Answers & Solutions for 26 JULY MORNING SHIFT JEE (Main)-2022 (Online) Phase-2 (Physics)

$$v = aw\cos wt$$

$$\cos\phi = \frac{R}{Z}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

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

$$T = 2\pi\sqrt{\frac{m}{k}}$$

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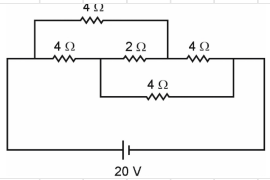
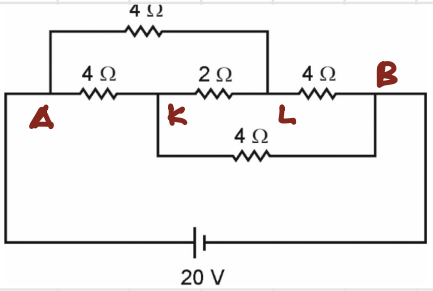
IIT JEE PHYSICS PAPER SOLUTION 26 JULY 2022 MORNING SHIFT QUESTIONS BASED ON NEWTONS LAW PULLEY, SHM ACC VS VELOCITY GRAPH,CAPACITOR WITH DIELECTRIC,EMW ARE TRICKY

1.



Find current through cell?

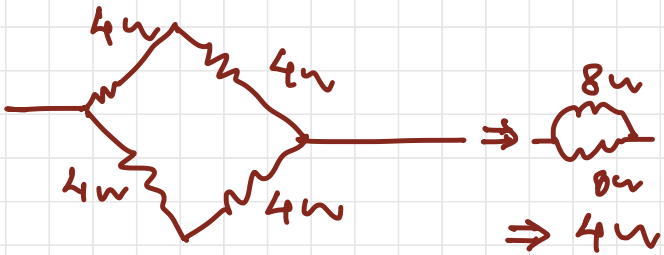


Find current through cell?

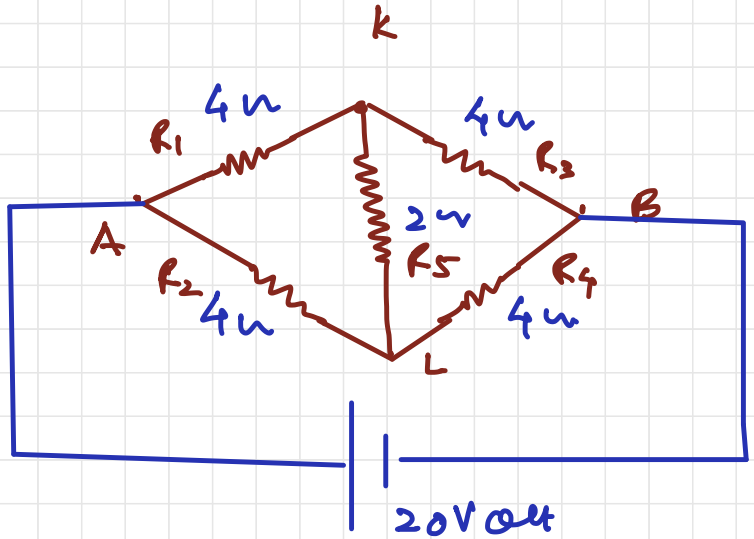
(1) 2 A (2) 4 A

(3) 5 A (4) 10 A

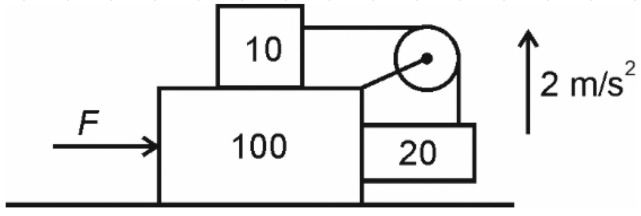
$\frac{R_1}{R_2} = \frac{R_3}{R_4}$ (BALANCED WHEATSTONE BRIDGE)



$I = \frac{20}{4} = 5A$

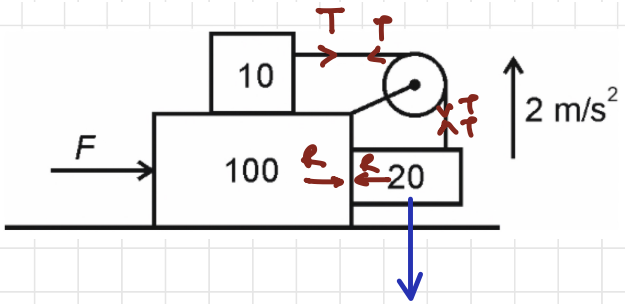


2. Assume all surfaces are friction less. Find value of force required such that 20 kg block moves with acceleration 2 m/s^2



(1) 2080 N (2) 3360 N

(3) 2420 N (4) 2820 N



$T - 20g = 20(2)$

$T = 40 + 200 = 240\ N$

$f = T$

$130a' = 240$

$a' = \frac{240}{130}\ m s^{-2}$

$f = (100+10+20)a'$

$= 130\,a'$

$f = 130 \times \frac{240}{130} = 240\ N$

3. A charged particle moving in a uniform magnetic field $B = 2i + 3j$ has acceleration $a = (\alpha i - 4j)$. The value of α is equal to

(1) 6

(2) 2

(3) $-\frac{8}{3}$

(4) $\frac{4}{5}$

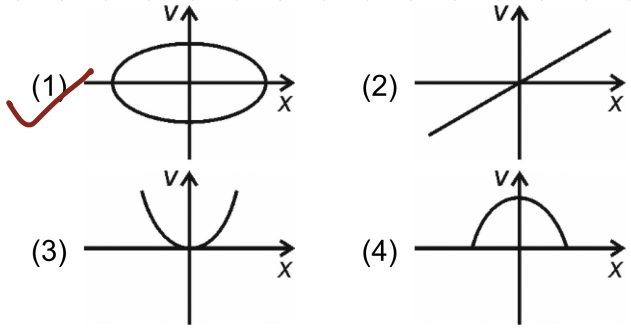
$\vec{a} \cdot \vec{B} = 0$, $(\alpha \hat{i} - 4\hat{j}) \cdot (2\hat{i} + 3\hat{j}) = 0$

$2(\alpha) - 12 = 0$

$2(\alpha) = 12$

$\alpha = 6$

4. In S.H.M. v-x graph will be



$x = a \sin \omega t$

$v = a\omega \cos \omega t$

$v = a\omega \sqrt{1 - \sin^2 \omega t}$

$v = a\omega \sqrt{1 - x^2/a^2}$

$= \omega \sqrt{a^2 - x^2}$

$v^2 = \omega^2 (a^2 - x^2)$

$v^2 = a^2\omega^2 - a^2x^2$

$v^2 + a^2x^2 = a^2\omega^2$

$\frac{v^2}{a^2\omega^2} + \frac{a^2x^2}{a^2\omega^2} = 1$

$\frac{v^2}{(a\omega)^2} + \frac{x^2}{\omega^2} = 1$

equation of ellipse

5) In an LR circuit if $X_L = R$ then power factor is P_1. In another LCR series circuit if $X_L = X_C$ then power factor is P_2. Then value of P_1/P_2 is equal is

(1) 1 : 1 (2) 1 : 2

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

$$\cos\phi_1 = P_1 \Rightarrow \frac{R}{Z} = \frac{R}{\sqrt{R^2+X_L^2}} = \frac{R}{\sqrt{R^2+R^2}}$$

$$= \frac{R}{R\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$\cos\phi_2 = P_2 = \frac{R}{Z} \Rightarrow \frac{R}{R} = 1$$

at resonance $\cos\phi = 1$

$$\frac{P_1}{P_2} = \frac{1}{\sqrt{2}}$$

6. A coil of 200 turns and another coil of 400 turns have same length 20 cm. Find ratio of magnetic field at centre.

(1) 1 : 2
(2) 2 : 1
(3) 1 : 4
(4) 4 : 1

$$B_1 = \frac{\mu_0}{2\pi} \frac{N_1 (2\pi r_1) I}{r_1^2} = \frac{\mu_0}{2} \frac{N_1 I}{r_1}$$

$$B_2 = \frac{\mu_0}{2} \frac{N_2 I}{r_2}$$

$$l = 200 (2\pi r_1) = 400 (2\pi r_2)$$

$$r_1 = 2 r_2$$

$$\frac{B_1}{B_2} = \frac{\mu_0}{2} \frac{N_1 I}{r_1} \frac{2 r_2}{\mu_0 N_2 I}$$

$$= \frac{N_1 r_2}{N_2 r_1} = \frac{200}{400} \frac{r_2}{2 r_2} = \frac{1}{4}$$

7)A monkey climbs rope with 4 m/s2 acceleration and when it climbs down his acceleration is 5 m/s2. Weight of monkey is 50 kg and maximum tension is 350 N.

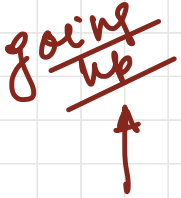
Find correct option.

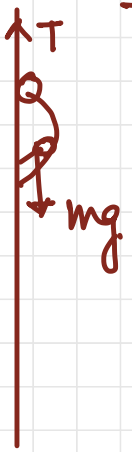
(1) T = 700 N, when climbs upwards

(2) T = 350 N, when climbs downwards

(3) Rope will break when climbs upward

(4) Rope will break when climbs downward





$T - mg = ma$

$T = m(g+a)$

$= 50(10+4)$

$= 14 \times 50$

$= 700\,N$

$mg - T = ma$

$T = m(g-a)$

$= 50(10-5) = 250\,N$

8. Wave equation is given.

$y = 2 \times 10^{-8} \sin(kx + \omega t + \phi)$ (cm) Find amplitude?

(1) 2×10^{-8} cm (2) 5×10^{-6} cm

(3) 4×10^{-6} cm (4) 8×10^{-6} cm

$y = 2 \times 10^{-8} \sin(kx + \omega t + \phi)$

Compare with

$y = a \sin(kx + \omega t + \phi)$

$a = 2 \times 10^{-8}$ cm

9) In YDSE experiment fringe width $\beta = 12$ cm is given, if the setup is dipped in medium having refractive index $\mu = 4/3$ find new fringe width

(1) 6
(2) 9
(3) 12
(4) 16

$$\beta = \frac{D\lambda}{d}$$

when dipped

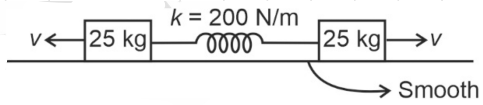
$$\beta' = \frac{D\lambda'}{d}$$

$$\frac{\beta}{\beta'} = \frac{\lambda}{\lambda'} = \mu$$

$$\beta' = \frac{\beta}{\mu} = \frac{12}{(4/3)} = 9\,cm$$

10) With spring at its natural length two blocks are given velocity v = 1 m/s. The maximum extension in the spring is equal to

(1) 5 cm
(2) 0.5 m
(3) 0.25 m
(4) 0.1 m

10. 

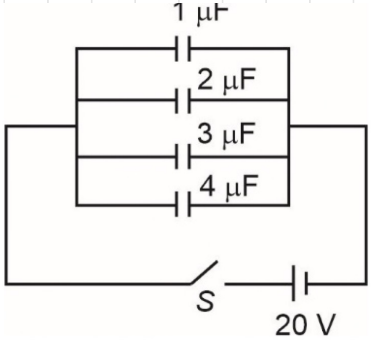
$$2\left(\frac{1}{2}mv^2\right) = \frac{1}{2}kx^2$$

$$2 \times 25 \times (1)^2 = 200\,x^2$$

$$x^2 = \frac{50}{200} = \frac{1}{4}$$

$$x = \frac{1}{2}\text{ mt} = 0.5\text{ mt}$$

11.



After closer of the switch S find the total charge flown through the switch.

(1) 100 μC (2) 50 μC

(3) 45 μC (4) 200 μC

$\Rightarrow$ All capacitors are in parallel

$C_{eq} = (1+2+3+4)\,\mu F$

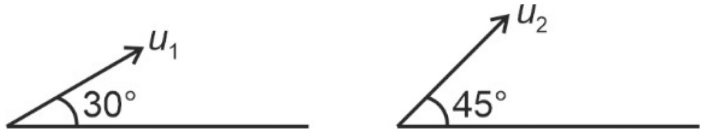
$= 10\,\mu F$

$q = (C_{eq})(V)$

$= (10\,\mu F)(20)$

$= 200\,\mu C$

12. For the two projectiles shown below:



Find $\frac{u_1}{u_2}$ if time to reach maximum height is same

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

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

$$T_1 = T_2$$

$$\frac{u_1 \sin\theta_1}{g} = \frac{u_2 \sin\theta_2}{g}$$

$$\frac{u_1}{u_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{1}{\sqrt{2}} \times \frac{2}{1} = \sqrt{2}$$

13) The decrease in weight of a rocket when it in 32 km above surface of earth.

(1) 1%
(2) 2%
(3) 3%
(4) 4%

$$g' = g\left(1 - \frac{2h}{R}\right)$$

$$\frac{g'}{g} = 1 - \frac{2h}{R}$$

$$\frac{2h}{R} = 1 - \frac{g'}{g} = \frac{g - g'}{g} = \frac{mg - mg'}{mg} = \frac{w - w'}{w}$$

$$\frac{\Delta w}{w} = \frac{2 \times 32}{6400} \Rightarrow \frac{\Delta w}{w} = \frac{1}{100} = .01$$

1%

14. If velocity of electron is x times than neutron and de-Broglie wavelengths are same then find x.

(1) 2531 (2) 2000

(3) 1835 (4) 729

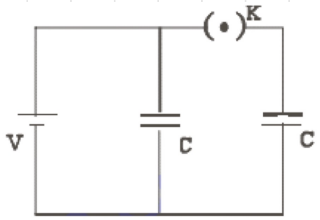
$$\lambda_e = \lambda_n$$

$$m_e v_e = m_n v_n$$

$$v_e = \left(\frac{m_n}{m_e}\right) v_n$$

$$x = \frac{m_n}{m_e} = 1835$$

Q15: A source of potential difference V is connected to the combination of two identical capacitors as shown in the figure. When key K is closed, the total energy stored across the combination is E_1. Now key K is opened and dielectric of dielectric constant 5 is introduced between the plates of the capacitors. The total energy stored across the combination is now E_2. The ratio will be : E_1 / E_2



(A) $\frac{1}{10}$

(B) $\frac{2}{5}$

(C) $\frac{5}{13}$ ✓

(D) $\frac{5}{26}$

CASE-I $\quad E_1 = \frac{1}{2}(2C)V^2$

CASE-2 — $E_2 = \frac{1}{2}(KC)V^2 + \frac{1}{2}(KC)\left(\frac{V}{K}\right)^2$

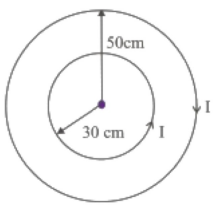
$= \frac{1}{2}V^2\left[KC + \frac{KC}{K^2}\right]$

$= \frac{1}{2}V^2\left[KC + \frac{C}{K}\right]$

$= \frac{1}{2}CV^2\left\{5 + \frac{1}{5}\right\} = \frac{1}{2}CV^2\left(\frac{26}{5}\right)$

$E_1/E_2 = \frac{\frac{1}{2}(2C)V^2}{\frac{1}{2}CV^2\left(\frac{26}{5}\right)} = \frac{10}{26} = \frac{5}{13}$

Q16: Two concentric circular loops of radii and are placed in x-y plane as shown in the figure. A current is flowing through them in the direction as shown in figure. The net magnetic moment of this system of two circular loops is approximately:



(A) $\frac{7}{2}\hat{k}\text{Am}^2$

(B) $-\frac{7}{2}\hat{k}\text{Am}^2$ ✓

(C) $7\hat{k}\text{Am}^2$

(D) $-7\hat{k}Am^2$

$$M_1 = I\pi(0.5)^2(-\hat{k})$$

$$M_2 = I\pi(0.3)^2(\hat{k})$$

$$\vec{M} = M_1 + M_2$$

$$= \pi I\left(\frac{25}{100} - \frac{9}{100}\right)\hat{k}$$

$$= -\frac{22}{7}(I)\left(\frac{16}{100}\right)\hat{k}$$

$$\vec{M} = -3.52\,\hat{k}\,Am^2$$

$$= -\frac{I}{2}\hat{k}\,Amp\,mt^2$$

Q17: A velocity selector consists of electric field $\vec{E} = E\hat{k}$ and magnetic field $\vec{B} = \hat{B}\hat{j}$ with $B = 12mT$. The value E required for an electron of energy $728eV$ moving along the positive x-axis to pass undeflected is :
(Given, mass of electron $= 9.1 \times 10^{-31}$ kg)

(A) $192kVm^{-1}$

(B) $192\ mVm^{-1}$

(C) $9600kVm^{-1}$

(D) $16kVm^{-1}$

$\vec{E} = E\hat{k}$

$\vec{B} = B\hat{j}$.

$B = 12 \times 10^{-3}\ T$

$E = 728 \times 1.6 \times 10^{-19}\ J = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2 \times 728 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}}$

$= 16 \times 10^6\ mt/sec$

$qvB = qE$

$E = vB = 12 \times 10^{-3} \times 16 \times 10^6$

$= 192 \times 10^3\ V/m$

$= 192\ kV/m$

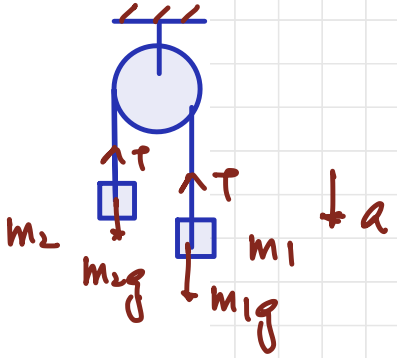
Q18: Two masses M_1 and M_2 are tied together at the two ends of a light inextensible string that passes over a frictionless pulley. When the mass M_2 is twice that of M_1. the acceleration of the system is a_1. When the mass M_2 is thrice that of M_1. The acceleration of The system is a_2. The ratio $\frac{a_1}{a_2}$ will be:

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

(B) $\frac{2}{3}$ ✓

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

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



$m_1g - T = m_1a$

$T - m_2g = m_2a$

ADD

$g(m_1 - m_2) = a(m_1 + m_2)$

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

CASE-I

$a_1 = \frac{2m_1g - m_1g}{3m_1}$

$a_1 = g/3$

CASE-2

$a_2 = \frac{3m_1g - m_1g}{4m_1}$

$a_2 = g/2$

$\frac{a_1}{a_2} = \frac{g/3}{g/2} = \frac{2}{3}$

Q19: Mass numbers of two nuclei are in the ratio of 4: 3. Their nuclear densities will be in the ratio of

(A) 4 : 3

(B) $\left(\frac{3}{4}\right)^{\frac{1}{3}}$

(C) 1 : 1 ✓

(D) $\left(\frac{4}{3}\right)^{\frac{1}{3}}$

$$R = R_0 A^{1/3}$$

$$\text{Density of nucleus} = \frac{\text{mass of nucleus}}{\text{volume of nucleus}}$$

$$\rho = \frac{mA}{\frac{4}{3}\pi R^3}$$

$$= \frac{m(A)}{\frac{4}{3}\pi R_0^3 A} = \frac{3m}{4\pi R_0^3}$$

$\rho \rightarrow$ independent of mass number

Q20: The area of cross section of the rope used to lift a load by a crane is $2.5 \times 10^{-4}\ m^2$ . . The maximum lifting capacity of the crane is 10 metric tons. To increase the lifting capacity of the crane to 25 metric tons, the required area of cross section of the rope should be : (take $g = 10\ ms^{-2}$

(A) $6.25 \times 10^{-4}\ m^2$

(B) $10 \times 10^{-4}\ m^2$

(C) $1 \times 10^{-4}\ m^2$

(D) $1.67 \times 10^{-4}\ m^2$

$$\text{BREAKING STRESS} = \frac{\text{MAX LIFTING CAPACITY}}{\text{Area of cross-section of rope}}$$

$$\frac{10}{2.5 \times 10^{-4}} = \frac{25}{A}$$

$$A = 625 \times 10^{-6}\ m^2$$

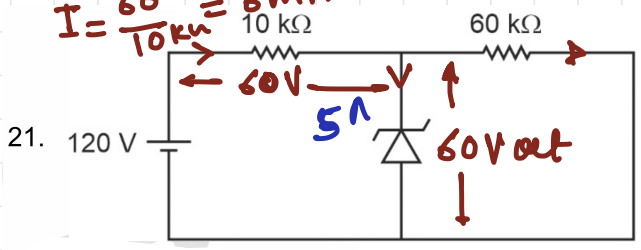
$$= 6.25 \times 10^{-4}\ m^2$$

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21

In the circuit shown the potential drop across the diode is 60 V then current through diode is ____ mA.



$I = \frac{60}{10k\Omega} = 6mA$

60V — V — 5^

60V out

$I_1 = \frac{60}{60 \times 10^3}$

$= 1mA$

→ current through the zener diode =

22)A drop breaks in 729 smaller identical droplets. It T is the surface tension and R is the radius of bigger drop then change in the surface potential energy is $n\pi R^2 T$. The value of n is _____.

$$E_i = 4\pi R^2 T$$

$$E_f = 729 \times 4\pi r^2 (T)$$

$$729 \left(\frac{4}{3}\pi r^3\right) = \frac{4}{3}\pi R^3$$

$$R = 9r \Rightarrow r = R/9$$

$$\Delta E = E_f - E_i$$

$$= 729 \times 4\pi \times \left(\frac{R}{9}\right)^2 T - 4\pi R^2 T$$

$$= 32\pi R^2 T$$

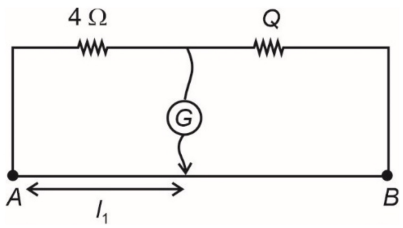
23. In an EM wave if amplitude of magnetic field component is 2×10^{-8} T then the value amplitude of electric field component is _____ V/m.

$$E_0 = c B_0$$

$$= 3 \times 10^{8} \times 2 \times 10^{-8}$$

$$= 6 \text{ Volt/mt}$$

24.



In a meter bridge experiment balance point is l_1 = 40 cm away from point A. Now if an unknown resistance of x Ω is added to 4 Ω resistance in series then balance point is 80 cm from point A. Then value of x is _____.

Case-I

$$\frac{4}{40} = \frac{Q}{60} \Rightarrow Q = 6\ \Omega$$

Case-2

$$\frac{4+x}{80} = \frac{6}{20}$$

$$4+x = 24$$

$$x = 20\text{-ohm}$$

25)Temperature of 7 moles of a monoatomic gas is raised by 40 K. The change in internal energy of the sample is equal to 420 R. (R is universal gas constant)

$$\Delta U = \frac{f}{2} n R (\Delta T)$$

$$= \frac{3}{2} \times 7 \times 40 \times R$$

$$= 420R$$

Sol. $\Delta U = \frac{f}{2} nR\Delta T$

$$= \frac{3}{2} \times 7 \times 40 \times R$$

$$= 420R$$

26)Find the number of photons coming out per unit time of a source that emits a light of wavelength 900 nm of intensity 100 W/m^2 through its surface area of 1 m2. (In multiple of 10^{19}

$I = IA$

Energy of one photon $= \frac{hc}{\lambda}$

Number of photon coming out per unit time

$$= \frac{100\lambda}{hc} = \frac{100 \times 9 \times 10^{-7}}{6.625 \times 10^{-34} \times 3 \times 10^{8}}$$

$$= 45 \times 10^{19}$$

27. Trajectory of a projectile is $5y = 5x\left(1-\frac{x}{10}\right)$. Find initial velocity

$y = x\tan\theta\left(1-\frac{x}{R}\right)$

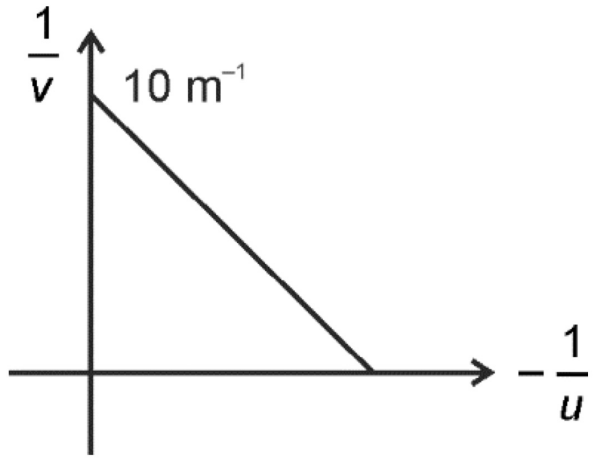
$y = x\left(1-\frac{x}{10}\right)$

$\tan\theta = 1$, $R = 10$ $\theta = 45^\circ$

$\frac{u^2 \sin 2\theta}{g} = 10$, $u^2 = 100$

$u = 10\ m\ s^{-1}$

(28) In a biconvex lens graph between v and u is as shown. The focal length of lens is equal to _____ cm

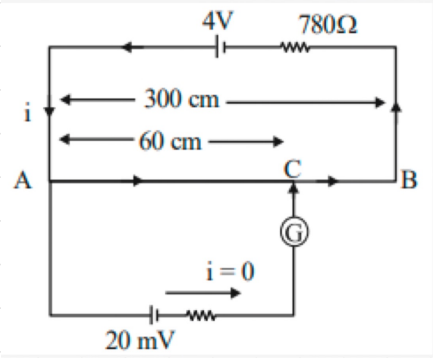


$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

From graph

$$\frac{1}{10} = \frac{1}{f} \Rightarrow f = 10\,\text{cm}$$

Q29: A potentiometer wire of length 300 cm is connected in series with a resistance 780 Ω and a standard cell of emf 4V. A constant current flows through potentiometer wire. The length of the null point for cell of emf 20 mV is found to be 60 cm. The resistance of the potentiometer wire is 20 Ω



R — Resistance of potentiometer wire

$$i = \frac{4}{R+780}$$

300 cm is having a resistance R

60 cm " " " " $= \frac{R \times 60}{300}$

Under balance condition

$$20 \times 10^{-3} = \left(\frac{4}{R+780}\right) \times \frac{R \times 60}{(300)}$$

$$\frac{20}{1000} = \frac{240R}{(300)(R+780)}$$

$$40R = R + 780$$

$$39R = 780 \Rightarrow R = \frac{780}{39} = 20\text{-ohm}$$

Q30: As per given figures, two springs of spring constants K and 2K are connected to mass m. If the period of oscillation in figure (a) is 3s, then the period of oscillation in figure (b) will be $\sqrt{x}$. The value of x is __2__.

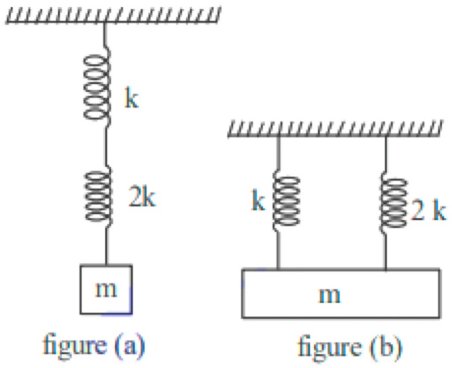


figure (a) figure (b)

2.00

CASE-1 $k_{eq} = \frac{(k)(2k)}{3k} = \frac{2k}{3}$

$T_1 = 2\pi\sqrt{\frac{m}{2k/3}} = 2\pi\sqrt{\frac{3m}{2k}}$

CASE-2 $k_{eq} = 3k$

$T_2 = 2\pi\sqrt{\frac{m}{3k}}$

$\frac{T_1}{T_2} = \sqrt{\frac{3m}{2k}\frac{3k}{m}} = \frac{3}{\sqrt{2}}$

$\frac{3}{T_2} = \frac{3}{\sqrt{2}}$ $T_2 = \sqrt{2} = \sqrt{x}$

$x = 2.0$

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QUESTIONS BASED ON NEWTONS LAW PULLEY, SHM ACC VS VELOCITY GRAPH,CAPACITOR WITH DIELECTRIC,EMW ARE TRICKY