JEE-Main-27-07-2022-Shift-2 (Memory Based)

Physics

Question: A proton is accelerated in cyclotron of radius of D as 60cm and magnetic field as 1 T.... Find kinetic energy of the proton

Options:

(a) 4.88×10^{-12} J = Mev

(b) 2.88×10^{-12} J = Mev

(c) 1.88×10^{-12} J = Mev

(d) 3.88×10^{-12} J = Mev

Answer: (b)

Solution:

$$k = \frac{B^2 q^2 R^2}{2m}$$

$$= \frac{1\left(1.6\times10^{-19}\right)^2\left(60\times10^{-2}\right)^2}{2\left(1.67\times10^{-27}\right)}$$

$$= 2.88\times10^{-12} J$$

Question: Base current changes from 20 μA to 25 μA and collector current changes from 4 mA to 6 mA current gain in common emitter transistor is

Options:

(a) 400

(b) 200

(c) 100

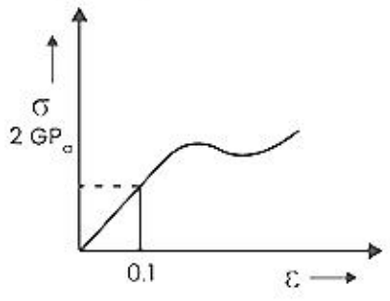
(d) 300

Answer: (a)

Solution:

$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2mA}{5\mu A} = 400$$

Question: Following is the graph between longitudinal stress and strain for a wire, find value of young's modulus of elasticity for this wire



Options:

(a) 40 GP_a

(b) 30 GP_a
(c) 20 GP_a
(d) 10 GP_a
Answer: (c)
Solution:

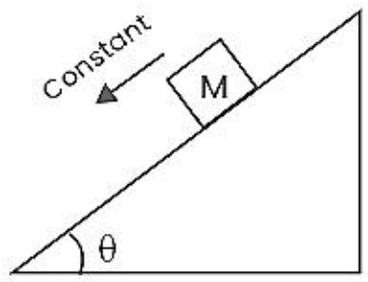
$$\gamma = \frac{\sigma}{6} = \frac{2\times10^9}{0.1} = 20GP_a$$

Question: The activity of radioactive material be 6.4 x 10^{-4} Curie. Its half life is 5 days, then the activity will be 5 x 10^{-6} Curie after.
Options:
(a) 7 days
(b) 15 days
(c) 25 days
(d) 21 days
Answer: (d)
Solution:

$$A = A_0\left(\frac{1}{2}\right)^{t/T_1/2} \Rightarrow 5\times10^{-6} = 64\times10^{-5}\left(\frac{1}{2}\right)^{t/3}$$

$$\frac{1}{128} = \left(\frac{1}{2}\right)^{t/3} \Rightarrow t = 21\,\text{days}$$

Question: A Block slides down cm a rough inclined plane with constant velocity. Find constant force.



Options:
(a) mg/2
(b) 2mg
(c) mg
(d) mg/3
Answer: (c)
Solution:

$\mu mg\cos\theta = mg\sin\theta$

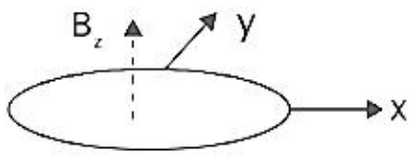
$\therefore$ Total force on plank

$= mg\sin\theta\left(\text{along the incline}\right)$

$mg\cos\theta^{+}\left(\perp\text{to incline}\right)$

= mg (resultant)

Question: $\overline{B} = 3t^3\hat{j} - 3t^2\hat{k}$ for a ring, in xy plane. Find EMF induced at t = 2 s?



Options:

(a) 10 A

(b) 12 A

(c) 14 A

(d) 16 A

Answer: (b)

Solution:

$\phi = B_z.A_x r$

$= -3t^2 A$

$\varepsilon = -\dfrac{d\phi}{dt}$

$= +3A.2t$

$= 6At$

$\varepsilon_2 = 6A(2)$

$\therefore \varepsilon_2 = 12 \rightarrow$ assumed

Question: In an LRC AC circuit, the frequency of voltage source is 60 % of resonance frequency. Find current in this circuit. L = 0.01 H, R = 10 Ω , C = 1 μF. Voltage rms value is 50

Options:

(a) 0.67 A

(b) 0.47 A

(c) 0.37 A

(d) 0.57 A

Answer: (b)

Solution:

$f_r = \dfrac{1}{2\pi\sqrt{LC}} = \dfrac{1}{2\pi\sqrt{0.01\times10^{-6}}}$

$f_r = \dfrac{10000}{2\pi} = 1592H_g$

So, $(2\pi f.L) = 60, x_c = \dfrac{1}{2\pi fc} = 166$

$so\, i = \dfrac{v}{\sqrt{R^2 + (x_i - x_c)^2}} = \dfrac{50}{106} = 0.47\,\text{A}$

Question: how charge 4 μc should be split in two parts so that when kept at a fixed distance, force between them is maximum

Options:

(a) 3μC, 2μC

(b) 2μC, 2μC

(c) 1μC, 2μC

(d) 5μC, 2μC

Answer: (b)

Solution:

For maximum force, $\frac{dF}{dq}=0$

$$\therefore \frac{d}{dq}\left(\frac{kq(Q-q)}{r^2}\right)=0$$

$$\text{Or, } \frac{d}{dq}\left(qQ-q^2\right)=0$$

$$\text{Or, } Q-2q=0$$

$$\Rightarrow q=\frac{Q}{2}$$

Question: Which of the following statement is not true regarding photo electric effect

Options:

(a) Square of velocity depends on incident frequency linerly

(b) Existence of threshold frequency proves particle nature of light

(c) Increase in intensity changes the photocurrent

(d) Most of the energy in incident light is used in emission of photoelectron

Answer: (d)

Solution:

Most of the energy in incident light is used in emission of photoelectron

Question: If energy density is $\frac{\alpha}{\beta}\sin\left(\frac{\alpha x}{kT}\right)$ find the dimensions of β [k – Boltzmann constant, T – temperature, x is length]

Options:

(a) L^2

(b) L^3

(c) L^4

(d) L

Answer: (a)

Solution:

$$\frac{\alpha}{\beta}=\frac{\text{Energy}}{\text{Volume}}$$

Also, $\alpha x=KT$

$$\therefore \alpha = \frac{kT}{x} = \frac{\left[ML^2T^{-2}K^{-1}\right]\left[K\right]}{L}$$

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

$$\therefore \beta = \alpha \times \frac{L^3}{ML^2T^{-2}} = \left[MLT^{-2}\right]\frac{\left[L^3\right]}{\left[ML^2T^{-2}\right]}$$

$$= \left[L^2\right]$$

Question: A Carnot engine is operating between T_1 and T_2 temperature. Find ratio of the efficiency of this engine in the 2 cases:

Case 1: $T_1 = 300k, T_2 = 200k$

Case 2: $T_1 = 200k, T_2 = 100k$

Options:

(a) $\frac{1}{2}$

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

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

(d) $\frac{5}{3}$

Answer: (b)

Solution:

$$\eta_1 = 1 - \frac{T_2}{T_1} = 1 - \frac{200}{300} = \frac{1}{3}$$

$$\eta_2 = 1 - \frac{T_2}{T_1} = 1 - \frac{100}{200} = \frac{1}{2}$$

$$\frac{\eta_1}{\eta_2} = \frac{\frac{1}{3}}{\frac{1}{2}} = \frac{2}{3}$$

Question: If $A_m = 1$ and $A_c = 5$. Find modulation index?

Options:

(a) 0.2

(b) 0.3

(c) 0.4

(d) 0.5

Answer: (a)

Solution:

$$m = \frac{A_m}{A_c} = \frac{1}{5} = 0.2$$

Question: The time taken by a particle at rest to reach down a smooth inclined plane inclined at $30°$ is 2 sec. Find time taken by the particle to travel same distance down the inclined plane at angle of $45°$.

Options:

(a) $\sqrt{2}$

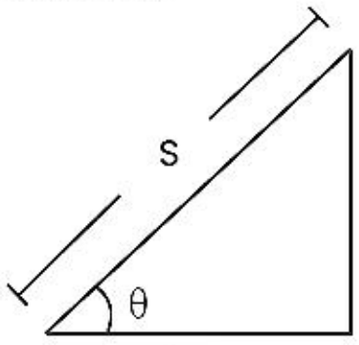
(b) $\sqrt{2\sqrt{2}}$

(c) $\sqrt{3}$

(d) $2\sqrt{2}$

Answer: (b)

Solution:



$$s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}g\sin\theta t^2$$

And $s_1 = s_2$

$$\frac{1}{2}g\sin 30(2)^2 = \frac{1}{2}g\sin 45°t^2$$

$$t^2 = \frac{(2)^2}{\sqrt{2}} = \sqrt{2\sqrt{2}}$$

Question: The speed of bullet becomes $\frac{1}{3}$ of initial speed after penetrating 2cm. If it starts at $4 + xcm$ find x?

Options:

(a) 0.1 cm

(b) 0.2 cm

(c) 0.3 cm

(d) 0.5 cm

Answer: (d)

Solution:

$$\frac{v^2}{9} = v^2 - 2a(4)$$

$$2a(9) = v^2\left(1-\frac{1}{9}\right) = v^2 \times \frac{8}{9}$$

$$2a = v^2\frac{2}{9}$$

Now, $0 = v^2 - 2a(s)$

$$v^2 = v^2 \times \frac{2}{9}s$$

$$s = \frac{9}{2} = 4.5cm$$

$$\therefore 4 + x = 4.5$$

$$\therefore x = 0.5cm$$

Question: Time taken for the particle to reach from point A to C is $l\left[1+\sqrt{2}\right]$ find value of t.

Assume all surfaces smooth. Velocity at A is just enough to reach B.

Options:

(a) $\sqrt{2}$

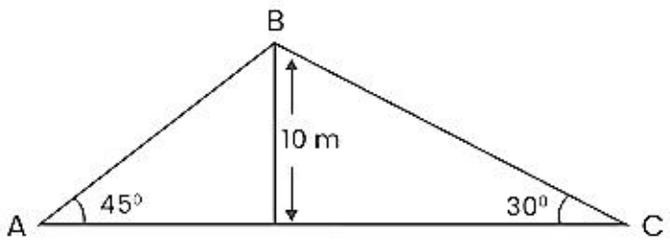
(b) $\left(1+\sqrt{2}\right)$

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

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

Answer: (d)

Solution:



$A \to B$

$$\frac{1}{2}mu^2 = mgh$$

$$\Rightarrow u = \sqrt{2gh} = 10\sqrt{2}$$

So, $v = u + at \Rightarrow 0 = 10\sqrt{2} - \frac{10}{\sqrt{2}}.t$

$t = 2\sec$

$B \to C$

$$s = ut + \frac{1}{2}at^2 \Rightarrow \frac{10}{\sin 30^\circ} = 0 + \frac{1}{2}g\sin 30^\circ t^2$$

$$20 = \frac{5}{2}t^2 \Rightarrow t = \sqrt{8} = 2\sqrt{2}$$

So total time $= 2 + \sqrt{2} = 2\left(1+\sqrt{2}\right)$

Question: For n^{th} frequency $\rightarrow 400Hz$

$(n+1)^{th}$ frequency $\rightarrow 450Hz$

On a string of 30 cm fixed at both ends. T = 2700 N. Find μ ?

Options:

(a) 2 kg

(b) 3 kg

(c) 6 kg

(d) 8 kg

Answer: (b)

Solution:

$400 = nf_1$

$450 = (n+1) f_1$

$\therefore 450 = 400 + f_1$

$\therefore f_1 = 50Hz$

Now, $50 = \frac{1}{2 \times 0.3}\sqrt{\frac{2700}{\mu}}$

$(100 \times 0.3)^2 = \frac{2700}{\mu}$

$\therefore \mu = \frac{2700}{900}$

$\therefore \mu = 3kg / m$

Question: The drift speed of free electrons in a conductor does not depends upon:

Options:

(a) The material of the conductor

(b) The temperature of the conductor

(c) The potential difference applied across the ends of the conductor

(d) The area of cross section of the conductor

Answer: (d)

Solution:

The drift velocity is known to be primarily depends on the applied voltage and the molecular structure of the wire and hence the material of the conductor. Slight temperature depends is also observed.

Question: If in a meter bridge, area of cross section of wire is doubled, null point

Options:

(a) Increases

(b) Decreases

(c) Remains same

(d) None of these

Answer: (c)

Solution:

Null point will remain same as resistance of both sides will decrease in the same ratio.