FINAL JEE–MAIN EXAMINATION – JULY, 2022

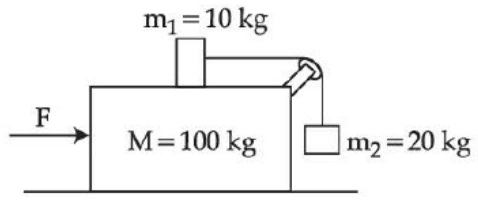
(Held On Tuesday 26th July, 2022) **TIME : 9 : 00 AM to 12 : 00 NOON**

PHYSICS | **TEST PAPER WITH SOLUTION**

SECTION-A

1. Three masses M = 100 kg, m_1 = 10 kg and m_2=20 kg are arranged in a system as shown in figure. All the surfaces are frictionless and strings are inextensible and weightless. The pulleys are also weightless and frictionless. A force F is applied on the system so that the mass m_2 moves upward with an acceleration of 2 ms^{-2}. The value of F is :

(Take g = 10 ms^{-2})



(A) 3360 N (B) 3380 N

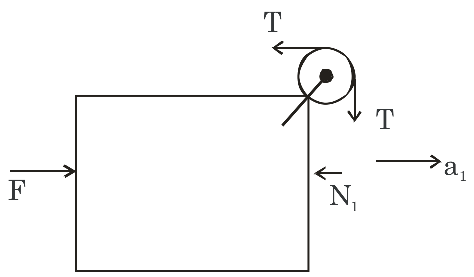
(C) 3120 N (D) 3240 N

Official Ans. by NTA (C)

Allen Ans. (A)

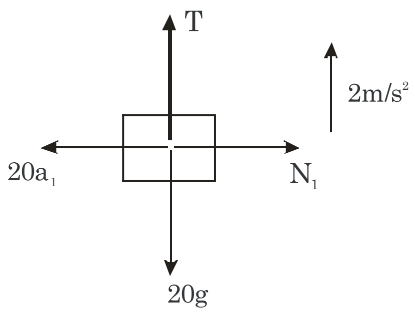
Sol. Let acceleration of 100 kg block = a_1

FBD of 100 kg block w.r.t ground



$F–T–N_1 = 100\ a_1$ ……..(i)

FBD of 20 block wrt 100kg

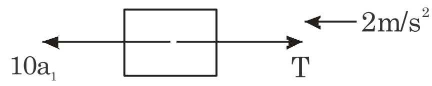


$T - 20g = 20(2)$

$T = 240$ ….. (ii)

$N_1 = 20a_1$ ….. (iii)

FBD of 10 kg block wrt 100 kg



$$10a_1 - 240 = 10(2)$$

$$a_1 = 26\,m/s^2$$

$$F - 240 - 20(26) = 100 \times 26$$

$\Rightarrow$ F = 3360 N

2. A radio can tune to any station in 6 MHz to 10 MHz band. The value of corresponding wavelength bandwidth will be :

(A)4 m (B) 20 m

(C) 30 m (D) 50 m

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. Given: Frequency f_1 = 6MHz

Frequency f_2 = 10MHz

$$\lambda_1 = \frac{c}{f_1}$$

$$\lambda_2 = \frac{c}{f_2}$$

Wavelength bandwidth = λ_2-λ_1 = 20 m

3. The disintegration rate of a certain radioactive sample at any instant is 4250 disintegrations per minute. 10 minutes later, the rate becomes 2250 disintegrations per minute. The approximate decay constant is :

(Take $\log_{10}1.88 = 0.274$)

(A)0.02 min^{-1} (B) 2.7 min^{-1}

(C) 0.063 min^{-1} (D) 6.3 min^{-1}

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. At t=0 disintegration rate = 4250 dpm

At t=10 disintegration rate = 2250 dpm

$A = A_o e^{-\lambda t}$

$2250 = 4250 e^{-\lambda(10)}$

$\Rightarrow \lambda(10) = \ln\left(\frac{4250}{2250}\right)$

$\Rightarrow \lambda = 0.063 \text{min}^{-1}$

4. A parallel beam of light of wavelength 900 nm and intensity 100 Wm^{-2} is incident on a surface perpendicular to the beam. Tire number of photons crossing 1 cm^2 area perpendicular to the beam in one second is :

(A) 3×10^{16} (B) 4.5×10^{16}

(C) 4.5×10^{17} (D) 4.5×10^{20}

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. Wavelength of incident beam $\lambda = 900 \times 10^{-9}$ m

Intensity of incident beam =I= 100 W/m^2

No. of photons crossing per unit sec

$$= n = \frac{E_{net}}{E_{single\ photon}} = \frac{IA\lambda}{hc}$$

$$= \frac{(100)(1\times10^{-4})(900\times10^{-9})}{6.62\times10^{-34}\times3\times10^{8}} = 4.5\times10^{16}$$

5. In young's double slit experiment, the fringe width is 12mm. If the entire arrangement is placed in water of refractive index $\frac{4}{3}$, then the fringe width becomes (in mm)

(A) 16 (B) 9

(C) 48 (D) 12

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. For a given light wavelength corresponding a medium of refractive index μ

$\lambda_{med} = \frac{\lambda_{vacuum}}{\mu}$

and we know that fringe width $\beta = \frac{\lambda D}{d}$

Therefore, $\beta_{med} = \frac{\beta_{vacuum}}{\mu} = \frac{12}{\frac{4}{3}} = 9$ mm

6. The magnetic field of a plane electromagnetic wave is given by

$\vec{B} = 2\times10^{-8}\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{j}T$

The amplitude of the electric field would be

(A) $6Vm^{-1}$ along x-axis

(B) $3Vm^{-1}$ along z-axis

(C) $6Vm^{-1}$ along z-axis

(D) $2\times10^{-8}Vm^{-1}$ along z-axis

Official Ans. by NTA (C)

Allen Ans. (C)

Sol.

$c = \frac{E_0}{B_0} \Rightarrow E_0 = cB_0$

$E_0 = (3\times10^{8})(2\times10^{-8})$

$E_0 = 6Vm^{-1}$

As, $\vec{B} =$ along y-axis

$\vec{v} =$ along negative x-axis

hence $\vec{E}_0 =$ along z-axis

7. In a series LR circuit $X_L = R$ and power factor of the circuit is P_1. When capacitor with capacitance C such that $X_L = X_C$ is put in series, the power factor becomes P_2. The ratio $\frac{P_1}{P_2}$ is

(A) $\frac{1}{2}$ (B) $\frac{1}{\sqrt{2}}$

(C) $\frac{\sqrt{3}}{\sqrt{2}}$ (D) 2 : 1

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. In case of L-R circuit

$Z=\sqrt{X_L^2+R^2}$ & power factor

$P_1=\cos\phi=\frac{R}{Z}$

As $X_L=R$

$\Rightarrow Z=\sqrt{2}R$

$\Rightarrow P_1=\frac{R}{\sqrt{2}R}\Rightarrow P_1=\frac{1}{\sqrt{2}}$

In case of L-C-R circuit

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

As $X_L=X_C$

$\Rightarrow Z=R$

$\Rightarrow P_2=\cos\phi=\frac{R}{R}=1$

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

8. A charge particle is moving in a uniform magnetic field $(2\hat{i}+3\hat{j})T$. If it has an acceleration of $(\alpha\hat{i}-4\hat{j})m/s^2$, then the value of α will be

(A) 3 (B) 6 (C) 12 (D) 2

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. As $\vec{F}=q(\vec{v}\times\vec{B})$

$\vec{a}=\frac{q}{m}(\vec{v}\times\vec{B})$

So, $\vec{a}\,\&\,\vec{B}$ are $\perp$ to each other

Hence, $\vec{a}.\vec{B}=0$

$(\alpha\hat{i}-4\hat{j}).(2\hat{i}+3\hat{j})=0$

$\alpha(2)+(-4)(3)=0$

$\alpha=\frac{12}{2}\Rightarrow\alpha=6$

9. B_X and B_Y are the magnetic field at the centre of two coils of two coils X and Y respectively, each carrying equal current. If coil X has 200 turns and 20 cm radius and coil Y has 400 turns and 20 cm radius, the ratio of B_X and B_Y is

(A)1 : 1 (B) 1 : 2

(C)2 : 1 (D) 4 : 1

Official Ans. by NTA (B)

Allen Ans. (B)

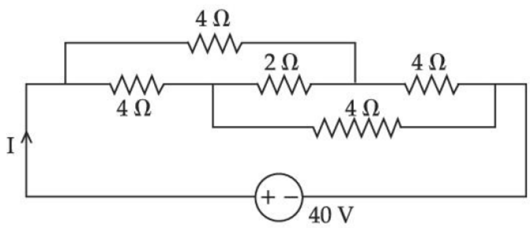
Sol. At centre $B=N\left(\frac{\mu_0 i}{2R}\right)$

$B_x=200\left(\frac{\mu_0 i}{2\times 20cm}\right)$

$B_y=400\left(\frac{\mu_0 i}{2\times 20cm}\right)$

$\frac{B_x}{B_y}=\frac{1}{2}$

10. The current I in the given circuit will be :

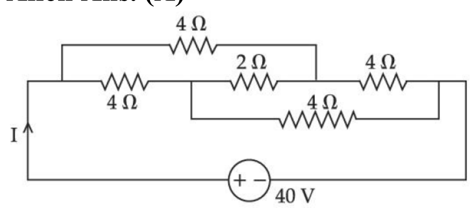


(A) 10A (B) 20 A

(C) 4A (D) 40A

Official Ans. by NTA (A)

Allen Ans. (A)



Sol.

Given circuit is balanced wheat stone bridge

Hence 2Ω can be neglected

$R_{net}=4\Omega$

$I=\frac{40}{4}$

I = 10A

11. The total charge on the system of capacitance $C_1 = 1\mu F$, $C_2 = 2\mu F$, $C_3 = 4\mu F$ and $C_4 = 3\mu F$ connected in parallel is

(Assume a battery of 20V is connected to the combination)

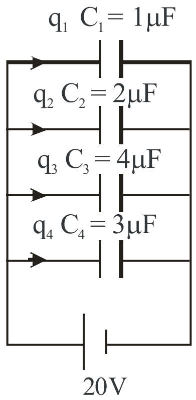
(A) $200\mu C$ (B) 200C

(C) $10\mu C$ (D) 10C

Official Ans. by NTA (A)

Allen Ans. (A)

Sol.



Total charge = $q_1 + q_2 + q_2 + q_4$

$= 1 \times 20 + 2 \times 20 + 4 \times 20 + 3 \times 20 = 200\mu C$

12. When a particle executes simple Harmonic motion, the nature of graph of velocity as function of displacement will be :

(A)Circular (B)Ellipitical

(C)Sinusoidal (D) Straight line

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. For a particle in SHM, its speed depends on position as

$v = \omega\sqrt{A^2 - x^2}$

Where ω is angular frequency and A is amplitude

Now $v^2 = \omega^2 A^2 - \omega^2 x^2$

So, $\frac{v^2}{(\omega A)^2} + \frac{x^2}{(A)^2} = 1$

So graph between v and x is elliptical

13. 7 mole of certain monoatomic ideal gas undergoes a temperature increase of 40K at constant pressure. The increase in the internal energy of the gas in this process is

(Given $R = 8.3\ JK^{-1}mol^{-1}$)

(A) 5810 J (B) 3486 J

(C) 11620J (D) 6972 J

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. For a quasi-static process the change in internal energy of an ideal gas is

$\Delta U = nC_V\,\Delta T$

$= n \times \frac{3R}{2} \times \Delta T$

[molar heat capacity at constant volume for mono atomic gas = $\frac{3R}{2}$]

$\Delta U = 7 \times \frac{3}{2} \times 8.3 \times 40 = 3486J$

14. A monoatomic gas at pressure P and volume V is suddenly compressed to one eighth of its original volume. The final pressure at constant entropy will be:

(A) P (B) 8P (C) 32P (D) 64 P

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. Constant entropy means process is adiabatic

PV^γ = constant

$V_2 = \frac{V_1}{8}$

$P_1V_1^\gamma = P_2V_2^\gamma$

$P_1V_1^\gamma = P_2\left(\frac{V_1}{8}\right)^{5/3}$

$P_1V_1^{5/3} = \frac{P_2V_1^{5/3}}{32}$

$\mathbf{P_2} = 32P_1$

15. A water drop of radius 1cm is broken into 729 equal droplets. If surface tension of water is 75 dyne/cm, then the gain in surface energy upto first decimal place will be :

[Given $\pi = 3.14$]

(A) 8.5×10^{-4} J (B) 8.2×10^{-4} J

(C) 7.5×10^{-4} J (D) 5.3×10^{-4} J

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. Initial surface energy = TA

Where T is surface tension and A is surface area

$$U_i = \left(\frac{75\times10^{-5}}{10^{-2}}\frac{N}{m}\right)\times\left[4\pi\left(1\times10^{-2}\right)^2\right]$$

$$= 75\times10^{-3}\times4\pi\times10^{-4} = 942\times10^{-7}\text{ J}$$

To get final radius of drops by volume conservation

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

R = Initial radius

r = final radius

$$r = \frac{R}{(729)^{1/3}} = \frac{R}{9} = \frac{1}{9}\text{cm}$$

Final surface energy

$$U_f = 729[TA]$$

$$= 729\left[\frac{75\times10^{-5}}{10^{-2}}\frac{N}{m}\right]\times\left[4\pi\left(\frac{1}{9}\times10^{-2}\right)^2\right]$$

$$= 729\left[75\times10^{-3}\times\frac{4\pi\times10^{-4}}{81}\right]$$

$$= 9\left[942\times10^{-7}\text{ J}\right]$$

Gain in surface energy

$$\Delta U = 9\times942\times10^{-7} - 942\times10^{-7}$$

$$= 8\times942\times10^{-7}\text{ J} = 7536\times10^{-7}\text{ J}$$

$$= 7.5\times10^{-4}\text{ J}$$

16. The percentage decrease in the weight of a rocket, when taken to a height of 32 km above the surface of earth will, be :

(Radius of earth = 6400km)

(A) 1 % (B) 3%

(C) 4% (D) 0.5%

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. Acceleration due to gravity at a height h<< R is

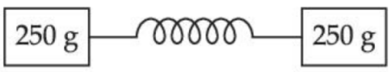
$$g' = g\left(1-\frac{2h}{R}\right)$$

$$\therefore \frac{\Delta g}{g} = \frac{2h}{R}$$

$$\Rightarrow \frac{\Delta g}{g}\times100 = \frac{2h}{R}\times100$$

$$= 2\times\frac{32}{6400}\times100 = 1\%$$

17. As per the given figure, two blocks each of mass 250g are connected to a spring of spring constant 2Nm^{-1}. If both are given velocity v in opposite directions, then maximum elongation of the spring is :



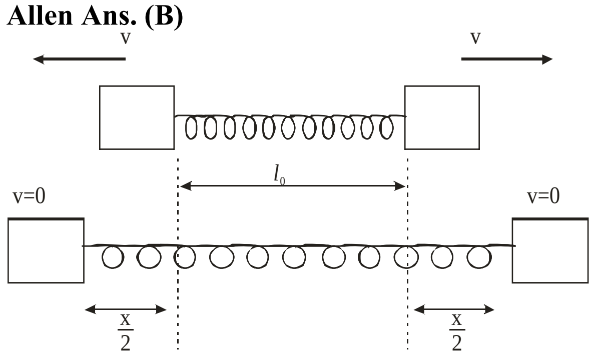
(A) $\frac{v}{2\sqrt{2}}$ (B) $\frac{v}{2}$

(C) $\frac{v}{4}$ (D) $\frac{v}{\sqrt{2}}$

Official Ans. by NTA (B)

Allen Ans. (B)

Sol.



using energy conservation

$$\frac{1}{2}mv^2\times2 = \frac{1}{2}kx^2$$

$$\Rightarrow \frac{1}{4}v^2 = \frac{1}{2}\times2\times x^2$$

$$\therefore x = \frac{v}{2}$$

18. A monkey of mass 50kg climbs on a rope which can withstand the tension (T) of 350N. If monkey initially climbs down with an acceleration of $4m/s^2$ and then climbs up with an acceleration of $5m/s^2$. Choose the correct option $\left(g = 10m/s^2\right)$

(A) T = 700N while climbing upward

(B) T = 350 N while going downward

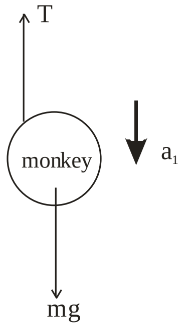
(C) Rope will break while climbing upward

(D) Rope will break while going downward

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. F.B.D of monkey while moving downward

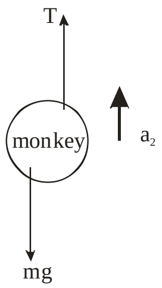


Using Newton's second law

$mg - T = ma_1$

$\therefore$ $500 - T = 50 \times 4 \Rightarrow T = 300$ N

F.B.D of monkey while moving up



Using Newton's second law of motion

$T - mg = ma_2$

$\Rightarrow$ $T - 500 = 50 \times 5$

$\Rightarrow$ T = 750 N

Breaking strength of string = 350 N

$\therefore$ String will break while monkey is moving upward

19. Two projectile thrown at 30^0 and 45^0 with the horizontal respectively, reach the maximum height in same time. The ratio of their initial velocities is

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

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

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. **Time taken to reach maximum height**

$$t = \frac{u\sin\theta}{g}$$

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

$$\Rightarrow u_1\sin 30 = u_2\sin 45$$

$$\Rightarrow \frac{u_1}{u_2} = \frac{1/\sqrt{2}}{1/2} = \frac{\sqrt{2}}{1}$$

20. A screw gauge of pitch 0.5mm is used to measure the diameter of uniform wire of length 6.8cm, the main scale reading is 1.5 mm and circular scale reading is 7. The calculated curved surface area of wire to appropriate significant figures is :

[Screw gauge has 50 divisions on the circular scale]

(A) $6.8cm^2$ (B) $3.4cm^2$

(C) $3.9cm^2$ (D) $2.4cm^2$

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. $L.C. = \frac{P}{N} = \frac{0.5mm}{50} = 0.01$ mm

Length of wire = 6.8 cm

Diameter of wire = 1.5 mm + 7 × L.C

= 1.5 mm + 7 × .01 = 1.57 mm

Curved surface area = $\pi D\ell$

$= 3.14 \times 6.8 \times 1.57 \times 10^{-1}\ cm^2$

$= 3.352\ cm^2 = 3.4\ cm^2$

SECTION-B

1. If the initial velocity in horizontal direction of a projectile is unit vector $\hat{i}$ and the equation of trajectory is $y = 5x(1-x)$. The y component vector of the initial velocity is ______ $\hat{j}$

(Take $g = 10 m/s^2$)

Official Ans. by NTA (5)

Allen Ans. (5)

Sol. $u_x = 1$

$y = 5x(1-x)$

$$\frac{dy}{dt} = 5\frac{dx}{dt} - 10x\frac{dx}{dt}$$

For initial y-component of velocity

$$u_y = \left(\frac{dy}{dt}\right)_{x=0} \Rightarrow 5(1) = 5$$

$$\vec{u}_y = 5\hat{j}$$

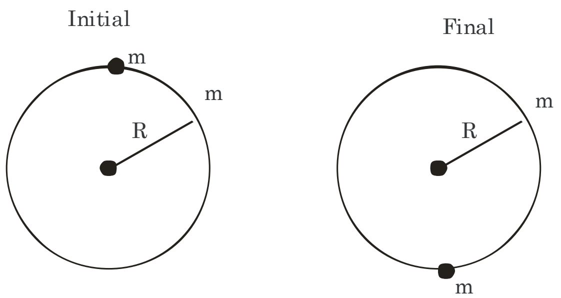
2. A disc of mass 1 kg and radius R is free of rotate about a horizontal axis passing through its centre and perpendicular to the plane of disc. A body of same mass as that of disc is fixed at the highest point of the disc. Now the system is released, when the body comes to the lowest position, its angular speed will be $4\sqrt{\frac{x}{3R}}$ rad s^{-1} where x = ______

$(g = 10ms^{-2})$

Official Ans. by NTA (5)

Allen Ans. (5)

Sol.



using conservation of mechanical energy

$$mg2R = \frac{1}{2}I_{disc}\,\omega^2 + \frac{1}{2}I_{particle}\omega^2$$

$$mg2R = \frac{\omega^2}{2}\left[\frac{mR^2}{2} + mR^2\right]$$

$$mg2R = \frac{\omega^2}{2}\frac{3}{2}mR^2$$

$$\frac{3}{4}\omega^2 = \frac{2g}{R}$$

$$\omega^2 = \frac{8g}{3R}$$

$$\omega = \sqrt{\frac{80}{3R}}$$

Given $\omega = 4\sqrt{\frac{x}{3R}}$

$$16\frac{x}{3R} = \frac{80}{3R}$$

$x = 5$

3. In an experiment of determine the Young's modulus of wire of a length exactly 1m, the extension in the length of the wire is measured as 0.4mm with an uncertainty of ± 0.02 mm when a load of 1kg is applied. The diameter of the wire is measured as 0.4mm with an uncertainty of ± 0.01 mm. The error in the measurement of Young's modulus (ΔY) is found to be $x \times 10^{10} Nm^{-2}$. The value of x is ______

[Take $g = 10m/s^2$]

Official Ans. by NTA (2)

Allen Ans. (2)

Sol. $L = 1m$

$\Delta L = 0.4 \times 10^{-3}$ m

$m = 1kg$

$d = 0.4 \times 10^{-3}m$

$$\frac{F}{A} = Y\frac{\Delta L}{L}$$

$$Y = \frac{FL}{A\Delta L} = \frac{(mg).(1)}{\left(\frac{\pi d^2}{4}\right)0.4\times10^{-3}}$$

$$\Rightarrow \frac{10\times4}{\pi\left(0.4\times10^{-3}\right)^2\times0.4\times10^{-3}}$$

$$Y = \frac{40}{\pi\left(0.4\times10^{-3}\right)^3}$$

$$Y = \frac{40\times7}{22\times64\times10^{-3}\times10^{-9}}$$

$Y = 0.199 \times 10^{-12}\ N/m^2$

$$\frac{\Delta Y}{Y} = \frac{\Delta F}{F}+\frac{\Delta L}{L}+\frac{\Delta A}{A}+\frac{\Delta(\Delta L)}{(\Delta L)}$$

$$= \frac{0.02}{0.4}+2\frac{\Delta d}{d} = \frac{0.2}{4}+2\times\frac{0.01}{0.4}$$

$$= \frac{0.1}{2}+\frac{0.1}{2} = 0.1$$

$$\Rightarrow \Delta Y = 0.1\times Y$$

$= 0.199\times10^{11} = 1.99\times10^{10}$

4. When a car is approaching the observer, the frequency of horn is 100Hz. After passing the observer, it is 50Hz. If the observer moves with the car, the frequency will be $\frac{x}{3}$ Hz where x = ___

Official Ans. by NTA (200)

Allen Ans. (200)

Sol. $$f_1 = 100 = f_0\left(\frac{C}{C-V_s}\right)$$

C = speed of sound

V_S = speed of source

$$f_2 = 50 = f_0\left(\frac{C}{C+V_s}\right)$$

$$\frac{f_1}{f_2} = 2 = \frac{C+V_s}{C-V_s}$$

$2C - 2V_s = C + V_s$

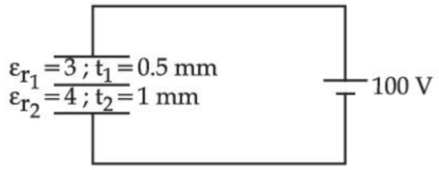
$3V_s = C$

$$V_S = \frac{C}{3}$$

$$100 = f_0\frac{C}{\frac{2C}{3}} = \frac{3}{2}f_0$$

$$f_0 = \frac{200}{3}$$

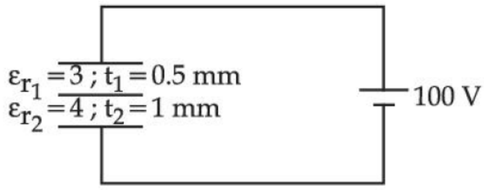
5. A composite parallel plate capacitor is made up of two different dielectric materials with different thickness $(t_1 \text{ and } t_2)$ as shown in figure. The two different dielectric material are separated by a conducting foil F. The voltage of the conducting foil is ____V.



Official Ans. by NTA (60)

Allen Ans. (60)

Sol.



Capacitance of each capacitor

$$C_1 = \frac{A3\epsilon_0}{\frac{1}{2}} = 6A\epsilon_0$$

$$C_2 = A4\epsilon_0 = 4A\epsilon_0$$

Equivalent capacitance

$$C_{eq} = \frac{C_1C_2}{C_1+C_2} \Rightarrow \frac{24}{10}A\epsilon_0$$

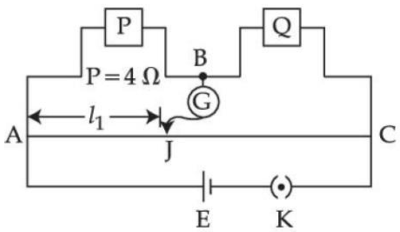
$$q_{net} = C_{eq}(\Delta V) \Rightarrow 240A\epsilon_0$$

$$\Delta V_2 = \frac{240\ A\epsilon_0}{4A\epsilon_0} = 60V$$

$(\Delta V_2 = \text{Potential drop across } C_2)$

$V_{foil} = 60V$

6. Resistance are connected in a meter bridge circuit as shown in the figure. The balancing length l_1 is 40cm. Now an unknown resistance x is connected in series with P and new balancing length is found to be 80cm measured from the same end. Then the value of x will be ______ Ω



Official Ans. by NTA (20)

Allen Ans. (20)

Sol. Initially, $\frac{P}{Q}=\frac{40cm}{60cm}=\frac{2}{3}$ ...(1)

Finally, $\frac{P+x}{Q}=\frac{80cm}{20cm}=\frac{4}{1}$ ...(2)

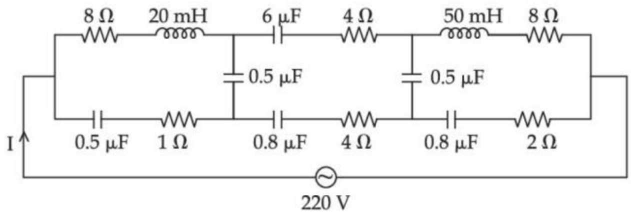
Divide (2) by (1)

$$\frac{P+x}{P}=4\times\frac{3}{2}=6$$

$\Rightarrow$ $1+\frac{x}{P}=6\Rightarrow\frac{x}{P}=5$

$\therefore$ $x = 5P = 5 \times 4 = 20\Omega$

7. The effective current I in the given circuit at very high frequencies will be ____A



Official Ans. by NTA (44)

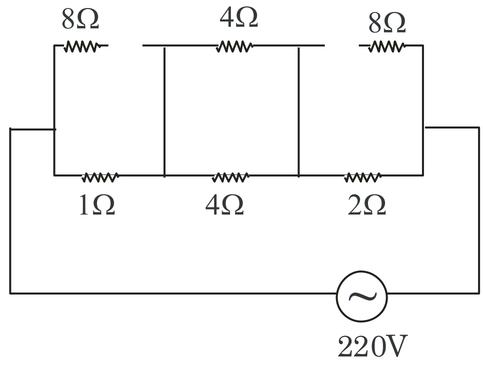
Allen Ans. (44)

Sol. At very high frequencies,

$$X_C=\frac{1}{\omega C}\approx 0$$

Also $X_L=\omega L\approx\infty$

Thus, equivalent circuit can be redrawn as

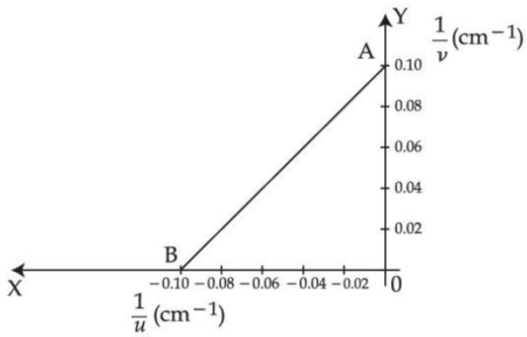


$Z = 1 + 2 + 2 = 5\Omega$

$$I=\frac{220V}{5\Omega}=44A$$

8. The graph between $\frac{1}{u}$ and $\frac{1}{v}$ for a thin convex lens in order to determine its focal length is plotted as shown in the figure. The refractive index of length is 1.5 and its both the surfaces have same radius of curvatures R. The value of R will be ____cm.

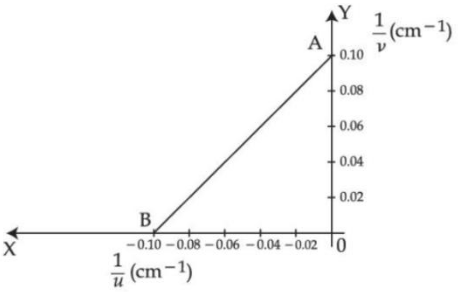
(Where u = object distance , v = image distance)



Official Ans. by NTA (10)

Allen Ans. (10)

Sol.



For point B, $\frac{1}{u} = -0.10\,\text{cm}^{-1}, \frac{1}{v} = 0$

$\therefore$ Thus, u = –10cm, v = ∞

i.e. f = 10 cm

$$\Rightarrow \quad \frac{1}{10\text{cm}} = (1.5-1)\left(\frac{2}{R}\right) = \frac{1}{R} \Rightarrow R = 10\text{cm}$$

9. In a hydrogen spectrum , λ be the wavelength of first transition line of Lyman series. The wavelength difference will be "aλ" between the wavelength of 3rd transition line of Paschen series and that of 2nd transition line of Balmer Series where a = ________

Official Ans. by NTA (5)

Allen Ans. (5)

Sol. For first line of Lyman

$$\frac{1}{\lambda} = R\left(1-\frac{1}{4}\right) = R\left(\frac{3}{4}\right)$$

$$\Rightarrow \quad \lambda = \frac{4}{3R} \quad \ldots(1)$$

3rd line(Paschen)

$$\frac{1}{\lambda_3} = R\left(\frac{1}{3^2}-\frac{1}{6^2}\right) = \frac{R}{9}\times\frac{3}{4}$$

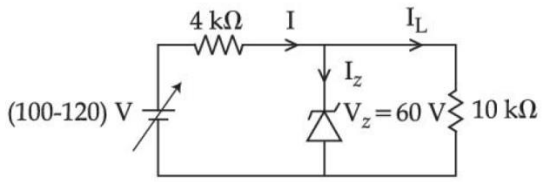
2nd line(Balmer)

$$\frac{1}{\lambda_2} = R\left(\frac{1}{2^2}-\frac{1}{4^2}\right) = \frac{R}{4}\times\frac{3}{4}$$

Thus $a\lambda = \lambda_3 - \lambda_2 = \frac{12}{R} - \frac{16}{3R} = \frac{20}{3R}$ putting (1)

$$a\left(\frac{4}{3R}\right) = \frac{20}{3R} \Rightarrow a = 5$$

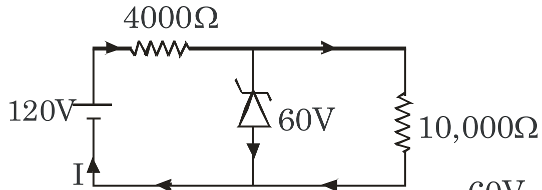
10. In the circuit shown below, maximum zener diode current will be ____mA



Official Ans. by NTA (9)

Allen Ans. (9)

Sol. Consider input 120V



$$I_L = \frac{60\text{V}}{10{,}000\Omega} = 0.006\text{A}$$

$$I = \frac{(120-60)\text{V}}{4000\Omega} = 0.015\text{A}$$

Thus $I_2 = I - I_L$

= 0.015 – 0.006 = 0.009 A = 9 mA