ComedK 2024 Question Paper

Time Allowed :3 Hour	**Maximum Marks :**300	**Total Questions :**75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 180 questions. The maximum marks are 180.
3. There are three parts in the question paper consisting of Physics, Chemistry, and Mathematics, each having 60 questions of equal weightage.
4. Each part (subject) has two sections.
   (i) **Section-A:** This section contains 50 multiple-choice questions (MCQs) with only one correct answer. Each question carries 1 mark for a correct answer and 0.25 mark will be deducted for a wrong answer.
   (ii) **Section-B:** This section contains 10 questions, where the answer to each question is a numerical value. Each question carries 1 mark for a correct answer and 0.25 mark will be deducted for a wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

1 PHYSICS

1. The resistance of the galvanometer and shunt of an ammeter are 90 ohms and 10 ohms respectively, then the fraction of the main current passing through the galvanometer and the shunt respectively are:

(A) $\frac{1}{90}$ and $\frac{1}{10}$
(B) $\frac{1}{10}$ and $\frac{1}{90}$
(C) $\frac{9}{10}$ and $\frac{1}{10}$
(D) $\frac{1}{90}$ and $\frac{9}{10}$

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2. A glass of hot water cools from 90°C to 70°C in 3 minutes when the temperature of the surroundings is 20°C. What is the time taken by the glass of hot water to cool from 60°C to 40°C if the surrounding temperature remains the same at 20°C?

(A) 15 minutes
(B) 6 minutes
(C) 12 minutes
(D) 8 minutes

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3. When two objects are moving along a straight line in the same direction, the distance between them increases by 6 m in one second. If the objects move with their constant speed towards each other, the distance decreases by 8 m in one second. Then the speed of the objects are:

(A) 14 m/s, 2 m/s
(B) 7 m/s, 1 m/s
(C) 3.5 m/s, 2 m/s
(D) 3.5 m/s, 1 m/s

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4. In the Young's double slit experiment, the 2nd bright fringe for red light coincides with the 3rd bright fringe for violet light. Then the value of 'n' is: (Given: wavelength

of red light = 6300 Å and wavelength of violet light = 4200 Å)

(A) 2

(B) 4

(C) 3

(D) 1

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5. A metal ball of mass m is projected at an angle θ with the horizontal with an initial velocity u. If the mass and angle of projection are doubled keeping the initial velocity the same, the ratio of the maximum height attained in the former to the latter case is:

(A) 1 : 2

(B) 2 : 1

(C) 1 : 3

(D) 3 : 1

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6. The threshold frequency for a metal surface is ν_0. A photoelectric current I is produced when it is exposed to a light of frequency $\frac{11}{6}\nu_0$ and intensity I_0. If both the frequency and intensity are halved, the new photoelectric current I_1 will become:

(A) $I_1 = \frac{1}{4}I$

(B) $I_1 = 2I$

(C) $I_1 = 0$

(D) $I_1 = \frac{1}{2}I$

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7. A 500 W heating unit is designed to operate on a 400 V line. If line voltage drops to 160 V, the percentage drop in heat output will be:

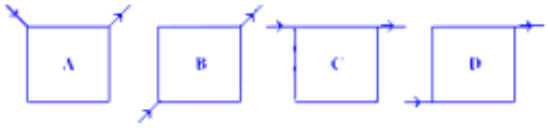
(A) 74%

(B) 85%

(C) 84%

(D) 75%

8. Current flows through uniform, square frames as shown in the figure. In which case is the magnetic field at the centre of the frame not zero?



(A) A

(B) D

(C) C

(D) B

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9. A transformer which steps down 330 V to 33 V is to operate a device having impedance 110 Ω. The current drawn by the primary coil of the transformer is:

(A) 0.3 A

(B) 0.03 A

(C) 3 A

(D) 1.5 A

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10. A cell of emf E and internal resistance r is connected to two external resistances R1 and R2 and a perfect ammeter. The current in the circuit is measured in four different situations:

(A) without any external resistance in the circuit.

(B) with resistance R_1 only.

(C) with R_1 and R_2 in series combination.

(D) with R_1 and R_2 in parallel combination.

The currents measured in the four cases in ascending order are:

(A) $c < b < d < a$

(B) $a < b < d < c$

(C) $c < d < b < a$

(D) $a < d < b < c$

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11. Select the unit of the coefficient of mutual induction from the following.

(A) volt second / ampere

(B) weber ampere

(C) ampere / weber

(D) volt ampere / second

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13. A particle executes a simple harmonic motion of amplitude A. The distance from the mean position at which its kinetic energy is equal to its potential energy is:

(A) 0.91 A

(B) 0.71 A

(C) 0.81 A

(D) 0.51 A

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14. A body of mass 5 kg at rest is rotated for 25 s with a constant moment of force 10 Nm. Find the work done if the moment of inertia of the body is 5 kg m^2.

(A) 625 J

(B) 125 J

(C) 6250 J

(D) 1250 J

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15. In the normal adjustment of an astronomical telescope, the objective and eyepiece are 32 cm apart. If the magnifying power of the telescope is 7, find the focal lengths of the objective and eyepiece.

(A) $f_o = 7\,\text{cm}$ and $f_e = 28\,\text{cm}$

(B) $f_o = 28\,\text{cm}$ and $f_e = 7\,\text{cm}$

(C) $f_e = 28\,\text{cm}$ and $f_o = 4\,\text{cm}$

(D) $f_o = 28\,\text{cm}$ and $f_e = 4\,\text{cm}$

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17. If A is the areal velocity of a planet of mass M, then its angular momentum is:

(A) $\frac{MA}{2}$

(B) MA

(C) $2MA$

(D) $\frac{MA}{3}$

---

18. When a particular wave length of light is used, the focal length of a convex mirror is found to be 10 cm. If the wavelength of the incident light is doubled keeping the area of the mirror constant, the focal length of the mirror will be:

(A) 5 cm

(B) 20 cm

(C) 15 cm

(D) 10 cm

---

19. The mass of a particle A is double that of particle B and the kinetic energy of B is $\frac{1}{8}$ that of A. Then the ratio of the de-Broglie wavelength of A to that of B is:

(A) 1 : 2

(B) 2 : 1

(C) 1 : 4

(D) 4 : 1

---

20. A coil of inductance 1H and resistance 100 is connected to an alternating current source of frequency $\frac{50}{\pi}$ Hz. What will be the phase difference between the current and voltage?

(A) 90°

(B) 30°

(C) 60°

(D) 45°

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21. The current through a conductor is a when the temperature is 0°C. It is b when the temperature is 100°C. The current through the conductor at 220°C is:

(A) $\frac{5ab}{11b-6a}$

(B) $\frac{5ab}{6a-11b}$

(C) $\frac{5ab}{11a-6b}$

(D) $\frac{11ab}{5a-6b}$

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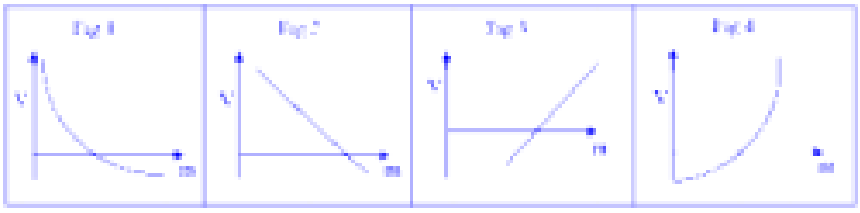
22. Which of the following graph shows the variation of velocity with mass for the constant momentum?



(A) Fig 3

(B) Fig 1

(C) Fig 2

(D) Fig 4

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23. For a $30°$ prism, when a ray of light is incident at an angle $60°$ on one of its faces, the emergent ray passes normal to the other surface. Then the refractive index of the prism is:

(A) $\sqrt{3}$

(B) $\frac{\sqrt{3}}{2}$

(C) 1.5

(D) 1.33

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24. A coil offers a resistance of 20 ohms for a direct current. If we send an alternating current through the same coil, the resistance offered by the coil to the alternating current will be:

(A) 0Ω

(B) Greater than 20Ω

(C) Less than 20Ω

(D) 20Ω

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25. A square shaped aluminium coin weighs 0.75 g and its diagonal measures 14 mm. It has equal amounts of positive and negative charges. Suppose those equal charges were concentrated in two charges (+Q and -Q) that are separated by a distance equal to the side of the coin, the dipole moment of the dipole is:

(A) 34.8 Cm

(B) 3.48 Cm

(C) 3480 Cm

(D) 348 Cm

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26. If the earth has a mass nine times and radius four times that of planet X, the ratio of the maximum speed required by a rocket to pull out of the gravitational force of planet X to that of the earth is:

(A) $\frac{2}{3}$

(B) $\frac{9}{4}$

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

(D) $\frac{4}{9}$

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27. Two similar coils A and B of radius 'r' and number of turns 'N' each are placed concentrically with their planes perpendicular to each other. If I and $2I$ are the respective currents passing through the coils then the net magnetic induction at the centre of the coils will be:

(A) $\sqrt{3}\left(\mu_0 \frac{NI}{2r}\right)$
(B) $\sqrt{5}\left(\mu_0 \frac{NI}{2r}\right)$
(C) $5\mu_0 \frac{NI}{2r}$
(D) $3\mu_0 \frac{NI}{r}$

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28. An ideal diode is connected in series with a capacitor. The free ends of the capacitor and the diode are connected across a 220 V ac source. Now the potential difference across the capacitor is:

(A) 110 V
(B) 311 V
(C) $2\sqrt{110}$ V
(D) $\sqrt{220}$ V

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29. Which of the following statement is true regarding the centre of mass of a system?

(A) The centre of mass depends on the size and shape but does not depend on the distribution of mass of the body.
(B) The centre of mass depends on the coordinate system.
(C) The centre of mass of a system depends on the size and shape of the body but independent of the co-ordinate system.
(D) The centre of mass of a body always lies inside the body.

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30. A ray of light travelling through a medium of refractive index $\frac{5}{4}$ is incident on a glass of refractive index $\frac{3}{2}$. Find the angle of refraction in the glass, if the angle of incidence at the given medium - glass interface is 30°

(A) $\sin^{-1}\left(\frac{1}{2}\right)$

(B) $\sin^{-1}\left(\frac{1}{3}\right)$

(C) $\sin^{-1}\left(\frac{5}{12}\right)$

(D) $\sin^{-1}\left(\frac{6}{5}\right)$

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31. The ratio of the radii of the nucleus of two element X and Y having the mass numbers 232 and 29 is:

(A) 4 : 1

(B) 1 : 4

(C) 1 : 2

(D) 2 : 1

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32. When light wave passes from a medium of refractive index μ to another medium of refractive index 2μ, the phase change occurs to the light is:

(A) 180°

(B) 90°

(C) 60°

(D) zero

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33. On increasing the temperature of a conductor, its resistance increases because

(A) Electron density decreases

(B) Relaxation time increases

(C) Number of collisions between electrons decreases

(D) Relaxation time decreases

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34. The difference in energy levels of an electron at two excited levels is 13.75 eV. If it makes a transition from the higher energy level to the lower energy level then what will be the wavelength of the emitted radiation?

Given:

$h = 6.6 \times 10^{-34}\,\mathrm{m^2\,kg\,s^{-1}}$, $c = 3 \times 10^{8}\,\mathrm{ms^{-1}}$, $1\,\mathrm{eV} = 1.6 \times 10^{-19}\,\mathrm{J}$

(A) 900 nm

(B) 90° A

(C) 9000 nm

(D) 900 A

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35. A string of length 25 cm and mass 10^{-3} kg is clamped at its ends. The tension in the string is 2.5 N. The identical wave pulses are generated at one end and at regular interval of time, Δt. The minimum value of Δt, so that a constructive interference takes place between successive pulses is:

(A) 0.2 s

(B) 1 s

(C) 40 ms

(D) 20 ms

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36. A cubical box of side 1 m contains Boron gas at a pressure of 100 $\mathrm{Nm^{-2}}$. During an observation time of 1 second, an atom travelling with the rms speed parallel to one of the edges of the cube, was found to make 500 hits with a particular wall, without any collision with other atoms. The total mass of gas in the box in gram is:

(A) 30

(B) 0.3

(C) 3

(D) 0.03

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38. A circular coil of radius 0.1 m is placed in the X-Y plane and a current 2 A is passed through the coil in the clockwise direction when looking from above. Find the magnetic dipole moment of the current loop.

(A) $0.02\pi\,\mathrm{Am^2}$ in the $-\hat{x}$ direction

(B) $0.02\pi\,\mathrm{Am^2}$ in the $-\hat{z}$ direction

(C) 0.02π Am^2 in the $+\hat{y}$ direction

(D) 0.02π Am^2 in the $+\hat{z}$ direction

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39. A body is moving along a circular path of radius r with a frequency of revolution numerically equal to the radius of the circular path. What is the acceleration of the body if radius of the path is $\frac{5}{\pi}$ m?

(A) $100\pi\,\text{ms}^{-2}$

(B) $500\pi\,\text{ms}^{-2}$

(C) $25\pi\,\text{ms}^{-2}$

(D) $\left(\frac{500}{\pi}\right)\,\text{ms}^{-2}$

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40. Which of the given dimensional formula represents heat capacity?

(A) $[ML^2T^{-2}K^{-1}]$

(B) $[ML^2T^{-1}K^{-1}]$

(C) $[ML^2T^{-2}K^{-2}]$

(D) $[MLT^{-2}K^{-1}]$

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41. If potential (in volt) in a region is expressed as $V(x, y, z) = 6xy - y + 2yz$, the electric field (in N/C) at point (1, 0, 1) is:

(A) $-7j$

(B) $+7j$

(C) $-6i + 7j$

(D) $6i - 7j$

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42. The closest approach of an alpha particle when it makes a head-on collision with a gold nucleus is 10×10^{-14} m. Then the kinetic energy of the alpha particle is:

(A) 3640 J

(B) 3.64 J

(C) 3.64×10^{-16} J

(D) 3.64×10^{-13} J

43. A one kg block of ice at $-1.5^{\circ}C$ falls from a height of 1.5 km and is found melting. The amount of ice melted due to fall, if 60% energy is converted into heat is (Specific heat capacity of ice is 0.5 cal g^{-1} C^{-1}, Latent heat of fusion of ice = 80 cal g^{-1})

(A) 1.69 g

(B) 10 g

(C) 16.9 g

(D) 17.9 g

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44. 64 rain drops of the same radius are falling through air with a steady velocity of 0.5 cm s^{-1}. If the drops coalesce, the terminal velocity would be

(A) 1.25 cm s^{-1}

(B) 0.08 m s^{-1}

(C) 0.8 m s^{-1}

(D) 1.25 m s^{-1}

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45. The capacitance of a parallel plate capacitor is 400 pF. It is connected to an ac source of 100 V having an angular frequency 100 rad s^{-1}. If the rms value of the current is 4 A, the displacement current is:

(A) 4×10^{-2} A

(B) 0.4 A

(C) 4 A

(D) 4 A

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46. Though Sn and Si are 4th group elements, Sn is a metal while Si is a semiconductor because

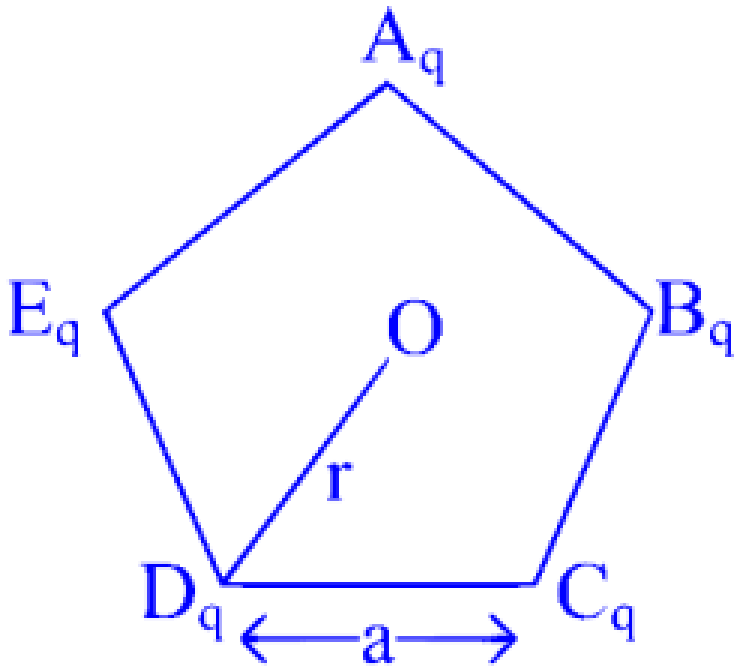
(A) Sn has more electrons than Si

(B) The energy gap of Sn is zero volt while that of Si is 0.07 V

(C) The energy gap of Sn is 1.1 eV while that of Si is 0.07 V

(D) Sn has more holes than Si

47. Five charges, 'q' each are placed at the corners of a regular pentagon of side 'a' as shown in figure. First, charge from 'A' is removed with other charges intact, then charge at 'A' is replaced with an equal opposite charge. The ratio of magnitudes of electric fields at O, without charge at A and that with equal and opposite charge at A is



(A) 4 : 1

(B) 2 : 1

(C) 1 : 4

(D) 1 : 2

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48. Two circular coils of radius 'a' and '2a' are placed coaxially at a distance 'x' and '2x' respectively from the origin along the X-axis. If their planes are parallel to each other and perpendicular to the X-axis and both carry the same current in the same direction, then the ratio of the magnetic field induction at the origin due to the smaller coil to that of the bigger one is:

(A) 2 : 1

(B) 1 : 1

(C) 1 : 4

(D) 1 : 2

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49. A metallic rod of 2 m length is rotated with a frequency 100 Hz about an axis passing through the centre of the circular ring of radius 2 m. A constant magnetic field 2 T is applied parallel to the axis and perpendicular to the length of the rod. The emf developed across the ends of the rod is:

(A) 800 π volt

(B) 1600 π volt

(C) 1600 volt

(D) 400 π volt

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50. The power of a gun which fires 120 bullets per minute with a velocity 120 ms^{-1} is: (given the mass of each bullet is 100 g)

(A) 86400 W

(B) 14.4 kW

(C) 1.44 kW

(D) 1220 W

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51. The width of the fringes obtained in the Young's double slit experiment is 2.6 mm when light of wavelength 6000°A is used. If the whole apparatus is immersed in a liquid of refractive index 1.3 the new fringe width will be:

(A) 2.6 mm

(B) 5.2 mm

(C) 2 mm

(D) 4 mm

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52. An electric bulb of volume 300 cm^3 was sealed off during manufacture at a pressure of 1 mm of mercury at 27°C. The number of air molecules contained in the bulb is, (R = 8.31 J mol^{-1} K^{-1} and $N_A = 6.02 \times 10^{23}$)

(A) 9.67×10^{16}

(B) 9.65×10^{15}

(C) 9.67×10^{17}

(D) 9.65×10^{18}

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53. Find the binding energy of the tritium nucleus: [Given: mass of $^3H = 3.01605\,u$; $m_p = 1.00782\,u$; $m_n = 1.00866\,u$]

(A) 8.5 MeV

(B) 8.5 J

(C) 0.00909 MeV

(D) 0.00909 eV

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54. In a single slit diffraction experiment, for slit width α, the width of the central maxima is β. If we double the slit width then the corresponding width of the central maxima will be:

(A) 4β

(B) β

(C) $\frac{\beta}{2}$

(D) 2β

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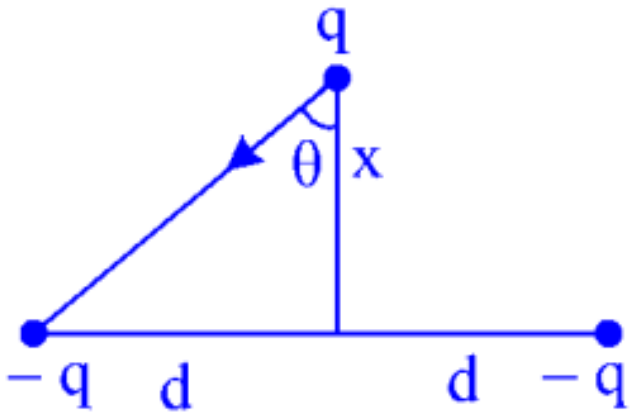
55. Two charges $-q$ each are fixed, separated by distance $2d$. A third charge q of mass m placed at the mid-point is displaced slightly by $x'(x \ll d)$ perpendicular to the line joining the two fixed charges as shown in the figure. The time period of oscillation of q will be:



(A) $T = \sqrt{\frac{8\epsilon_0 m}{q^2}} x^2$

(B) $T = \sqrt{\frac{8\epsilon_0 m}{q^2}} x^3$

(C) $T = \sqrt{\frac{4\epsilon_0 m}{q^2}} x^3$

(D) $T = \sqrt{\frac{8\epsilon_0 m}{q^2}} x^2$

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56. Two metal spheres, one of radius $\frac{R}{2}$ and the other of radius $2R$ respectively have the same surface charge density. They are brought in contact and separated. The ratio of their new surface charge densities is:

(A) 2 : 1

(B) 4 : 1

(C) 1 : 4

(D) 1 : 2

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57. Find the value of n in the given equation $P = \rho v^n$ where P is the pressure, ρ is the density, and v is the velocity.

(A) $n = \frac{1}{2}$

(B) $n = 1$

(C) $n = 3$

(D) $n = 2$

58. A stone of mass 2 kg is hung from the ceiling of the room using two strings. If the strings make an angle 60° and 30° respectively with the horizontal surface of the roof, then the tension on the longer string is:

(A) $\sqrt{3}/2\,\mathrm{N}$

(B) $10\sqrt{3}\,\mathrm{N}$

(C) 10 N

(D) $\sqrt{3}\,\mathrm{N}$

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59. A parallel plate capacitor is filled by a dielectric whose relative permittivity varies with the applied voltage (U) as $\epsilon = 2U$. A similar capacitor with no dielectric is charged to $U_0 = 78$ V. It is then connected to the uncharged capacitor with the dielectric. Find the final voltage on the capacitors.

(A) 6V

(B) 8V

(C) 2V

(D) 4V

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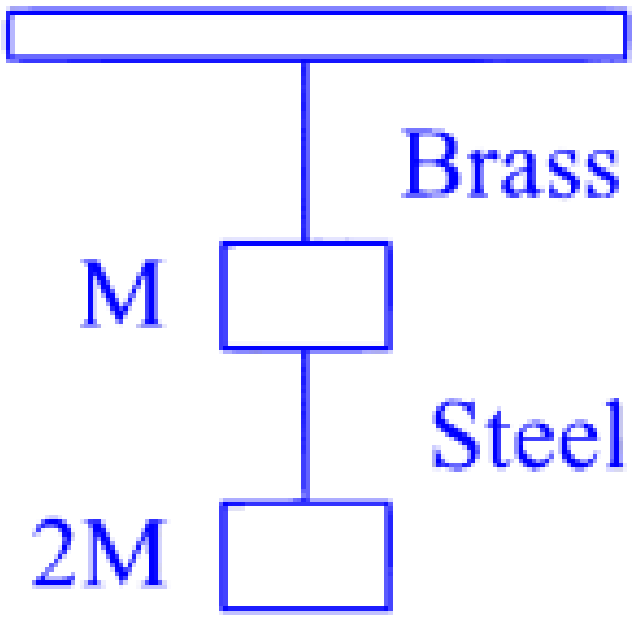
60. If the ratio of lengths, radii and Young's Moduli of steel and brass wires in the figure are a, b, and c respectively, then the corresponding ratio of increase in their lengths would be:



(A) $\frac{a}{3bc}$

(B) $\frac{3a}{2bc}$

(C) $\frac{2a}{3bc}$

(D) $\frac{2ab^2}{c}$
