# INDIAN ASSOCIATION OF PHYSICS TEACHERS

## National Standard Examination in Physics - 2024

**Date of Examination: December 22, 2024**
**Time: 8:30 AM to 10:30 AM**

## Question Paper Code: 65

| Student's Roll No: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|

***Write the Question Paper Code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the Question Paper.***

**Instructions to Candidates:**

1. Use of mobile phone, smart watch, and iPad during examination is STRICTLY **PROHIBITED.**
2. In addition to this Question Paper, you are given OMR Answer Sheet along with candidate's copy.
3. On the Answer Sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   **Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.**
4. On the OMR Answer Sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **Eleven-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials (means login id and password, respectively) for accessing your performance / result in National Standard Examination in Physics – 2024.
6. Question Paper has two parts. In part A-1 (Q. No.1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

**Q.No.22** 


In part A-2 (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative (s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

**Q.No.54** 


7. Attempt all sixty questions. For **Part A-1,** each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A-2,** you get 6 marks if all the correct alternatives are marked. No negative marks in this part.
8. Rough work may be done in the space provided. There are **13** printed pages in this paper
9. Use of **Non - programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting Answer Paper, take away the Question Paper & candidate's copy of OMR sheet for your future reference.

**Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR Answer Sheet.**

**Answer Sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.**

**DO NOT WRITE ON THE BACK SIDE OF THE ANSWER SHEET.**

**Instructions to Candidates (Continued) :**
***You may read the following instructions after submitting the Answer Sheet.***

12. **Comments/Inquiries/Grievances regarding this Question Paper, if any, can be shared on the Inquiry/Grievance column on www.iapt.org.in on the specified format till Dec 26, 2024**

13. **The Answers/Solutions to this Question Paper will be available on the website: www.iapt.org.in by Dec 24, 2024.** The score card may be downloaded after Dec 30, 2024

14. **CERTIFICATES and AWARDS:**
Following certificates shall be awarded by IAPT to the students, successful in the NATIONAL STANDARD EXAMINATION IN PHYISCS – 2024
(i) "CENTRE TOP 10 %" To be downloaded from iapt.org.in after 30.01.25
(ii) "STATE TOP 1 %" Will be dispatched to the examinee
(iii) "NATIONAL TOP 1 %" Will be dispatched to the examinee
(iv) "GOLD MEDAL & MERIT CERTIFICATE" to all students who attend OCSC – 2025 at HBCSE Mumbai
Certificate for centre toppers shall be uploaded on iapt.org.in

15. List of students (with centre number and roll number only) having score above **Minimum Admissible Score** (MAS) will be displayed on the website: **www.iapt.org.in** by **Dec 28, 2024. See the MAS clause** on the Student's brochure on the web.

16. List of students eligible to appear for Indian National Physics Olympiad (INPhO – 2025) shall be displayed on **www.iapt.org.in** by Dec 31, 2024.

**Physical constants you may need….**

| | |
|---|---|
| Magnitude of charge on electron $e = 1.60 \times 10^{-19} C$ | Avogadro's constant $A = 6.023 \times 10^{23}\ mol^{-1}$ |
| Mass of electron $m_e = 9.11 \times 10^{-31} kg$ | Speed of light in free space $c = 3 \times 10^{8}\ ms^{-1}$ |
| Mass of proton $m_p = 1.67 \times 10^{-27} kg$ | Speed of sound in dry air at 0°C $v = 332\ ms^{-1}$ |
| Acceleration due to gravity $g = 9.81\ ms^{-2}$ | Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12} C^2 / Nm^2$ |
| Universal gravitational constant $G = 6.67 \times 10^{-11} Nm^2 / kg^2$ | Permeability of free space $\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$ |
| Universal gas constant $R = 8.31\ J / mol\ K$ | Planck's constant $h = 6.625 \times 10^{-34}\ Js$ |
| Boltzmann constant $k = 1.38 \times 10^{-23}\ J$ / K | Faraday constant $= 96,500\ C\ mol^{-1}$ |
| Stefan's constant $\sigma = 5.67 \times 10^{-8} W / m^2 K^4$ | Rydberg constant $R = 1.097 \times 10^{7}\ m^{-1}$ |
| Atmospheric pressure (at STP) = $1.013 \times 10^5$ $Nm^{-2}$ | Astronomical unit $= 1.50 \times 10^{11}\ m$ |

# INDIAN ASSOCIATION OF PHYSICS TEACHERS
## NATIONAL STANDARD EXAMINATION IN PHYSICS
## (NSEP – 2024)

**Time: 120 minute** **Max. Marks: 216**

**Attempt All the Sixty Questions**

## A – 1
**ONLY ONE OUT OF THE FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION.**

1. A solid sphere and a solid cube, made of same material and having same surface area, are heated to the same temperature and are kept in same surrounding. The ratio of their initial rate of cooling is

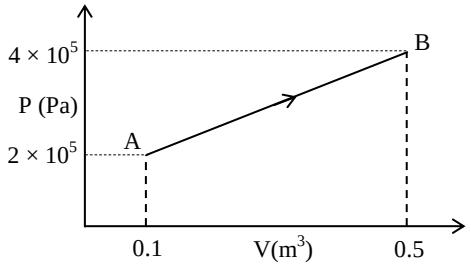
   (a) $\sqrt{\frac{\pi}{2}}$ : 1 (b) $\sqrt{\frac{\pi}{3}}$ : 1 (c) $\sqrt{\frac{\pi}{6}}$ : 1 (d) $\frac{\pi}{\sqrt{3}}$ : 1

2. One mole of an ideal gas A with $\gamma = \frac{5}{3}$ is mixed with n moles of another ideal gas B with $\gamma = \frac{7}{5}$ in a vessel; the two gases A and B are non-interacting. If the γ of the mixture is found to be $\frac{19}{13}$, then n is

   (a) 1 (b) 2 (c) 3 (d) 1.5

3. A diatomic gas contained in a vessel is subjected to a thermodynamic process such that its pressure changes with volume as shown in the figure

   Change in internal energy during the process is
   (a) $4.5 \times 10^5$ J
   (b) $3.2 \times 10^5$ J
   (c) $7.6 \times 10^5$ J
   (d) $5.7 \times 10^5$ J




4. A uniform chain of length $\ell$ and mass M is lying on a smooth table with one third of its length hanging vertically down over the edge of the table. The work required to pull the hanging part on the table is

   (a) $\frac{Mg\ell}{3}$ (b) $\frac{Mg\ell}{6}$ (c) $\frac{Mg\ell}{9}$ (d) $\frac{Mg\ell}{18}$

5. A balloon, initially at rest rises from the ground with a constant acceleration $\frac{g}{8}$. When its height is h above the ground, a packet is dropped from it. The time, the packet takes to reach the ground is

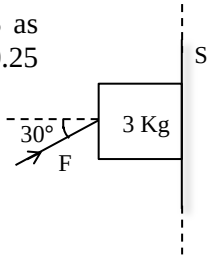
   (a) $\sqrt{\frac{h}{2g}}$ (b) $\sqrt{\frac{h}{g}}$ (c) $\sqrt{\frac{2h}{g}}$ (d) $2\sqrt{\frac{h}{g}}$

6. A ball is projected at an angle α from horizontal. After time t, the direction of velocity makes angle β with horizontal. The velocity of the ball at the highest point of its path (during motion) is

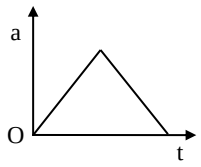
   (a) $\frac{gt}{\sin\alpha - \sin\beta}$ (b) $\frac{gt}{\cos\beta - \cos\alpha}$ (c) $\frac{gt}{\tan\alpha - \tan\beta}$ (d) $\frac{gt}{\cot\alpha - \cot\beta}$

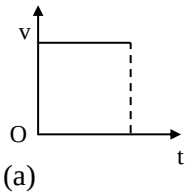
7. A force F = 100 N is applied to a 3 kg block in contact with a vertical surface S as shown. The coefficient of friction between surface S and the block is μ = 0.25 (take g = 10 ms$^{-2}$). The frictional force acting on the block is

   (a) nearly 21.6 N downward (b) 20 N downward
   (c) 20 N upward (d) 30 N upward

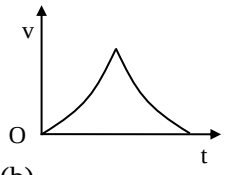


8. Acceleration - time plot of a particle moving in a straight line, starting from rest is shown in figure. The velocity-time (v-t) plot is best represented by

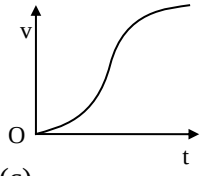


(a)



(b)



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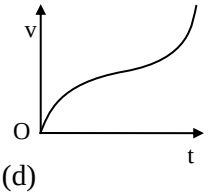
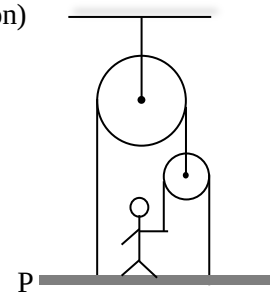


(d)

9. With what force must the man pull the rope to hold the platform P in position? Weight of man is W. (Neglect the weight of the rope, pulley and platform. Also neglect any friction)



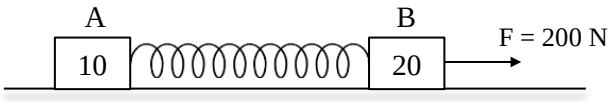

(a) $\frac{W}{4}$

(b) $\frac{W}{2}$

(c) W

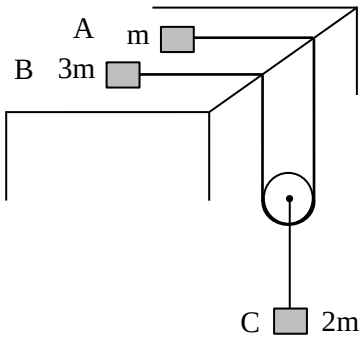
(d) 2W

10. Two blocks A and B of masses l0 kg and 20 kg respectively are connected by a spring. As a result of a force F = 200 N applied on block B, the acceleration of the block B at any instant is 12 $ms^{-2}$ towards right. The acceleration of the block A at that instant is




(a) 4 $ms^{-2}$ towards left
(b) 4 $ms^{-2}$ towards right
(c) 24 $ms^{-2}$ towards left
(d) 20 $ms^{-2}$ towards right

11. Two small blocks A and B of masses m and 3m are placed on a smooth horizontal table. A massless and un-stretchable string joining them hangs over the edge and supports a massless pulley, which itself carries a block C of mass 2m suspended by another string. The parts of string on the table are parallel and perpendicular to the edge of the table. The acceleration of block C is




(a) $\frac{g}{5}$

(b) $\frac{g}{3}$

(c) $\frac{2g}{3}$

(d) $\frac{2g}{5}$

12. A certain triple star system consists of two stars each of mass m revolving in the same circular orbit of radius r around the central star of mass M = 2m. The two stars are always at the opposite ends of a diameter of the circular orbit. If T is the time period of the two stars, then $T^2$ is given by

(a) $T^2 = \frac{4\pi^2}{Gm} r^3$
(b) $T^2 = \frac{4\pi^2}{Gm} r^3 \left(\frac{1}{5}\right)$
(c) $T^2 = \frac{4\pi^2}{Gm} \left(\frac{2}{3}\right)$
(d) $T^2 = \frac{4\pi^2}{Gm} r^3 \left(\frac{4}{9}\right)$

13. Two balls of same mass and same initial speed collide with each other. The collision is perfectly inelastic. If $\frac{1}{4}$ th of the initial kinetic energy is lost during the collision, the angle between the initial velocities of the balls is

(a) 60° (b) 90° (c) 120° (d) 180°

14. In the relation $P = \frac{\alpha}{\gamma} e^{-\frac{\alpha z}{kT}}$ where P is pressure, z is height, k is Boltzmann constant and T is temperature. The dimensional formula for γ is

(a) $[M^0 L^2 T^0]$ (b) $[M\ L^2\ T]$ (c) $[M^0\ L^0\ T^0]$ (d) $[M^0 L^2 T^{-1}]$

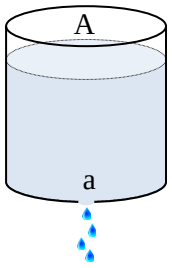
15. The terminal speed of a small spherical gold ball (radius r; density 19.5 gm/cc) in a viscous liquid (density 1.5 gm/cc) is 16 cm/s. The terminal speed of a sphere of silver (radius 1.5r; density 10.5 gm/cc) in the same liquid will be

(a) 8 cm/s (b) 18 cm/s (c) 12 cm/s (d) 5.3 cm/s

16. Water drains through an opening of area 'a' from the bottom of a cylindrical container of cross- sectional area A. If the motion of the water surface is not ignored, then the speed *v* at which the water comes out is given by

(a) $v^2 = \frac{2gh}{1-\frac{a}{A}}$ (b) $v^2 = \frac{2gh}{1-\frac{a^2}{2A^2}}$

(c) $v^2 = \frac{2gh}{1-\frac{a^2}{A^2}}$ (d) $v^2 = \frac{2gh}{1+\frac{a^2}{A^2}}$




17. A force exerts an impulse J on an object, changing its speed from u to v. The force is applied in the direction of motion of the object. The work done by the force is

(a) $J(v+u)$ (b) $\frac{J}{2}(v-u)$ (c) $\frac{J}{2}(v+u)$ (d) $\frac{2Juv}{v+u}$

18. Two small stars of masses $M_1$ and $M_2$ initially far apart are at rest. The stars move towards each other under gravitational attraction. The velocity of approach, when the two stars are a distance d apart, is equal to

(a) $\sqrt{\frac{GM_1}{d}} + \sqrt{\frac{GM_2}{d}}$ (b) $\sqrt{\frac{2G(M_1+M_2)}{d}}$

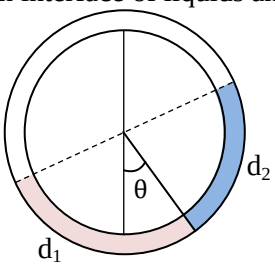
(c) $\sqrt{\frac{2GM_1}{d}} + \sqrt{\frac{2GM_2}{d}}$ (d) $\sqrt{\frac{2G}{\left(\frac{1}{M_1}+\frac{1}{M_2}\right)d}}$

19. Three uniform thin identical rods, each of mass M and length L form the sides of an equilateral triangle. If $I_1$ denotes the moment of inertia of this system about an axis through a corner and perpendicular to plane of the triangle and $I_2$ denotes the moment of inertia of this system about an axis through the circumcentre of the triangle and perpendicular to its plane, then one obtains

(a) $I_1 = \frac{3}{2}ML^2,\ I_2 = \frac{ML^2}{2}$ (b) $I_1 = \frac{ML^2}{2},\ I_2 = \frac{ML^2}{6}$

(c) $I_1 = \frac{ML^2}{3},\ I_2 = \frac{ML^2}{3}$ (d) $I_1 = \frac{3}{2}ML^2,\ I_2 = ML^2$

20. A small uniform transparent tube, bent in the form of a circle, is rigidly placed with its plane vertical. Equal volumes of two immiscible liquids of density $d_1$ and $d_2$ ($d_1 : d_2 = 3 : 1$) fill half the tube (one quadrant each liquid) the angle θ between the radius passing through common interface of liquids and the vertical diameter satisfies




(a) $\tan\theta = 3$ (b) $\tan\theta = \frac{1}{3}$

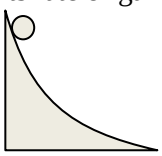
(c) $\tan\theta = 2$ (d) $\tan\theta = \frac{1}{2}$

21. A lawn roller (in the form of a solid cylinder) of mass M and radius R is being pulled by a horizontal force F at its centre. Minimum coefficient of friction between the roller and the surface needed to prevent slipping is

(a) $\frac{F}{2Mg}$ (b) $\frac{F}{3Mg}$ (c) $\frac{1}{2}$ (d) $\frac{2F}{3Mg}$

22. A solid spherical ball rolls down a curved ramp as shown. As its speed increases, its rate of gaining speed

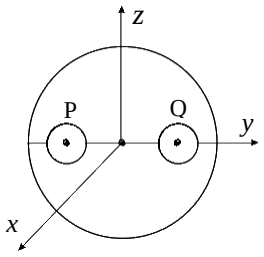
(a) goes on increasing
(b) goes on decreasing
(c) remains unchanged
(d) first increases, then decreases



23. A bar magnet is moved to and fro, first thrusting it into and then withdrawing it from, a circular coil of metal wire. In this experiment

(a) a direct current (dc) is induced (b) an alternating current (ac) is induced
(c) neither dc nor ac is induced (d) only alternating voltage is induced, not the current

24. A solid sphere of uniform density ρ and mass M has radius 4 m. Its centre is at the origin of the Cartesian coordinate system. Two spherical cavities of radii 1m have been created by taking out the solid material such that the centres of the two cavities are at P (0, –2, 0) and Q (0, 2, 0) respectively. What is the gravitational field at the origin of the coordinate axes?




(a) $\frac{31GM}{1024}$ (b) $\frac{Gm}{1024}$

(c) 31 GM (d) zero

25. A uniform solid sphere made of a material with specific gravity $\rho = \frac{1}{2}\rho_w$ (where $\rho_w$ is the specific gravity of water) is floating in water. If the sphere is slightly pressed down and released, the angular frequency of subsequent oscillations is approximately given by

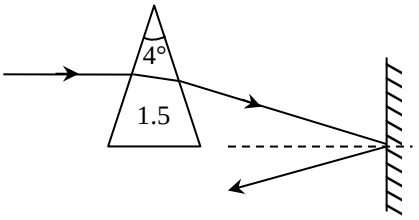
(a) $\sqrt{\frac{3g}{2R}}$ (b) $\sqrt{\frac{g}{R}}$ (c) $\sqrt{\frac{2g}{3R}}$ (d) $\sqrt{\frac{\pi g}{4R}}$

26. Two infinitely long parallel wires carrying currents $I_1$ and $I_2$ respectively are placed a distance d = 4 cm apart. The magnitude of the net magnetic field between the two wires is found to reach a minimum at a point 1 cm away from the first wire. The ratio of the two currents and their relative direction is

(a) $\frac{I_2}{I_1} = 9$, antiparallel (b) $\frac{I_2}{I_1} = 9$, parallel

(c) $\frac{I_2}{I_1} = 3$, antiparallel (d) $\frac{I_2}{I_1} = 6$, parallel

27. A horizontal beam of light passes through a thin glass prism (refractive index 1.5) having an apex angle of 4°. After passing through the prism, the beam of light is reflected from a vertical plane mirror as shown in the figure. The angle, through which the plane mirror be rotated to make the reflected beam horizontal, is




(a) 1°
(b) 2°
(c) 3°
(d) 4°

28. The amplitudes of the electric and magnetic fields associated with a beam of light of intensity 477.9 W/m$^2$ are, respectively,
(a) $3 \times 10^2$ V/m and $1 \times 10^{-6}$ T
(b) $6 \times 10^2$ V/m and $2 \times 10^{-6}$ T
(c) $9 \times 10^2$ V/m and $3 \times 10^{-6}$ T
(d) $12 \times 10^2$ V/m and $4 \times 10^{-6}$ T

29. A laser beam (wavelength 663 nm, power 3 mW) is incident on a surface. How many photons are incident on the surface per second?
(a) $10^6$ (b) $10^9$ (c) $10^{10}$ (d) $10^{16}$

30. In ancient lore, the Earth was supposed to be flat and infinite. If this mythical Earth really was an infinite flat plane of thickness H with the same density as that of our real Earth (assumed to be a homogeneous sphere of radius R), what must H be in order that the strength of gravity at the surface be the same as in the case of the present spherical Earth.
(a) $\frac{2}{3}$R (b) $\frac{1}{3}$R (c) $\frac{1}{2}$R (d) R

31. The magnitude of the electric field, due to a long positively charged straight wire at a perpendicular distance r from it, is proportional to $\frac{1}{r}$. Two electrons are orbiting such a long straight wire in circular orbits perpendicular to the wire with radii 1 Å and 2 Å. The ratio of their respective speeds is
(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 4 : 1

32. Undesired reflection of light often produces glare which hinders a clear vision/view of a classical art picture behind the glass. To reduce glare, the outer surface of the glass is coated by a thin film. If the refractive index of glass is $\mu_g = 1.60$ and that of the coating is $\mu_f = 2.55$, the thickness of the film likely to eliminate the glare (extinguish the front surface reflection) completely for an incident light of wavelength $\lambda = 510$ nm is
(a) 50 nm (b) 100 nm (c) 150 nm (d) 225 nm

33. A plano convex lens has thickness 4 cm at its centre. When placed on a horizontal table with the curved surface in contact with the table, the apparent depth of the bottom most point of the lens appears to be 3 cm. If the lens is turned upside down such that plane face is in contact with the table, the apparent depth of the center of the plane face of the lens is found to be $\frac{25}{8}$ cm. The focal length of the lens is
(a) 25 cm (b) 50 cm (c) 75 cm (d) 100 cm

34. A simple pendulum, consisting of a light inextensible string of length $\ell$ attached to a small heavy bob of mass m, is at rest. The bob is imparted a horizontal impulsive force which gives it a velocity of $\sqrt{4g\ell}$. The speed of the bob at its highest point is
(a) 0 (b) $\sqrt{\frac{1}{3}g\ell}$ (c) $\sqrt{\frac{2}{3}g\ell}$ (d) $\sqrt{\frac{8}{27}g\ell}$

35. On a very cold day, the thickness of ice layer formed over a freeze lake is $x_0$ ( say at t = 0). If the thickness of ice layer after a time $t$ becomes $x$ (latent heat of fusion is $L$, thermal conductivity of ice is $K$, density of ice is $\rho$ and temperature of the surroundings is $-\theta\,°C$) then

(a) $x^2 - x_0^{\,2} = \dfrac{K\theta}{\rho L}t$ (b) $x^2 - x_0^{\,2} = \dfrac{\rho L}{K\theta}t$ (c) $x^2 - x_0^{\,2} = \dfrac{2K\theta}{\rho L}t$ (d) $x^2 - x_0^{\,2} = \dfrac{2\rho L}{K\theta}t$

36. A neutral hydrogen molecule has two protons and two electrons. If one of the electrons is removed, we get a hydrogen molecular ion ($H_2^+$). In the ground state of $H_2^+$, the two protons are separated by roughly 1.5 Å and the electron is roughly 1 Å from each proton. The potential energy of the system is

(a) − 38.4 eV (b) − 19.2 eV (c) − 9.6 eV (d) zero

37. A metal sphere is charged with a positive charge $+Q$ and is surrounded by a concentric uncharged spherical metal shell. Potential difference between the surface of the sphere and the outer surface of the shell is $V$. If the shell is now given a charge $-3Q$, the potential difference between the two will be

(a) $-2V$ (b) $V$ (c) $2V$ (d) $4V$

38. Positive charge +Q is uniformly distributed throughout the volume of a solid sphere of radius R. The sphere has a smooth narrow tunnel through its centre. Due to electrostatic attraction, a small particle of mass m and negative charge − q, initially at rest far from the sphere, approaches it along the line of the tunnel, reaches the surface of the sphere with a speed $v$ and continues to move through the tunnel. Its speed at the centre of the sphere will be

(a) 0 (b) $v$ (c) $v\sqrt{2}$ (d) $v\sqrt{1.5}$

39. Two identical point charges are separated by a distance r in air. The force between them is F. A large dielectric slab of dielectric constant $K = 4$ and thickness $\dfrac{r}{2}$ is inserted between them. Now the electrostatic force between the two charges is

(a) $\dfrac{F}{2}$ (b) $\dfrac{4F}{9}$ (c) $\dfrac{F}{9}$ (d) $F$

40. The conduction current in a copper wire of radius 0.1 mm and length 0.1 m is 1.0 A. If the number of free carriers in copper is $n = 10^{23}$ per cc, then

(a) the drift velocity of the charge carriers is $v_d = 2$ mm per sec

(b) the thermal velocity of the charge carriers is $v_{th} = 2$ km per sec

(c) the current density in the wire is J = 318 amp per $cm^2$

(d) The mobility of the charge carriers is μ = 23 $cm^2$ per volt sec

41. A resistance of 40 Ω is connected to a source of alternating current rated 220 V, 50 Hz. The time taken by the current to change from its maximum value to the rms value is

(a) 2.5 s (b) 0.25 s (c) 2.5 ms (d) 1.5 ms

42. A 12 V, 60 W lamp is connected to the secondary of a step-down transformer, whose primary is connected to AC mains of 220 V. Assuming the transformer to be ideal, the current in the primary winding is estimated to be

(a) 0.27 A (b) 2.7 A (c) 3.7 A (d) 0.37 A

43. The equations of two progressive waves are given by

$y_1 = 5\sin 2\pi(x - vt)\,cm$ and $y_2 = 3\sin 2\pi(x - vt + 1.5)\,cm$.

These waves simultaneously pass through an elastic string. The amplitude of the resulting wave is

(a) 4 cm (b) 2 cm (c) 8 cm (d) 1 cm

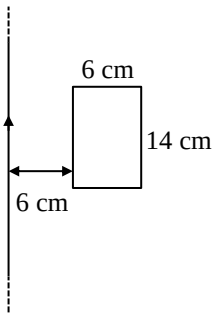
44. Interference is observed by two coherent sources separated by a distance 5λ along Y-axis, where λ is the wavelength of light. One source being placed at the origin. A detector is moved along the positive X – axis. The number of points on the X-axis, excluding the points x = 0 and x = ∞, at which resultant intensity is maximum, are

(a) 4 (b) 5 (c) ∞ (d) 0

45. In an experiment with Quincke's tube, sound of wavelength λ is being used. If the Quincke's tube is adjusted to produce a maximum intensity $I_0$. The distance through which the sliding tube be moved to obtain an intensity equal to $\frac{I_0}{2}$ is

(a) $\frac{\lambda}{2}$ (b) $\frac{\lambda}{3}$ (c) $\frac{\lambda}{4}$ (d) $\frac{\lambda}{8}$

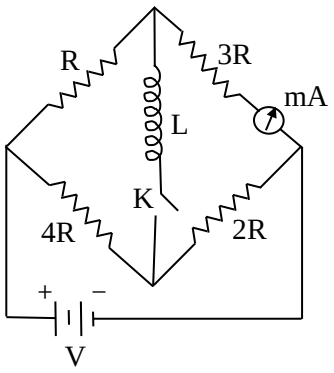
46. A rectangular loop of copper wire (length $l$ = 14 cm and breadth b = 6 cm) is placed coplanar with a current carrying infinitely long straight conductor at a distance of 6 cm from it as shown. The resistance of the metallic wire forming the loop is five ohm per meter. The longer sides of the loop are parallel to the wire. The nearest side being at 6 cm. If the upward flowing current through the conductor is increasing at a rate of 1.45 ampere per second, the estimated induced current in the closed rectangular loop is




(a) 14 nA (b) 28 nA (c) 14 mA (d) 28 μA

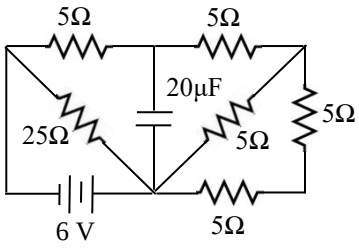
47. A long time after the key K is closed the reading of the milliammeter is 20 mA. The reading of the milliammeter just when the key was closed would have been

(a) 0 mA (b) 20 mA
(c) 25 mA (d) 30 mA




48. In the given circuit all the resistances (except one) are equal to $5\,\Omega$ each as shown. The charge on the capacitor in a state when it is fully charged, is

(a) 75 μC (b) 45 μC
(c) 24 μC (d) 15 μC

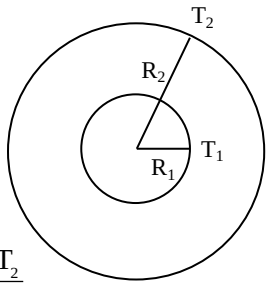


**A – 2**

**ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT**

**MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT.**

49. The figure shows a spherical shell of inner radius $R_1$ and outer radius $R_2$. Temperature of inner surface of the shell is $T_1$ and that at outer surface is $T_2$ ($T_1 > T_2$). The shell is made of a material of thermal conductivity K. Choose the correct option(s)



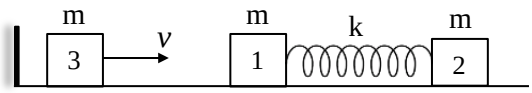

(a) Heat current through the shell is proportional to $T_1 - T_2$

(b) Heat current through the shell is proportional to $\frac{R_1 R_2}{R_2 - R_1}$

(c) At a distance $r = \frac{2R_1 R_2}{R_1 + R_2}$ from the centre; temperature is $\frac{T_1 + T_2}{2}$

(d) At a distance $r = \sqrt{R_1 R_2}$ from the centre, the temperature is $T = \frac{T_1 + T_2}{2}$

50. Two elastic blocks (1) and (2) of equal mass m are connected by a spring of normal length $\ell_0$ and rest on a frictionless horizontal table. The force constant of the spring is k. A third block (3) of mass m strikes elastically the left block (1) with velocity v. Choose the correct statement(s)



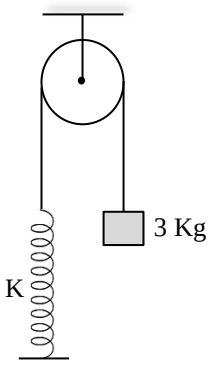

(a) At some instant, during the motion if the speeds of block (1) and block (2) are $v_1$ and $v_2$ with respect to ground then $v_1 v_2 = \frac{k x^2}{2m}$

(b) Stored energy of the spring is $\frac{1}{4}mv^2$ when it is compressed to the maximum

(c) Maximum length of the spring is $L_{max} = \ell_0 + v\sqrt{\frac{m}{k}}$

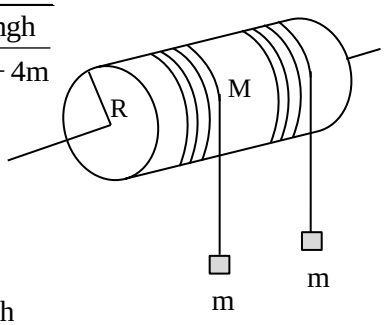
(d) After collision, velocity of the centre of mass of blocks (1) and (2) is constant and is equal to $\frac{v}{2}$

51. A 3 kg mass is fastened to a light string that passes over a frictionless and massless pulley with the other end tied to a vertical massless spring fixed on the ground. Initially when the mass is held stationary, the spring is unstretched. Now the mass is released from rest and drops a distance $x_0 = 10$ cm, before coming to rest (momentarily). Using g = 10 ms$^{-2}$, one can claim that the




(a) force constant of spring is K = 300 N/m
(b) at the lowest point, mass experiences an upward acceleration of 10 ms$^{-2}$.
(c) tension in the string, when mass is at lowest point, is 30 N
(d) speed of mass when it has fallen a distance 5 cm below starting point is approximately 0.71ms$^{-1}$.

52. A uniform solid cylinder of mass M and radius R rotates on a horizontal axis. Each of the two equal masses m hangs with the help of massless cord, wrapped around the cylinder. The system is released from rest. The observations reveal that



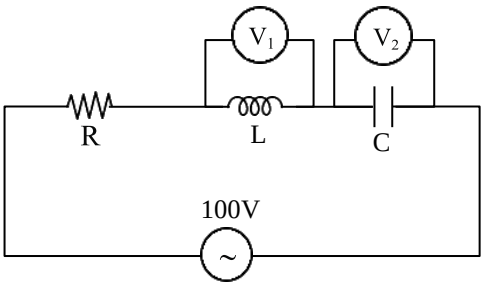

(a) Velocity of each mass after it has fallen a distance h is $v = 2\sqrt{\frac{2mgh}{M+4m}}$

(b) Acceleration of each mass is $a = \frac{4mg}{M+4m}$

(c) Tension in each cord is $T = \frac{Mmg}{M+4m}$

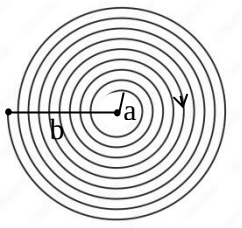
(d) Kinetic energy of each mass m after it has fallen a distance h is mgh

53. In the circuit shown, resistance R = 100 Ω, inductance $L = \frac{1}{\pi}$ H and capacitance $C = \frac{4}{\pi}$ μF are connected in series with an AC source of 100 volt and frequency 'f'. If the readings of the hot wire voltmeters $V_1$ and $V_2$ are same, the correct parameters are




(a) the frequency f = 125 Hz
(b) the frequency f = 250 Hz
(c) the current through resistance R is 1 A
(d) the voltage $V_1 = V_2 = 500$ volt

54. A long thin insulated metal wire forms a plane spiral of N = 1000 tight turns and carries a current of 8 mA. The inner and outer radii are a = 5 cm and b = 10 cm respectively. Choose the correct statement(s).




(a) The magnetic induction B at the centre is $B \approx 70\,\mu T$
(b) The magnetic dipole moment of the system is $p_m \approx 0.15\,Am^2$
(c) The magnetic moment is directed inward normal to the plane of paper for clockwise current.
(d) The magnetic field is directed outward normal to the plane of paper for the clockwise current.

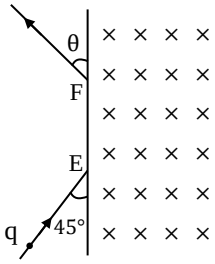
55. A particle, having charge (e) equal to that of an electron and mass 200 times the mass of an electron called μ meson (sometimes muon), moves in a circular orbit around a nucleus of total charge (e) [consider the mass of nucleus to be infinite and Bohr's model to be valid]. In such a mesonic atom, when a μ meson jumps from $n^{th}$ orbit to the $2^{nd}$ orbit (for all n = 3, 4, 5, ……), the wavelength of the emitted radiation lies in the range of

(a) γ rays (b) X-rays (c) Infrared radiations (d) microwaves

56. The magnetic field perpendicular to the plane of a circular conducting ring of radius r changes at a rate of $\frac{dB}{dt}$. The correct statement(s) is/are

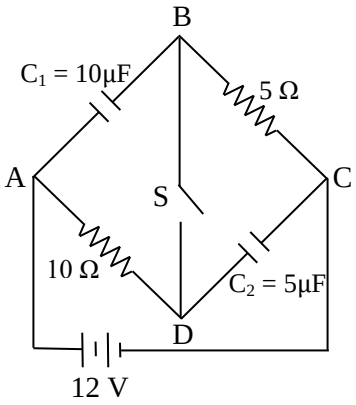
(a) The emf induced in the ring is $\pi r^2 \frac{dB}{dt}$
(b) The emf induced in the ring is $2\pi r \frac{dB}{dt}$
(c) Potential difference between diametrically opposite points on the ring is half the induced emf
(d) All points on the ring are at the same potential

57. A particle of mass m = $1.6 \times 10^{-27}$ kg and charge q = $1.6 \times 10^{-19}$ C enters a uniform field B = 1.0 T with a speed v = $10^7$ $ms^{-1}$ at point E along the direction shown at an angle of 45° with the straight boundary of the region of magnetic field. The magnetic field B is directed along the inward normal to the plane of the paper. The charged particle leaves the field at point F. The correct statement(s) is/are




(a) The angle θ = 45°
(b) The distance EF = 0.141 m.
(c) The charged particle traverses a semicircle with in the field region.
(d) If the direction of the magnetic field B is reversed, the charge particle will spend 47.1 nano second in the region of magnetic field before coming out.

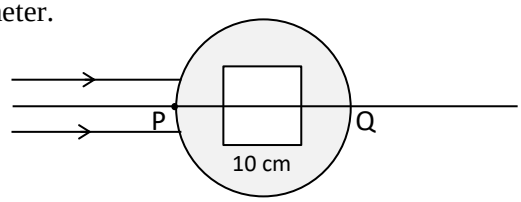
58. In the given electric network the capacitors $C_1$ and $C_2$ are being charged. The correct statement (s) is/are




(a) The charge on capacitor $C_1$ is 120 μC when switch S is open for a long time
(b) The charge on capacitor $C_1$ is 80 μC when switch S is closed for a long time
(c) The charge on capacitor $C_2$ is 60 μC when switch S is open for a long time
(d) The charge on capacitor $C_2$ is 40 μC when switch S is closed for a long time.

59. The correct statement(s) in relation to semiconductor studies is/are
(a) Light emitting diode (LED) is often made of GaAs and not of Silicon or Germanium
(b) An increase in doping concentration decreases the depletion region width in a p-n junction
(c) In a direct band gap semiconductor, the acceptor level is just above the top of the valence band
(d) In a direct band gap semiconductor, the donor level is just below the bottom of conduction band

60. A glass $\left(\mu = \frac{3}{2}\right)$ sphere of radius 20 cm has a cubic cavity of edge length 10 cm. The body centre of the cavity coincides with the centre of the sphere as shown (the cross-section only). A paraxial beam of light coming from a distant source, parallel to a certain diameter PQ of the sphere is incident on the sphere from left side, the vertical parallel faces of the cubic cavity being perpendicular to the considered diameter of the sphere. The parallel rays suffer refractions through the sphere before being focussed at a point on the considered diameter.




The correct statement(s) is/are
(a) After the first refraction the rays are directed to a point at a distance 60 cm from the Pole P
(b) After the second refraction the rays are directed to a point at a distance 45 cm from the Pole P
(c) After the third refraction the rays are directed to a point at a distance 55 cm from the pole P
(d) After the fourth refraction the rays are directed to a point at a distance 50 cm from the pole P

# Rough Work