\frac{dn}{dx}$$

$$IL^{-2} = \frac{ITL^{-3}(\mu_e)MLT^{-2}}{IT} + IT(D_e)\frac{1}{L^4}$$

$\mu_e = [M^{-1}IT^2]$

$D_e = [L^2T^{-1}]$

10. [4]

$$a_e = \frac{F}{m}\uparrow$$

$$a_s = -g\downarrow$$

$$a_{s/e} = a_s - a_e = \frac{F}{m} + g = \frac{F+Mg}{M}$$

$$s = ut + \frac{1}{2}at^2$$

$$1 = \frac{1}{2}\left(\frac{F+Mg}{M}\right)t^2$$

$$t = \sqrt{2\frac{M}{F+Mg}}$$

11. [1]

$$\text{Change} = 2v\sin\left(\frac{60^\circ}{2}\right) = v,\quad \text{Imp.} = \Delta p = mv$$

12. [4]

$$F = ks^{-1/3}$$

$$a = \frac{k}{m}s^{-1/3}$$

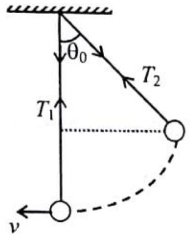
$$\int vdv = \frac{k}{m}\int s^{-1/3}ds \Rightarrow \frac{v^2}{2} = \frac{k}{m}\left[\frac{3s^{2/3}}{2}\right]$$

$v \propto s^{1/3}$

$P = Fv \propto s^{-1/3}\times s^{1/3}$

$P \propto s^0$

13. [3]



$$T_1 - mg = \frac{mv^2}{\ell}$$

$$T_1 = mg + \frac{m}{\ell}[2g\ell(1-\cos\theta)]$$

$T_1 = 3mg - 2\ mg\cos\theta$

$T_2 = mg\cos\theta$

$$\frac{T_1}{T_2} = \frac{6}{5}$$

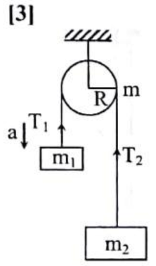
$$\frac{3mg - 2mg\cos\theta}{mg\cos\theta} = \frac{6}{5}$$

$15\ mg - 10\ mg\cos\theta = 6\ mg\cos\theta$

$15\ mg = 16\ mg\cos\theta$

$\cos\theta = 15/16$

14. [3]



$m_1 g - T_1 = m_1 a$

$T_2 - m_2 g = m_2 a$ .... (ii)

$\therefore\ (T_1 - T_2) + (m_1 + m_2)\,a = (m_1 - m_2)\,g$

$\Rightarrow\ T_1 - T_2 = (m_1 - m_2)\,g - (m_1 + m_2)\,a$

$\tau = (T_1 - T_2)\,R = I\alpha$

$= (1/2)\,mR^2\,(a/R)$ .... (iii)

$\Rightarrow (T_1 - T_2) = (1/2)\,ma$ .... (iv)

From (iii) and (iv)

$(1/2)\,ma = (m_1 - m_2)\,g - (m_1 + m_2)\,a$

$$\Rightarrow a = \frac{m_1 - m_2}{m_1 + m_2 + (m/2)}\,g$$

15. [2]

$$g_A = \frac{GM}{\left(R + \frac{R}{2}\right)^2} = \frac{4GM}{9R^2}$$

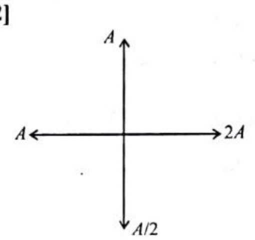
$$g_B = \frac{GMr}{R^3} = \frac{GM}{R^3} \times \frac{R}{2} = \frac{GM}{2R^2}$$

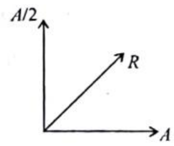
$$\frac{g_B}{g_A} = \frac{1}{2} \times \frac{9}{4} = \frac{9}{8}$$

16. [3]

I & III are showing S.H.M. on the basis of superposition principle.

17. [2]





$$R = \sqrt{A^2 + \frac{A^2}{4}} = \frac{\sqrt{5}A}{2}$$

18. [1]

$$f = \frac{v}{4(l + 2x)} \quad \text{where } x = 0.6\ r$$

$\therefore$ higher the radius lower the frequency

19. [2]

$P_1 = 5 \times 10^5$

$V_1 = 0.1\ m^3$

$T_1 = 320\ k$

$$n_1 = \frac{P_1 V_1}{RT_1} = \frac{5 \times 10^4}{8.3 \times 320} \quad \text{.... (i)}$$

$$n_2 = \frac{4 \times 10^4}{8.3 \times 300}$$

$$\Delta n = n_1 - n_2 = \frac{10^4}{8.3}\left[\frac{5}{320} - \frac{4}{300}\right]$$

$$\Rightarrow \frac{10^4}{8.3}\left[\frac{1500 - 1280}{300 \times 320}\right]$$

$$\Rightarrow \frac{220 \times 10^4}{320 \times 3 \times 8.3 \times 10^2}$$

$\Rightarrow$ 2.76 mole

Now of N_2 leaked out = 2.76 × 28

$\Rightarrow$ 77.28 gm

Most probable answer = 84 gm

20. [2]

In time interval of 't', 10% decays so in next interval of 't' again 10% of remaining sample will decayed hence total 81% sample in left so 19% will decay.

21. [1]

Energy of photon (1) $E_1 = \dfrac{12400}{\lambda(\mathring{A})}$ eV

I case

$E_1 = \dfrac{12400}{4000} = 3.1$ eV

$\because$ $V_{stopping} = 500$ m $\Rightarrow KE$ of emitted $e^- = 0.5$ eV

$\because$ $E_{photon} = W + KEe^-$

$\Rightarrow$ Work function w = 2.6 eV

II case

$V_{stopping} = 800$ mv $\Rightarrow$ $KE_{e^-} = 0.8$ eV

$\therefore$ $E_{photon} = W + KE_{e^-}$

$= 2.6 + 0.8$

$= 3.4$ eV

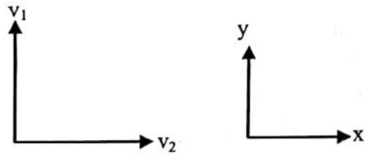
$\because$ $E_{photon} = \dfrac{12400}{\lambda(\mathring{A})}$ eV

$3.4 = \dfrac{12400}{\lambda}$

$\lambda = 3650$ Å $= 365$ nm

22. [4]

Let m be the mass of each particle and thus verticals are v_1 and v_2 respectively



$\bar{v}_{cm(x)} = \dfrac{mv_2}{2m} = \dfrac{v_2}{2}$

$\bar{v}_{cm(y)} = \dfrac{mv_1}{2m} = \dfrac{v_1}{2}$

$\bar{v}_{2cm(x)} = v_2 - \dfrac{v_2}{2} = \dfrac{v_2}{2}$

$\bar{v}_{2cm(y)} = -\dfrac{v_1}{2}$

So magnitude of velocity of 2nd particle is C.O.M frame becomes $\sqrt{\dfrac{v_2^2}{4} + \dfrac{v_1^2}{4}} = \dfrac{\sqrt{v_1^2 + v_2^2}}{2}$

$\lambda = \dfrac{h}{mv_1} \Rightarrow v_1 = \dfrac{h}{m\lambda_1}$

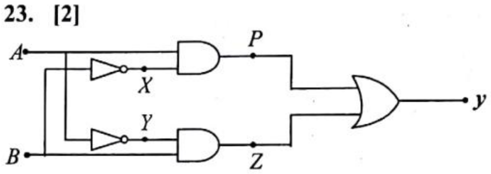
$\lambda_2 = \dfrac{h}{mv_2} \Rightarrow v_2 = \dfrac{h}{m\lambda_2}$

So De broglie wavelength of 2nd partical in COM frame is

$$\lambda = \frac{h}{m\sqrt{\dfrac{v_1^2+v_2^2}{2}}} = \frac{2h}{m\sqrt{\dfrac{h^2}{m^2\lambda_1^2} + \dfrac{h^2}{n_2^2\lambda_2^2}}} = \frac{2}{\sqrt{\dfrac{1}{\lambda_1^2} + \dfrac{1}{\lambda_2^2}}}$$

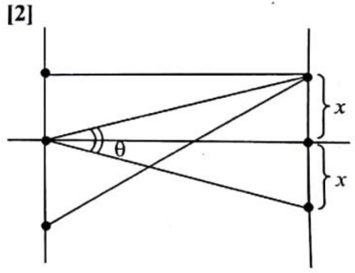
$$\Rightarrow \frac{2\lambda_1\lambda_2}{\sqrt{\lambda_1^2+\lambda_2^2}}$$

23. [2]



A	B	X	Y	Z	P
0	1	1	0	0	0
1	0	0	0	0	0

24. [2]



$I + I + 2\sqrt{I}\sqrt{I}\cos\phi$

$2I = 2I + 2I\cos\phi$

$\cos\phi = 0$

$\phi = \dfrac{\pi}{2}$

$\dfrac{2\pi\Delta x}{\lambda} = \dfrac{\pi}{2}$

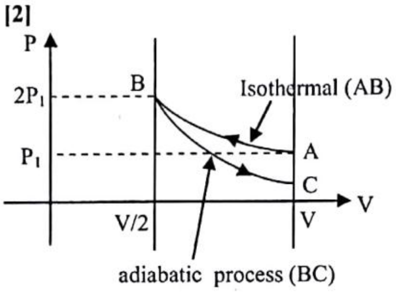
$\Delta x = \dfrac{\lambda}{4}$

$\dfrac{dx}{D} = \dfrac{\lambda}{4}$

$x = \dfrac{D\lambda}{4d}$

$\theta = \dfrac{2x}{D} = \dfrac{2}{D} \times \dfrac{D\lambda}{4d} = \dfrac{\lambda}{2d}$

25. [2]



In process BC

$$2P_1 \times \left(\frac{V}{2}\right)^{\gamma} = P_3(V)^{\gamma}$$

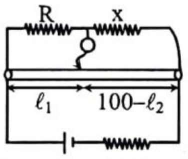
$$P_3 = 2P_1\left(\frac{1}{2}\right)^{\gamma}$$

$$= 2 \times P_1(0.5)^{7/5}$$

$$= 2 \times P_1 \times 0.368$$

$$= 0.76\, P_1$$

26.[4]



$R_0 = 50 \pm 0.2\Omega$

$R = 50\Omega$ & $\Delta R = 0.\ 2\Omega$

$\ell_0 = 60 \pm 0.2$ cm

$\ell = 60$ cm, $\Delta\ell = 0.2$ cm

$\ell_1 \pm 0.2$ cm & $(100 - \ell_1) \pm 0.4$ cm

$$x = \frac{R(100 - \ell_0)}{\ell_0}$$

$$x = \frac{50 \times 40}{60} = \frac{200}{6} = 33.33$$

$\%x = \%R + 2\%\ \ell_0$

$$100 \times \frac{\Delta x}{x} = \frac{0.2}{50} \times 100 + 2 \times \frac{0.2}{60} \times 100$$

$$= 0.4 + 0.66 = \frac{1.06}{100} \times x = \Delta x$$

$$= \frac{2}{5} + \frac{2}{3} = \frac{6+10}{15}$$

$$= \frac{16}{15} \times \frac{100}{3 \times 100} = \frac{16}{45}$$

27. [3]

Average Newton cooling method

$$\frac{70-90}{4.8} = K\left[\frac{70+90}{2} - 20\right] \quad \ldots(1)$$

$$\Rightarrow -\frac{20}{4.8} = K[80-20] \Rightarrow -\frac{20}{4.8} = K \times 60$$

for next cooling by 10°C

$$\frac{60-70}{t} = K\left[\frac{60+70}{2} - 20\right] \quad \ldots(2)$$

$$\Rightarrow -\frac{10}{t} = K[65-20]$$

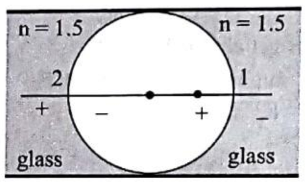
$$\Rightarrow -\frac{10}{t} = K \times 45$$

$$\Rightarrow -\frac{10}{t} = 45 \times \left(\frac{-20}{4.8 \times 60}\right)$$

$$t = \frac{+10 \times 3 \times 4.8}{45}$$

$t = 3.2$ minutes

28.[3]



I_1 due to refraction at surface (1)

$$\frac{1.5}{V} - \frac{1}{R/2} = \frac{1.5-1}{R}$$

$$\frac{1.5}{V} = \frac{2}{R} + \frac{0.5}{R}$$

$$\frac{1.5}{V} = \frac{2.5}{R}$$

$$V = \frac{15}{25}R$$

$$\Rightarrow \frac{3}{5}R = 0.6R$$

I_2 due to refraction at surface (2)

$$\frac{1.5}{V} - \frac{1}{-3R/2} = \frac{1.5-1}{-R}$$

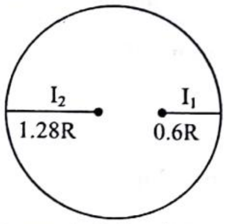
$$\frac{1.5}{V} = -\frac{2}{3R} - \frac{0.5}{R}$$

$$\frac{1.5}{V} = \frac{-3.5}{3R}$$

$V = \frac{-4.5}{3.5} R$

$\Rightarrow -\frac{9}{7} R$

$\Rightarrow -1.285 R$



distance between I_1 & $I_2 = 0.114 R$

29. [4]

Mass number get charge by $\Rightarrow 4 \times n$

because atomic number charge occur only in α decay

$4n = 232 - 208$

$4n = 24$

$n = 6$

$\alpha \Rightarrow 4$

Mass number get charge by $\Rightarrow 24$

New atomic number $\Rightarrow 90 - 6 \times 2 + P$

$90 - 12 + P = 82$

$P = 94 - 90 = 4$

$\beta \Rightarrow 4$

30. [1]

$x = \frac{f\lambda}{d} = \frac{100 \times 5893 \times 10^{-8}}{0.01}$

$= 0.5893$ cm