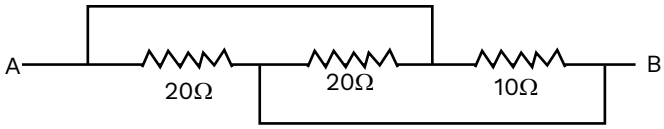
PHYSICS

1. Find the equivalent resistance of the given circuit :



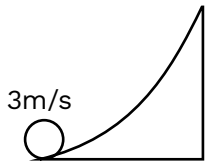
Ans. 5 Ω

Sol. $\frac{1}{R}=\frac{1}{20}+\frac{1}{20}+\frac{1}{10}$

$=\frac{1+1+2}{20}=\frac{4}{20}=\frac{1}{5}$

R = 5 Ω

2. Find out the maximum height achieved by a hollow spherical ball moving with a velocity of 3 m/s as shown in the figure.



Ans. $\frac{3}{4}$

Sol. Wall = $K_f - K_i$

$-mgh = 0-\left(\frac{1}{2}mv^2+\frac{1}{2}I\omega^2\right)$

$mgh=\left(\frac{1}{2}mv^2+\frac{1}{2}\times\frac{2}{3}mR^2\omega^2\right)$

$gh=\frac{v^2}{2}+\frac{v^2}{3}$

$h=\frac{5v^2}{6g}=\frac{3}{4}$

3. Find the value of maximum height attained by the body. Given the equation of trajectory is:

$y=x-\frac{x^2}{20}$

Ans. 5

Sol. for y_{max}

$\frac{dy}{dx}=0$

$1-\frac{2x}{20}=0$

$x=10$

y = 10 – 5 = 5

4. A bullet of mass 0.1 kg moving with speed 400 m/s strikes a block of mass 3.9 kg kept on the surface. Combined system comes at rest after travelling a distance of 20 m. Find the coefficient of friction between block and surface.

Ans. 0.25

Sol. $P_i = P_f$

$0.1 \times 400 = 4 \times u$

$u = 10$ m/s .....(1)

$v^2 = u^2 + 2as$

$0 = 100 + 2 \times a \times 20$

$a = -2.5$ m/s^2 .....(2)

$a = -\mu_k g$

$\mu_k = 0.25$

5. A carnot engine, operating between hot reservoir of temperature $T_1 = 127°C$ and cold reservoir of temperature $T_2 = 27°C$. If work done by the gas in this process is 2000J, then the heat supplied to the reservoir will be :

Ans. 8000J

Sol. $$\eta = 1 - \frac{T_c}{T_H} = \frac{w}{Q_{supp}}$$

$$1 - \frac{300}{400} = \frac{2000}{Q_{supp}}$$

$Q_{supp} = 8000$J

6. What will be the value of effective gravitational acceleration constant at a height, h <<< R. Here, h is distance from the surface of earth and R is radius of earth.

Sol. $$g' = \frac{g_0}{\left(1+\frac{h}{R}\right)^2} \simeq g_0\left(1-\frac{2h}{R}\right)$$

7. Statement 1: Area under $\vec{v}$-t curve gives distance travelled by particle

Statement 2: Area under $\vec{a}$-t curve gives change in velocity of particle

Ans. FT

Sol. Area under velocity time graph gives displacement and area under acceleration time graph gives change in velocity

8. Power radiated by a linear antenna of length l at wave length λ is directly proportional to:

Ans. $\left(\frac{\ell}{\lambda}\right)^2$

9. In Balmer series of a H-atom, the ratio of wavelength of L_α and L_β line is:

Ans. $\frac{20}{27}$

Sol. $$\frac{1}{\lambda} = Z^2R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda_1} = Z^2R\left(\frac{1}{4} - \frac{1}{9}\right) = Z^2R\left(\frac{5}{36}\right)$$

$$\frac{1}{\lambda_2} = Z^2R\left(\frac{1}{4} - \frac{1}{16}\right) = Z^2R\left(\frac{3}{16}\right)$$

$$\frac{\lambda^2}{\lambda_1} = \frac{5}{16} / \frac{3}{16} = \frac{5}{36} \times \frac{16}{3} = \frac{20}{27}$$

10. Fringe width in YDSE for a light of wavelength 400 nm is 2mm. Find the fringe width if wavelength is 600 nm.

Ans. 3 mm

Sol. $W = \frac{D\lambda}{d}$

$2 = \frac{D \times 400}{d}$

$W' = \frac{D \times 600}{d}$

$\frac{w'}{2} = \frac{6}{4}$

W' = 3 mm

11. Kinetic Energy of O_2 gas at 300K is x. Find the temperature at which the K.E. will be 2x.

Ans. 600K

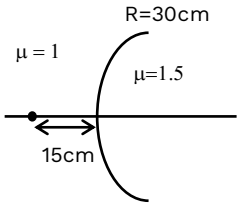
Sol. $K \propto T$

$\frac{K_2}{K_1} = \frac{T_2}{T_1}$

$\frac{2x}{x} = \frac{T_2}{300}$

$T_2 = 600K$

12. A point object is in front of a curved refractive surface of radius of curvature 30 cm at a distance of 15 cm. Find the position of image.



Ans. 30cm

Sol. $\frac{1.5}{V} - \frac{1}{-15} = \frac{1.5-1}{30}$

$\frac{1.5}{V} = \frac{1}{60} - \frac{1}{15}$

V = – 30cm

13. Find the distance of the point where electric potential due to a charge 5×10^{-9} C is 50 V. ($K = 9 \times 10^9$ N m^2/C^2)

Ans. 0.9m

Sol. $V = \frac{Kq}{r}$

$50 = \frac{9 \times 10^9 \times 5 \times 10^{-9}}{r}$

$r = \frac{45}{50} = 0.9m$

14. Statement – 1: Electromagnet have soft iron core.
Statement – 2: Soft iron have high retentivity and low coercivity.

Ans. TF

15. A conducting rod of length 10 cm is moving in a uniform magnetic field B = 0.4 T. If motional emf induced across the end of rod is 0.08V, then find the speed of rod.

Ans. 2 m/s

Sol. $\varepsilon = Blv$

$0.08 = 0.4 \times 0.1 \times v$

$v = 2$ m/s

16. In a LCR series circuit, R = 100 Ω, L = 1H, C = 6.25 μF. Find the quality factor.

Ans. 4

Sol. $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

$= \frac{1}{100}\sqrt{\frac{1}{6.25 \times 10^{-6}}}$

$= \frac{1}{100}\sqrt{\frac{10^8}{625}}$

$= \frac{10_4}{100 \times 25}$

$Q = 4$

17. Which rays are emitted when a metal is bombarded with high speed e^-?

Ans. x-rays

18. Match the following

	Physical quantity	Dimension formula
(i)	Torque	(P) $ML T^{-1}$
(ii)	Stress	(Q) $ML^{-1} T^{-1}$
(ii)	Coefficient of viscosity	(R) $ML^{-1} T^{-2}$
(iv)	Young's modulus of elasticity	(S) $ML^2 T^{-2}$

Ans. i-S, ii-R, iii-Q, iv-R

Sol. $[\tau] = ML^2T^{-2}$

$[\sigma] = ML^{-1}T^{-2}$

$[\eta] = ML^{-1}T^{-1}$

$[\gamma] = ML^{-1}T^{-2}$

19. Which of the following electromagnetic wave has the highest energy?

(A) x-ray (B) Infrared

(C) Microwave (D) Radio wave

Ans. (A)

20. In a nuclei sample, if after 5 days number of nuclei left is 8×10^3, find the initial number of nuclei. Given that in 3 days nuclei become $\frac{1}{8^{th}}$ of their initial amount.

Ans. 256×10^3

Sol. $N = \frac{N_0}{(2)^n}$

$$8\times10^{3}=\frac{N_0}{(2)^5}$$

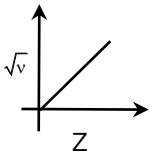
$$N_0=8\times10^{3}\times32$$

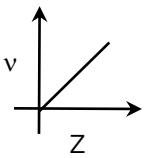
$N_0 = 256 \times 10^{-3}$

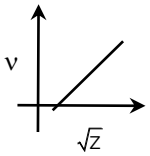
21. In a conducting wire of cross section area X mm^2, current flowing is 2 A. If the number of electrons flowing per unit volume is Y, find the drift velocity. (In terms of e)

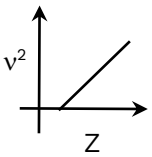
Ans. $\frac{2}{eXY}$

22. According to Mosley's law, which of the following graph is correct -

(A) 

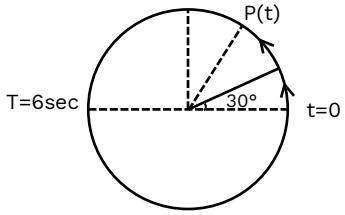
(B) 

(C) 

(D) 

Ans. (A)

23. Write the equation of SHM if it's projection is given by the following diagram ?



Ans. $R\sin\left(\omega t+\frac{\pi}{6}\right)$

24. A body of mass 5 kg has initial linear momentum of 10 kg m/s is acted upon by a force of 2 N for 5 sec. The change in kinetic energy in joules is:

Ans. 81.6J

Sol. m = 5 kg

$P = mv_1 = 100$ kg ms^{-1}

$$v_1=\frac{100}{5}=20\ m/s$$

F = 2N

$$a=\frac{F}{m}$$

$$a=\frac{2}{5}$$

$a = 0.4\ m/sec^2$

$\Delta t = 2sec$

$$\Delta x = v_1t + \frac{1}{2}at^2$$

$\Delta x = 20(2) + \frac{1}{2}(0.4)(2)^2$

$\Delta x = 40 + 0.8 = 40.8$

$W = F \times \Delta x = 2 \times 40.8J$

$W = \Delta KE = 81.6J$

25. Find the change in energy stored in a capacitor of 600 pF capacitance charged at 50 V, once connected with another 600 pF uncharged capacitor.

Ans. 0.56 μJ

Sol. $\frac{1}{2} \times 600\,pF\left[50^2 - 25^2\right] = 0.56\ \mu J$

26. If a satellite is orbiting the earth at a distance h from the center of the earth has angular momentum L. Then, find the angular momentum of the same satellite if it is orbiting at a distance 10h.

Ans. $L' = \sqrt{10}\,L$

Sol. $L = mvr = m\sqrt{\frac{GM}{r}} \times r$

$= m\sqrt{GMr}$

$L \propto \sqrt{r}$

$\Rightarrow \frac{L'}{L} = \sqrt{\frac{10h}{h}}$

$L' = \sqrt{10}\,L$

27. The ratio of magnetic field due to coil at centre and at a distance of R form the centre on the axis passing through the centre and perpendicular to the plane of ring is $\sqrt{x} : 1$ (R is the radius of coil), find the value of x

Ans. 8

Sol. $B_1 = \frac{\mu_0 I}{2R}$

$B_2 = \frac{\mu_0}{4\pi} \times \frac{2i \times \pi R^2}{\left(R^2 + R^2\right)^{3/2}}$

$\frac{B_1}{B_2} = \sqrt{\frac{8}{1}}$

28. Write the number of significant digits in 0024.200

Ans. 5

29. A block moving with speed 1 m/s comes to rest after moving for 20 cm over a rough surface. The coefficient of friction between the block and surface.

Ans. 0.25

30. Find the moment of inertia of solid sphere about an axis along the tangent.

Ans. $\frac{7MR^2}{5}$