KMPK PRE-PSPM 1 2023/2024 SUGGESTION ANSWER SCHEME

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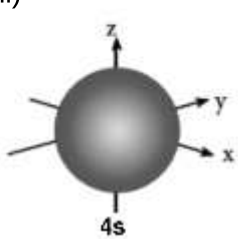
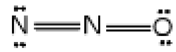
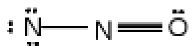
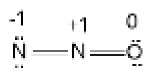
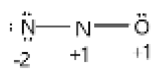
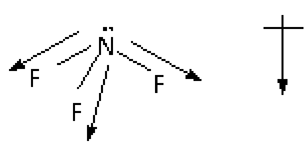
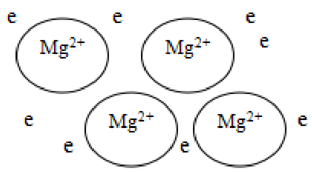
1	(a)	Percentage by volume (%v/v) = $\frac{\text{volume solute}}{\text{volume solution}}$ x 100%	1M
		5% = $\frac{\text{volume solute}}{0.94\ L}$ x 100% @	1M
		Volume solute = $\frac{5\% \times 0.94\ L}{100\%}$	
		= 0.047 L	1M
	(b)	(i) The half-reaction for the redox reaction:	
		Oxidation: $Sn^{2+} \longrightarrow Sn^{4+} + 2e$	1M
		Reduction: $MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O$	1M
		(ii) Oxidation: $(Sn^{2+} \longrightarrow Sn^{4+} + 2e) \times 5$	
		Reduction: $(MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O) \times 2$	
		Overall: $2MnO_4^- + 5Sn^{2+} + 16H^+ \longrightarrow 2Mn^{2+} + 5Sn^{4+} + 8H_2O$	1M
	(c)	(i) $Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$	1M
		(ii) No.of mole of Zn = 1.6g / 65.4gmol^{-1} = 0.02446 mol	1M
		No.of mole of HCl = (1.00M)(230ml) / 1000 =0.23 mol	1M
		From balanced equation,	
		1 mol of Zn reacts with 2 mol of HCl	1M
		0.02446 mol of Zn reacts with 0.04892 mol of HCl (needed)	1M
		Since the amount of 0.04892 mol HCl needed is less than 0.23 mol	1M
		HCl available; Therefore, HCl is an excess reactant and Zn is a limiting reactants.	1M
		(iii) From balanced equation,	
		1 mol of Zn produced 1 mol of $ZnCl_2$	1M
		0.02446 mol of Zn produced 0.02446 mol of $ZnCl_2$	1M
		Mass of $ZnCl_2$ = No.of mole $ZnCl_2$ x Molar mass of $ZnCl_2$	
		= 0.02446 mol x 136.4 g/mol	1M
		= 3.336 g	1M

		(iii) From balanced equation, 1 mol of Zn produced 1 mol of H_2 Thus, no. of mole of H_2 = 0.02446 mol At STP, 1 mol H_2 gas occupies 22.4 L H_2 gas 0.02446 mol H_2 gas occupies $\frac{0.02446 \text{ mol } H_2}{1 \text{ mol } H_2} \times 22.4 \text{ L } H_2$ gas = 0.5479 L	1M 1M 1M 1M
2	(a)	$v = \frac{c}{\lambda}$ @ $v = \frac{3.0 \times 10^8 \text{ ms}^{-1}}{486.4 \times 10^{-9} \text{ m}}$ $v = 6.17 \times 10^{14} \text{ s}^{-1}$	 1
		(ii) $\frac{1}{\lambda} = R_H \ (1/n_1^2 - 1/n_2^2)$, $n_1 < n_2$ @ $\frac{1}{486.4 \times 10^{-9}} = 1.097 \times 10^7 \ (1/2^2 - 1/n_2^2)$ $n_2 = 4$ Electron makes a transition from energy level n = 4 to n = 2	 1 1 1
		(iii) Balmer series	1
	(b)	(i) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^2$	1
		(ii) (4, 0, 0, -½) (4, 0, 0, +½) (3, 2, 0, -½) or any combination of m from -2 to +2 and s= +½	1 1 1
		(iii)  	1 (with label)
		(iv) X^{3+} : $1s^2 2s^2 2p^6 3s^2 3p^6$	1

3	a)	i) A  B  C 	1 1 1
		ii) A  B  C 	1 1 1
		iii) **Structure B** -smallest formal charges among all structures @ - negative charge resides on the more electronegative atom.	1 1
	(b)	i) 	1
		ii) Trigonal pyramidal	1
		iii) sp^3	1
		iv) Molecule is **polar** Molecule is unsymmetrical @ not arranged symmetrically @ The bond dipole moments cannot cancel each other , $\mu \neq 0$	1 1

	c)	i) **Electron sea model**  - Metallic bond in magnesium metal is the electrostatic forces between the magnesium ion, Mg and the sea of delocalised electrons.	1 1
		ii) - Number of valence electrons in aluminium is greater than that in magnesium. @ - The positive charge of aluminium ion (+3) is greater than that of magnesium ion (+2) @ - Hence the electrostatic forces(metallic bond) of metal ions towards the electron sea(cloud) in aluminium metal are stronger than that in magnesium metal. - Therefore, the boiling point of aluminium is higher than magnesium.	2 marks
4	(a)	(i) The conditions: Low pressure & high temperature (ii) By using PV = nRT P = 745/760 = 0.9803 atm So, Mr = (mass)(RT) / PV = (10.50)(0.08206)(30+273.15) / (0.9803)(8.00) = 33.31 g/mol (iii) Assumption can be accepted: - Volume of the gas particles is negligible compared to the volume of its container. - Intermolecular attractive forces between gas particles are negligible. - The collisions between the gas particles are elastic. - Average kinetic energy of gas particles is directly proportional to the temperature.	1 + 1 Formula or substitution = 1 Final answer 1 Any one correct assumption = 1

	(b)	(i) - Vapour pressure is the pressure exerted by the vapour molecules (above the surface of liquid) which are in equilibrium with its liquid. - Boiling point is the temperature in which the vapour pressure of its liquid is equal to external atmospheric pressure. (ii) Vapour pressure is inversely proportional to the boiling point. @ when vapour pressure increase, boiling point decrease (iii) Decreasing strength of intermolecular forces: NH_3, PH_3, BH_3 @ $NH_3 > PH_3 > BH_3$	1 1 1 1
5	(a)	$K_p = K_c (RT)^{\Delta n}$ $= 5(0.08206 \times 373)^{-1}$ or $K_p =$ **0.163** $2NO_2(g) \rightleftharpoons N_2O_4(g)$ Initial Concentration (M): **1**, 0 Change in Concentration (M): *-2x*, *+x* Equilibrium Concentration (M): *1-2x*, *x*	1 1 1 [NO_2] 1 ICE Table 1

<table>
<tr>
<td></td>
<td></td>
<td>$K_C = \dfrac{[N_2O_4]}{[NO_2]^2}$
$5 = \dfrac{x}{(1-2x)^2}$ or
$5 - 21x + 20x^2 = 0$
$x = 0.685$ (neglected)
$x = 0.365$
$[N_2O_4] = 0.365$ M</td>
<td>1
1</td>
</tr>
<tr>
<td></td>
<td>(b)</td>
<td>Helium gas added at constant pressure:
-Kp remains unchanged.
-amount of NO_2 increase</td>
<td>1
1</td>
</tr>
<tr>
<td>6</td>
<td>(a)</td>
<td>$pH = -\log [H_3O^+]$ @
$1.16 = -\log [H_3O^+]$
$[H_3O^+] = 0.0692$ M
<table>
<tr><td></td><td colspan="4">HIO_3 (aq) + H_2O (l) $\rightleftharpoons$ H_3O^+ (aq) + IO_3^- (aq)</td></tr>
<tr><td>Initial concentration (M)</td><td>0.10</td><td>-</td><td>0</td><td>0</td></tr>
<tr><td>Change in concentration (M)</td><td>-x</td><td>-</td><td>+x</td><td>+x</td></tr>
<tr><td>Equilibrium concentration (M)</td><td>0.10-x</td><td>-</td><td>x</td><td>x</td></tr>
</table>
$[H_3O^+] = x = 0.0692$ M</td>
<td>M1
M2
equation M3
ice table M4
M5
M6</td>
</tr>
</table>

		degree dissociation, $\alpha = \dfrac{\text{change in concentration of reactant, x}}{\text{Initial concentration of reactant, c}}$ @ $= \dfrac{0.0692\ M}{0.10\ M}$ $= 0.692$	
	(b)	(i) $N_2H_5Cl\ (aq) \rightarrow N_2H_5^+\ (aq) + Cl^-\ (aq)$	M7
		Hydrolysis reaction $N_2H_5^+\ (aq) + H_2O\ (l) \rightleftharpoons N_2H_4\ (aq) + H_3O^+\ (aq)$	M8
		Only $N_2H_5^+$ will hydrolyse with water to form H_3O^+ ion. Thus, this is acidic salt, **pH $<$ 7**	M9
		(ii) methyl orange @ methyl red @ bromophenol blue @ chlorophenol blue.	any one M10
	(c)	$AgCl\ (s) \rightleftharpoons Ag^+\ (aq) + Cl^-\ (aq)$	M11
		$Q_{sp} = [Ag^+][Cl^-]$ @ $= (1.0 \times 10^{-6})^2$	M12
		$= 1.0 \times 10^{-12}$	M13
		$Q_{sp} < K_{sp}$, the solution is unsaturated. No precipitate is formed.	M14