# PHYSICS

## SECTION - A

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

**Choose the correct answer:**

1. In a simple pendulum of length 10 m, string is initially kept horizontal and the bob is released. 10% of energy is lost till the bob reaches lowermost position. Then find speed of bob at lowermost position.

(1) 6 m/s

(2) $6\sqrt{5}$ m/s

(3) $7\sqrt{5}$ m/s

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

**Answer (2)**

**Sol.** $W_{total} = \Delta K$

$\Rightarrow \quad 0.9mgl = \frac{1}{2}mv^2$

$\Rightarrow \quad v = \sqrt{1.8\times10\times10}$

$= 6\sqrt{5}$ m/s

2. The intensity at each slit are equal for a YDSE and it is maximum ($I_{max}$) at central maxima. If $I$ is intensity for phase difference $\frac{7\pi}{2}$ between two waves (at screen).

Then $\frac{I}{I_{max}}$ is

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

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

**Answer (1)**

**Sol.** $I = I_{max}\cos^2\left(\frac{\Delta\phi}{2}\right)$

$\frac{I}{I_{max}} = \cos^2\frac{7\pi}{4} \qquad \because \ \Delta\phi = \frac{7\pi}{2}$

$\frac{I}{I_{max}} = \cos^2\left(\frac{\pi}{4}\right) = \frac{1}{2}$

3. An electromagnetic wave has electric field given by $\vec{E} = (9.6\hat{j})\sin\left[2\pi\left\{30\times10^6 t - \frac{1}{10}x\right\}\right]$, $x$ and $t$ are in SI units. The maximum magnetic field is

(1) $3.2 \times 10^{-8}$

(2) $9.6 \times 10^{-8}$

(3) $1.7 \times 10^{-8}$

(4) $10^{-7}$

**Answer (1)**

**Sol.** $\frac{E}{B} = C$

$\Rightarrow \quad B = \frac{E}{C} = 3.2\times10^{-8}$

4. A planet at distance $r$ from sun takes 200 days to complete one revolution around sun. What will be time period for a planet at distance $\frac{r}{4}$ from the sun?

(1) 50 days

(2) 25 days

(3) 100 days

(4) 12.5 days

**Answer (2)**

**Sol.** $T^2 \propto R^3$

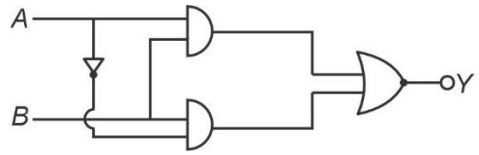
$\frac{200^2}{T^2} = \frac{r^3}{\left(\frac{r}{4}\right)^3}$

$\frac{200}{T} = (4)^{\frac{3}{2}}$

$\frac{200}{8} = T$

$\Rightarrow \quad T = 25$ days

5. The truth table for the combination of logical gates




(1)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

(2)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

(3)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

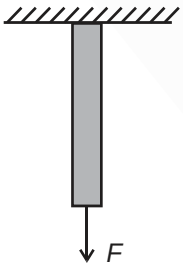
(4)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

**Answer (3)**

**Sol.** $Y = A \cdot B + \overline{A} \cdot B = B(A + \overline{A}) = B$

6. A uniform wire has length $L$ and radius $r$. It is acted on by a force $F$ as shown. The elongation is $\Delta l$. If $F$ and $r$ are both halved, the new elongation will be :




(1) $\frac{\Delta l}{2}$

(2) $\Delta l$

(3) $4\Delta l$

(4) $2\Delta l$

**Answer (4)**

**Sol.** $\Delta l = \frac{FL}{Ay} \propto \frac{F}{r^2}$

$\Rightarrow \Delta l' = \frac{\frac{1}{2}}{\left(\frac{1}{2}\right)^2}\Delta l = 2\Delta l$

7. Two forces $F_1$ and $F_2$ are applied on two rods $P$ and $Q$ of same materials such that elongation in rods are same. If ratio of their radii is $x : y$ and ratio of length is $m : n$, then ratio of $F_1 : F_2$ is

(1) $\left(\frac{y}{x}\right)^2 \frac{n}{m}$

(2) $\left(\frac{x}{y}\right)^2 \cdot \frac{n}{m}$

(3) $\left(\frac{x}{y}\right)^2 \cdot \frac{m}{n}$

(4) $\left(\frac{y}{x}\right)^2 \cdot \left(\frac{m}{n}\right)$

**Answer (2)**

**Sol.** $\Delta l_1 = \frac{F_1 l_1}{YA_1}, \Delta l_2 = \frac{F_2 l_2}{YA_2}$

$\frac{F_1}{F_2} = \frac{A_1}{A_2} \times \frac{l_2}{l_1} = \left(\frac{r_1}{r_2}\right)^2 \left(\frac{l_2}{l_1}\right) = \frac{x^2}{y^2} \cdot \frac{n}{m}$

8. Two charged particles $A$ and $B$ have charge $q$ each while masses are $m_1$ & $m_2$. Both have same velocity $v$ and enter into a transverse magnetic field $B$ such that their radii are $r_1$ & $r_2$. Then the ratio $m_1 : m_2$ is

(1) $\frac{r_2}{r_1}$

(2) $\left(\frac{r_1}{r_2}\right)^2$

(3) $\frac{r_1}{r_2}$

(4) $\left(\frac{r_2}{r_1}\right)^2$

**Answer (3)**

**Sol.** $r = \frac{mv}{Bq}$

$r \propto m \Rightarrow \frac{r_1}{r_2} = \frac{m_1}{m_2}$

9. A liquid drop of radius $R$ is divided into 27 identical drops. If surface tension of the drops is $T$, then find work done in this process.

(1) $4\pi R^2T$

(2) $3\pi R^2T$

(3) $8\pi R^2T$

(4) $\frac{1}{8}\pi R^2T$

**Answer (3)**

**Sol.** $W = T \times$ change in area ($\Delta S$)

From volume conservation

$$\frac{4}{3}\pi R^3 = 27\pi r^3 \times \frac{4}{3}$$

$R = 3r$

$$r = \frac{R}{3}$$

$$\therefore \quad \Delta S = 4\pi r^2 \times 27 - 4\pi R^2$$

$$= 4\pi \times \frac{R^2}{9} \times 27 - 4\pi R^2 = 2\left(4\pi R^2\right)$$

$$W = 8\pi R^2T$$

10. Alternating voltage and current in circuit is given as

$V = (100 \sin\omega t)$ volt

$$I = 100\sin\left(\omega t + \frac{\pi}{3}\right)\text{mA}$$

Find average power dissipated in circuit.

(1) 2.5 w

(2) 5 w

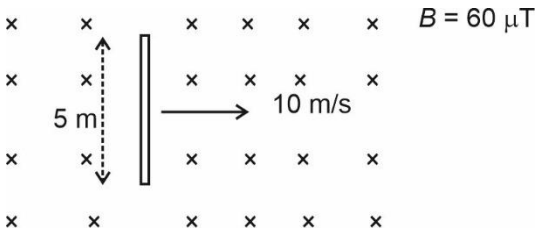
(3) 10 w

(4) 20 w

**Answer (1)**

**Sol.** $$P_{avg} = IV\cos\phi = \frac{100}{\sqrt{2}} \times \frac{100\times10^{-3}}{\sqrt{2}}\cos 60° = 2.5 \text{ w}$$

11. Consider a rod moving in a magnetic field as shown:




The induced emf across the ends of the rod is

(1) 3 mV

(2) 6 mV

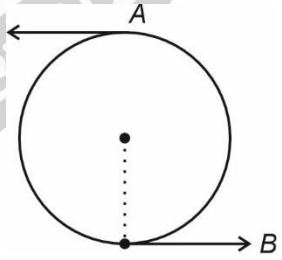
(3) 0 V

(4) 1 mV

**Answer (1)**

**Sol.** $\varepsilon = B\ell v = 3$ mV

12. A particle connected with light thread is performing vertical circular motion. Speed at point $B$ (Lowermost point) is of just sufficient, so that it is able to complete its circular motion. Ignoring air friction, find the ratio of kinetic energy at $A$ to that at $B$. (A being top-most point)




(1) 1 : 5

(2) 5 : 1

(3) $1:7\sqrt{2}$

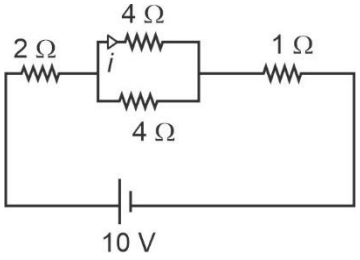
(4) $1:5\sqrt{2}$

**Answer (1)**

**Sol.** $v_A = \sqrt{gL}$

$$v_B = \sqrt{5gL}$$

$$\Rightarrow \quad \frac{k_A}{k_B} = \frac{1}{5}$$

13. 


In given circuit, an ideal battery is connected with four resistances as shown. Find current $i$ as mentioned in diagram.

(1) 2 A (2) 1 A

(3) 4 A (4) 0.5 A

**Answer (2)**

**Sol.** req = 2 + 2 + 1 = 5 Ω

$$i_b = \frac{10}{5} = 2 \text{ A}$$

$$i = \frac{i_b}{2} = 1 \text{ A}$$

14.

15.

16.

17.

18.

19.

20.

## SECTION - B

**Numerical Value Type Questions:** This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. A physical quantity $Q$ depends on other physical quantities $a$, $b$ and $c$ as

$$Q = \frac{a^4 b^3}{c^2}$$

If maximum percentage error in measurement of $a$, $b$ and $c$ are 3%, 4% and 5% respectively, then find maximum percentage error in measurement of $Q$.

**Answer (34)**

**Sol.** $Q = \frac{a^4 b^3}{c^2}$

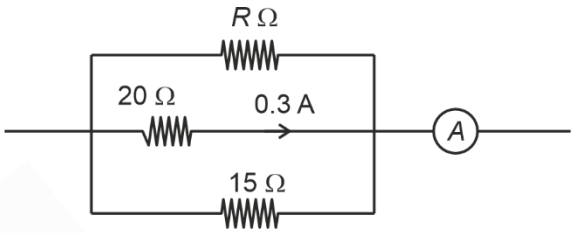
$$\frac{\Delta Q}{Q} = 4\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 2\frac{\Delta c}{c}$$

$$\frac{\Delta Q}{Q} \times 100 = 4(3) + 3(4) + 2(5)$$

$$= 12 + 12 + 10$$

% error $\frac{\Delta Q}{Q}\% = 34\%$

22. Consider the circuit shown :




The ammeter reads 0.9 A. Value of $R$ is _____

**Answer (30)**

**Sol.** 20 Ω & 15 Ω in parallel

$\Rightarrow$ 20 × 0.3 = 15 × $i$

$\Rightarrow$ $i$ = 0.4 A

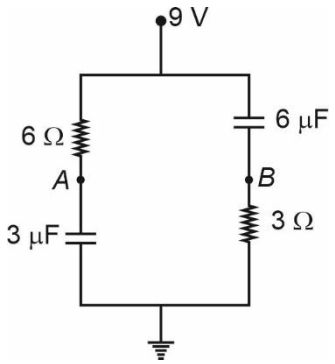
$\Rightarrow$ $i_R$ = 0.9 – 0.3 – 0.4 A

= 0.2 A

$\Rightarrow$ $R$ × 0.2 = 20 × 0.3

$\Rightarrow$ $R$ = 30 Ω

23. Consider the circuit shown :




Charge on 6 μF when $A$ and $B$ are shorted is _____ μC.

**Answer (36)**

**Sol.** In steady state, 6 Ω and 3 Ω are in series.

$\Rightarrow$ $\Delta V_{6\Omega} = 6\text{ V} = \Delta V_{6\mu F}$

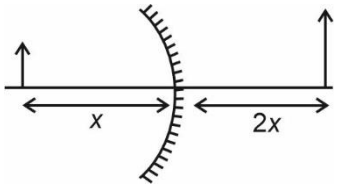
$\Rightarrow$ $\phi = CV = 36\ \mu C$

24. Distance between twice-magnified virtual image of an object placed in front of mirror is 15 cm. Find focal length of spherical mirror in cm.

**Answer (10)**

**Sol.** Magnified virtual image of real object

$\Rightarrow$ Concave mirror




$\left(\frac{v}{u}\right) = 2$

$\Rightarrow$ $2x + x = 15$

$x = 5$ cm

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

$\Rightarrow$ $\frac{1}{10} - \frac{1}{5} = \frac{1}{f}$

$\frac{1-2}{10} = \frac{-1}{10} = \frac{1}{f}$

$\Rightarrow$ $f = -10$

25. The displacement of a particle changing with time as $x = 6t^3 - 12t^2 + 20t + 30$. Find velocity (in m/s) of particle when it's acceleration became zero. ($t$ is time in s)

**Answer (12)**

**Sol.** $v = \frac{dx}{dt} = 20$

$= 18t^2 - 24t + 20$

$a = \frac{dv}{dt} = 36t - 24$

At $a = 0$

$t = \frac{24}{36} = \frac{2}{3}$ sec

Then,

$v = 18 \times \frac{4}{9} - 24 \times \frac{2}{3} + 20$

$= 8 - 16 + 20 = 12$ m/s

26. Electric field in a region is given by $\vec{E} = \left(6\hat{i} + 7\hat{j} + 8\hat{k}\right)$ units. An area of 30 units is considered in $y$-$z$ plane. Calculate the electric flux through this area.

**Answer (180)**

**Sol.** $\phi = \vec{E} \cdot \vec{A} = \left(6\hat{i} + 7\hat{j} + 8\hat{k}\right) \cdot 30\hat{i} = 180$

27. $N$ moles of non-linear polyatomic gas (degree of freedom 6) is mixed with 2 moles of monoatomic gas. The resultant mixture has molar specific heat equal to that of a diatomic gas, then $N$ is

**Answer (4)**

**Sol.** $\frac{n_1 \frac{f_1}{2} R + n_2 \frac{f_2}{2} R}{n_1 + n_2} = \frac{5}{2} R$

$\frac{2 \times \frac{3}{2} R + N \times \frac{6}{2} R}{N + 2} = \frac{5}{2} R$

$\frac{6 + 6N}{N + 2} = 5$

$6 + 6N = 5N + 10$

$N = 4$

28. A particle starts oscillation from origin on $x$-axis with period of oscillation (6) sec and amplitude $A$. If time taken by particle to reach from $x = A$ to $x = \frac{\sqrt{3}}{2}A$ for the first time is $\tau$ then. Value of $6\tau$ is _____ sec.

**Answer (3)**

**Sol.** $x = A\sin\left(\omega t + \frac{\pi}{2}\right)$

$x = A\cos\omega t$

$\frac{\sqrt{3}}{2}A = A\cos\left(\frac{2\pi}{\tau}t\right)$

$\frac{\sqrt{3}}{2} = \cos\left(\frac{\pi}{3}t\right)$

$\frac{\pi}{6} = \frac{t}{3}\pi$

$t = \frac{1}{2} = 0.5$

$6\tau = 3$

29.

30.