FINAL JEE–MAIN EXAMINATION – JULY, 2021

(Held On Sunday 25th July, 2021) **TIME : 3 : 00 PM to 6 : 00 PM**

PHYSICS — TEST PAPER WITH SOLUTION

SECTION-A

1. The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is : (When v stands for velocity)

(1) $2\,mv^3$ (2) $2\,mnv^3$
(3) $2nv^3$ (4) $2n^2v^3$

Official Ans. by NTA (1)

Sol. $t = mx^2 + nx$

$$\frac{1}{v} = \frac{dt}{dx} = 2mx + n$$

$$v = \frac{1}{2mx+n}$$

$$\frac{dv}{dt} = -\frac{2m}{(2mx+n)^2}\left(\frac{dx}{dt}\right)$$

$$a = -(2m)v^3$$

2. In a simple harmonic oscillation, what fraction of total mechanical energy is in the form of kinetic energy, when the particle is midway between mean and extreme position.

(1) $\frac{1}{2}$ (2) $\frac{3}{4}$ (3) $\frac{1}{3}$ (4) $\frac{1}{4}$

Official Ans. by NTA (2)

Sol. $$K = \frac{1}{2}m\omega^2\left(A^2 - x^2\right)$$

$$= \frac{1}{2}m\omega^2\left(A^2 - \frac{A^2}{4}\right)$$

$$= \frac{1}{2}m\omega^2\left(\frac{3A^2}{4}\right)$$

$$K = \frac{3}{4}\left(\frac{1}{2}m\omega^2A^2\right)$$

3. A force $\vec{F} = \left(40\hat{i} + 10\hat{j}\right)N$ acts on a body of mass 5 kg. If the body starts from rest, its position vector $\vec{r}$ at time t = 10 s, will be :

(1) $\left(100\hat{i} + 400\hat{j}\right)m$ (2) $\left(100\hat{i} + 100\hat{j}\right)m$

(3) $\left(400\hat{i} + 100\hat{j}\right)m$ (4) $\left(400\hat{i} + 400\hat{j}\right)m$

Official Ans. by NTA (3)

Sol. $$\frac{d\vec{v}}{dt} = \vec{a} = \frac{\vec{F}}{m} = \left(8\hat{i} + 2\hat{j}\right)m/s^2$$

$$\frac{d\vec{r}}{dt} = \vec{v} = \left(8t\,\hat{i} + 2t\,\hat{j}\right)m/s$$

$$\vec{r} = \left(8\hat{i} + 2\hat{j}\right)\frac{t^2}{2}m$$

At t = 10 sec

$$\vec{r} = \left[\left(8\hat{i} + 2\hat{j}\right)50\right]m$$

$$\Rightarrow \vec{r} = \left(400\hat{i} + 100\hat{j}\right)m$$

4. A prism of refractive index μ and angle of prism A is placed in the position of minimum angle of deviation. If minimum angle of deviation is also A, then in terms of refractive index

(1) $2\cos^{-1}\left(\frac{\mu}{2}\right)$ (2) $\sin^{-1}\left(\frac{\mu}{2}\right)$

(3) $\sin^{-1}\left(\sqrt{\frac{\mu-1}{2}}\right)$ (4) $\cos^{-1}\left(\frac{\mu}{2}\right)$

Official Ans. by NTA (1)

Sol. $$\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\mu = \frac{\sin\left(\frac{A+A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\mu = \frac{\sin A}{\sin\frac{A}{2}} = 2\cos\frac{A}{2}$$

$$A = 2\cos^{-1}\left(\frac{\mu}{2}\right)$$

5. A heat engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by 62°C, its efficiency get doubled. The temperature of the source is :

(1) 124°C (2) 37°C
(3) 62°C (4) 99°C

Official Ans. by NTA (4)

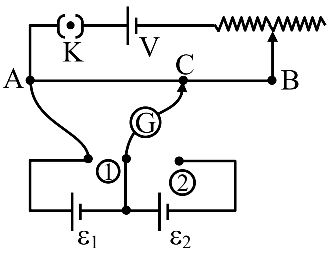
Sol. $\eta = 1 - \frac{T_L}{T_H}$ … (i)

$$2\eta = 1 - \frac{(T_L - 62)}{T_H} = 1 - \frac{T_L}{T_H} + \frac{62}{T_H}$$

$$\Rightarrow \eta = \frac{62}{T_H} \Rightarrow \frac{1}{6} = \frac{62}{T_H} \Rightarrow T_H = 6 \times 62 = 372K$$

In °C $\Rightarrow 372 - 273 = 99°C$

6. In the given potentiometer circuit arrangement, the balancing length AC is measured to be 250 cm. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes 400 cm. The ratio of the emf of two cells, $\frac{\varepsilon_1}{\varepsilon_2}$ is :



(1) $\frac{5}{3}$ (2) $\frac{8}{5}$ (3) $\frac{4}{3}$ (4) $\frac{3}{2}$

Official Ans. by NTA (1)

Sol. $E_1 = k\ell_1$ … (i)

$E_1 + E_2 = k\ell_2$ … (ii)

$$\frac{E_1}{E_1 + E_2} = \frac{\ell_1}{\ell_2} = \frac{250}{400} = \frac{5}{8}$$

$8E_1 = 5E_1 + 5E_2$

$3E_1 = 5E_2$

$$\frac{E_1}{E_2} = \frac{5}{3}$$

7. Two ions having same mass have charges in the ratio 1 : 2. They are projected normally in a uniform magnetic field with their speeds in the ratio 2 : 3. The ratio of the radii of their circular trajectories is :

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

Official Ans. by NTA (2)

Sol. $R = \frac{mv}{qB} \Rightarrow \frac{R_1}{R_2} = \frac{\frac{mv_1}{q_1B}}{\frac{mv_2}{q_2B}} = \frac{v_1}{q_1} \times \frac{q_2}{v_2} = \frac{q_2}{q_1} \times \frac{v_1}{v_2}$

$$= \frac{2}{1} \times \left(\frac{2}{3}\right) = \frac{4}{3}$$

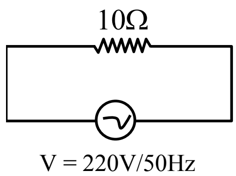
8. A 10Ω resistance is connected across 220V – 50Hz AC supply. The time taken by the current to change from its maximum value to the rms value is:

(1) 2.5 ms (2) 1.5 ms

(3) 3.0 ms (4) 4.5 ms

Official Ans. by NTA (1)

Sol.



$\Rightarrow i = i_0 \sin\omega t$

When $i = i_0$

$$i_0 = i_0 \sin \omega t_1 \Rightarrow \omega t_1 = \frac{\pi}{2} \text{ … (i)}$$

When $i = \frac{i_0}{\sqrt{2}}$

$$\frac{i_0}{\sqrt{2}} = i_0 \sin \omega t_2 \Rightarrow \omega t_2 = \frac{\pi}{4} \text{ … (ii)}$$

Time taken by current from maximum value to rms value

$$\Rightarrow (t_1 - t_2) = \frac{\pi}{2\omega} - \frac{\pi}{4\omega} = \frac{\pi}{4\omega} = \frac{\pi}{4 \times 2\pi f}$$

$$= \frac{1}{8 \times 50}$$

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

= 2.5 ms

9. A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around :

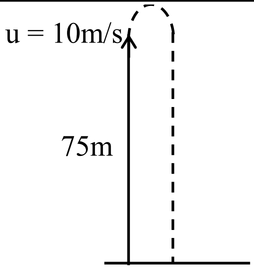
(takes the value of g as 10 m/s^2)

(1) 300 m (2) 200 m

(3) 125 m (4) 250 m

Official Ans. by NTA (3)

Sol.



Object is projected as shown so as per motion under gravity

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

$$-75 = +10t + \frac{1}{2}(-10)t^2 \Rightarrow t = 5 \text{ sec}$$

Object takes t = 5 s to fall on ground

Height of balloon from ground

H = 75 + ut

= 75 + 10 × 5 = 125 m

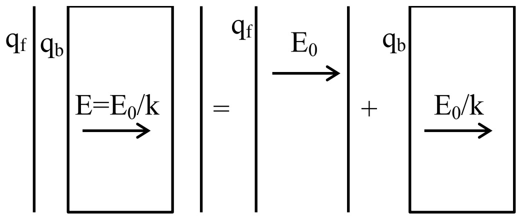
10. If q_f is the free charge on the capacitor plates and q_b is the bound charge on the dielectric slab of dielectric constant k placed between the capacitor plates, then bound charge q_b can be expressed as :

(1) $q_b = q_f\left(1 - \frac{1}{\sqrt{k}}\right)$ (2) $q_b = q_f\left(1 - \frac{1}{k}\right)$

(3) $q_b = q_f\left(1 + \frac{1}{\sqrt{k}}\right)$ (4) $q_b = q_f\left(1 + \frac{1}{k}\right)$

Official Ans. by NTA (2)

Sol.



When a dielectric is inserted in a capacitor

Due to free charge $\vec{E} = \vec{E}_0$ only

After dielectric $E' = \frac{E_0}{k}$

$$q_B = q_f\left(1 - \frac{1}{k}\right)$$

11. Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is W, the weight of the same object on that planet will be :

(1) 2W (2) W (3) $2^{\frac{1}{3}}$ W (4) $\sqrt{2}$ W

Official Ans. by NTA (3)

Sol. Density is same

$$M = \frac{4}{3}\pi R^3\rho,\ 2m = \frac{4}{3}\pi R'^3\rho$$

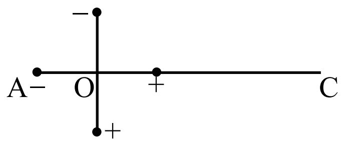
$$R' = 2^{1/3}R$$

$$\omega = \frac{GMm}{R^2}$$

$$\omega_2 = \frac{G2Mm}{R'^2}$$

$$\omega_2 = 2^{1/3}\omega$$

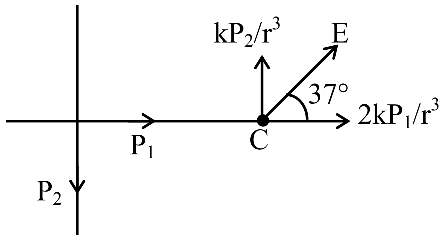
12. Two ideal electric dipoles A and B, having their dipole moment p_1 and p_2 respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of 37° with the axis. The ratio of the dipole moment of A and B, $\frac{p_1}{p_2}$ is : (take sin 37° = $\frac{3}{5}$)



(1) $\frac{3}{8}$ (2) $\frac{3}{2}$ (3) $\frac{2}{3}$ (4) $\frac{4}{3}$

Official Ans. by NTA (3)

Sol.



$$\tan 37° = \frac{3}{4} = \frac{\frac{kP_2}{r^3}}{\frac{2kP_1}{r^3}} = \frac{P_2}{2P_1} = \frac{3}{4}$$

$$\frac{P_2}{P_1} = \frac{3}{2}$$

$$\frac{P_1}{P_2} = \frac{2}{3}$$

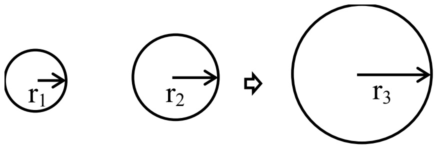
13. Two spherical soap bubbles of radii r_1 and r_2 in vacuum combine under isothermal conditions. The resulting bubble has a radius equal to :

(1) $\frac{r_1 r_2}{r_1 + r_2}$ (2) $\sqrt{r_1 r_2}$

(3) $\sqrt{r_1^2 + r_2^2}$ (4) $\frac{r_1 + r_2}{2}$

Official Ans. by NTA (3)

Sol.



no. of moles is conserved

$n_1 + n_2 = n_3$

$P_1V_1 + P_2V_2 = P_3V$

$$\frac{4S}{r_1}\left(\frac{4}{3}\pi r_1^3\right) + \frac{4S}{r_2}\left(\frac{4}{3}\pi r_2^3\right) = \frac{4S}{r_3}\left(\frac{4}{3}\pi r_3^3\right)$$

$$r_1^2 + r_2^2 = r_3^2$$

$$r_3 = \sqrt{r_1^2 + r_2^2}$$

14. The force is given in terms of time t and displacement x by the equation

F = A cos Bx + C sin Dt

The dimensional formula of $\frac{AD}{B}$ is :

(1) $[M^0 L T^{-1}]$ (2) $[M L^2 T^{-3}]$

(3) $[M^1 L^1 T^{-2}]$ (4) $[M^2 L^2 T^{-3}]$

Official Ans. by NTA (2)

Sol. $[A] = [MLT^{-2}]$

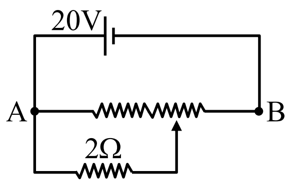
$[B] = [L^{-1}]$

$[D] = [T^{-1}]$

$$\left[\frac{AD}{B}\right] = \frac{[MLT^{-2}][T^{-1}]}{[L^{-1}]}$$

$$\left[\frac{AD}{B}\right] = [ML^2T^{-3}]$$

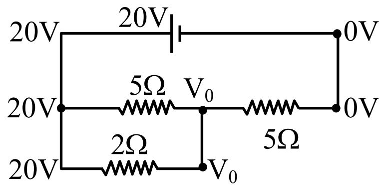
15. The given potentiometer has its wire of resistance 10Ω. When the sliding contact is in the middle of the potentiometer wire, the potential drop across 2Ω resistor is :



(1) 10 V (2) 5 V (3) $\frac{40}{9}$ V (4) $\frac{40}{11}$ V

Official Ans. by NTA (3)

Sol.



$$\frac{20 - V_0}{5} + \frac{0 - V_0}{5} + \frac{20 - V_0}{2} = 0$$

$$4 + 10 = \frac{2V_0}{5} + \frac{V_0}{2}$$

$$14 = \frac{4V_0 + 5V_0}{10}$$

$$V_0 = \frac{140}{9}\text{Volt}$$

Potential difference across 2Ω resistor is $20 - V_0$

That is $\left(20 - \frac{140}{9}\right)$Volt

Hence answer is $\left(\frac{40}{9}\right)$Volt

16. An electron moving with speed v and a photon moving with speed c, have same D-Broglie wavelength. The ratio of kinetic energy of electron to that of photon is :

(1) $\frac{3c}{v}$ (2) $\frac{v}{3c}$ (3) $\frac{v}{2c}$ (4) $\frac{2c}{v}$

Official Ans. by NTA (3)

Sol. $\lambda_e = \lambda_{Ph}$

$$\frac{h}{p_e} = \frac{h}{p_{ph}}$$

$$\sqrt{2mk_e} = \frac{E_{ph}}{c}$$

$$2mk_e = \frac{(E_{ph})^2}{c^2}$$

$$\frac{k_e}{E_{ph}} = \frac{E_{ph}}{c^2}\left(\frac{1}{2m}\right)$$

$$= \frac{p_{ph}}{c}\left(\frac{1}{2m}\right)$$

$$= \frac{p_e}{c}\left(\frac{1}{2m}\right)$$

$$= \frac{mv}{c}\frac{1}{2m}$$

$$= \frac{v}{2c}$$

17. The instantaneous velocity of a particle moving in a straight line is given as $v = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is :

(1) $3\alpha + 7\beta$ (2) $\frac{3}{2}\alpha + \frac{7}{3}\beta$

(3) $\frac{\alpha}{2} + \frac{\beta}{3}$ (4) $\frac{3}{2}\alpha + \frac{7}{2}\beta$

Official Ans. by NTA (2)

Sol. $V = \alpha t + \beta t^2$

$$\frac{ds}{dt} = \alpha t + \beta t^2$$

$$\int_{S_1}^{S_2} ds = \int_1^2 \left(\alpha t + \beta t^2\right) dt$$

$$S_2 - S_1 = \left[\frac{\alpha t^2}{2} + \frac{\beta t^3}{3}\right]_1^2$$

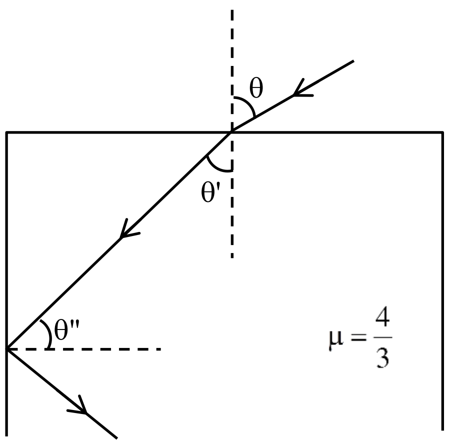
As particle is not changing direction

So distance = displacement.

$$\text{Distance} = \left[\frac{\alpha[4-1]}{2} + \frac{\beta[8-1]}{3}\right]$$

$$= \frac{3\alpha}{2} + \frac{7\beta}{3}$$

18. A ray of light entering from air into a denser medium of refractive index $\frac{4}{3}$, as shown in figure. The light ray suffers total internal reflection at the adjacent surface as shown. The maximum value of angle θ should be equal to :

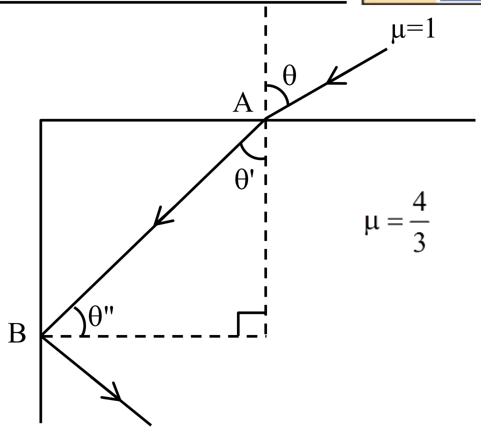


(1) $\sin^{-1}\frac{\sqrt{7}}{3}$ (2) $\sin^{-1}\frac{\sqrt{5}}{4}$

(3) $\sin^{-1}\frac{\sqrt{7}}{4}$ (4) $\sin^{-1}\frac{\sqrt{5}}{3}$

Official Ans. by NTA (1)

Sol.



At maximum angle θ ray at point B goes in gazing emergence, at all less values of θ, TIR occurs.

At point B

$$\frac{4}{3} \times \sin\theta'' = 1 \times \sin 90°$$

$$\theta'' = \sin^{-1}\left(\frac{3}{4}\right)$$

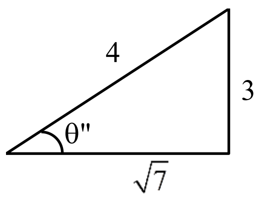
$$\theta' = \left(\frac{\pi}{2} - \theta''\right)$$

At point A

$$1 \times \sin\theta = \frac{4}{3} \times \sin\theta'$$

$$\sin\theta = \frac{4}{3} \times \sin\left(\frac{\pi}{2} - \theta''\right)$$

$$\sin\theta = \frac{4}{3}\cos\left[\cos^{-1}\frac{\sqrt{7}}{4}\right]$$



$$\sin\theta = \frac{4}{3} \times \frac{\sqrt{7}}{4}$$

$$\theta = \sin^{-1}\left(\frac{\sqrt{7}}{3}\right)$$

19. When radiation of wavelength λ is incident on a metallic surface, the stopping potential of ejected photoelectrons is 4.8 V. If the same surface is illuminated by radiation of double the previous wavelength, then the stopping potential becomes 1.6 V. The threshold wavelength of the metal is :

(1) 2λ (2) 4λ (3) 8λ (4) 6λ

Official Ans. by NTA (2)

Sol. $V_S = h\nu - \phi$

$$4.8 = \frac{hc}{\lambda} - \phi \quad \ldots (i)$$

$$1.6 = \frac{hc}{2\lambda} - \phi \quad \ldots (ii)$$

Using above equation (i) – (ii)

$$3.2 = \frac{hc}{\lambda} - \frac{hc}{2\lambda}$$

$$3.2 = \frac{hc}{2\lambda} \quad \ldots (iii)$$

$$\left[\lambda = \frac{hc}{6.4}\right]$$

Put in equation (ii)

$\phi = 1.6$

$$\frac{hc}{\lambda_{th}} = 1.6$$

$$\lambda_{th} = \frac{hc}{1.6}$$

$$= \left(\frac{hc}{6.4}\right) \times 4 = 4\lambda$$

20. Two vectors $\vec{X}$ and $\vec{Y}$ have equal magnitude. The magnitude of $(\vec{X} - \vec{Y})$ is n times the magnitude of $(\vec{X} + \vec{Y})$. The angle between $\vec{X}$ and $\vec{Y}$ is :

(1) $\cos^{-1}\left(\frac{-n^2-1}{n^2-1}\right)$ (2) $\cos^{-1}\left(\frac{n^2-1}{-n^2-1}\right)$

(3) $\cos^{-1}\left(\frac{n^2+1}{-n^2-1}\right)$ (4) $\cos^{-1}\left(\frac{n^2+1}{n^2-1}\right)$

Official Ans. by NTA (2)

Sol. Given X = Y

$$\sqrt{X^2 + Y^2 - 2 \times Y \cos\theta}$$

$$= n\sqrt{X^2 + Y^2 + 2 \times Y \cos\theta}$$

Square both sides

$$2X^2(1 - \cos\theta) = n^2.2X^2(1 + \cos\theta)$$

$$1 - \cos\theta = n^2 + n^2\cos\theta$$

$$\cos\theta = \frac{1-n^2}{1+n^2}$$

$$\theta = \cos^{-1}\left[\frac{n^2-1}{-n^2-1}\right]$$

SECTION-B

1. A system consists of two types of gas molecules A and B having same number density 2×10^{25} / m^3. The diameter of A and B are 10 Å and 5 Å respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is _______ $\times 10^{-2}$

Official Ans. by NTA (25)

Sol. $\because$ mean free path

$$\lambda = \frac{1}{\sqrt{2}\pi d^2 n}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{d_2^2 n_2}{d_1^2 n_1}$$

$$= \left(\frac{5}{10}\right)^2 = 0.25 = 25 \times 10^{-2}$$

2. A light beam of wavelength 500 nm is incident on a metal having work function of 1.25 eV, placed in a magnetic field of intensity B. The electrons emitted perpendicular to the magnetic field B, with maximum kinetic energy are bent into circular arc of radius 30 cm. The value of B is _______ $\times 10^{-7}$ T.

Given hc = 20×10^{-26} J-m, mass of electron $= 9 \times 10^{-31}$ kg

Official Ans. by NTA (125)

Sol. By photoelectric equation

$$\frac{hc}{\lambda} - \phi = k_{max}$$

$$k_{max} = \frac{1240}{500} - 1.25 \approx 1.25$$

$$r = \frac{\sqrt{2mk}}{eB}$$

$$B = \frac{\sqrt{2mk}}{er}$$

$= 125 \times 10^{-7}$T

3. A message signal of frequency 20 kHz and peak voltage of 20 volt is used to modulate a carrier wave of frequency 1 MHz and peak voltage of 20 volt. The modulation index will be :

Official Ans. by NTA (1)

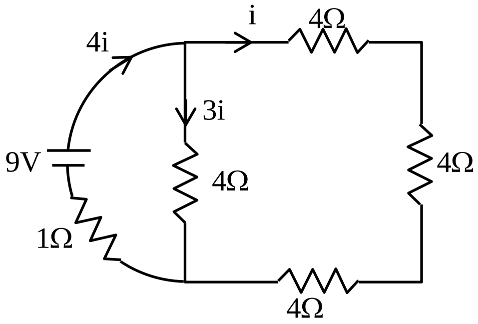
Sol. Modulation index

$$\mu = \frac{A_m}{A_c} = \frac{20}{20} = 1$$

4. A 16 Ω wire is bend to form a square loop. A 9V supply having internal resistance of 1 Ω is connected across one of its sides. The potential drop across the diagonals of the square loop is ________ $\times 10^{-1}$ V

Official Ans. by NTA (45)

Sol. here assume current as



By KVL in outer loop

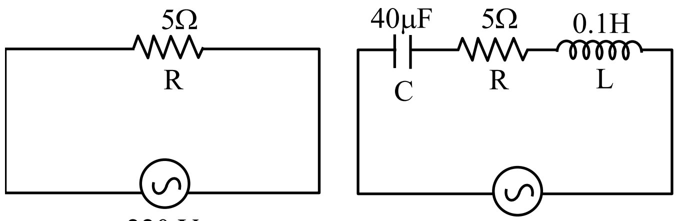
$9 - 12i - 4i = 0$

$16i = 9$

$8i = \frac{9}{2} = 4.5$

$= 45 \times 10^{-1}$

5. Two circuits are shown in the figure (a) & (b). At a frequency of _______ rad/s the average power dissipated in one cycle will be same in both the circuits.



220 V figure (a)

220 V figure (b)

Official Ans. by NTA (500)

Sol. For figure (a)

$$P_{avg} = \frac{V_{rms}^2}{R}$$

$$\frac{V_{rms}^2}{Z^2} \times R = \frac{V_{rms}^2}{R} \times 1$$

$$R^2 = Z^2$$

$$25 = \left(\sqrt{(x_C - x_L)^2 + 5^2}\right)^2$$

$$25 = (x_c - x_L)^2 + 25$$

$$x_c = x_L \Rightarrow \frac{1}{\omega C} = \omega L$$

$$\omega^2 = \frac{1}{LC} = \frac{10^6}{0.1 \times 40}$$

$$\omega = 500$$

6. From the given data, the amount of energy required to break the nucleus of aluminium $^{27}_{13}Al$ is _____ x $\times 10^{-3}$ J.

Mass of neutron = 1.00866 u

Mass of proton = 1.00726 u

Mass of Aluminium nucleus = 27.18846 u

(Assume 1 u corresponds to x J of energy)

(Round off to the nearest integer)

Official Ans. by NTA (27)

Sol. $\Delta m = (Zm_P + (A - Z)m_n) - M_{A\ell}$

$= (13 \times 1.00726 + 14 \times 1.00866) - 27.18846$

$= 27.21562 - 27.18846$

$= 0.02716$ u

$E = 27.16\, x \times 10^{-3}$ J

7. A force of $F = (5y + 20)\hat{j}$ N acts on a particle. The workdone by this force when the particle is moved from y = 0 m to y = 10 m is ______ J.

Official Ans. by NTA (450)

Sol. $F = (5y + 20)\hat{j}$

$$\omega = \int F dy = \int_0^{10} (5y + 20) dy$$

$$= \left(\frac{5y^2}{2} + 20y\right)_0^{10}$$

$$= \frac{5}{2} \times 100 + 20 \times 10$$

$= 250 + 200 = 450$ J

8. A solid disc of radius 20 cm and mass 10 kg is rotating with an angular velocity of 600 rpm, about an axis normal to its circular plane and passing through its centre of mass. The retarding torque required to bring the disc at rest in 10 s is _____ $\pi \times 10^{-1}$ Nm.

Official Ans. by NTA (4)

Sol. $\tau = \frac{\Delta L}{\Delta t} = \frac{I(\omega_f - \omega_i)}{\Delta t}$

$$\tau = \frac{\frac{mR^2}{2} \times [0 - \omega]}{\Delta t}$$

$$= \frac{10 \times (20 \times 10^{-2})^2}{2} \times \frac{600 \times \pi}{30 \times 10}$$

$= 0.4\pi = 4\pi \times 10^{-2}$

9. In a semiconductor, the number density of intrinsic charge carriers at 27°C is $1.5 \times 10^{16} / m^3$. If the semiconductor is doped with impurity atom, the hole density increases to $4.5 \times 10^{22} / m^3$. The electron density in the doped semiconductor is _______ $\times 10^9/m^3$.

Official Ans. by NTA (5)

Sol. $n_e n_h = n_i^2$

$$n_e = \frac{n_i^2}{n_h} = \frac{(1.5\times10^{16})^2}{4.5\times10^{22}}$$

$$= \frac{1.5\times1.5\times10^{32}}{4.5\times10^{22}}$$

$5 \times 10^9 /m^3$

10. The nuclear activity of a radioactive element becomes $\left(\frac{1}{8}\right)^{th}$ of its initial value in 30 years. The half-life of radioactive element is ________ years.

Official Ans. by NTA (10)

Sol. $A = A_0 e^{-\lambda t}$

$$\frac{A_0}{8} = A_0 e^{-\lambda t} \Rightarrow \lambda t = \ln 8$$

$\lambda t = 3\ln 2$

$$\frac{\ln 2}{\lambda} = \frac{t}{3} = \frac{30}{3} = 10 \text{ years}$$