PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. The dimension of latent heat is

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

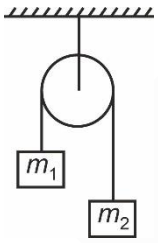
(3) $[M^0LT^{-2}]$ (4) $[M^{-1}L^2T^{-2}]$

Answer (2)

Sol. $[L]=\frac{Q}{M}=\frac{ML^2T^{-2}}{M}$

$=\left[L^2T^{-2}\right]$

2. In the pulley-block system shown, the pulley and the block are ideal. If the acceleration of the blocks is $\frac{g}{8}$, find $m_1 : m_2$ (Given $m_2 > m_1$)



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

(3) 3 : 4 (4) 9 : 11

Answer (1)

Sol. $a=\frac{(m_2-m_1)g}{(m_1+m_2)}=\frac{g}{8}$

$\frac{m_1}{m_2}=\frac{7}{9}$

3. Velocity of a particle of mass m as a function of displacement x is given by $v=\alpha\sqrt{x}$.

Work done to move it from $x = 0$ to $x = d$ is

(1) $\frac{m\alpha^2}{2}.d$ (2) $m\alpha^2.d$

(3) $\frac{3m\alpha^2d}{2}$ (4) $2m\alpha^2d$

Answer (1)

Sol. $W = \Delta KE$

$W=\frac{1}{2}m\left[\left(\alpha\sqrt{d}\right)^2-\left(\alpha\sqrt{0}\right)^2\right]$

$W=\frac{m\alpha^2d}{2}$

4. Two persons are pulling a rope towards themselves with force of 200 N each. If Young's modulus is 2×10^{11} N/m^2 and area of cross is 2 cm^2 for the rope. The elongation in the rope is, if distance of their holding the rope is 2 m.

(1) 10 μm (2) 20 μm

(3) 5 μm (4) 40 μm

Answer (1)

Sol. $\frac{Fl}{YA}=\Delta l$

$\frac{200\times2}{2\times10^{11}\times2\times10^{-4}}=\Delta l$

$100 \times 10^{-7} = \Delta l$

10×10^{-6} m $= \Delta l$

5. A galvanometer having resistance of 200 Ω shows full deflection at 20 μA. If the galvanometer has to measure current up to 200 *m*A, the shunt resistance required is

(1) $\frac{200}{99}$ Ω (2) $\frac{200}{999}$ Ω

(3) $\frac{20}{99}$ Ω (4) 200 × 999 Ω

Answer (2)

Sol. $20\,\mu A = \left(\frac{R_S}{R_S + 200}\right) 20\,mA$

$R_S + 200 = 1000\ R_S$

$R_S = \frac{200}{999}\ \Omega$

6. A particle oscillating simple harmonic motion such that its speed and acceleration at distance 2 m from mean position are 4 m/s and 16 m/s^2 respectively.

(1) $\sqrt{10}$ m (2) $\sqrt{6}$ m

(3) $\sqrt{8}$ m (4) $\sqrt{3}$ m

Answer (2)

Sol. $4 = \omega\sqrt{A^2 - 4}$ …(i)

$16 = 2\omega^2$ …(ii)

from (i) and (ii)

$A = \sqrt{6}$ m

7. **Assertion :** Object at radius of curvature of biconvex lens forms image at same distance an other side of lens.

Reason : Image of a real object formed by concave lens is always virtual and erect.

(1) Assertion and reason are correct and reason is correct explanation of assertion.

(2) Assertion and reason are correct but reason is not correct explanation of assertion.

(3) Assertion is correct but Reason is incorrect

(4) Assertion is incorrect but Reason is correct

Answer (2)

Sol. Theoretical $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ & $|v| = |u| = 2f$

8. The equivalent energy of 1 gm mass is equal to

(1) 8.3×10^{26} MeV (2) 5.6×10^{26} MeV

(3) 8.3×10^{12} MeV (4) 5.6×10^{12} MeV

Answer (2)

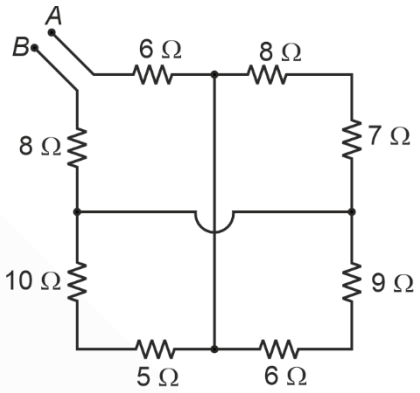
Sol. $E = mc^2$

$= \frac{1 \times 10^{-3} \times 9 \times 10^{16}}{1.6 \times 10^{-19}}$ eV

$= 5.625 \times 10^{32}$ eV

$= 5.6 \times 10^{26}$ MeV

9. Find equivalent resistance between terminal is A and B for the given network.

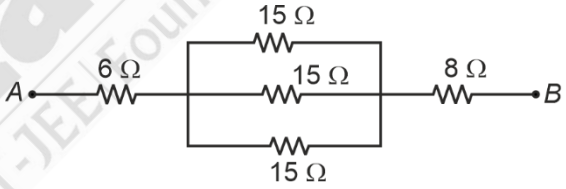


(1) 16 Ω (2) 20 Ω

(3) 15 Ω (4) 19 Ω

Answer (4)

Sol. Simplifying the circuit, we get



$R_{AB} = 14 + \frac{15}{3} = 19\ \Omega$

10. A person covers first half of the distance with 6 m/s and rest half of the distance is covered with 9 m/s and 15 m/s in two equal time intervals. Find average speed of the journey.

(1) 12 m/s (2) 9 m/s

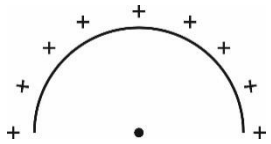
(3) 10 m/s (4) 8 m/s

Answer (4)

Sol. Average speed in second half distance $= \frac{9+15}{2} = 12$ m/s

Average speed of journey $= \frac{2d}{\frac{d}{6}+\frac{d}{12}} = 8$ m/s

11. Find the potential at the centre of a uniformly charged semi-circular wire with uniform linear charge density of 4 nC/m.



(1) 36π volts (2) 29π volts

(3) 9π volts (4) Zero volts

Answer (1)

Sol. $v = \frac{kQ}{R}$

$= \frac{9\times10^{9}(\pi R)\times4\times10^{-9}}{R}$

$= 36\pi$ volt

12. An astronaut takes a body of mass m from the surface of the earth to an altitude $\frac{R}{20}$ (R is the radius of the earth, g is acceleration due to gravity at surface of earth)

Find change in gravitational potential energy of the body.

(1) $\frac{mgR}{20}$ (2) $\frac{mgR}{21}$

(3) $\frac{mgR}{15}$ (4) $\frac{mgR}{25}$

Answer (2)

Sol. $\Delta U = U_f - U_i = \frac{-GMm}{\left(\frac{R+R}{20}\right)} - \left(\frac{-GMm}{R}\right)$

$\Delta U = \frac{GMm}{21R} = m\left(\frac{GM}{R^2}\right)\cdot\frac{R}{21} = \frac{mgR}{21}$

13. Energy associated with a photon is 1.42 eV. Find wavelength of photon. (Take hc = 1240 nmeV)

(1) 628.26 nm (2) 873.24 nm

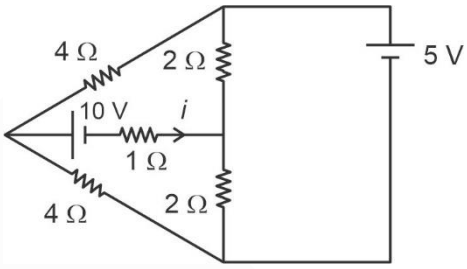
(3) 625.22 nm (4) 820.23 nm

Answer (2)

Sol. $E = \frac{hc}{\lambda}$

$\lambda = \frac{1240n \text{ MeV}}{1.42 \text{ eV}}$

$= 873.24$ nm

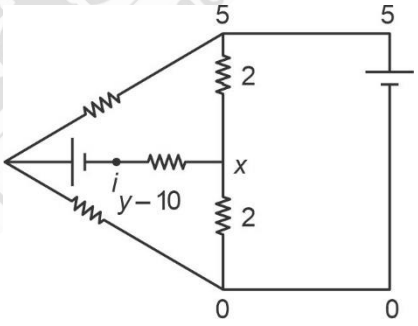
14. 

Find current i in the given DC circuit.

(1) 1.25 A (2) 5 A

(3) 2.5 A (4) 1 A

Answer (3)

Sol. 

$\frac{x-5}{2}+\frac{x}{2}+\frac{x-y+10}{1}=0$

$x-5+x+2x-2y+20=0$

$4x-2y=-15$ …(i)

$\frac{y-5}{4}+\frac{y-0}{4}+\frac{y-10-x}{1}=0$

$y - 5 + y - 0 - 4y - 40 - 4x = 0$

$6y - 4x = 45$ …(ii)

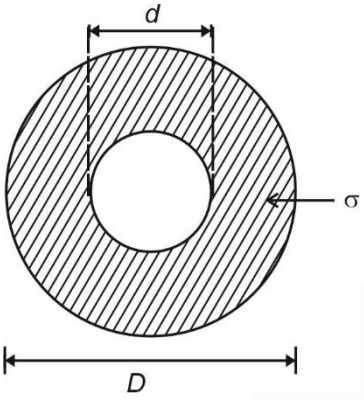
$i = 2.5$ A

$4y = 30$

$y = \frac{15}{2}$

And $x = 0$

15. An object of diameter D has cavity of diameter d as shown. Relative density of material of object is σ. Find $\frac{D}{d}$ such that the object just completely submerge in water.



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

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

Answer (2)

Sol. $V = \frac{4}{3}\pi\left(\frac{D}{2}\right)^3$

$V_C = \frac{4}{3}\pi\left(\frac{d}{2}\right)^3$

$\frac{4}{3}\pi\left(\frac{D}{2}\right)^3 = \frac{4}{3}\pi\left\{\left(\frac{D}{2}\right)^3 - \left(\frac{d}{2}\right)^3\right\}\sigma$

$D^3 = (D^3 - d^3)\sigma$

$1 = \left\{1 - \left(\frac{d}{D}\right)^3\right\}\sigma$

$1 - \frac{1}{\sigma} = \left(\frac{d}{D}\right)^3$

$\left(\frac{\sigma}{\sigma-1}\right)^{\frac{1}{3}} = \frac{D}{d}$

16. A capacitor is connected with a bulb to an ac source. After some time dielectric is introduced between the plates of the capacitor. The brightness of the bulb will

(1) Increase

(2) Decrease

(3) No change

(4) First increase then decrease

Answer (1)

Sol. $c' = kc$

$X_c = \frac{1}{\omega c}$

$X_c' = \frac{1}{kc\omega}$

z decreases

$\therefore$ i will increase.

17. Two vector $\vec{A}$ and $\vec{B}$ having magnitude A and B respectively are inclined at angle $\theta = \cos^{-1}\left(\frac{5}{9}\right)$. If they satisfied the relation $\left|\vec{A}+\vec{B}\right| = \sqrt{2}\left|\vec{A}-\vec{B}\right|$ and given that $\left|\vec{A}\right| = n\left|\vec{B}\right|$, then value of n may be

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

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

Answer (2)

Sol. $\sqrt{A^2+B^2+2AB\cos\theta} = \sqrt{2}\sqrt{A^2+B^2-2AB\cos\theta}$

$$(nB)^2+B^2+2(nB)B\times\frac{5}{9} = 2\left[(nB)^2+B^2-2(nB)B\times\frac{5}{9}\right]$$

$$n^2+1-\frac{10}{3}n = 0$$

$3n^2 + 3 - 10n = 0$

$3n^2 - 10n + 3 = 0$

$3n^2 - 9n - n + 3 = 0$

$3n(n-3) - 1(n-3) = 0$

$n = 3$

$$n = \frac{1}{3}$$

18. In an adiabatic process $\left(\gamma = \frac{3}{2}\right)$, a gas expands to double of its initial volume.

Find the work done by gas if initial temperature is T. (Number of moles of gas = 1)

(1) $RT\left(2-\sqrt{2}\right)$ (2) $RT\left(2+\sqrt{2}\right)$

(3) $\frac{RT}{2+\sqrt{2}}$ (4) $\frac{RT}{2-\sqrt{2}}$

Answer (1)

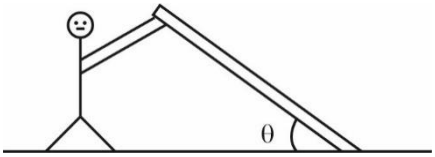
Sol. $TV^{\gamma-1} = T_1(2V)^{\gamma-1}$

$$\Rightarrow \quad T_1 = \frac{T}{\sqrt{2}}$$

$$W = \frac{nR\left(T-\frac{T}{\sqrt{2}}\right)}{\frac{3}{2}-1} = \sqrt{2}RT\left(\sqrt{2}-1\right)$$

$$= RT\left(2-\sqrt{2}\right)$$

19. A man is holding a rod as shown in figure from one end while the other end is making an angle θ with the ground. Find the contact force between rod and man if weight of rod is W.



(1) $\frac{W}{2}\sin\theta$

(2) $\frac{W}{3}\cos\theta$

(3) $\frac{W}{3}\sin\theta$

(4) $\frac{W}{2}\cos\theta$

Answer (4)

Sol. $mg\cos\theta\frac{l}{2} = N\times l$

$$N = \frac{mg}{2}\cos\theta = \frac{W\cos\theta}{2}$$

20. If the energy of α-particle, proton and an electron are same and the simplest ratio of their de–Broglie wavelength is

(1) 2 : 1 : 1244

(2) 1836 : 4 : 1

(3) 1 : 4 : 7340

(4) 1 : 4 : 1836

Answer (3)

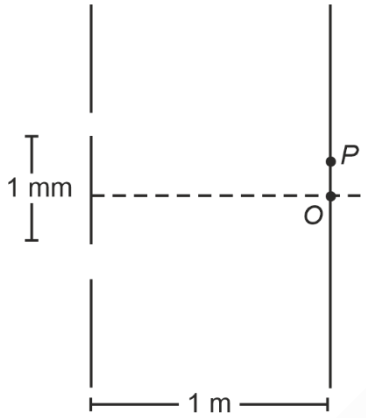
Sol. $\lambda = \frac{h}{\sqrt{2mE}}$

$$\lambda \propto \frac{1}{\sqrt{m}}$$

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. In the *YDSE* set up shown below, point *P* is having $\left(\frac{1}{4}\right)^{th}$ the maximum intensity. If the minimum distance of *P* from *O* is $N \times 10^{-4}$ m, find *N*. (Given wavelength of light = 600 nm)



Answer (2)

Sol. $\frac{I_0}{4} = I_0 \cos^2 \frac{\phi}{2}$

$\phi = 120°$

$\Delta x = \frac{\lambda}{2\pi} \times \frac{2\pi}{3} = \frac{\lambda}{3}$

$\Delta x = \frac{dy}{D} = \frac{\lambda}{3}$

$y = \frac{\lambda D}{3d} = \frac{600 \times 10^{-9} \times 1}{3 \times 10^{-3}}$

$= 2 \times 10^{-4}$ m

22. A choke coil draws 4 A current from 20 V DC and $\frac{4}{5}$ A current from 20 V AC (of frequency of 50 Hz). The inductance of the coil is $\frac{x}{10}$ H. Find nearest integer *x*.

Answer (4)

Sol. $R = 5\ \Omega$

$\sqrt{5^2 + x_L^2} = \frac{20}{\left(\frac{4}{5}\right)} = 25$

$25 + x_L^2 = 625$

$x_L = \sqrt{600}$

$L = \frac{10\sqrt{6}}{20\pi \times 50} = \frac{\sqrt{6}}{2\pi}$ H

$= 0.4$ H

23. String wrapped on a circular disc of radius $r = 20$ cm. The moment of inertia of disc is 0.4 kgm^2. The string is pulled with a constant force of 40 N. The angular velocity of the disc at time $t = 2$ sec is *K* rad/s.

Find the value of *K*. (Initially disc is at rest)

Answer (40)

Sol. $\tau = I\alpha$

$40 \times 0.2 = 0.4 \cdot \alpha \Rightarrow \alpha = 20$ rad/s^2

$\therefore \omega = \omega_i + \alpha t$

$\boxed{\omega = 40 \text{ rad/s}}$

24.

25.

26.

27.

28.

29.

30.