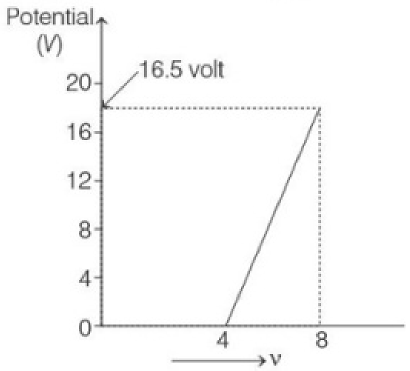
BITSAT - Paper 2022

Solved Paper

Question 1

The stopping potential (V_0) versus frequency (v) of a graph for photoelectric effect in a metal. From the graph, the planck's constant (h) is.



Options:

A. $6.60 \times 10^{-34} \mathrm{J}-\mathrm{s}$

B. $6.69 \times 10^{-34} \mathrm{J}-\mathrm{s}$

C. $6.62 \times 10^{-34} \mathrm{J}-\mathrm{s}$

D. $6.63 \times 10^{-34} \mathrm{J}-\mathrm{s}$

Answer: A

Solution:

Solution:

$eV_0 = h(v - v_0) = hv - hv_0$

$V_0 = \left(\frac{h}{e}\right) v - \left(\frac{h}{v}\right) v_0$ ....(i)

From Eq. (i), it follows that the slope of the graph is $\frac{h}{e}$.

Therefore,

$h = e \times \text{slope} = 1.6 \times 10^{-19} \times \frac{165 - 0}{(8 - 4) \times 10^{15}}$

$= 16 \times 10^{-19} \times \frac{16.5}{4} \times 10^{15} = 6.6 \times 10^{-34} \mathrm{J} - \mathrm{s}.$

Question 2

In a resonance column first and second resonance are obtained at depths 24 cm and 78 cm the third resonance will be obtained at depth.

Options:

A. 160 cm

B. 132 cm

C. 131 cm

D. 152 cm

Answer: B

Solution:

Solution:
Given, first resonance column at deoth, $l_1 = 24\text{cm}$
Second resonance column at depth, $l_2 = 78\text{cm}$
Third resonance column at depth, $l_3 = ?$
As$l_1 + x = \frac{\lambda}{4} = 24 \ldots\ldots\ldots\ldots\ldots (i)$
$l_2 + x = \frac{3\lambda}{4} = 78 \ldots\ldots\ldots\ldots\ldots (ii)$
$l_3 + x = \frac{5\lambda}{4} \ldots\ldots\ldots\ldots\ldots (iii)$
From Eqs. (i) and (ii),
$x = \frac{l_2 - 3l_1}{2} = \frac{78 - 3(24)}{2} = 3 \ldots\ldots\ldots\ldots\ldots\ldots (iv)$
substituting l_1 and x value, we get
$l_3 = 5(24) + 4(3)$
$\Rightarrow l_3 = 132\text{cm}.$

Question 3

A submarine A travelling at $17\frac{\text{m}}{\text{s}}$ is being chased along the line of its velocity by another submarine B travelling at $34\frac{\text{m}}{\text{s}}$. B sends a sonar signal of 600Hz to detect A and receives a reflected sound of frequency v. The of v is [Speed of sound in water $= 1500\text{ms}^{-1}$]

Options:

A. 613.7 Hz

B. 6137 Hz

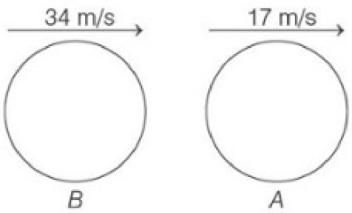
C. 62 Hz

D. 539 Hz

Answer: A

Solution:

Solution:
Given, velocity of submarine A, $v_A 17\text{m} / \text{s}$
Velocity of Submarine B, $v_B = 34\text{m} / \text{s}$
Signal sent by submarine B is detected by submarine A can be shown as



Frequency of the signal, $f_0 = 600\text{Hz}$

speed of sound in water $v_s = 1500\text{ms}^{-1}$

Frequency received by submarine A is

$$f_1 = \left(\frac{v_S - v_A}{v_S - v_B}\right) f_0 = \left[\frac{1500 - 17}{1500 - 34}\right] \times 600\text{hz}$$

$$f_1 = \frac{1483}{1466} \times 600 \ldots\ldots\ldots\ldots \text{(i)}$$

Frequency received by submarine is

$$f_2 = \left(\frac{v_S + v_B}{v_{svA}}\right) f_1$$

Substituting given values and f_1 value from Eq. (i), we get

$$f_2 = \left(\frac{1500 + 34}{1500 + 17}\right) \times \left[\frac{1483}{1466} \times 600\right]$$

$$f_2 = 1.0112 \times 1.0115 \times 600$$

$$f_2 = 613.7\text{Hz.}$$

Question 4

Transverse waves of the same frequency are generated in two steel wires A and B. The diameter of A is twice that of B and the tension in A is half that in B. The ratio of the velocities of the waves in A and B is

Options:

A. 1:2

B. $1 : \sqrt{2}$

C. $1 : 2\sqrt{2}$

D. $3 : 2\sqrt{2}$

Answer: C

Solution:

Solution:

The velocity if transverse waves is given by

$v = \sqrt{\frac{T}{m}}$ where, T = Tension and m = mass per unit length of the wire. If r is the radius if the wire and ρ its density then,

$$m = \pi r^2 \rho$$

$$\therefore v = \sqrt{\frac{T}{m}} = \sqrt{\frac{T}{\pi r^2 \rho}}$$

$$\therefore v_A = \frac{\sqrt{T_A}}{r_A \sqrt{\pi \rho}}$$

and $v_B = \frac{\sqrt{T_B}}{r_B \sqrt{\pi \rho}}$

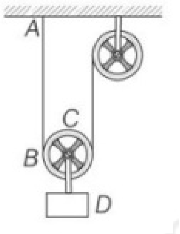
Now, $\frac{v_a}{v_B} = \sqrt{\frac{T_A}{T_B}} \cdot \frac{r_B}{r_A}$

$\because r_A = 2r_B$ and $T_A = \frac{1}{2}T_B$

Hence, $\frac{v_A}{v_B} = \frac{1}{2\sqrt{2}}$

Question 5

In the diagram shown below, both the strings AB and CD are made of same material and have same cross-section. The pulleys are light and fictionless. If the speed of wave in string AB is v_1 and in CD is v_2, then $\frac{v_1}{v_2}$ is



Options:

A. 1

B. $\sqrt{2}$

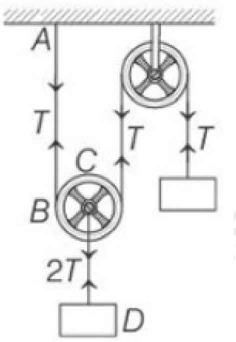
C. 2

D. $\frac{1}{\sqrt{2}}$

Answer: D

Solution:

Solution:



Let the speed of wave in string be v and tension in string b e T.

$v \propto \sqrt{T}$

$\frac{v_{AB}}{v_{CD}} = \frac{\sqrt{T}}{2T} = \frac{1}{\sqrt{2}}$

Question 6

What will be the acceleration due to gravity at a depth d , where g is

acceleration due to gravity on the surface of earth?

Options:

A. $\frac{g}{\left[1+\frac{d}{R}\right]^2}$

B. $g\left[1-\frac{2d}{R}\right]$

C. $\frac{g}{\left[1-\frac{d}{R}\right]^2}$

D. $g\left[1-\frac{d}{R}\right]$

Answer: D

Solution:

Solution:
Acceleration due to gravity at the surface of earth,

$g = G\frac{M}{R^2} = \frac{4}{3}\pi\rho GR \ldots\ldots\ldots\ldots\ldots. \text{(i)}$

$\left[\because M = \frac{4}{3}\pi R^3 \cdot \rho\right]$

Where, $\rho =$ density of earth.
Acceleration due to gravity at depth d from the surface of earth,

$g' = \frac{4}{3}\pi\rho G(R-d) \ldots\ldots\ldots. \text{(ii)}$

From Eqs. (i) and (ii), we get

$g' = g\left[1-\frac{d}{R}\right]$

Question 7

A direct current of 6A is superimposed on an alternating current $I = 10\sin\omega t$ flowing through a wire. The effective value of the resulting current will be

Options:

A. $5\sqrt{2}$

B. $5\sqrt{3}$

C. 9.27

D. 8.37

Answer: C

Solution:

Solution:
Given, $I = 6 + 10\sin\omega t$

$$I_{eff} = \left[\frac{\int_0^T I^2 dt}{\int_0^T dt}\right]^{\frac{1}{2}} = \left[\frac{1}{T}\int_0^T (6 + 10\sin\omega t)^2 dt\right]^{\frac{1}{2}}$$

$$= \left[\frac{1}{T}\int_0^T (36 + 120\sin\omega t + 100\sin^2\omega t) dt\right]^{\frac{1}{2}}$$

But as, $\frac{1}{T}\int_0^T \sin\omega t dt = 0$ and $\frac{1}{T}\int_0^T \sin^2 W t = \frac{1}{2}$

$$\Rightarrow I_{eff} = \left[36 + \frac{1}{2} \times 100\right]^{\frac{1}{2}} = 0.97$$

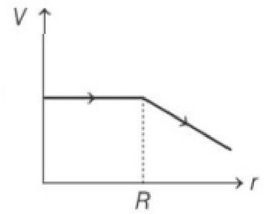
Thus, $I_{eff} = 9.27A$.

Question 8

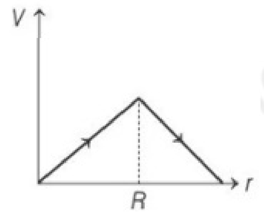
Which one of the following graphs represents the variation of electric potential with distance r from the centre of a non-conducting charged sphere of radius R ?

Options:

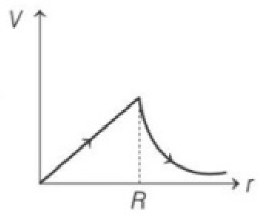
A.



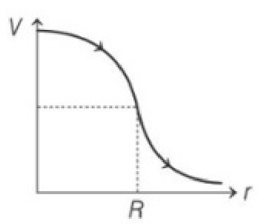
B.



C.



D.



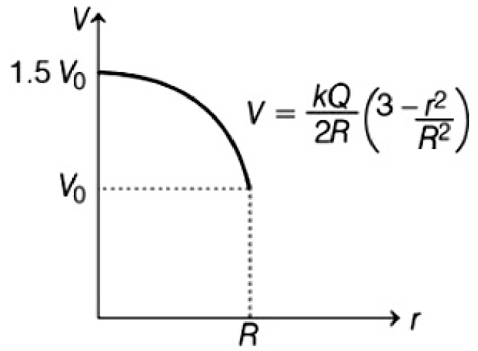
Answer: D

Solution:

Solution:

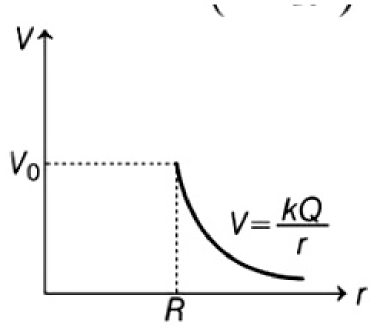
Electric potential at centre $R = 0$

$V_{\text{centre}} = 1.5 V_{\text{surface}}$



where, $V_0 = \frac{kQ}{R}$

$V_{\text{inside}} = \frac{kQ}{2R}\left(3 - \frac{r^2}{R^2}\right)$



$V_{\text{outside}} = k\frac{Q}{r} \propto \frac{1}{r}$

Question 9

For an insulator, the forbidden energy gap is

Options:

A. Zero

B. 1 eV

C. 2 eV

D. 5 eV

Answer: D

Solution:

Solution:
For an insulator, $E_g > 3\text{eV}$, that is why electron transition from valence band to conduction band is not possible. For semiconductor E_g is 0.2eV to 0.3eV, while for metals $E_g > 5\text{eV}$.

Question 10

A machine gun fires 300 bullets per min if the mass of each bullet is 10g and the velocity of the bullets is $600ms^{-1}$, the power (in kW) of the gun is

Options:

A. 43200

B. 9

C. 72

D. 7.2

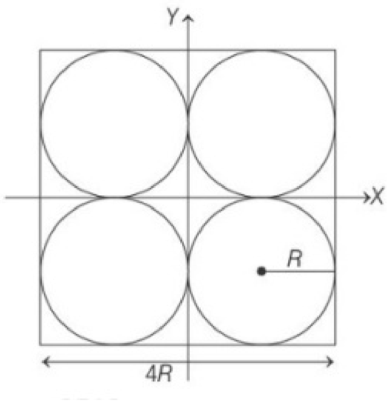
Answer: B

Solution:

Solution:
Work done by the gun = total kinetic energy of the bullets
$= n\frac{1}{2}mv^2 = 300 \times \frac{1}{2} \times 10 \times 10^{-3} \times (600)^2$
$= 150 \times 10 \times 10^{-3} \times 600 \times 600$
Power of gun $= \frac{\text{work done}}{\text{Time taken}}$
$= \frac{150 \times 10 \times 10^{-3} \times 600 \times 600}{60s}$
$= 9kW \ (\because 1 \text{ minute} = 60 \text{ seconds})$

Question 11

Four holes of radius 5cm are cut from a thin square plate of 20cm and mass 1kg. The moment of inertia of the remaining portion about Z -axis is



Options:

A. $15 \, kg - m^2$

B. $0.37 \, kg - m^2$

C. $0.0017 \, kg - m^2$

D. $0.08\,\mathrm{kg}-\mathrm{m}^2$

Answer: C

Solution:

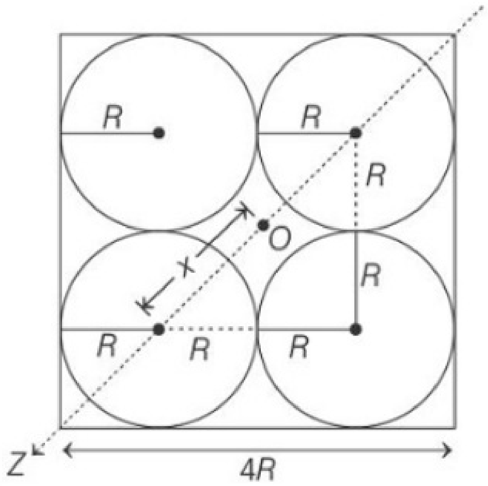
Solution:

Area mass density, $\sigma = \frac{M}{16R^2}(\because \text{Area} = 4R \times 4R = 16R^2)$

Mass of each hole $m_1 = \sigma\pi R^2 = \frac{M}{16R^2}\pi R^2 = \frac{\pi M}{16}$

Distance between centre of plate and centre of hole

$x = \frac{\sqrt{(2R)^2 + (2R)^2}}{2} = \frac{2\sqrt{2}R}{2}$



Moment of inertia of one hole at about Z-axis

$I_1 = \frac{1}{2}m_1R^2 + m_1x^2 = \frac{5\pi}{32}MR^2$

Moment of inertia of whole plate about Z-axis,

$I = \frac{M(4R)^2}{6} = \frac{8}{3}MR^2$

Required moment of Inertia

$I_0 = I - 4I_1, = \left[\frac{8}{3} - 4\left(\frac{5\pi}{32}\right)\right]MR^2 = \left[\frac{8}{3} - \frac{5\pi}{8}\right]MR^2$

Given, R=5cm and M=1kg

So, $I_0\left[\frac{8}{3} - \frac{5\pi}{8}\right]1 \times 25 \times 10^{-4} = 0.0017\mathrm{kg} - \mathrm{m}^2$

Question 12

a particle of mass m is projected with velocity v at an angle θ with the horizontal. At its highest point, it explodes into two pieces of equal mass, one of the piece continue to move on the original trajectory, then the velocity of second piece is.

Options:

A. $2v\cos\theta$

B. $v\cos\theta$

C. $3v\cos\theta$

D. $\frac{v}{2}\cos\theta$

Answer: B

Solution:

Solution:
According to the law of conservation of linear momentum at the highest point,
$mv\cos\theta = \frac{m}{2}(v\cos\theta) + \frac{m}{2}v'$
$\Rightarrow mv\cos\theta = \frac{m}{2}v\cos\theta = \frac{m}{2}v'$
$\Rightarrow v' = 2\left(v\cos\theta - \frac{v\cos\theta}{2}\right) = v\cos\theta$

Question 13

In the circuit shown assume the diode to be ideal. When V_i increases from $-2V$ to $6V$, the change in current is (in mA)

Options:

A. Zero

B. 20

C. $\frac{25}{8}$

D. 32

Answer: B

Solution:

Solution:
$I_{initial} = 0 \text{ for } V_i \le +1V$
This diode conduct only beyond $V_i = +1V$
$I_{final} = \frac{5}{250} = 0.02A$
So, change in $I = 0.02A = 20mA$

Question 14

The de-Broglie wavelength of an electron moving with a velocity $\frac{c}{3}(c = 3 \times 10^8 m/s)$ is equal to the wavelength of photon. The ratio of the kinetic energies of electron and photon is

Options:

A. 1 : 4

B. 1 : 3

C. 1 : 2

D. 2 : 1

Answer: B

Solution:

Solution:

The de-Brogile wavelength, $\lambda = \frac{h}{mv}$

Here, $\lambda_e = \frac{h}{m_e \frac{c}{3}}$ and $\lambda_p = \frac{h}{m_p c}$

Given, $\lambda_e = \lambda_p$

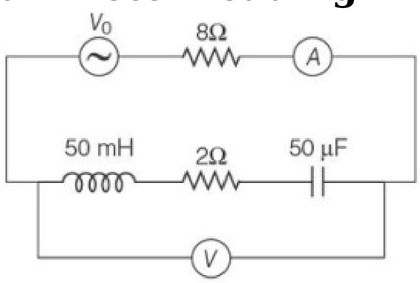
So, $\frac{h}{m_e \frac{c}{3}} = \frac{h}{m_p c}$

$\Rightarrow \frac{m_e}{m_p} = 3$

Ratio of K E $= \frac{K_e}{K_p} = \frac{\frac{1}{2} m_e v_e^2}{\frac{1}{2} m_p v_p^2} = \frac{1}{3} \left(\because \frac{m_e}{m_p} = 3, v_e = \frac{c}{3} \text{and } v_p = c \right)$

Question 15

In the circuit shown in the figure, the AC source gives a voltage $V = 20 \cos(2000t)$ neglecting source resistance, the voltmeter and ammeter reading will be



Options:

A. 0V, 0.47A

B. 2.82V, 1.41A

C. 1.41V, 0.47A

D. 1.5V, 8.37A

Answer: B

Solution:

Solution:
Given,
$R_1 = 8\Omega$
$R_2 = 2\Omega$
$L = 5mH$

$C = 50\mu F$
and $V_0 = 20\cos(2000t)$
Independence, $Z = \sqrt{R^2 + (X_L - X_C)^2}$
As, here, $X_L = \omega L = 2000 \times 5 \times 10^{-3} = 10\Omega$
Similarly, $X_L = \frac{1}{\omega}C = \frac{1}{2000 \times 50 \times 10^{-6}} = 10\Omega$
$\because X_L = X_C$, Hence, $i_{max} = \frac{V_0}{Z} = \frac{20}{(8+2)} = 2A$
Hence, $i_{rms} = \frac{i_{max}}{\sqrt{2}} = \frac{2}{\sqrt{2}} = 1.41A$
and $V = R_2 i_{rms} = 1.41A \times 2$
$= 282V$

Question 16

An electromagnetic wave is propagating along X -axis. At x = 1 cm and t = 18 s, its electric vector |E| = 8V / m, then the magnitude of its magnetic vector is

Options:

A. 266×10^{-8}

B. 3×10^{-7}

C. 3.14×10^{-8}

D. 3.16×10^{-7}

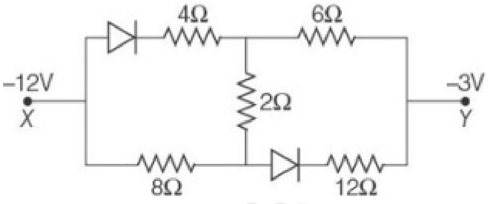
Answer: A

Solution:

Solution:
As we know that, $\frac{E}{B} = c$
so, $B = \frac{E}{c} = \frac{8}{3} \times 10^8 = 266 \times 10^{-8}$

Question 17

In the following circuit the equivalent resistance between X and Y is ...... Ω



Options:

A. 5

B. 12

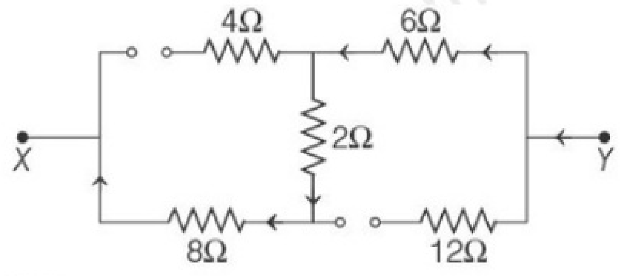
C. 16

D. 20

Answer: C

Solution:

Solution:
According to the given figure X is at lower potential w.r.t y. Hence, both diodes are in revere biasing, so, equivalent citcuit can be redrawn as follows



Equivalent resistance between X and Y
$R_{eq} = 8 + 2 + 6 = 16\Omega$

Question 18

A monoatomic gas of molar mass m is kept in a insulated container. Container is moving with velocity v. If the container is suddenly stopped, then the change in the temperature of the gas is

Options:

A. $\frac{mv^2}{4R}$

B. $\frac{mv^2}{2R}$

C. $\frac{mv^2}{R}$

D. $\frac{mv^2}{3R}$

Answer: D

Solution:

Solution:
Let the insulated container has n moles of the monoatomic gas. The loss of kinetic energy of the gas,
$\Delta E_K = \frac{1}{2}(mv)v^2$
If the change in temperature of the gas is ΔT , then heat gained by the gas is,
$\Delta Q = \frac{3}{2}nR\Delta T$
Now, according to question,
$\Delta Q = \Delta E_K$
$\frac{3}{2}nR\Delta T = \frac{1}{2}mnv^2$

$\Rightarrow \Delta T = \frac{mv^2}{3R}$

Question 19

A projectile is projected with the velocity of $\left(3\hat{i} + 4\hat{j}\right)$ m / s. The horizontal range of the projectile will be

Options:

A. 1.2m

B. 2.4m

C. 3.6m

D. 4.5m

Answer: B

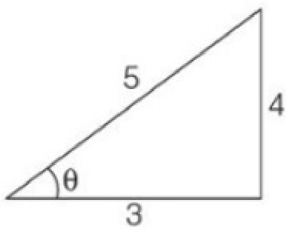
Solution:

Solution:

Given, $v = 3\hat{i} + 4\hat{j}$

$\therefore v = |v| = \sqrt{3^2 + 4^2} \Rightarrow v = 5m/s$

From figure,



$\sin\theta = \frac{4}{5}$ and $\cos\theta = \frac{3}{5}$

$\because R = \frac{v^2 \sin 2\theta}{g}$

$= \frac{v^2 . 2\sin\theta . \cos\theta}{g}$

$= \frac{5 \times 5 \times 2 \times \frac{4}{5} \times \frac{3}{5}}{10} = 24m$

Question 20

A transistor is connected in common-emitter (CE) configuration. The collector supply is 8V and the voltage drop across a resistor is 500Ω in the collector circuit is 0.6V. If the current gain factor α is 0.96 , find the base current

Options:

A. 25μA

B. 50μA

C. 20μA

D. 35μA

Answer: B

Solution:

Solution:
Given, $V_{CC} = 8V$
Voltage drop, $V_0 = \Delta I_C R_L = 0.6V$
Load Resistor, $R_L = 500\Omega$
Gain factor, $\alpha = 0.96$
$\because \beta = \frac{\alpha}{1-\alpha} = \frac{0.96}{1-0.96} = 24$
Now, $V_0 = \Delta I_C R_L$
$0.6 = \Delta I_C \times 500$
$\Delta I_C = \frac{0.6}{500} = 1.2 \times 10^{-3}A$
Now, $\beta = \frac{\Delta I_C}{\Delta I_B}$
$\therefore$ Base current $\Delta I_B = \frac{\Delta I_C}{\beta} = \frac{1.2 \times 10^{-3}}{24} = 5 \times 10^{-5}$
$= 50 \times 10^{-6}$
$\Delta I_B = 50\mu A$

Question 21

A solid sphere of 80 kg and radius 15m moving in a space becomes a circular disc of radius 20m in 1h. The rate of change of moment of Inertia in this process is ......

Options:

A. $\frac{30}{9} kg^{-m^2 s^{-1}}$

B. $\frac{25}{9} kg - m^2 s^{-1}$

C. $\frac{10}{9} kg - m^2 s^{-1}$

D. $\frac{22}{9} kg - m^2 s^{-1}$

Answer: D

Solution:

Solution:
Given, mass of solid sphere $= 80kg$
radius of solid sphere, $R_s = 15m$
radius of circular disc, $R_c = 20m$
and time $= 1\,hour = 60\,minutes = 60 \times 60sec$
$\therefore$ Moment if inertia of solid sphere, $I_s = \frac{2}{5} M R^2$

$= \frac{2}{5} \times 80 \times (15)^2$

$= 7200 \text{kg} - \text{m}^2$

Similarly,

moment of inertia of the disc, $I_c = \frac{1}{2} M R_c^2$

$= \frac{1}{2} \times 80 \times (20)^2$

$= 16000 \text{kg} - \text{m}^2$

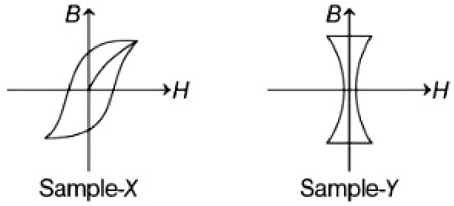
Rate of change of moment of Inertia $= \frac{I_c - I_s}{t}$

$= \frac{16000 - 7200}{60 \times 60}$

$= \frac{22}{9} \text{kg} - \text{m}^2 \text{s}^{-1}$

Question 22

If the $B - H$ curves of two samples of X and Y of iron are as shown below, then which one of the following statement is correct?



Options:

A. Both X and Y are suitable for making electromagnets.

B. Both X and Y are suitable for making permanent magnet.

C. X is suitable for making permanent magnet and Y for making electromagnet.

D. X is suitable for making electromagnet and Y is suitable for permanent magnet.

Answer: C

Solution:

Solution:
For permanent magnet we prefer a material with high retentivity and high coercivity. For electromagnet, we prefer high saturated magnetism, low coercivity and least possible area of hysteris loop.
Therefore, X is suitable for making parmanent magnet and γ for making electromagnet.

Question 23

In a radioactive material the activity at time t_1, is A_1 and at a later time t_2, it is A_2. If the decay constant of the material is λ, then

Options:

A. $A_1 = A_2 e^{-\lambda(t_1 - t_2)}$

B. $A_1 = A_2 e^{\lambda(t_1 - t_2)}$

C. $A_1 = A_2 \left(\frac{t_2}{t_1}\right)$

D. $A_1 = A_2$

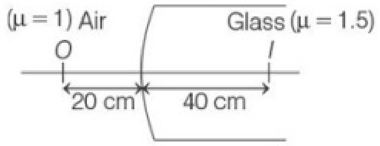
Answer: A

Solution:

Solution:
From radioactive decay law,
$-\frac{dN}{dt} \propto N$ or $-\frac{dN}{dt} = \lambda N$
Thus, $A = -\frac{dN}{dt}$ or $A = \lambda N$
$\Rightarrow A = \lambda N_0 e^{-\lambda t}$ ....(i)
Where, $A_0 = \lambda N_0$ is the activity of the radioactive material at time, $t = 0$
At time, $t_1 \ldots\ldots A_1 = A_0 e^{-\lambda t_1}$. . (ii)
At time, $t_2 \ldots\ldots A_2 = A_0 e^{-\lambda t_2}$....... (iii)
On didviding Eq. (ii) by Eq. (iii), we have
$\frac{A_1}{A_2} = \frac{e^{-\lambda t_1}}{e^{-\lambda t_2}} = e^{-\lambda(t_1 - t_2)}$
$\Rightarrow A_1 = A_2 e^{-\lambda(t_1 - t_2)}$

Question 24

A mosquito O is sitting infront of a glass rod having spherical end of radius of curvature 40 cm. The image would be formed at



Options:

A. 40 cm left

B. infinity

C. 20 cm to the right

D. 15 cm to the left

Answer: A

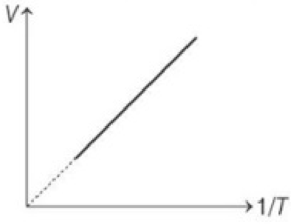
Solution:

Solution:
As, we know, $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$
$\Rightarrow \frac{1.5}{v} = \frac{1}{(-20)} = \frac{1.5 - 1}{+40}$
$\Rightarrow v = -40\text{cm}$

Negative sign shows that image is obtained on the same side of object i.e., towards left.

Question 25

One mole of an ideal diatomic gas undergoes a process as shown in the figure. The molar specific heat of the gas in the process is



Options:

A. $\frac{3R}{2}$

B. $\frac{R}{2}$

C. $\frac{5R}{2}$

D. $\frac{7R}{2}$

Answer: A

Solution:

Solution:

In the curve, $V \propto \frac{1}{T}$

$\Rightarrow V = m\frac{1}{T}$ where, $m =$ slope of curve.

$\Rightarrow VT =$ constant

$\therefore TdV + VdT = 0 \ldots\ldots\ldots (i)$

$\Rightarrow dV = -\frac{V}{T}dT$

As, $Q = \Delta U + W$

$CdT = C_V dT + pdV \ldots\ldots (ii)$

$CdT = C_V dT - \frac{p}{T}VdT$

$\Rightarrow C = C_V - p\frac{V}{T}$

$= C_V - R\left(\because p\frac{V}{T} = R\right)$

For diatomic gas, $C_V = \frac{5}{2}R$

$\therefore C = C_V - R = \frac{5}{2}R - R = 3\frac{R}{2}$

Question 26

A capillary tube is attached horizontally to a constant heat arrangement. If the radius of the capillary tube is increased by 25%, then the rate of flow of liquid will change nearly by

Options:

A. 100%

B. 112%

C. 124%

D. 144%

Answer: D

Solution:

Solution:
Liquid volume coming out of the tube per second

$V = \frac{p\pi r^4}{8\eta l}$

$\Rightarrow V \,\alpha r^4$

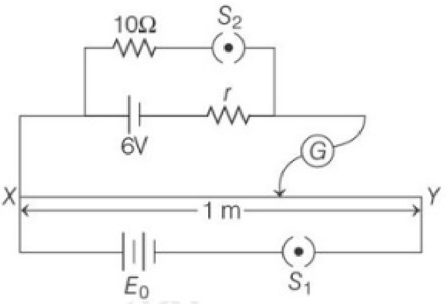
$\Rightarrow V_2 V_1 = \left[\frac{r_2}{r_1}\right]^4 \Rightarrow V_2 = V_1\left[\frac{125}{100}\right]^4 = V_1\left(\frac{5}{4}\right)^4$

$\Rightarrow V_2 = V_1(244)$

so, now $\frac{\Delta V}{V} = \frac{V_2 - V_1}{V_1} = \frac{(244)V_1 - V_1}{v_1} = 144\%$

Question 27

In the arrangement shown in figure, when the switch S_2 is open, the galvanometer, shows no deflection for $l = 50\,cm$ when the switch S_2 is closed, the galvanometer shows no deflection for $l = 0.416m$. The internal resistance (r) of 6V cell is



Options:

A. 2Ω

B. 3Ω

C. 5Ω

D. 9Ω

Answer: A

Solution:

Solution:

When S_2 open.
Assume resistance of $X\gamma = R$
Resistance of wire per unit length, $x = \frac{R}{L} = R\Omega m^{-1}$
$\because I = \frac{E_0}{R}$
Now, the potential drop across 50 cm length is $6V$, so
$\frac{E_0}{R} \times R \times \frac{50}{100} = 6$
$\Rightarrow E_0 = 12V$
When S_2 closed, potential drop across $0.416cm$ length,
$V_1 = \frac{E_0}{R} \times R \times 0.416 = 12 \times 12 \times 0.416 \approx 5V$
Hence, $E - Ir = 5V$
$\Rightarrow 6 - Ir = 5$
$\because I = \frac{5}{10}$
$\therefore 6 - 5 = \frac{5}{10} r$
$\Rightarrow r = 2\Omega$

Question 28

In a young's double slit arrangement frings are produced using light of wavelength 4000Å. One slit is covered by a thin plate of glass of refractive index 1.4 and the other with another glass plate of same thickness but of refractive index 1.7. By doing so the central bright shifts to original sixth fringe from Centre. Thickness of glass plate is

Options:

A. $2\mu m$

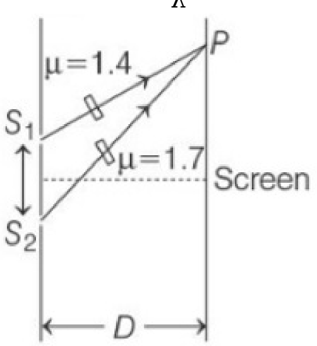
B. $8\mu m$

C. $11\mu m$

D. $16\mu m$

Answer: B

Solution:

Solution:
As, shift $\Delta x = \frac{\beta}{\lambda}(\mu - 1)t$


Shift due to one plate $\Delta x_1(\mu_1 - 1)t$
Shift due to another path $\Delta x_2 = \frac{\beta}{\lambda}(\mu_2 - 1)t$

Net shift $\Delta x = \Delta x_2 - \Delta x_1 = \frac{\beta}{\lambda}(\mu_2 - \mu_1)t \ldots\ldots (i)$

Also, it is given that $\Delta x = 6\beta$

Hence, $6\beta = \frac{\beta}{\lambda}(\mu_1 - \mu_2)t$

$\Rightarrow t = 6\frac{\lambda}{(\mu_1 - \mu_2)} = 6 \times \frac{4000}{(1.7 - 1.4)} - 80000Å$

$\Rightarrow t = 8 \times 10^{-6} = 8\mu m$

Question 29

An electric current I enters and leaves a uniform circular wire of radius r through diametrically opposite points. A charged particle q moves along the axis of circular wire passes through its centre at speed v. The magnetic force on the particle when it passes through the centre has a magnitud

Options:

A. $\frac{qv\mu_0 I}{2\pi r}$

B. $qv\frac{\mu_o I}{\pi r}$

C. $\frac{qv\mu_0 I}{r}$

D. 0

Answer: D

Solution:

Solution:

Force on a moving charged particle in uniform magnetic field

$F = Bqv\sin\theta \ldots\ldots (i)$

Since, charge particle moves along the axis odf circular current carrying loop, therefore, $\theta = 0°$ or $180°$

When $\theta = 0°$; $f = Bqv\sin 0°$

$F = 0$

When $\theta = 180°$, $f = Bqv\sin 180°$

$F = 0$

Question 30

An achromatic convergent doublet of two lenses in contact has a power of +5D. The power of converging lens is +6D. The ratio of the dispersive power of the convergent and divergent lenses is

Options:

A. 3 : 7

B. 2 : 3

C. 1 : 5

D. 5 : 3

Answer: C

Solution:

Solution:

The condition of achromatism is $W_1P_1 + W_2P_2 = 0$

$\Rightarrow W_1P_1 = -W_2P_2$

$\Rightarrow \frac{W_1}{W_2} = \frac{P_2}{P_1} \ldots\ldots\ldots (i)$

Now, $P_1 + P_2 = 4D \ldots\ldots\ldots (ii)$

but, Power of converting lens,

$P_1 = 5D$

$\because$ Power of diverging lens

$P_2 = 4D - P_1$ [From ii]

$= 4D - 5D = -D$

$\therefore$ From Eq. (i), we have

$\frac{W_1}{W_2} = \frac{P_2}{P_1} = \frac{-(-D)}{5D} = \frac{1}{5} \Rightarrow \frac{W_1}{W_2} = \frac{1}{5}$
