# JEE-Main-28-07-2022-Shift-1 (Memory Based)

## Physics

**Question:** A rod of mass M and length L with current I is placed on an inclined plane with angle of inclination 45 degree. A magnetic field of B tesla is applied upwards on this rod such that it is equilibrium. Find current I in terms of M,L, and B:

**Options:**

(a) $i=\frac{mg}{BL}\sin\theta$

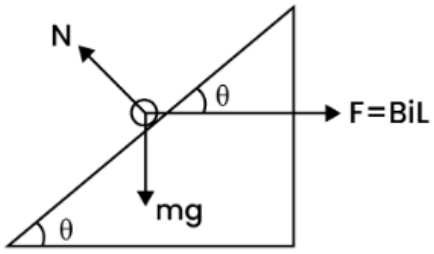
(b) $i=\frac{mg}{BL}\tan\theta$

(c) $i=\frac{BL}{mg}\tan\theta$

(d) $i=\frac{BL}{mg}\sin\theta$

**Answer:** (b)

**Solution:**




By lamrim's theorem

$$\frac{BiL}{\sin(90+90-\theta)}=\frac{mg}{\sin(90-\theta)}$$

$$\boxed{i=\frac{mg}{BL}\tan\theta}$$

**Question:** If the projection of vector $\vec{A}=2\hat{i}+4\hat{j}-2\hat{k}$ on $\vec{B}=\hat{i}+2\hat{j}+\alpha\hat{t}$ is equal to zero. Find the value of 'α'.

**Options:**

(a) $\alpha=5$

(b) $\alpha=4$

(c) $\alpha=6$

(d) $\alpha=2$

**Answer:** (a)

**Solution:**

If the projection of a vector is zero on another it means they are $\perp$ to each other.

$\Rightarrow A.B = 0$

$\Rightarrow 2+8-2\alpha = 0$

solving $\alpha = 5$

**Question:** Find ratio of torque if dipole moment 'p' is placed in electric field of strength 1.5 x $10^{-24}$ N/c and 4.5 x $10^{-24}$ N/c respectively.

**Options:**

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

(b) $\frac{1}{6}$

(c) $\frac{1}{4}$

(d) $\frac{1}{3}$

**Answer:** (d)

**Solution:**

$\frac{1}{3} = \frac{\tau_1}{\tau_2}$

$\tau_{MAX} = PE$

$\frac{\tau_1}{\tau_2} = \frac{PE_1}{PE_2} = \frac{1.5\times10^{-24}}{4.5\times10^{-24}} = \frac{1}{3}$

**Question:** In case of amplitude modulation to avoid distortion, the modulation index (μ) should be

**Options:**

(a) $\mu \le 1$

(b) $\mu > 1$

(c) $\mu = 2$

(d) $\mu = 0$

**Answer:** (a)

**Solution:**

Modulation index is defined as the ratio of the amplitude of the modulation wave and the amplitude of the carrier wave for avoiding distortion.

$\mu = \frac{A_m}{A_c}$

$A_c > A_m \therefore \mu \le 1$

**Question:** A carnot engine has efficiency 50%. If the temperature of sink is reduced by 40°C its efficiency increases by 30% the temperature of source is?

**Options:**

(a) 166.67°K

(b) 466.67°K

(c) 266.67°K

(d) 366.67°K

**Answer:** (c)

**Solution:**

Initial efficiency = 0.5

Initial efficiency $= \frac{0.5 \times 30}{100} + 0.5 = 0.65$

So A to D

$0.5 = 1 - \frac{T_C}{T_H} \ldots (1)$

$0.65 = 1 - \frac{T_C - 40}{T_H}$

$0.65 = \left(1 - \frac{T_C}{T_H}\right) + \frac{40}{T_H}$

$0.15 = \frac{40}{T_H} \Rightarrow T_H = 266.67k$

**Question:** What r dimensions of $B^2/\mu_0$

**Options:**

(a) $\left[M^{-1}L^{1}T^{-2}\right]$

(b) $\left[M^{1}L^{-1}T^{-2}\right]$

(c) $\left[M^{1}L^{1}T^{-2}\right]$

(d) $\left[M^{-1}L^{-1}T^{2}\right]$

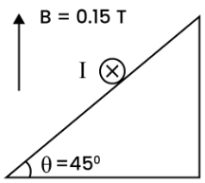
**Answer:** (b)

**Solution:**

Dimension of $\frac{B^2}{\mu_0} = \frac{\left[MT^{-2}I^{-1}\right]^2}{\left[MLT^{-2}I^{-2}\right]}$

$= M^{1}L^{-1}T^{-2}$

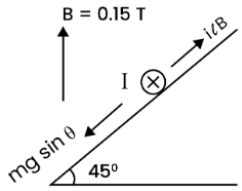
**Question:** A wire of linear density r = 0.45 kg $m^{-1}$ is in equilibrium on incline as thrown




Find current in wire.

**Options:**

(a) 10 A
(b) 30 A
(c) 20 A
(d) 40 A
**Answer:** (b)
**Solution:**




According to diagram

$ilB\sin\theta = d\lg\sin\theta$

$(\theta = 45°)$

$$i = \frac{dg}{B}$$

$$i = \frac{0.45\times 10}{0.15}$$

$$i = 30A$$

**Question:** Two identical capacitors having capacity 40μF are connected in series. If dielectric of dielectric constant K is inserted in one of man the net capacity becomes 24μF. Find K.
**Options:**
(a) 3.5
(b) 2.5
(c) 1.5
(d) 5.5
**Answer:** (c)
**Solution:**
If capacitors are connected n series the

$$C_{eq} = \frac{C_1C_2}{C_1 + C_2}$$

$$24 = \frac{40\times 40k}{(40+40k)}$$

$$960 + 960k = 1600k$$

$$(1600 - 960)k = 96°$$

$$k = \frac{960}{640}$$

k = 1.5

**Question:** Radioactive sample is 64 time more hazardous than permissible value. Half life of the sample is 2hrs 30 mins. After how many hours it will be safe to operation in the laboratory?

**Options:**

(a) 10 hrs

(b) 15 hrs

(c) 9 hrs

(d) 7 hrs

**Answer:** (b)

**Solution:**

We know

$$N = N_0\left(\frac{1}{2}\right)^n$$

$$N_0 = 64N_0\left(\frac{1}{2}\right)^n$$

$$\left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^6$$

$$\boxed{n = 6}$$

We know

$$n = \frac{6}{68/2} = 6$$

$$n = \frac{t}{2.5} = 6$$

$$t = 15\,\text{hr}$$

**Question:** In medium with relative permittivity 1 and relative permeability 4, the speed of light is

**Options:**

(a) 1.5 x $10^8$ m/s

(b) 4.5 x $10^8$ m/s

(c) 5.5 x $10^8$ m/s

(d) 3.5 x $10^8$ m/s

**Answer:** (a)

**Solution:**

$$\mu = \sqrt{\varepsilon_r \mu_r} = \sqrt{1\times 4} = 2$$

$$\Rightarrow v = \frac{c}{\mu} = \frac{3\times 10^8}{2}$$

$$= 1.5\times 10^8\, m/s$$

**Question:** Find speed of the wave which is represented by equation $y=-5\sin\frac{2\pi}{\lambda}(400t-x)$ where x and y are in meters t is seconds

**Options:**

(a) 800 m/s

(b) 400 m/s

(c) 80 m/s

(d) 1200 m/s

**Answer:** (b)

**Solution:**

$$y=-5\sin\left(\frac{800\pi}{\lambda}t-\frac{2\pi}{\lambda}x\right)$$

Comparing with $y=A\sin(\omega t-kx)$

$$\omega=\frac{800\pi}{\lambda}$$

$$k=\frac{2\pi}{\lambda}$$

$$V=\frac{\omega}{k}=\frac{800\pi/\lambda}{2\pi/\lambda}$$

$$V=400m/s$$

**Question:** Find percentage change in 'g'. If radius of earth shrinks by 2%,mass remains constant

**Options:**

(a) 2

(b) 3

(c) 4

(d) 5

**Answer:** (c)

**Solution:**

G increased by 4%

$$g=\frac{GM_e}{R_e^2}$$

$$\frac{dg}{g}=\frac{GM_e}{\frac{GM_e}{R_e^2}\frac{(x)}{R_e^3}dR_e}$$

$$\frac{dg}{g}=-2\frac{dR_e}{R_e}=-2(.02)=+0.4$$

$$\frac{dg}{g}\times100=4$$

**Question:** In a purely inductive AC circuit, the equation of current is given as

$i = i_0 \sin\left(\omega t - \frac{\pi}{6}\right)$

The equation of voltage is going to be:

**Options:**

(a) $i_0 \omega L \sin\left(\omega t + \frac{\pi}{3}\right)$

(b) $i_0 \omega L \sin\left(\omega t - \frac{\pi}{3}\right)$

(c) $i_0 L \sin\left(\omega t + \frac{\pi}{3}\right)$

(d) $i_0 \omega L \, \mathrm{s}\cos\left(\omega t + \frac{\pi}{3}\right)$

**Answer:** (a)

**Solution:**

Voltage leads current by $\frac{\pi}{2}$

So phase of voltage $= \left(\omega t - \frac{\pi}{6} + \frac{\pi}{2}\right)$

$V_0 = i_0 Z = i_0 \omega L$

So, $V = i_0 \omega L \sin\left(\omega t + \frac{\pi}{3}\right)$

**Question:** Find ratio of maximum torque on dipole placed in electric field.

Given $\frac{P_1}{P_2} = 2$

$E_1 = 4.5 \times 10^{-24} N/C$ and $E_2 = 1.5 \times 10^{-24} N/C$

**Options:**

(a) 2

(b) 5

(c) 8

(d) 6

**Answer:** (d)

**Solution:**

$\tau_{MX} = \rho E$

$\frac{\tau_1}{\tau_2} = \frac{P_1 E_1}{P_2 E_2} = \frac{2 \times 4.5 \times 10^{-24}}{1.5 \times 10^{-24}} = 6$

**Question:** Force required to stretch a wire of cross-section area $1cm^2$ to double its length shall be: (Given Young's modulus of wire $2\times10^{11}$ Pascal. (Assuming no significant change in area)

**Options:**

(a) 10M pascal

(b) 20M Pascal

(c) 30M Pascal

(d) 40M Pascal

**Answer:** (b)

**Solution:**

$$\frac{FL}{AY}=\Delta L$$

To double the length $\Delta L = L$

$$\frac{FL}{AY}=L \Rightarrow F = A.Y$$

$$F=\left(1\times10^{-4}m^2\right)\times\left(2\times10^{11}Pa\right)$$

$$=2\times10^{7}Pa$$

$$=20\text{M Pascal}$$

**Question:** A monkey sitting on a large tree of height 19.6m drops a mango from its hands. Below on the road soldiers are marching at a speed of 9 km/h. Find the current distance of soldier from the tree who will be able to catch the mango. (Ignore the height of soldier)

**Options:**

(a) 5 m

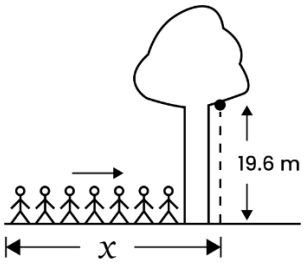
(b) 15 m

(c) 20 m

(d) 25 m

**Answer:** (a)

**Solution:**




Speed of soldiers $9\times\frac{5}{18}=2.5m/s$

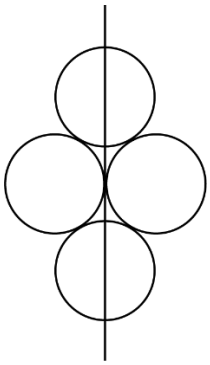
Time taken by mango to reach ground $=\sqrt{\frac{2h}{g}}$

$t = \sqrt{\frac{2\times 19.6}{9.8}} = 28$

Hence, distance of soldier $x = v \times t$

$x = 2.5 \times 2 = 5m$

**Question:** 4 Identical discs are placed as shown. If MOI is $\frac{x}{4}ma^2$. Find X (a = Diameter.)



**Options:**

(a) 4

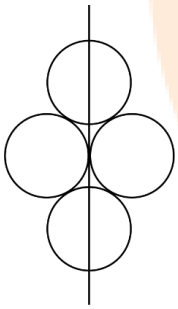
(b) 6

(c) 10

(d) 12

**Answer:** (d)

**Solution:**



Radius of each disc is a.

So net $MOI = \left(\frac{Ma^2}{4}\right)\times 2 + \left(\frac{Ma^2}{4} + Va^2\right)\times 2$

Net $MOI = \frac{Ma^2}{2} + \frac{5Ma^2}{2}$

$= \frac{6Ma^2}{2}$

$= 3Ma^2$

Hence after comparing it with $\frac{x}{4}\mu a^2, X$ will be 12.

**Question:** Radioactive sample is 64 time more hazardous than permissible value. Half life of the sample is 30 days. After how many days it will be same to operate in the laboratory?

**Options:**

(a) 90 days

(b) 120 days

(c) 180 days

(d) 365 days

**Answer:** (c)

**Solution:**

We know $N = N_0\left(\frac{1}{2}\right)^n$

$N_0 = 64N_0\left(\frac{1}{2}\right)^n$

$\left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^6$

$\boxed{n = 6}$

We know $n = \frac{t}{\frac{t_1}{2}} = 6$

$t = 6 \times 30\, days$

$t = 180\, days$

**Question: Assertion:** Average momentum of atoms depend on temperature.

**Reason:** If temperature is doubled and $O_2$ breaks into 2 'O' atoms; then RMS of 'O' atoms is doubled.

**Options:**

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true, but the reason is not the correct explanation of the assertion.

(c) If assertion is false, but reason is True.

(d) If both the assertion and reason are false.

**Answer:** (c)

**Solution:**

Statement one is false because Average momentum is always zero. And it does not depend on any other physical parameters as well as the molecules are moving randomly.

And Statement 2 is correct because of the formula of rms speed

**Question:** An electron is accelerated from rest in potential $\Delta V$ then de Broglie wavelength is

**Options:**

(a) 13.27

(b) 13.50

(c) 16.15
(d) 12.27
**Answer:** (d)
**Solution:**

We know $\lambda = \frac{h}{P}$ or $\lambda = \frac{h}{\sqrt{2me\Delta V}}$

For $e^{-1}$ ($\lambda$ in $\mathring{A}$)

$\lambda = \frac{12.27}{\sqrt{\Delta V}}\mathring{A}$