# JEE MAIN-2006

## PHYSICS

[Time: 2 Hours]

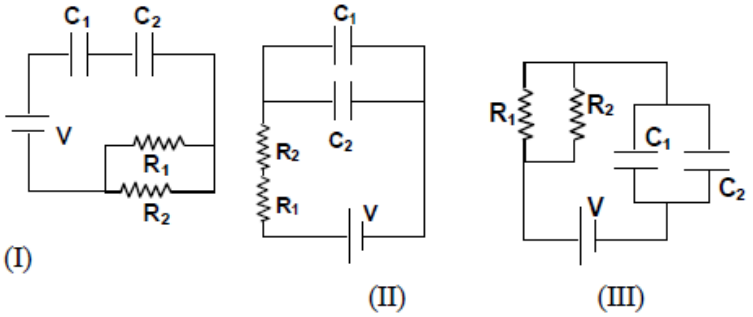
### General Instructions:

***Note:*** *The marking Scheme is (+3, −1) for question numbers 1 to 12, (+5, −1) for question numbers 13 to 20, (+5, −2) for question numbers 21 to 32 and (+6, 0) for question numbers 33 to 40.*

1. Given,

$R_1 = 1\Omega \quad C_1 = 2\mu F$

$R_2 = 1\Omega \quad C_2 = 4\mu F$




The time constants (in $\mu S$ ) for the circuits I, II, III are respectively

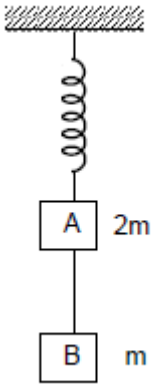
(A) $18, 8/9, 4$

(B) $18,\ 4, 8/9$

(C) $4, 8/9, 18$

(D) $8/9, 18,\ 4$

2. Two blocks $A$ and $B$ of masses 2m and $m$, respectively, are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in the figure. The magnitudes of acceleration of $A$ and $B$, immediately after the string is cut, are respectively



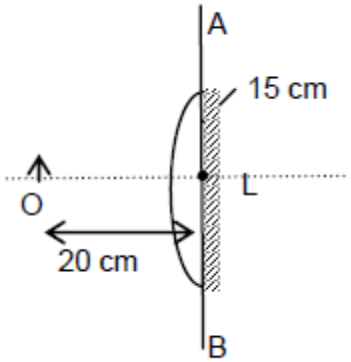

(A) $g, g/2$

(B) $g/2, g$

(C) $g, g$

(D) $g/2, g/2$

3. A point object is placed at a distance of 20 cm from a thin plano-convex lens of focal length 15 cm, if the plane surface is silvered. The image will form at



(A) 60 cm left of $AB$

(B) 30 cm left of $AB$

(C) 12 cm left of $AB$

(D) 60 cm right of $AB$

4. A biconvex lens of focal length $f$ forms a circular image of sun of radius $r$ in focal plane. Then

(A) $\pi r^2 \propto f$

(B) $\pi r^2 \propto f^2$

(C) if lower half part is covered by black sheet, then area of the image is equal to $\pi r^2/2$

(D) if f is doubled, intensity will increase

5. Given a sample of Radium- 226 having half-life of 4 days. Find the probability, a nucleus disintegrates after 2 half lives.

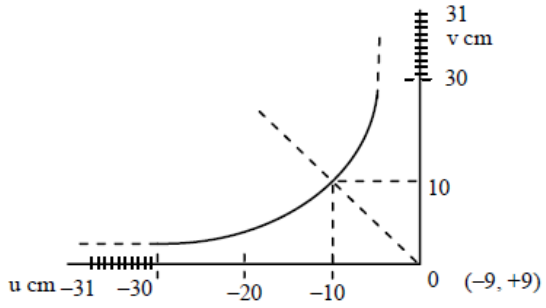
(A) 1

(B) 1/2

(C) 1.5

(D) 3/4

6. Graph of position of image *vs* position of point object from a convex lens is shown. Then, focal length of the lens is



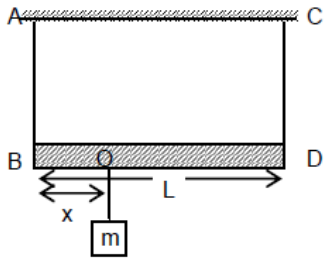

(A) $0.50 \pm 0.05$cm

(B) $0.50 \pm 0.10$cm

(C) $5.00 \pm 0.05$cm

(D) $5.00 \pm 0.10$cm

7. A massless rod is suspended by two identical strings $AB$ and $CD$ of equal length. A block of mass m is suspended from point $O$ such that $BO$ is equal to '$x$'. Further, it is observed that the frequency of 1st harmonic (fundamental frequency) in $AB$ is equal to 2nd harmonic frequency in $CD$. Then, length of $BO$ is




(A) $L/5$

(B) $4L/5$

(C) $3L/4$

(D) $L/4$

8. A system of binary stars of masses $m_A$ and $m_B$ are moving in circular orbits of radii $r_A$ and $r_B$ respectively. If $T_A$ and $T_B$ are the time periods of masses $m_A$ and $m_B$ respectively, then

(A) $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{3/2}$

(B) $T_A > T_B \left(\text{If } r_A > r_B\right)$

(C) $T_A > T_B \left(\text{If } m_A > m_B\right)$

(D) $T_A = T_B$ $[+3, -1]$

9. A solid sphere of mass $M$, radius $R$ and having moment of inertia about an axis passing through the centre of mass as $I$, is recast into a disc of thickness $t$, whose moment of inertia about an axis passing through its edge and perpendicular to its plane remains $I$. Then, radius of the disc will be

(A) $\frac{2R}{\sqrt{15}}$

(B) $R\sqrt{\frac{2}{15}}$

(C) $\frac{4R}{\sqrt{15}}$

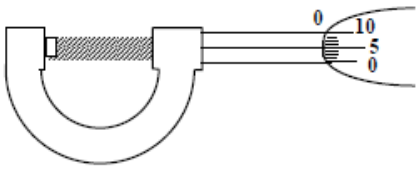
(D) $\frac{R}{4}$ $[+3, -1]$

10. A student performs an experiment for determination of $g\left(=\frac{4\pi^2\ell}{T^2}\right), \ell \approx 1m$, and he commits an error of $\Delta\ell$.

For $T$ he takes the time of n oscillations with the stop watch of least count $\Delta T$ and he commits a human error of $0.1\text{sec}$. For which of the following data, the measurement of $g$ will be most accurate?

| | $\Delta\ell$ | $\Delta T$ | $n$ | Amplitude of oscillation |
|---|---|---|---|---|
| (A) | 5mm | 0.2sec | 10 | 5mm |
| (B) | 5mm | 0.2sec | 20 | 5mm |
| (C) | 5mm | 0.1sec | 20 | 1mm |
| (D) | 1mm | 0.1sec | 50 | 1mm |

11. The circular divisions of shown screw gauge are $50$. It moves $0.5\,\text{mm}$ on main scale in one rotation. The diameter of the ball is



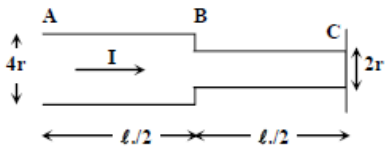

(A) $2.25\,\text{mm}$

(B) $2.20\,\text{mm}$

(C) $1.20\,\text{mm}$

(D) $1.25\,\text{mm}$

12. Consider a cylindrical element as shown in the figure. Current flowing the through element is I and resistivity of material of the cylinder is $\rho$.



Choose the correct option out the following.

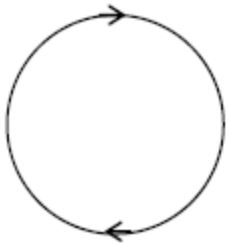
(A) Power loss in first half is four times the power loss in second half.

(B) Voltage drop in first half is twice of voltage drop in second half.

(C) Current density in both halves are equal.

(D) Electric field in both halves is equal.

13. In the given diagram, a line of force of a particular force field is shown. Out of the following options, it can never represent



(A) an electrostatic field

(B) a magnetostatic field

(C) a gravitational field of a mass at rest

(D) an induced electric field

14. The electrostatic potential $(\phi_r)$ of a spherical symmetric system, kept at origin, is shown in the adjacent figure, and given as

$$\phi_r = \frac{q}{4\pi \in_0 r_0} \quad (r \geq R_0)$$

$$\phi_r = \frac{q}{4\pi \in_0 R_0} \quad (r \leq R_0)$$

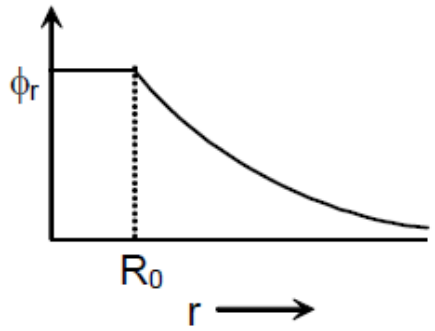
Which of the following option(s) is/are correct?

(A) For spherical region $r \le R_0$, total electrostatic energy stored is zero.

(B) Within $r = 2R_0$, total charge is q.

(C) There will be no charge anywhere except at $r = R_0$.

(D) Electric field is discontinuous at $r = R_0$.




15. A solid cylinder of mass m and radius $r$ is rolling on a rough inclined plane of inclination $\theta$. The coefficient of friction between the cylinder and incline is $\mu$. Then

(A) frictional force is always $\mu mg\cos\theta$

(B) friction is a dissipative force

(C) by decreasing $\theta$, frictional force decreases

(D) friction opposes translation and supports rotation.

16. Function $x = A\sin^2\omega t + B\cos^2\omega t + C\sin\omega t\cos\omega t$ represents *SHM*

(A) for any value of $A, B$ and $C$ (except $C = 0$)

(B) if $A = -B;\ C = 2B$, amplitude $= \left|B\sqrt{2}\right|$

(C) if $A = B; C = 0$

(D) if $A = B;\ C = 2B$, amplitude $= |B|$

17. In a dark room with ambient temperature $T_0$, a black body is kept at a temperature $T$. Keeping the temperature of the black body constant (at $T$), sunrays are allowed to fall on the black body through a hole in the roof of the dark room. Assuming that there is no change in the ambient temperature of the room, which of the following statement(s) is/are correct?

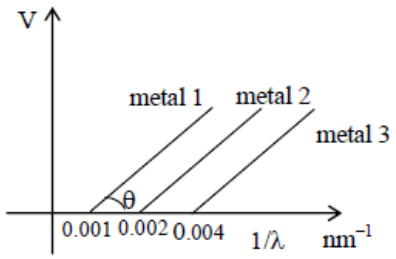
(A) The quantity of radiation absorbed by the black body in unit time will increase.

(B) Since emissivity = absorptivity, hence the quantity of radiation emitted by black body in unit time will increase.

(C) Black body radiates more energy in unit time in the visible spectrum.

(D) The reflected energy in unit time by the black body remains same.

18. The graph between $1/\lambda$ and stopping potential $(V)$ of three metals having work functions $\phi_1, \phi_2$ and $\phi_3$ in an experiment of photo-electric effect is plotted as shown in the figure. Which of the following statement(s) is/are correct? [Here $\lambda$ is the wavelength of the incident ray].



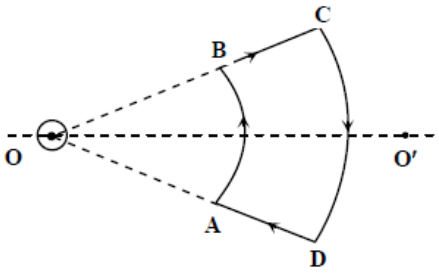

(A) Ratio of work functions $4\,\phi_1 : \phi_2 : \varphi_3 = 1:2:4$

(B) Ratio of work functions $\phi_1 : \phi_2 : \varphi_3 = 4:2:1$

(C) $\tan\theta$ is directly proportional to $hc/e$, where $h$ is Planck's constant and $c$ is the speed of light.

(D) The violet colour light can eject photoelectrons from metals $2$ and $3$.

19. An infinite current carrying wire passes through point $O$ and in perpendicular to the plane containing a current carrying loop $ABCD$ as shown in the figure. Choose the correct option (s).



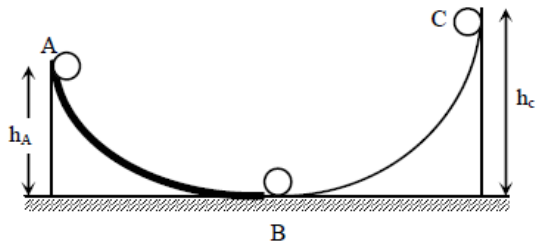

(A) Net force on the loop is zero.

(B) Net torque on the loop is zero.

(C) As seen from $O$, the loop rotates clockwise.

(D) As seen from $O$, the loop rotates anticlockwise

20. A ball moves over a fixed track as shown in the figure. From $A$ to $B$ the ball rolls without slipping. Surface $BC$ is frictionless. $KA, KB$ and $KC$ are kinetic energies of the ball at $A, B$ and $C$, respectively. Then




(A) $h_A > h_C; \mathrm{K}_B > K_C$

(B) $h_A > h_C; \mathrm{K}_C > K_A$

(C) $h_A = h_C; \mathrm{K}_B = K_C$

(D) $h_A < h_C; \mathrm{K}_B > K_C$

21. Initially, the capacitor was uncharged. Now, switch $S_1$ is closed and $S_2$ is kept open. If time constant of this circuit is $\tau$, then

(A) after time interval $\tau$, charge on the capacitor is $CV/2$

(B) after time interval $2\tau$, charge on the capacitor is $CV\left(1-e^{-2}\right)$

(C) the work done by the voltage source will be half of the heat dissipated when the capacitor is fully charged.

(D) after time interval $2\tau$, charge on the capacitor is $CV\left(1-e^{-1}\right)$

22. After the capacitor gets fully charged, $S_1$ is opened and $S_2$ is closed so that the inductor is connected in series with the capacitor. Then,

(A) at $t=0$, energy stored in the circuit is purely in the form of magnetic energy

(B) at any time $t>0$, current in the circuit is in the same direction

(C) at $t>0$, there is no exchange of energy between the inductor and capacitor

(D) at any time $t>0$, instantaneous current in the circuit may $V\sqrt{\frac{C}{L}}$

23. If the total charge stored in the $LC$ circuit is $Q_0$, then for $t\geq 0$

(A) the charge on the capacitor is $Q=Q_0\cos\left(\frac{\pi}{2}+\frac{t}{\sqrt{LC}}\right)$

(B) the charge on the capacitor is $Q=Q_0\cos\left(\frac{\pi}{2}-\frac{t}{\sqrt{LC}}\right)$

(C) the charge on the capacitor is $Q=-LC\frac{d^2Q}{dt^2}$

(D) the charge on the capacitor is $Q=-\frac{1}{\sqrt{LC}}\frac{d^2Q}{dt^2}$

24. If level of liquid starts decreasing slowly when the level of liquid is at a height $h_1$ above the cylinder, the block just starts moving up. Then, value of $h_1$ is

(A) $2h/3$

(B) $5h/4$

(C) $5h/3$

(D) $5h/2$

25. Let the cylinder is prevented from moving up, by applying a force and water level is further decreased. Then, height of water level ( $h_2$ in figure) for which the cylinder remains in original position without application of force is

(A) $h/3$

(B) $4h/9$

(C) $2h/3$

(D) $h$

26. If height h2 of water level is further decreased, then

(A) cylinder will not move up and remains at its original position.

(B) for $h_2 = h/3$, cylinder again starts moving up

(C) for $h_2 = h/4$, cylinder again starts moving up

(D) for $h_2 = h/5$ cylinder again starts moving up

27. Two waves $y_1 = A\cos(0.5\pi x - 100\pi t)$ and $y_2 = A\cos(0.46\pi x - 92\pi t)$ are travelling in a pipe placed along $x$-axis. Find the number of times intensity is maximum in time interval of 1sec.

(A) 4

(B) 6

(C) 8

(D) 10

28. Find wave velocity of louder sound

(A) 100 m/s

(B) 192 m/s

(C) 200 m/s

(D) 96 m/s

29. Find the number of times $y_1 + y_2 = 0$ at $x = 0$ in 1sec

(A) 100

(B) 46

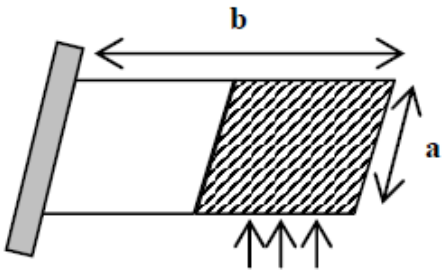
(C) 192

(D) 96

***Questions 30-32 could not be retrieved due to large length of comprehension.***

33. There is a rectangular plate of mass M kg of dimensions $(a \times b)$. The plate is held in horizontal position by striking $n$ small balls each of mass $m$ per unit area per unit time. These are striking in the shaded half region of the plate. The balls are colliding elastically with velocity $v$. What is $v$?

It is given $n = 100, M = 3\text{kg}, m = 0.01\text{kg}; b = 2m; a = 1m; g = 10\,\text{m/S}^2$.



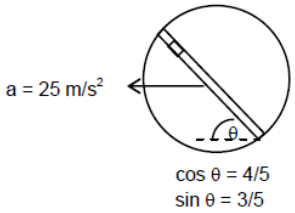

34. In an insulated vessel, 0.05 kg steam at 373 K and 0.45 kg of ice at 253 K are mixed. Then, find the final temperature of the mixture.

Given, $L_{\text{fusion}} = 80\,cal/g = 336\,J/g$, $L_{\text{vaporization}} = 540\,cal/g = 2268\,J/g$

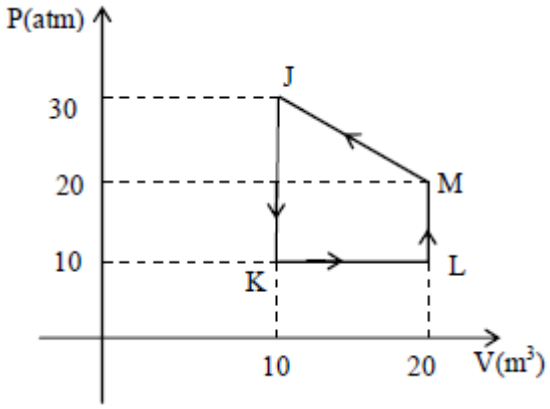
$S_{\text{ice}} = 2100\,J/\text{kg}\,K = 0.5\,cal/gK$ and $S_{\text{water}} = 4200\,J/\text{kg}\,K = 1\,cal/gK$

35. In hydrogen-like atom $(z = 11)$, $n^{th}$ line of Lyman series has wavelength $\lambda$ equal to the de-Broglie's wavelength of electron in the level from which it originated. What is the value of $n$?

36. A circular disc with a groove along its diameter is placed horizontally. A block of mass 1 kg is placed as shown. The co-efficient of friction between the block and all surfaces of groove in contact is $\mu = 2/5$. The disc has an acceleration of $25\,\text{m/s}^2$. Find the acceleration of the block with respect to disc.



37. Heat given to process is positive, match the following option of column I with the corresponding option of column II




| **Column I** | **Column II** |
|---|---|
| (A) JK | (P) $\Delta W > 0$ |
| (B) KL | (Q) $\Delta Q < 0$ |
| (C) LM | (R) $\Delta W < 0$ |
| (D) MJ | (S) $\Delta Q > 0$ |

38. Match the following Columns

| **Column I** | **Column II** |
|---|---|
| (A) Nuclear fusion | (P) Converts some matter into energy |
| (B) Nuclear fission | (Q) Generally possible for nuclei with low atomic number |
| (C) β-decay | (R) Generally possible for nuclei with higher atomic number |
| (D) Exothermic nuclear reaction | (S) Essentially proceeds by weak nuclear forces |

39. Match the following Columns

| **Column I** | **Column II** |
|---|---|
| (A) Dielectric ring uniformly charged | (P) Time independent electrostatic field out of system |
| (B) Dielectric ring uniformly charged rotating with angular velocity ω | (Q) Magnetic field |
| (C) Constant current in ring $i_0$ | (R) Induced electric field |
| (D) $i = i_0 \cos \omega t$ | (S) Magnetic moment |

40. A simple telescope used to view distant objects has eyepiece and objective lens of focal lengths $f_e$ and $f_0$, respectively. Then

| **Column I** | **Column II** |
|---|---|
| (A) Intensity of light received by lens | (P) Radius of aperture (R) |
| (B) Angular magnification | (Q) Dispersion of lens |
| (C) Length of telescope | (R) focal length $f_0$, $f_e$ |
| (D) Sharpness of image | (S) spherical aberration |