MOCK TEST 15

OPTIONAL NUMERICAL VALUE QUESTIONS (NVQs)

PHYSICS PART - II

OP21. If the radius of curvature of the path of two particles of same masses are in the ratio 1 : 2, then in order to have constant centripetal acceleration, their velocity, should be in the ratio of _____.

OP22. A refrigerator is to maintain eatables kept inside at 7°C. The coefficient of performance of refrigerator if room temperature is 38°C is _____.

OP23. A capillary tube of radius r is immersed vertically in a liquid such that liquid rises in it to height h (less than the length of the tube). Mass of liquid in the capillary tube is m. If radius of the capillary tube is increased by 50%, then mass of liquid that will rise in the tube, is ____ times.

OP24. 1/2 mole of helium is contained in a container at STP. How much heat energy is needed to double the pressure of the gas, (volume is constant). Heat capacity of gas is 3 j g^{-1} K^{-1}.

OP25. Velocity of sound waves in air is 330 m/s. For a particular sound wave in air, a path difference of 40 cm is equivalent to phase difference of 1.6 π. The frequency of this wave _____ Hz.

CHEMISTRY PART - II

OC46. HCl is added to MnO_2, PbO_2 and BaO. How many would not give H_2O_2?

OC47. The γ-form of iron has *fcc* structure (edge length 386 pm) and β-form has *bcc* structure (edge length 290 pm). The ratio of density of γ-form and β-from is _____.

OC48. Dry air was passed successively through a solution of 5 g of a solute in 80 g of water and then through pure water. The loss in weight of solution was 2.50 g and that of pure solvent 0.04 g. What is the molecular weight of the solute

OC49. The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom is $x \times 10^{15}$ s^{-1} will be. (Given ionization energy of $H = 2.18 \times 10^{-18}$ J $atom^{-1}$ and $h = 6.625 \times 10^{-34}$ Js)

OC50. If 0.50 mol of $CaCl_2$ is mixed with 0.20 mol of Na_3PO_4, the maximum number of moles of $Ca_3(PO_4)_2$ which can be formed, is _____.

MATHEMATICS PART - II

OM71. A biased coin with probability p, $0 < p < 1$, of heads to tossed until a head appears for the first time. If the probability that the number of tosses required is even is $\frac{2}{5}$, then p = _____.

OM72. The plane denoted by $P_1 : 4x + 7x + 4z + 81 = 0$ is rotated through a right angle about its line of intersection with the plane $P_2 : 5x + 3y + 10z = 25$. If the plane in its new position be denoted by P, and the distance of this plane from the origin is d, then the value of $[d/2]$ (where $[k]$ represents greatest integer less then or equal to k) is _____.

OM73. The value of $\int_0^8 |x - 5| dx$ is_____.

OM74. $\lim_{x \to \infty} \left(\sqrt{x^2 + 8x + 3} - \sqrt{x^2 + 4x + 3} \right) =$ _____.

OM75. A batsman scores runs in 10 innings 38, 70, 48, 34, 42, 55, 63, 46, 54,44, then the mean deviation about median is_____.

SOLUTIONS

MOCK TEST 15

PHYSICS PART - II

OP21. **(0.70)** The centripetal acceleration, $a = \frac{v^2}{r} \Rightarrow r = \frac{v^2}{a}$

$\therefore\ r \propto v^2$ or $v \propto \sqrt{r}$ (if a is constant),

$$\Rightarrow \frac{v_1}{v_2} = \sqrt{\frac{r_1}{r_2}} = \sqrt{\frac{1}{2}}$$

OP22. **(9.03)** Here, $T_1 = 38°C = 38 + 273 = 311$ K
$T_2 = 7°$ C $= 7 + 273 = 280$ K
$\therefore$ coefficient of performance of the refrigerator,

$$= \frac{T_2}{T_1 - T_2} = \frac{280}{311 - 280} = 9.03$$

OP23. **(1.5)** $h = \frac{2T\cos\theta}{r\rho g} \Rightarrow h \propto \frac{1}{r} \Rightarrow \frac{h_2}{h_1} = \frac{r_1}{r_2} = \frac{2}{3}$

$$\left(\because r_1 = r,\quad r_2 = r + 50\%\text{ of } r = \frac{3}{2}r\right)$$

New mass $m_2 = \pi r_2^2 h_2 \rho = \pi\left(\frac{3}{2}r_1\right)^2\left(\frac{2}{3}h_1\right)\rho$

$$= \frac{3}{2}\left(\pi r_1^2 h_1\right)\rho = \frac{3}{2}m$$

OP24. **(1638)** Here, $n = \frac{1}{2}$, $c_V = 3\ J\ g^{-1}\ K^{-1}$, $M = 4\ g\ mol^{-1}$

$\therefore\ C_V = Mc_V = 4 \times 3 = 12\ J\ mol^{-1}\ K^{-1}$

At constant volume $P \propto T$.

$\therefore\ \frac{P_2}{P_1} = \frac{T_2}{T_1} = 2,\ T_2 = 2T_1$

Rise in temperature $\Delta T = T_2 - T_1 = 2T_1 - T_1 = T_1 = 273\ K$

Heat required, $\Delta Q = nC_V\Delta T = \frac{1}{2} \times 12 \times 273 = 1638\ J$

OP25. **(660)** From $\Delta x = \frac{\lambda}{2\pi}\Delta\phi$,

$$\lambda = 2\pi\frac{\Delta x}{\Delta\phi} = \frac{2\pi(0.4)}{1.6\pi} = 0.5\,m$$

$$f = \frac{v}{\lambda} = \frac{330}{0.5} = 660\ Hz$$

CHEMISTRY PART - II

OC46. **(3)** MnO_2, PbO_2 and BaO will not give H_2O_2 with HCl. MnO_2 and PbO_2 will give Cl_2 and BaO will react with HCl to give $BaCl_2$ and water.

OC47. **(0.8481)** γ–form *fcc* Z = 4 a = 386 pm

β–form *bcc* Z = 2 a = 290 pm

$$\frac{\rho_\gamma}{\rho_\beta} = \frac{4M/N_A(386)^3}{2M/N_A(290)^3} = \frac{2(290)^3}{(386)^3} = 0.8481$$

OC48. **(70.31)**

OC49. **(3.08)** $E_{ionisation} = E_\infty - E_n = \frac{13.6Z_{eff}^2}{n^2}\,eV$

$$= \left[\frac{13.6Z^2}{n_2^2} - \frac{13.6Z^2}{n_1^2}\right]$$

$E = h\nu = \frac{13.6\times1^2}{(1)^2} - \frac{13.6\times1^2}{(4)^2}$; $h\nu = 13.6 - 0.85$

$\because\ h = 6.625 \times 10^{-34}$

$\nu = \frac{13.6 - 0.85}{6.625\times10^{-34}} \times 1.6\times10^{-19} = 3.08 \times 10^{15}\ s^{-1}$.

OC50. **(0.1)** $3CaCl_2 + 2Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6NaCl$

$\therefore$ 2 Moles of Na_3PO_4 = 3 mole of $CaCl_2$

= 1 mole $Ca_3(PO_4)_2$

$\therefore$ 0.2 mole of Na_3PO_4 = 0.3 mole of $CaCl_2$

= 0.1 mole of $Ca_3(PO_4)_2$

MATHEMATICS PART - II

OM71. **(0.33)** Let X denotes the number of tosses required. Then $P(X = r) = (1-p)^{r-1}\,.\,p$, for $r = 1, 2, 3$ .....

Let E denote the event that the number of tosses required is even.

Then $P(E) = P[(X = 2) \cup (X = 4) \cup (X = 6) \cup .....]$

$P(E) = P(X = 2) + P(X = 4) + P(X = 6) + ...$

$P(E) = (1-p)\,p + (1-p)^3\,p + (1-p)^5\,p + ... = \frac{1-p}{2-p}$

But we are given that $P(E) = \frac{2}{5}$, then we get $p = \frac{1}{3}$.

OM72. **(7)** $4x + 7y + 4z + 81 = 0$ ...(i)

$5x + 3y + 10z = 25$ ...(ii)

Equation of plane passing through their line of intersection is

$(4x + 7y + 4z + 81) + \lambda(5x + 3y + 10z - 25) = 0$

or $(4 + 5\lambda)x + (7 + 3\lambda)y + (4 + 10\lambda)z + (81 - 25\lambda) = 0$ ...(iii)

plane (iii) $\perp$ to (i), so

$4(4 + 5\lambda) + 7(7 + 3\lambda) + 4(4 + 10\lambda) = 0 \Rightarrow \lambda = -1$

From (iii), equation of plane is

$-x + 4y - 6z + 106 = 0$ ...(iv)

Distance of (iv) from (0, 0, 0)

$$= \frac{106}{\sqrt{1+16+36}} = \frac{106}{\sqrt{53}} \approx 14.6$$

$$\therefore \left[\frac{14.6}{2}\right] = [7.3] = 7.$$

OM73. **(17)**

OM74. **(2)** $\lim\limits_{x\to\infty} \frac{4x}{\left(\sqrt{x^2+8x+3} + \sqrt{x^2+4x+3}\right)}$ (On rationalization)

$$= \lim_{x\to\infty} \frac{4}{\left(\sqrt{1+\frac{8}{x}+\frac{3}{x^2}} + \sqrt{1+\frac{4}{x}+\frac{3}{x^2}}\right)} = 2$$

OM75. **(8.6)** Arrange the given data in ascending order,

We have 34, 38, 42, 44, 46, 48, 54, 55, 63, 70

Here, median $= M = \frac{46+48}{2} = 47$

($\because n = 10$, median is the mean of 5th and 6th term)

$\therefore$ Mean deviation $= \frac{\Sigma|x_i - M|}{n} = \frac{\Sigma|x_i - 47|}{10}$

$$= \frac{13+9+5+3+1+1+7+8+16+23}{10} = 8.6.$$