SK015
Chemistry1
Semester I
Session 2023/2024

Kimia 1
Semester I
Sesi 2023/2024

CHEMISTRY UNIT
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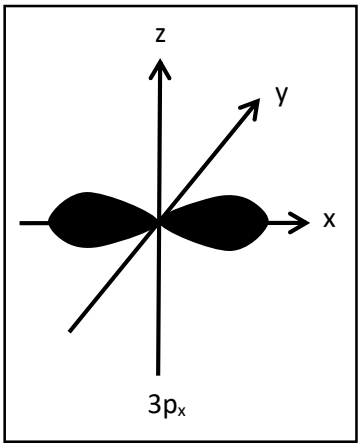
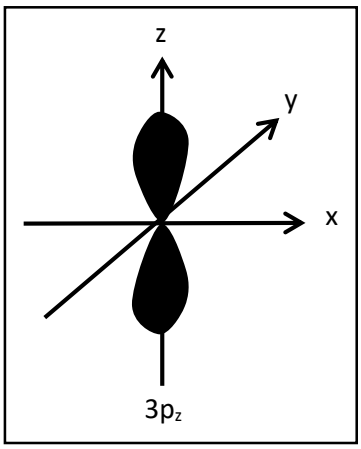
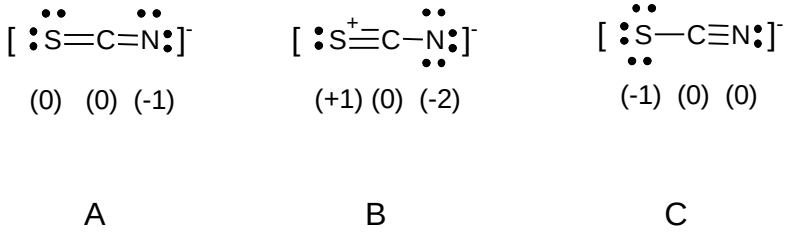
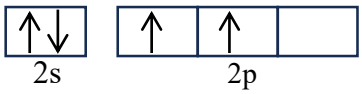
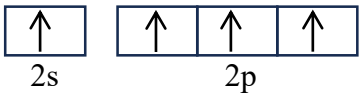
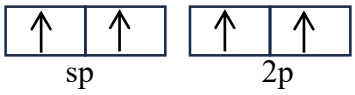
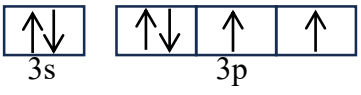
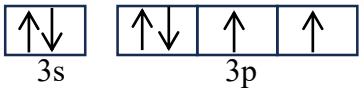
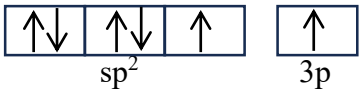
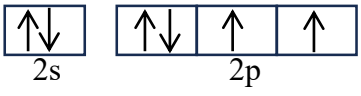
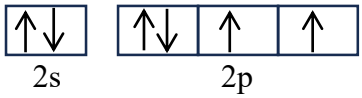
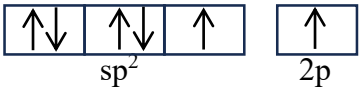
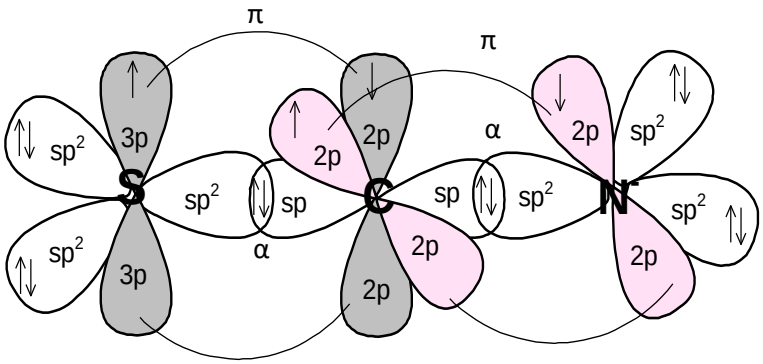
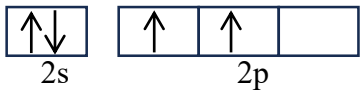
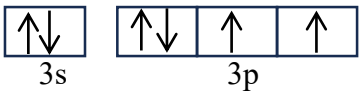
SMARTCHEM 1.0
CHEMISTRY 1
SUGGESTED ANSWER SCHEME

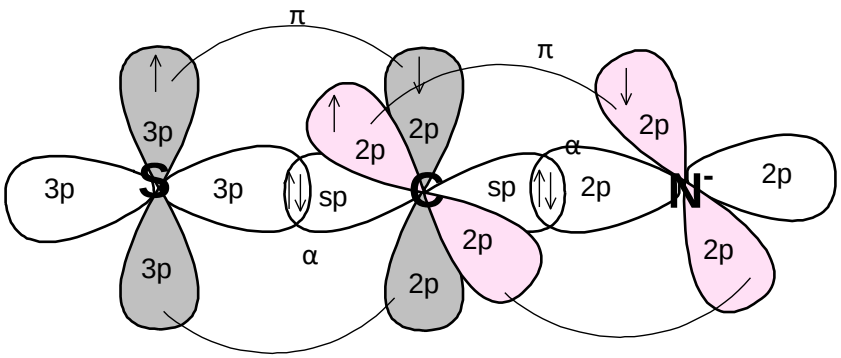
No.		Suggested Answer	Marks
1	(a)	$\text{Average atomic mass} = \frac{(24 \times 79) + (25 \times 10) + (26 \times 11)}{100}$	1
		Average atomic mass = 24.32 a.m.u	1
		$\text{Relative atomic mass} = \frac{24.32 \text{ a.m.u}}{\frac{1}{12} \times 12 \text{ a.m.u}}$	
		= **24.32**	1
	(b)	Mass of C = $\frac{12}{44} \times 21.5$ g = 5.8636 g	1
		Mass of H = $\frac{2}{18} \times 8.87$ g = 0.9856 g	1
		Element | C | H Mass (g) | 5.8636 | 0.9856 No. of mole(mole) | 0.4887 | 0.9856 Mole ratio | 1 | 2	1
		∴ Empirical formula = CH_2	1
		$[CH_2]$ n = 126.0	
		n = 9	1
		∴ **Molecular formula = C_9H_{18}**	1
	(c)	Assume that mass of nitric acid solution is 100.00 g	1
		∴ mass of solute is 85.00 g	1
		$n_{\text{solute, } HNO_3} = \frac{85.00 \text{ g}}{1+14+3(16) \text{g/mol}} = 1.349 \text{ mol}$	1
		$V_{\text{solution}} = \frac{100.00 \text{ g}}{0.8362 \text{ g/m}} = 119.6 \text{ mL}$	1
		$\text{Molarity} = \frac{\text{moles solute}}{\text{volume solution (L)}}$	
		@	
		$= \frac{1.3492 \text{ mol}}{119.5886 \times 10^{-3} \text{ L}}$	1
		= **11.282 mol L^{-1}**	1

	(d)	Oxidation: $(MnO_4^-(aq)+8H^+(aq)+ 5e^- \rightarrow Mn^{2+}(aq)+ 4H_2O\ (l))$ x 2	1
		Reduction: $(C_2O_4^{2-}(aq) \rightarrow 2CO_2\ (g)+ 2e^-)$ x 5	1
		Overall reaction:	
		$2MnO_4^-(aq)+ 5C_2O_4^{2-}(aq)+16H^+(aq) \rightarrow 2Mn^{2+}(aq)+ 10CO_2\ (g)+ 8H_2O$	1
	(e)	From balance equation,	
		1 mol $MnO_2 \equiv$ 4 mol HCl	
		Given, 0.86 mol MnO_2.	
		$\therefore$ 3.44 mol HCl needed.	1
		Moles HCl needed (3.44 mol) is more than moles HCl provided (48.2 g/36.5 $gmol^{-1}$ = 1.3205 mol),	
		hence HCl is Limiting reactant.	1
		From equation,	
		4 mol HCl $\equiv$ 1 mol Cl_2	
		$\therefore$ 1.3205 mol HCl $\equiv$ 0.3301 mol Cl_2	1
		Mass of Cl_2 gas produce = 0.3301 mol x 2(35.5) $gmol^{-1}$	
		= **23.44 g**	1
		Total Marks	**22**
		Max	**21**

No.		Suggested Answer	Marks
2 (a)	(i)	$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$; $n_1 < n_2$ or $1094 \times 10^{-9} = 1.097 \times 10^7 \left(\frac{1}{n_1^2} - \frac{1}{6^2} \right)$	1
		$n_1 = 3$	1
		The electron falls from n = 6 to n = 3	1
	(ii)	$E_n = - R_H (\frac{1}{n^2})$ @ $E_3 = - 2.18 \times 10^{-18} (\frac{1}{3^2})$	1
		$= - 2.42 \times 10^{-19}$ J	1
	(iii)	Paschen	1
2 (b)	(i)	$n = 3$, $l = 1$, $m = +1$, $s = +\frac{1}{2}$	1
		$n = 3$, $l = 1$, $m = -1$, $s = +\frac{1}{2}$	1
		Any 2 correct answers (different m value, same s value)	
	(ii)	 or  *Correct shape and label. $3p_y$ is not accepted.*	1
	(iii)	8 electrons	1
		Total marks	**10**

No.		Suggested Answer	Marks
3	(a)		1 1 1 1 mark - each structure
	(b)	Structure **A is the most plausible Lewis structure**. It is because its **negative formal charge is on the most electronegative N atom**. **N atom is more electronegative than S** atom in SCN^- molecules.	1 1 FC -1
	(c)	C ground state  C excited state  C hybrid  S ground state  S excited state  S hybrid  N^- ground state  N^- excited state  N^- hybrid 	1 1 1 1 mark (sp^2 hybrid orbital S) 1 mark (sp^2 hybrid orbital N^-)

			1 mark (Shape sp (C)) 1 mark (Shape sp^2 (S)) 1 mark (Shape sp^2 (N^-)) 1 mark (Overlapping sp) 1+1 marks (Overlapping π bond) & All labels are correct
		or C ground state  C excited state  C hybrid  S ground state  N^- ground state 	1 1 1 1 mark (3p obital S) 1 mark (2p orbital N^-)

			1mark (Shape sp (C)) 1 mark (Shape 3p (S)) 1 mark (Shape 2p (N^-)) 1 mark (Overlapping sp) 1+1 marks (Overlapping π bond) & All labels are correct
		TOTAL MARKS	**18**
		MAX MARKS	**17**

No.		Suggested Answer	Marks
4	(a)	P_{Total} = 745 torr	
		P_{N2} = 745 torr - 25 torr = 720 torr = 0.947 atm	1
		PV = nRT	1
		$n = \frac{PV}{RT}$	
		$= \frac{(0.947atm)(0.511L)}{(0.08206\ Latm\ mol^{-1}K^{-1})(299.15K)}$	1
		= 0.01971 mol	1
		Mass = 0.01971 mol x 28 $gmol^{-1}$ = **0.552 g**	1
	(b)	- A has higher boiling point because A has **stronger intermolecular forces** than B	1
		- **More energy is required** to overcome the intermolecular forces between A molecules than in B.	1
		- A can hardly vaporise to achieve atmospheric pressure**, therefore A has lower vapour pressure than B.**	1
		- Thus, A boils at higher temperature.	
		- **Boling point A is higher than B**.	1
		TOTAL MARKS	**9**

No.		Suggested Answer	Marks
5	(a)	$PCl_5\ (g) \leftrightharpoons PCl_3\ (g) + Cl_2\ (g)$	
		n_i 5.00 0 0 n_c -x +x +x n_e 5.00-x x x = 1.23 $[\ ]_e$ 3.77 1.23 1.23	1
		$Kc = \frac{[PCl_3][Cl_2]}{[PCl_3]}$	1
		$Kc = \frac{(1.23)(1.23)}{(3.77)}$	1
		= **0.401**	1
		$\Delta n = 2-1 = 1$	1
		$K_p = K_c(RT)^{\Delta n}$	1
		@	
		$K_p = (0.401)(0.08206 \times 298.15)^1$	
		= **9.81**	1
	(b)(i)	Equilibrium position shifts to the right / forward	1
	(b)(ii)	Equilibrium position shifts to the left / backward	1
		TOTAL MARKS	**9**

No.		Suggested Answer	Marks
6	(a)	$CH_3COOH\ (aq) + H_2O\ (l) \leftrightharpoons CH_3COO^-\ (aq) + H_3O^+\ (aq)$	1

	CH_3COOH	H_2O	$HCOO^-$	H_3O^+
$[\ ]_i$ / M	0.125	-	0	0
$[\ ]_c$ / M	- x	-	+x	+x
$[\ ]_e$ / M	0.125-x	-	X	x

1

$$K_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]} \quad @$$

1

$$1.8 \times 10^{-5} = \frac{(x)(x)}{0.125 - x}$$

Assume x is very small, $0.125 - x \approx 0.125$

$x = 1.5 \times 10^{-3}$ M

1

$[H_3O^+] = x = 1.5 \times 10^{-3}$ M

pH = -log $[H_3O^+]$

$= -\log (1.5 \times 10^{-3})$

1

pH = 2.82

	(b) (i)	$pH = pK_a + \log \frac{[C_6H_5COONa]}{[C_6H_5COOH]}$ @	
		$5.0 = -\log 6.3 \times 10^{-5} + \log \frac{[C_6H_5COONa]}{0.67}$	1
		$= 4.221$ M	1
		Mol of C_6H_5COONa = 4.221 M x 0.03 L	
		= 0.1266 mol	1
		Mass of C_6H_5COONa = 0.1266 mol x 144 g mol^{-1}	
		= **18.23 g**	1

	(b)(ii)	When small amount of KOH is added, it will be neutralized by C_6H_5COOH @ $C_6H_5COOH\ (aq) + OH^-\ (aq) \rightarrow C_6H_5COO^-\ (aq) + H_2O\ (l)$ The concentration of C_6H_5COOH will decrease a little while the concentration of $C_6H_5COO^-$ will increase. **The pH of the solution is not much affected.**	1 1
	(c)	$Mg(OH)_2\ (s) \leftrightharpoons Mg^{2+}\ (aq) + 2\ OH^-\ (aq)$ $K_{sp} = [Mg^{2+}]\ [OH^-]^2$ @ $2.0 \times 10^{-11} = [s]\ [2s]^2$ $2.0 \times 10^{-11} = 4s^2$ $= \mathbf{2.236 \times 10^{-6}\ mol\ L^{-1}}$	1 1 1
		TOTAL MARKS	**14**