JEE MAIN – 2020

PHYSICS

SECTION A

This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which Only One is correct.

1. Polarizer-analyzer set is adjusted such that the intensity of light coming out of the analyzer is just $10\ \%$ of the original intensity. Assuming that the polarizer-analyzer set does not absorb any light, the angle by which the analyzer needs to be rotated further to reduce the output intensity to be zero is

(1) 45°

(2) 90°

(3) 71.6°

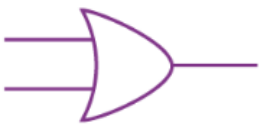
(4) 18.4°

2. Which of the following gives reversible operation?

(1) 

(2) 

(3) 

(4) 

3. A $60\ \text{HP}$ electric motor lifts an elevator with a maximum total load capacity of $2000\ \text{kg}$. If the frictional force on the elevator is $4000\ \text{N}$, the speed of the elevator at full load is close to (Given $1\ \text{HP} = 746\ \text{W}$, $g = 10\ \text{m/s}^2$)

(1) $1.5\ \text{m/s}$

(2) $1.7\ \text{m/s}$

(3) $2\ \text{m/s}$

(4) $1.9\ \text{m/s}$

4. A long solenoid of radius R carries a time (t) dependent current $I(t) = I_0 t(1-t)$. A ring of radius $2R$ is placed coaxially near its middle. During the time instant $0 \le t \le 1$, the induced current (I_R) and the induced EMF (V_R) in the ring changes as:

(1) Direction of I_R remains unchanged, and V_R is maximum at $t = 0.5\ \text{s}$

(2) Direction of I_R remains unchanged, and V_R is zero at $t = 0.25\ \text{s}$

(3) At $t = 0.5\ \text{s}$ direction of I_R reverses and V_R is zero

(4) At $t = 0.25\ \text{s}$ direction of I_R reverses and V_R is maximum

5. Two moles of an ideal gas with $\frac{C_P}{C_V} = \frac{5}{3}$ are mixed with 3 moles of another ideal gas with $\frac{C_P}{C_V} = \frac{4}{3}$. The value of $\frac{C_P}{C_V}$ for the mixture is

(1) 1.47

(2) 1.4

(3) 1.42

(4) 1.50

6. Consider a circular coil of wire carrying current I, forming a magnetic dipole. The magnetic flux through an infinite plane that contains the circular coil and excluding the circular coil area is given by φ_i. The magnetic flux through the area of the circular coil area is given by φ_0. Which of the following option is correct?

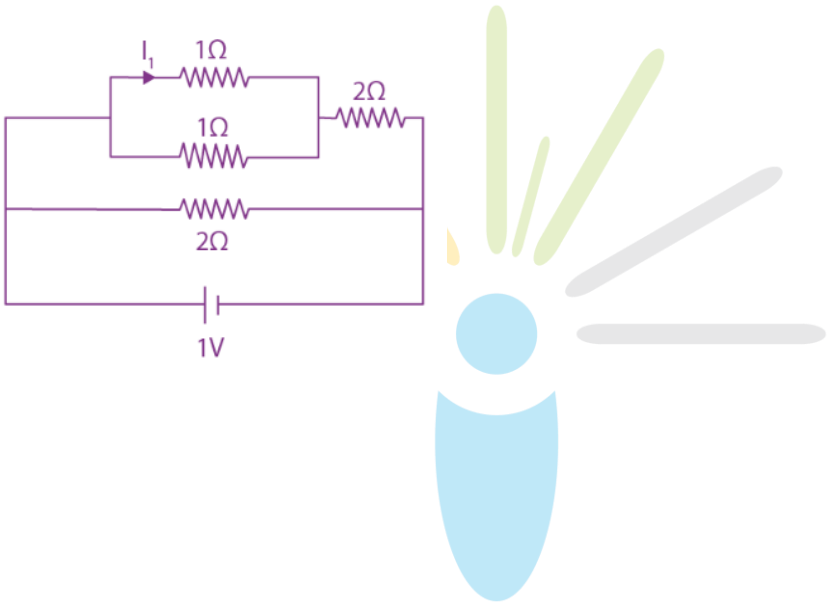
(1) $\varphi_i = -\varphi_0$

(2) $\varphi_i > \varphi_0$

(3) $\varphi_i < \varphi_0$

(4) $\varphi_i = \varphi_0$

7. The current (in A) flowing through $1\ \Omega$ resistor in the following circuit is



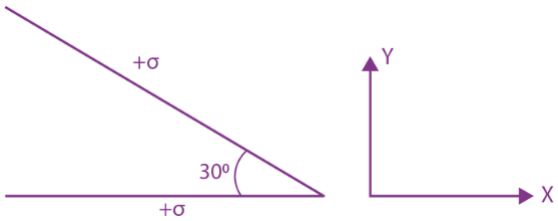
(1) 0.4

(2) 0.25

(3) 0.20

(4) 0.5

8. Two infinite planes each with uniform surface charge density $+\sigma\ \text{C/m}^2$ are kept in such a way that the angle between them is 30°. The electric field in the region shown between them is given by:



(1) $\frac{\sigma}{2\varepsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y}-\frac{1}{2}\hat{x}\right]$

(2) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y}-\frac{1}{2}\hat{x}\right]$

(3) $\frac{\sigma}{2\varepsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y}+\frac{1}{2}\hat{x}\right]$

(4) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y}+\frac{1}{2}\hat{x}\right]$

9. If the magnetic field in a plane electromagnetic wave is given by $B=3\times10^{-8}\sin\left(1.6\times10^{3}x+48\times10^{10}t\right)\hat{j}$ T then what will be expression for electric field?

(1) $E=3\times10^{-8}\sin\left(1.6\times10^{3}x+48\times10^{10}t\right)\hat{i}$ V/m

(2) $E=3\times10^{-8}\sin\left(1.6\times10^{3}x+48\times10^{10}t\right)\hat{j}$ V/m

(3) $E=60\sin\left(1.6\times10^{3}x+48\times10^{10}t\right)\hat{k}$ V/m

(4) $E=9\sin\left(1.6\times10^{3}x+48\times10^{10}t\right)\hat{k}$ V/m

10. The time period of revolution of electron in its ground state orbit in a hydrogen atom is 1.6×10^{-16}s . The frequency of revolution of the electron in its first excited state (in s^{-1}) is

(1) 6.2×10^{15}

(2) 7.8×10^{14}

(3) 1.6×10^{14}

(4) 5.6×10^{12}

11. A LCR circuit behaves like a damped harmonic oscillator. Comparing it with a physical spring-mass damped oscillator having damping constant' b ', the correct equivalence will be

(1) $L \to \frac{1}{b}, C \to \frac{1}{m}, R \to \frac{1}{k}$

(2) $L \to k, C \to b, R \to m$

(3) $L \to m, C \to k, R \to b$

(4) $L \to m, C \to \frac{1}{k}, R \to b$

12. Visible light of wavelength $6000 \times 10^{-8}\,\text{cm}$ falls normally on a single slit and produces a diffraction pattern. It is found that the second diffraction minima is at 60° from the central maxima. If the first minimum is produced at θ_1, then θ_1 is close to,

(1) 20°

(2) 45°

(3) 30°

(4) 25°

13. The radius of gyration of a uniform rod of length l about an axis passing through a point $\frac{l}{4}$ away from the center of the rod, and perpendicular to it, is

(1) $l\sqrt{\frac{7}{48}}$

(2) $l\sqrt{\frac{3}{8}}$

(3) $\frac{l}{4}$

(4) $\frac{l}{8}$

14. A satellite of mass m is launched vertically upward with an initial speed u from the surface of the earth. After it reaches height R ($R =$ radius of earth), it ejects a rocket of mass $\frac{m}{10}$ so that subsequently the satellite moves in a circular orbit. The kinetic energy of the rocket is ($G =$ gravitational constant; M is the mass of earth)

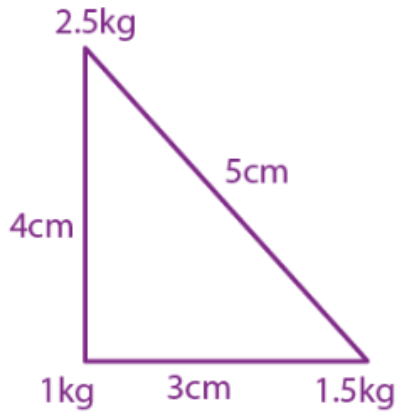
(1) $5m\left[u^2 - \frac{119GM}{200R}\right]$

(2) $\frac{m}{20}\left[u - \sqrt{\frac{2GM}{3R}}\right]^2$

(3) $\frac{m}{20}\left[u + \sqrt{\frac{5GM}{6R}}\right]^2$

(4) $\frac{m}{20}\left[u^2 + \frac{113GM}{200R}\right]$

15. Three-point particles of mass $1\ \text{kg}$, $1.5\ \text{kg}$ and $2.5\ \text{kg}$ are placed at three corners of a right triangle of sides $4\ \text{cm}, 3\text{cm}$ and $5\ \text{cm}$ as shown in the figure. The centre of mass of the system is at the point:



(1) $0.9\ \text{cm}$ right and $2\ \text{cm}$ above $1\ \text{kg}$ mass

(2) $2\ \text{cm}$ right and $0.9\ \text{cm}$ above $1\ \text{kg}$ mass

(3) $0.9\ \text{cm}$ right and $1.2\ \text{cm}$ above $1\ \text{kg}$ mass

(4) $0.6\ \text{cm}$ right and $2\ \text{cm}$ above $1\ \text{kg}$ mass

16. If we need a magnification of 375 from a compound microscope of tube length $150\ \text{mm}$ and an objective of focal length $5\ \text{mm}$, the focal length of the eye-piece should be close to:

(1) $22\ \text{mm}$

(2) $12\ \text{mm}$

(3) $2\ \text{mm}$

(4) $33\ \text{mm}$

17. Speed of transverse wave on a straight wire (mass $6\ \text{g}$, length $60\ \text{cm}$ and area of cross-section $1\ \text{mm}^2$) is $90\ \text{m/s}$. If the Young's modulus of wire is $16\times10^{11}\ \text{N/m}^2$, the extension of wire over its natural length is

(1) $0.03\ \text{mm}$

(2) $0.04\ \text{mm}$

(3) $0.02\ \text{mm}$

(4) $0.01\ \text{mm}$

18. $1\ \text{liter}$ of dry air at STP expands adiabatically to a volume of $3\ \text{liters}$. If $\gamma=1.4$, the work done by air is ($3^{1.4}=4.6555$) (take air to be an ideal gas)

(1) $48\ \text{J}$

(2) $100.8\ \text{J}$

(3) $90.5\ \text{J}$

(4) $60.7\ \text{J}$

19. A bob of mass m is tied by a massless string whose other end portion is wound on a fly wheel (disc) of radius r and mass m. When released from the rest, the bob starts falling vertically. When it has covered a distance h, the angular speed of the wheel will be:

(1) $r\sqrt{\dfrac{3}{4gh}}$

(2) $\dfrac{1}{r}\sqrt{\dfrac{4gh}{3}}$

(3) $\frac{r\sqrt{3}}{2gh}$

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

20. A parallel plate capacitor has plates of area A separated by distance 'd' between them. It is filled with a dielectric which has a dielectric constant varies as $k(x)=k(1+\alpha x)$, where 'x' is the distance measured from one of the plates. If $(\alpha d<<1)$, the total capacitance of the system is best given by the expression:

(1) $\frac{A\varepsilon_0 k}{d}\left[1+\left(\frac{\alpha d}{2}\right)^2\right]$

(2) $\frac{A\varepsilon_0 k}{d}\left[1+\left(\frac{\alpha d}{2}\right)\right]$

(3) $\frac{A\varepsilon_0 k}{d}\left[1+\left(\frac{\alpha^2 d}{2}\right)\right]$

(4) $\frac{A\varepsilon_0 k}{d}[1+\alpha d]$

SECTION B

This section contains 5 Numerical Value Questions

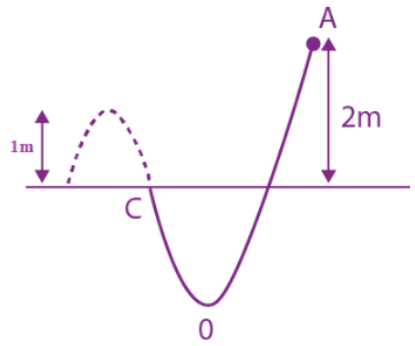
21. A non- isotropic solid metal cube has coefficient of linear expansion as $5\times10^{-5}/^{\circ}\mathrm{C}$ along the $x-$ axis and $5\times10^{-5}/^{\circ}\mathrm{C}$ along $y-$axis and $z-$axis. If the coefficient of volumetric expansion of the solid is $C\times10^{-6}/^{\circ}\mathrm{C}$ then the value of C is.....

22. A loop $ABCDEFA$ of straight edges has six corner points $A(0,0,0)$, $B(5,0,0)$, $C(5,5,0)$, $D(0,5,0)$, $E(0,5,5)$, $F(0,0,5)$. The magnetic field in this region is $B=\left(3\hat{i}+4\hat{k}\right)\mathrm{T}$. The quantity of flux through the loop $ABCDEFA$ (in Wb) is ---------.

23. A Carnot engine operates between two reservoirs of temperature $900\ \mathrm{K}$ and $300\ \mathrm{K}$. The engine performs $1200\ \mathrm{J}$ of work per cycle. The heat energy (in J) delivered by the engine to the low temperature reservoir, in a cycle, is.....

24. A particle of mass 1 kg slides down a frictionless track (AOC) starting from rest at a point A (height $2\ \mathrm{m}$). After reaching C, the particle continues to move freely in air as a projectile. When it reaches its highest point P (height $1\ \mathrm{m}$) the kinetic energy of the particle (in J) is:

(Figure drawn is schematic and not to scale; take $g=10\ \mathrm{m/s^2}$)



25. A beam of electromagnetic radiation of intensity $6.4\times10^{-5}\mathrm{W/cm^2}$ is comprised of wavelength, $\lambda=310\ \mathrm{nm}$. It falls normally on a metal ($\varphi=2\ \mathrm{eV}$) of surface area 1cm2. If one in 103 photons ejects an electron, total number of electrons ejected in $1\ \mathrm{s}$ is $10x$ ($hc=1024\ \mathrm{eV.nm}$, $1\mathrm{eV}=1.6\times10^{-19}\mathrm{J}$), then x is.....