MOCK TEST 9

OPTIONAL NUMERICAL VALUE QUESTIONS (NVQs)

PHYSICS PART - II

OP21. Two full turns of the circular scale of a screw gauge cover a distance of 1mm on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of (– 0.03) mm. While measuring the diameter of a thin wire, a student notes the main scale reading of 3 mm and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is ____ mm.

OP22. A capacitor with capacitance 5μF is charged to 5μC. If the plates are pulled apart to reduce the capacitance to 2μF, how much work (in J) is done?

OP23. When a ball is released from rest in a very long column of viscous liquid, its downward acceleration is 'a' (just after release). Its acceleration when it has acquired two third of the maximum velocity is a/X. Find the value of X.

OP24. The moment of inertia of a uniform semicircular wire of mass m and radius r, about an axis passing through its centre of mass and perpendicular to its plane is $mr^2\left(1-\frac{k}{\pi^2}\right)$ then find the value of k.

OP25. Three sound waves of equal amplitudes have frequencies (f –1), f, (f + 1). They superpose to give beats. The number of beafs produced per second will be ____.

CHEMISTRY PART - II

OC46. If N_A is Avogadro's number then number of valence electrons in 4.2g of nitride ions (N^{3-}) is x × NA. What will be the value of x.

OC47. The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom in terms of x × 10^{15} s^{-1} – 10 will be _____ .
(Given : ionization energy of H=2.18 ×10^{-18}J $atom^{-1}$and $h = 6.625 \times 10^{-34}$ J s)

OC48. In transforming 0.01 mole of PbS to $PbSO_4$ the volume of '10 volume' H_2O_2 required will be _____ .

OC49. KCl crystallises in the same type of lattice as does NaCl. Given that $r_{Na^+}/r_{Cl^-} = 0.55$ and $r_{K^+}/r_{Cl^-} = 0.74$. Calculate the ratio of the edge length of the unit cell for KCl to that of NaCl.

OC50. A weak electrolyte having the limiting equivalent conductance of 400 S cm^2 g. $equivalent^{-1}$ at 298 K is 2% ionized in its 0.1N solution. The resistance of this solution (in ohms) in an electrolytic cell of cell constant 0.4 cm^{-1} at this temperature is _____ .

MATHEMATICS PART - II

OM71. The line passing through the points (5, 1, a) and (3, b, 1) crosses the yz-plane at the point $\left(0, \frac{17}{2}, \frac{-13}{2}\right)$. Then $a+b$ is _____.

OM72. If ω is the cube root of unity, then $\begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix}$ =_____.

OM73. If odds against solving a question by three students are 2 : 1, 5 : 2 and 5 : 3 respectively, then probability that the question is solved only by one student is _____.

OM74. The interior angles of a polygon are in A.P. If the smallest angle be 120° and the common difference be 5°, then the number of sides of the polygon is _____.

OM75. The number of integer values of m, for which the x-coordinate of the point of intersection of the lines $3x + 4y = 9$ and $y = mx + 1$ is also an integer, is_____.

SOLUTIONS

MOCK TEST 9

PHYSICS PART - II

OP21. **(3.38)** Pitch $= \dfrac{1\text{mm}}{2} = 0.5\,\text{mm}$

Least count of screw gauge $= \dfrac{\text{pitch}}{\text{number of divisions}}$

$= \dfrac{0.5}{50}\text{mm} = 0.01\text{mm}$

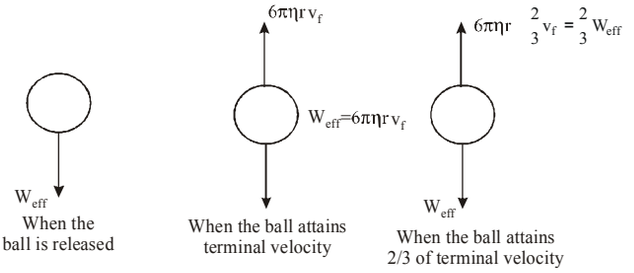
$\therefore$ Reading = [Main scale reading + circular scale reading × L.C] – (zero error)

= [3 + 35 × 0.01] – (– 0.03) = 3.38 mm

OP22. **(3.75 × 10^{-6})** $\dfrac{Q^2}{2c'} - \dfrac{Q^2}{2c} = \dfrac{Q^2}{2}\left[\dfrac{1}{c'} - \dfrac{1}{c}\right]$

$= \dfrac{\left(5\times10^{-6}\right)^2}{2}\left[\dfrac{1}{2\times10^{-6}} - \dfrac{1}{5\times10^{-6}}\right] = 3.75 \times 10^{-6}\ \text{J}$

OP23. **(3)**



When the ball is just released, the net force on ball is

$$W_{eff} = (mg - \text{buoyant force})$$

The terminal velocity v_f of the ball is attained when net force on the ball is zero.

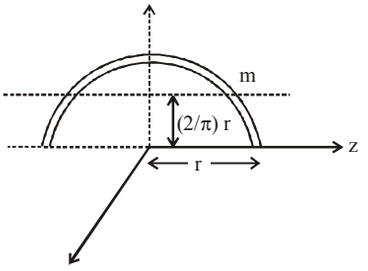
$\therefore$ Viscous force $6\pi\eta r\, v_f = W_{eff}$

When the ball acquires $\dfrac{2}{3}$rd of its maximum velocity v_f the viscous force is = $\dfrac{2}{3}W_{eff}$

Hence net force is $W_{eff} - \dfrac{2}{3}W_{eff} = \dfrac{1}{3}W_{eff}$

$\therefore$ required acceleration is a/3

OP24. **(4)**



Moment of inertia about z-axis, $I_z = mr^2$ (about centre of mass)

Applying parallel axes theorem, $I_z = I_{cm} + mk^2$

$I_{cm} = I_z - m\left(\dfrac{2}{\pi}r\right)^2 = mr^2 - \dfrac{m4r^2}{\pi^2} = mr^2\left(1 - \dfrac{4}{\pi^2}\right)$

i.e., k = 4

OP25. **(2)** Maximum number of beats = $(f + 1) - (f - 1) = 2$

CHEMISTRY PART - II

OC46. **(3)** $N_3^- = 10e^-$

4.2 g of N^{3-} ions have $= \dfrac{10\ N_A}{14} \times 4.2 = 3\ N_A$

OC47. **(3.08)** $\nu = \dfrac{1}{h} \times IE \times \left[\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right]$

$= \dfrac{2.18\times10^{-18}}{6.625\times10^{-34}} \times \left[\dfrac{1}{1} - \dfrac{1}{16}\right] = 3.08\times10^{15}\,\text{s}^{-1}$

OC48. **(44.8)** $PbS + 4H_2O_2 \rightarrow \underset{\text{Water}}{PbSO_4} + 4H_2O$

$4H_2O_2 \rightarrow 4H_2O + 2O_2$

$4(2+32)$ 2×22.4 litre

= 136 g at NTP.

From the above equation we can derive that

1 mole of PbS reacts with 0.01 × 4 i.e. 0.04 moles of H_2O_2. Thus,

volume of H_2O_2 needed $= \dfrac{0.04\times11.2}{10} = 0.0448$ L or 44.8 mL.

OC49. **(1.123)** $\dfrac{r_{Na^+}}{r_{Cl^-}} = 0.55$ and $\dfrac{r_{K^+}}{r_{Cl^-}} = 0.74$

$\dfrac{r_{Na^+}}{r_{Cl^-}} + 1 = 0.55 + 1$ and $\dfrac{r_{K^+}}{r_{Cl^-}} + 1 = 0.74 + 1$

$\dfrac{r_{Na^+} + r_{Cl^-}}{r_{Cl^-}} = 1.55$ and $\dfrac{r_{K^+} + r_{Cl}}{r_{Cl^-}}$ 1.74

Now edge length ratio of KCl and NaCl is

$\dfrac{1.74}{1.55} = \dfrac{r_{K^+} + r_{Cl^-}}{r_{Cl^-}} \times \dfrac{r_{Cl^-}}{r_{Na^+} + r_{Cl^-}} = 1.123.$

OC50. **(500)**

MATHEMATICS PART - II

OM71. (10) Equation of line through (5, 1, a) and

(3, b, 1) is $\frac{x-5}{-2}=\frac{y-1}{b-1}=\frac{z-a}{1-a}=\lambda$

$\therefore$ any point on this line is a $[-2\lambda+5, (b-1)\lambda+1, (1-a)\lambda+a]$

It crosses yz plane where $-2\lambda+5=0$

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

$$\therefore \left(0,(b-1)\frac{5}{2}+1,(1-a)\frac{5}{2}+a\right)=\left(0,\frac{17}{2},\frac{-13}{2}\right)$$

$$\Rightarrow (b-1)\frac{5}{2}+1=\frac{17}{2} \text{ and } (1-a)\frac{5}{2}+a=-\frac{13}{2} \Rightarrow b=4 \text{ and } a=6$$

OM72. (0) $\begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix} = \begin{vmatrix} 1+\omega+\omega^2 & \omega & \omega^2 \\ 1+\omega+\omega^2 & \omega^2 & 1 \\ 1+\omega+\omega^2 & 1 & \omega \end{vmatrix}$

[Applying $C_1 \to C_1 + C_2 + C_3$]

$$= \begin{vmatrix} 0 & \omega & \omega^2 \\ 0 & \omega^2 & 1 \\ 0 & 1 & \omega \end{vmatrix} = 0.$$

OM73. (0.45)

OM74. (9) Let the number of sides of the polygon be n.

Then the sum of interior angles of the polygon

$$= (2n-4)\frac{\pi}{2}=(n-2)\pi=(n-2)180°$$

Since the angles are in A.P. and $a = 120°$, $d = 5°$

Therefore, $\frac{n}{2}[2\times 120+(n-1)5]=(n-2)180$

$\Rightarrow 5n^2 - 125n + 720 = 0$

$\Rightarrow n^2 - 25n + 144 = 0 \Rightarrow (n-9)(n-16) = 0 \Rightarrow n = 9, 16$

But $n = 16$ gives $T_{16} = a + 15d = 120° + 15(5°) = 195°$, which is impossible as interior angle cannot be greater than 180°. Hence $n = 9$.

OM75. (2) Intersection of $3x + 4y = 9$ and $y = mx + 1$.

Calculation for x co-ordinate, $3x + 4(mx + 1) = 9 \Rightarrow (3 + 4m)x = 5$

$$\Rightarrow x=\frac{5}{3+4m}$$

For x to be an integer $3 + 4m$ should be a divisor of 5

i.e., 1, – 1, 5 or – 5.

Now, $3 + 4m = 1 \Rightarrow m = -1/2$ (not integer)

$3 + 4m = -1 \Rightarrow m = -1$ (integer)

$3 + 4m = 5 \Rightarrow m = 1/2$ (not an integer)

$3 + 4m = -5 \Rightarrow m = -2$ (integer) $\therefore$ There are 2 integral values of m.