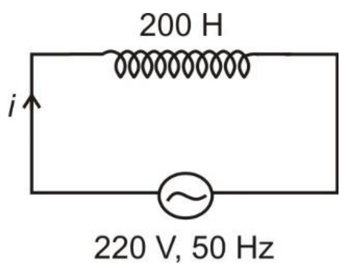
JUPITER ACADEMY

JEE Paper -2022

PHYSICS

1. Find I_{rms} in the following circuit



(1) 3.5 mA

(2) 35 mA

(3) 350 mA

(4) 3500 mA

Sol. Answer (1)

$$I_{rms} = \frac{V_{rms}}{z}$$

$$z = x_L = wL = 2\pi \times 50 \times 200$$

$$= 100 \times 200 \times \pi$$

$$x_L = 20000 \times \pi$$

$$\boxed{V_{rms} = 220 \text{ v}}$$

$$I_{rms} = \frac{220}{20000\pi} = 0.0035A = 3.5mA$$

2. A ball is thrown vertically upwards from a tower and reaches ground in 6 seconds. Another ball is thrown downwards with same position and with same speed reaches ground in 1.5 s. Time taken by the ball to reaches ground if dropped from same height is

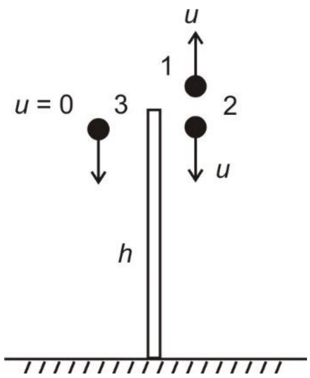
(1) 3 s

(2) 4 s

(3) 5 s

(4) 2 s

Sol. Answer (1)



$t_1 = 65, t_2 = 1.55$

$$h = -ut_1 + \frac{1}{2}gt_1^2 \text{ ....(1)}$$

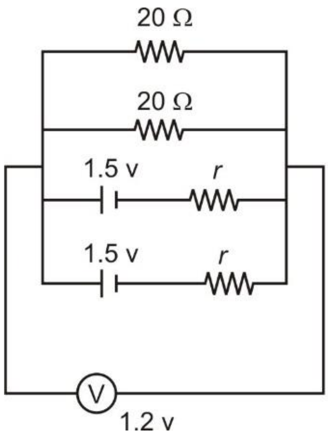
$$\text{and } h = ut_2 + \frac{1}{2}gt_2^2 \text{ ....(2)}$$

$$\text{and } h = \frac{1}{2}gt_3^2 \text{ ....(3)}$$

From (1) , (2) & (3) we get

$$t_3 = \sqrt{t_1 t_2} = \sqrt{6 \times 1.5} = 3 \text{ s}$$

3. For the circuit shown in figure, if voltmeter reads 1.2 V, then find the value of r



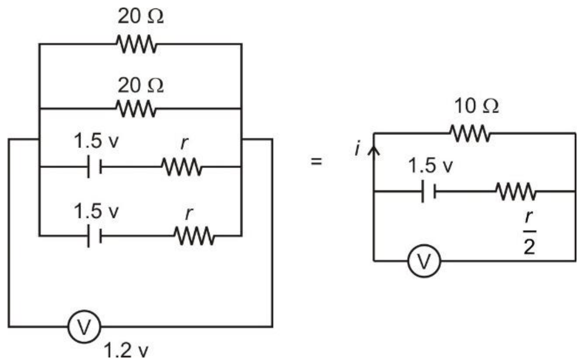
(1) 4Ω

(2) 5Ω

(3) 6Ω

(4) 8Ω

Sol. Answer (2)



$$i = \frac{1.5}{10+\frac{r}{2}} = \frac{3}{r+20}$$

But = v = 10i

$$\Rightarrow 1.2 = 10\left(\frac{3}{r+20}\right)$$

$$\Rightarrow r + 20 = \frac{300}{12} = 25$$

$$\Rightarrow r = 5\ \Omega$$

4. At height h above the earth surface, mass of the person becomes 1/3. Find height

(1) 4.68×10^6 m (2) 2.68×10^6 m

(3) 3.50×10^6 m (4) 4.20×10^6 m

Sol. Answer (1)

We have, $w_h = w\left(\frac{R}{h+R}\right)^2$

given $w_h = \frac{w}{3}$

$$\Rightarrow \frac{w}{3} = w\left(\frac{R}{h+R}\right)^2$$

$$\Rightarrow \sqrt{3}R = h + R$$

$$\Rightarrow h = (\sqrt{3}-1)R = 0.732 \times 6400$$

$$= 4684.8\text{ km}$$

$$= 4.68 \times 10^6\text{ m}$$

5. A projectile is projected with horizontal velocity 25 m/s. If the range of projectile is 75 m, then find the angle of projection of projectile

(1) $\theta = \tan^{-1}\left(\frac{4}{5}\right)$

(2) $\theta = \tan^{-1}\left(\frac{1}{2}\right)$

(3) $\theta = \tan^{-1}\left(\frac{3}{5}\right)$

(4) $\theta = \tan^{-1}(2)$

Sol. Answer (3)

Given $u_x = 25$ m/s, $\theta =$ angle of projection,

R = 75 m

We have, $R = u_x \times \frac{2u_y}{g}$

$$\Rightarrow u_y = \frac{75g}{2\times 25} = \frac{3g}{2}$$

$$\therefore \tan\theta = \frac{u_y}{u_x} = \frac{30}{2\times 25} = \frac{3}{5}$$

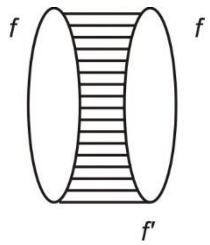
$$\theta = \tan^{-1}\left(\frac{3}{5}\right)$$

6. Find the effective focal length in the given combination. Two biconvex lens of focal length 10 cm and refractive index 1.5 are kept in contact with space between the index filled with a medium of refractive index 1.25

(1) $+\frac{10}{3}$cm (2) $+\frac{20}{3}$cm

(3) + 10 cm (4) + 20 cm

Sol. Answer (2)



Given $\mu = 1.5, f = 10\text{ cm}, \mu_l = 1.25$

$$\frac{1}{f} = (\mu - 1)\frac{2}{R}$$

$$\Rightarrow \frac{1}{10} = (1.5-1)\frac{2}{R}$$

$$\Rightarrow R = 10\text{ cm}$$

$$\therefore \frac{1}{f'} = (\mu_l - 1)\left(\frac{-2}{R}\right) = 0.25 \times \frac{-2}{10}$$

$$= -\frac{1}{20} \Rightarrow f' = -20\text{ cm}$$

We have, $\frac{1}{f_e} = \frac{1}{f} + \frac{1}{f'} + \frac{1}{f}$

$$= \frac{1}{10} - \frac{1}{20} + \frac{1}{10} = \frac{2-1+2}{20}$$

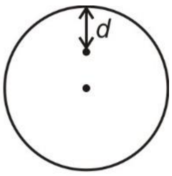
$$\Rightarrow f_e = \frac{20}{3} \text{ cm}$$

7. Find the depth below the surface of the earth where weight of an object is 1/3rd of its original weight. (R- Radius of the earth)

(1) $R/3$ (2) $2R/3$

(3) $R/2$ (4) $R/6$

Sol. Answer (2)



$$g_d = g_s\left(1 - \frac{d}{R}\right)$$

g_d = acceleration due to gravity at depth 'd'

g_s = acceleration due to gravity on surface

R = Radius of earth

As weight is 1/3rd of its original weigh (weight on the surface)

So, $\frac{1}{3}.\, g_s = g_s\left(1 - \frac{d}{R}\right)$

$$\Rightarrow \frac{1}{3} = 1 - \frac{d}{R}$$

$$\Rightarrow \frac{d}{R} = 1 - \frac{1}{3} = \frac{2}{3}$$

$$\Rightarrow \frac{d}{R} = \frac{2R}{3}$$

8. Two soap bubbles of radii 4 cm & 5 cm are placed in contact with each other. Radii of curvature of interface is

(1) 10 (2) 16

(3) 15 (4) 20

Sol. Answer (4)

Pressure difference at their common interface is,

$$= \frac{4T}{R_1} - \frac{4T}{R_2}$$

So, $\frac{4T}{R_{common}} = \frac{4T}{R_1} - \frac{4T}{R_2}$

$$\Rightarrow \frac{1}{R_{common}} = \frac{1}{R_1} - \frac{1}{R_2}$$

$$\Rightarrow \frac{1}{R_{com.}} = \frac{1}{4} - \frac{1}{5} = \frac{5-4}{20}$$

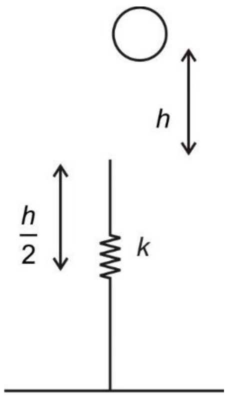
$$\Rightarrow R_{common} = 20 \text{ cm}$$

9. A ball dropped from height h falls on spring of spring constant, k. Ball sticks to the spring and came to rest when spring compressed by $\frac{h}{2}$, value of spring constant is

(1) $\frac{8\,mg}{h}$ (2) $\frac{6\,mg}{h}$

(3) $\frac{4\,mg}{h}$ (4) $\frac{12\,mg}{h}$

Sol. Answer (4)



Using work energy theorem between initial and final condition;

$$\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = w_{gravity} + w_{spring}$$

$$\Rightarrow 0 - 0 = mg\left(h + \frac{h}{2}\right) + \left(-\frac{1}{2}k\left(\frac{h}{2}\right)^2\right)$$

$$\Rightarrow \frac{1}{2}k\frac{h^2}{4} = \frac{3mgh}{2}$$

$$\Rightarrow h = \frac{12mg}{k}$$

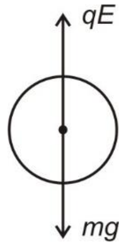
$$\Rightarrow k = \frac{12mg}{h}$$

10. If a charged ball of mass m = 0.1 g is held stationary by an electric field E = 2 ×10⁹ V/m. The charge on the ball is

(1) 5×10^{-9} C (2) 5×10^{-11} C

(3) 5×10^{-12} C (4) 5×10^{-13} C

Sol. Answer (4)



FBD of particle

For equilibrium;

$qE = mg$

$$\Rightarrow q = \frac{mg}{E} = \frac{0.1\times10^{-3}\times10}{2\times10^{9}} = \frac{10}{2}\times\frac{10^{-3}}{10^{9}\times10}$$

$q = 5\times10^{-13}$ C

11. The normal reaction N for a vehicle of 800 kg negotiating a turn on a 30° banked road at maximum possible speed is ____ × 10^3 kg m/s^2

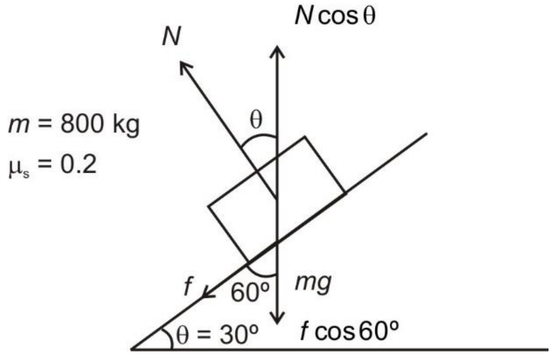
Given $\cos 30^\circ = \frac{\sqrt{3}}{2}$

$\mu_s = 0.2$

(1) 9.0 (2) 10.44

(3) 9.6 (4) 9.8

Sol. Answer (2)



As v is wax, friction is acting inwards

$f = \mu_s N$, for limiting case in vertical dissection

$N\cos\theta = mg + f\cos 60^\circ$

$\Rightarrow N\cos 30^\circ = mg + \mu_s N\cos 60^\circ$

$$\Rightarrow N\left[\frac{\sqrt{3}}{2} - 0.2x\frac{1}{2}\right] = 800\times10$$

$$\Rightarrow N = \frac{8000}{0.77} = 10.4\times10^{3}\text{ N}$$

12. Stopping potential for wavelength (λ) = 491 nm is 0.41 V. If wavelength is changed so that stopping potential becomes 1.02 V then wavelength of new wave is

(1) 4500 Å (2) 3955 Å

(3) 6000 Å (4) 4276 Å

Sol. Answer (2)

Using photoelectric equation:

$$\frac{hc}{\lambda} - \phi = ev_s$$

$$\boxed{hc = 12400\ ev\text{Å}}$$

(I) $\frac{12400}{4910} ev - \phi = e(0.41)\,v$

$\Rightarrow \phi = (2.52 - 0.41)\,ev = 2.11\,ev$

(II) $\frac{12400}{\lambda} - 2.11 = 1.02$

$$\Rightarrow \lambda = \frac{12400}{3.13} = 3961\text{ Å}$$

$\lambda = 3961$ Å

13. Efficiency of carnol engine was 25% at 27ºC. so what will be the increase in temperature required to increase its efficiency by 100%

(1) 150º C (2) 300º C

(3) 200º C (4) 400º C

Sol. Answer (3)

Given $x_1 = 25\% = 0.25, T_2 = 300K$

$x_2 = 2x_1 = 0.5$

We have, $x = 1 - \frac{T_2}{T_1} \Rightarrow \frac{1}{4} = 1 - \frac{300}{T_1}$

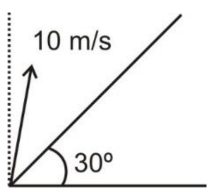
$$\Rightarrow \frac{3}{4} = \frac{300}{T_1} \Rightarrow T_1 = 400K$$

And in 2nd case, $x_2 = 1 - \frac{T_2}{T_1}$

$$\Rightarrow \frac{1}{2} = 1 - \frac{300}{T_1'} \Rightarrow T_1' = 600K$$

$\therefore$ increase of temperature = $T_1' - T_1 = 200K$

14. A projectile is projected with speed 10 m/s for maximum range on incline plane of angle of inclination 30º. The maximum range of projectile is

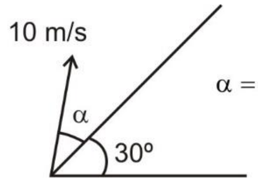


(1) $\frac{40}{3}$m (2) $\frac{10}{3}$m

(3) $\frac{20}{3}$m (4) 5 m

Sol. Answer (3)

Maximum range of projectile on an incline



$$\alpha = \frac{\pi}{4} - \frac{\theta}{2}$$

$$R_{max} = \frac{u^2}{g(1+\sin\theta)}$$

$$= \frac{10^2}{10\left(1+\frac{1}{2}\right)} = \frac{10\times 2}{3} = \frac{20}{3}\text{ m}$$

15. If a block is displaced from (1, 2) to (2, 3) on applying a force $\vec{F} = 4x^2\hat{i} + 3y^2\hat{j}$, find the change in kinetic energy

(1) 50.55 (2) 60.55

(3) 28.33 (4) 68.67

Sol. Answer (3)

$$\vec{F} = 4x^2\hat{i} + 3y^2\hat{j}$$

Block is displaced from (1, 2) to (2, 3)

Δ K.E. = Work done

So, $w = \int \vec{F}.d\vec{r}$

$$= \int 4x^2dx + 3y^2dy$$

$$= \int_1^2 4x^2dx + \int_2^3 3y^2dy$$

$$= \frac{4}{3}\left[(x)^3\right]_1^2 + \frac{3}{3}\left[(y)^3\right]_2^3$$

$$= \frac{4}{3}(8-1) + 1(27-8)$$

W = $\frac{28}{3} + 19 = 28.33$ joule

16. If $B = 10^9$ Nm^{-2} fractional charge in volume is 2%. Find volumetric stress required

(1) 1×10^7 Pa

(2) 2×10^7 Pa

(3) 3×10^7 Pa

(4) 4×10^7 Pa

Sol. Answer (2)

Given, $\frac{\Delta v}{v} = \frac{2}{100}$ and $B = 10^9$ Pa

We have, $B = \frac{\text{stress}}{\text{strain}} \Rightarrow \text{stress} = B\times\text{strain}$

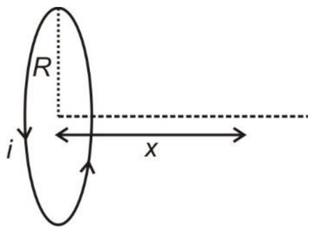
$$= 10^9 \times \frac{2}{100} = 2\times10^7 \text{ Pascal}$$

17. If at the centre of circular current carrying wire magnetic field is B_0, then magnetic field at distance $r/2$ from the axis of coil from centre is

(1) $\frac{2B_0}{\sqrt{5}}$ (2) $\frac{4B_0}{5\sqrt{2}}$

(3) $\frac{8B_0}{5\sqrt{5}}$ (4) $\frac{4B_0}{5\sqrt{5}}$

Sol. Answer (3)



$$B_{centre} = \frac{\mu_0 i}{2R} = B_0$$

$$B_{axis} = \frac{\mu_0}{4\pi}\frac{2\left(i\pi R^2\right)}{(R^2+x^2)^{3/2}}$$

$$B_{axis\left(x=\frac{R}{2}\right)} = \frac{\mu_0}{4\pi}\frac{2\left(i\pi R^2\right)}{\left(R^2+\left(\frac{R}{2}\right)^2\right)^{3/2}}$$

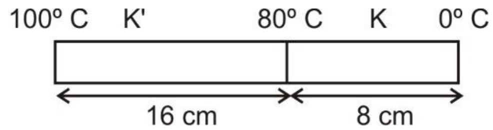
$$= \frac{\mu_0}{2\pi}\frac{i\pi R^2}{\left(\frac{5R^2}{4}\right)^{3/2}}$$

$$= \frac{\mu_0 i R^2}{2\frac{5\sqrt{5}}{8}R^3}$$

$$= \frac{\mu_0 i}{2R}\left(\frac{8}{5\sqrt{5}}\right)$$

$$B_{axis\left(x=\frac{R}{2}\right)} = B_0\left(\frac{8}{5\sqrt{5}}\right)$$

18. In the given figure, if the temperature of interface is 80ºC, then value of K' is

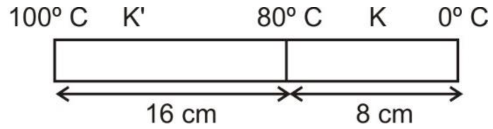


(1) 16K (2) 4K

(3) $8K$ (4) $12K$

Sol. Answer (3)

Since rods are connected in series heat current will be same



$$\frac{Q}{t}=\frac{K'A(100-80)}{16\times10^{-2}}=\frac{KA(80-0)}{8\times10^{-2}}$$

$$\Rightarrow\frac{K'\times20}{2}=K\times80$$

$$K'=8K$$

19. A liquid drop having mass m is in equilibrium in air. Electric field E is present in vertically upward direction. Find charge on drop.

(1) mg/E

(2) 2 mg/E

(3) 2 mg/4E

(4) Zero

Sol. Answer (1)

For equilibrium

$$qE=mg$$

$$q=\frac{mg}{E}$$

20. Equation two waves are given by

y = 5 sin (wt – kx)

y = 3 sin (wt – kx + 1.57)

Find resultant amplitude

(1) 8

(2) 2

(3) 4

(4) $\sqrt{34}$

Sol. Answer (4)

$$y_1=5\sin(wt-kx)$$

$$y_2=3\sin(wt-kx+1.57)$$

$$=3\sin\left(wt-kx+\frac{\pi}{2}\right)$$

Phase difference $(\Delta\phi)=\frac{\pi}{2}$

So, Area = $\sqrt{A_1^2+A_2^2+2A_1A_2\cos(\Delta\phi)}$

$$=\sqrt{(5)^2+(3)^2+2\times5\times3\times\cos\frac{\pi}{2}}$$

= $\sqrt{34}$ unit

21. If frequency of light is double of its threshold frequency its velocity is v_1 and if frequency is five time the threshold frequency its velocity is v_2, $v_2 = xv_1$. Find the value of x

(1) 1 (2) 2

(3) 3 (4) 4

Sol. Answer (2)

Using photoelectric equation;

$$hf-\phi=\frac{1}{2}mv_{\max}^2$$

(I) $h(2f_0)-hf_0=\frac{1}{2}mv_1^2$ ....(1)

(II) $h(5f_0)-hf_0=\frac{1}{2}mv_2^2$ ....(2)

Dividing (1)/(2)

$$\frac{hf_0}{4f_0}=\frac{v_1^2}{v_2^2}$$

$$\Rightarrow\boxed{v_2=2v_1}$$

So, $\boxed{x=2}$

22. In a given AC circuit which has maximum voltage V, and frequency 50 Hz . Find the time instant where the current in the circuit will be equal to its rms value

(1) 2 ms (2) 2.5 ms

(3) 3 ms (4) 3.5 ms

Sol. Answer (2)

Let $\mathrm{I}=\mathrm{I}_0\sin\omega t$

$$\mathrm{I}=\frac{\mathrm{I}_0}{\sqrt{2}}$$

$$\frac{\mathrm{I}_0}{\sqrt{2}}=\mathrm{I}_0\sin\omega t$$

$$\sin\omega t=\frac{1}{\sqrt{2}}$$

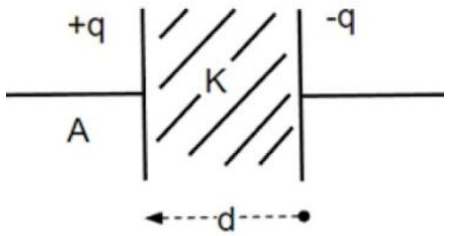
$$\omega t=\frac{\pi}{4}$$

$$100\pi t=\frac{\pi}{4}$$

$$t = \frac{1}{400}\,\text{sec}$$

$$t = 2.5\ \text{ms}$$

23. Electric field strength = E, Max charge = q, find the K ?



(1) $K = \frac{q}{\varepsilon_0 EA}$

(2) $K = \frac{qd}{\varepsilon_0 EA}$

(3) $K = \frac{qA}{\varepsilon_0 E}$

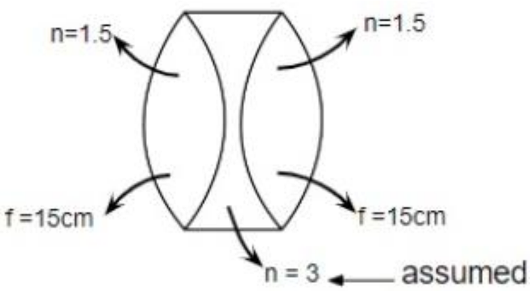
(4) None of these

Sol. Answer (1)

$$E = \frac{q}{KA\varepsilon_0}$$

$$K = \frac{q}{\varepsilon_0 EA}$$

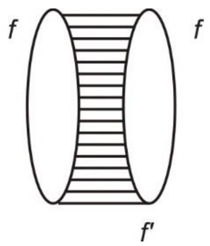
24. Find effective focal length



(1) –7.5 cm (2) –5.7 cm

(3) –7.4 cm (4) –6.7 cm

Sol. Answer (1)



$f = 15$ cm, μ=1.5, μ'=3

$$\frac{1}{f} = (\mu - 1)\left(\frac{2}{R}\right)$$

$$\Rightarrow \frac{1}{15} = \frac{1}{R}$$

and $\frac{1}{f'} = (\mu' - 1)\left(\frac{-2}{R}\right) = 2 \times \frac{-2}{15}$

$$= \frac{-4}{15}$$

$$\therefore \frac{1}{f_e} = \frac{1}{f} + \frac{1}{f'} + \frac{1}{f} = \frac{1}{15} - \frac{4}{15} + \frac{1}{15}$$

$$\Rightarrow f_e = -7.5\ \text{cm}$$

25. A particle of mass 100g is in horizontal circular motion with the help of 2m string fixed at one end over a smooth table. Maximum tension possible in string is 80 N. If maximum revolution per minute for the particle is given by k/π then find the value of k.

Sol. Answer (600)

$$T_{\max} = m\omega^2 L$$

$$\omega^2 = \frac{T_{\max}}{mL} = \frac{80}{\frac{1}{10} \times 2}$$

$$\omega^2 = 400$$

$$\omega = 20\ \text{rad/sec}$$

$$= \frac{20}{2\pi}\ \text{rev/s}$$

$$= \frac{10}{\pi}\ \text{rev/s}$$

$$= \frac{600}{\pi}\ \text{rad/m}$$

26. **Statement 1:** Magnetic field can't change K.E. and speed of body.

Statement 2: Force due to magnetic field always acts perpendicular to the velocity.

(1) Statement 1 is true, Statement 2 is true, Statement 2 is a correct explanation for Statement 1.

(2) Statement 1 is true, Statement 2 is true, Statement 2 is not a correct explanation for Statement 1.

(3) Statement 1 is true, Statement 2 is false.

(4) Statement 1 is false, Statement 2 is true.

Sol. Answer (1)

In magnetic field force is perpendicular to velocity

So, w = 0

$\Delta K.E = 0$

Both statement 1 and 2 is correct and 2 is correct explanation for statement 1.

27. A nucleus of atomic number 220 decays into atomic number 105 and 115. If binding energy per nucleon of reactants is 5.6 MeV each and product is 6.4 MeV. Find out energy released in this reaction.

(1) 176 MeV (2) 189 MeV

(3) 200 MeV (4) 160 MeV

Sol. Answer (1)

Q = 6.4 × 105 + 6.4 × 115 – 5.6 × 220

= 176 MeV

28. In a potentiometer, balance length for a cell of emf ε_1 is 75 cm. If the cell is replaced by another cell of emf ε_2 and $\frac{\varepsilon_1}{\varepsilon_2} = \frac{3}{2}$, then find the difference between initial length and final balance length.

(1) 15 cm (2) 20 cm

(3) 25 cm (4) 30 cm

Sol. Answer (3)

Given $l_1 = 75$ cm

We have, $\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$

$$\Rightarrow \frac{3}{2} = \frac{75}{l_2} \Rightarrow l_2 = 50 \text{ cm}$$

$$\therefore l_1 - l_2 = 25 \text{ cm}$$

29. In a medium electric field of any E.M. wave is 7 × 10^{-3} V/m. If relative permittivity & relative permeability of medium is 4 & 9 respectively, find magnetic field in the medium :

(1) 1.4 × 10^{-5} (2) 1.4 × 10^{-2}

(3) 1.4 × 10^{5} (4) 1.4 × 10^{-10}

Sol. Answer (4)

$$\frac{c}{v} = \mu$$

$$v = \frac{c}{\mu} = \frac{c}{\sqrt{\mu_r c_r}}$$

$$v = \frac{c}{\sqrt{4 \times 9}} = \frac{c}{6}$$

$$\frac{E_0}{B_0} = v \Rightarrow B_0 = \frac{E_0}{v}$$

$$B_0 = \frac{E_0}{\frac{c}{6}}$$

$$B_0 = \frac{7 \times 10^{-3} \times 6}{3 \times 10^8}$$

$$B_0 = 14 \times 10^{-11}$$

$$B_0 = 1.4 \times 10^{-10} T$$

30. A particle of mass 200g moving in circular motion which is tied by a massless string of length 2m that can bear a maximum 80 N tension. What is the maximum possible speed with which particle can move on circular path.

(1) $10\sqrt{2}$ m/s

(2) $20\sqrt{2}$ m/s

(3) 20 m/s

(4) $30\sqrt{2}$ m/s

Sol. Answer (2)

$$T = \frac{mv^2}{\ell}$$

$$80 \times 2 = \frac{1}{5} \times v^2$$

$$v = \sqrt{800}$$

$$= 10\sqrt{8} = 20\sqrt{2}$$

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