ANSWER SCHEME

KOLEJ MATRIKULASI KELANTAN
KELANTAN MATRICULATION COLLEGE

CHEMXCESS

CHEMISTRY 1
SK015
2 Jam

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU.
DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

INSTRUCTION TO CANDIDATE

1. This questions paper consists of 6 questions.
2. Answer **ALL** questions and write in the foolscap papers.
3. All the steps must be shown clearly. Use new page for each questions.
4. Maximum marks awarded are shown in the brackets at the end of each questions or section.
5. The use of non- programmable scientific calculator is permitted.

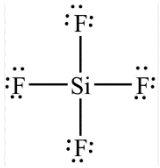
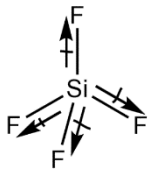
No	Marks allocated	Marks
1	21	
2	10	
3	17	
4	9	
5	9	
6	14	
Total	**80**	

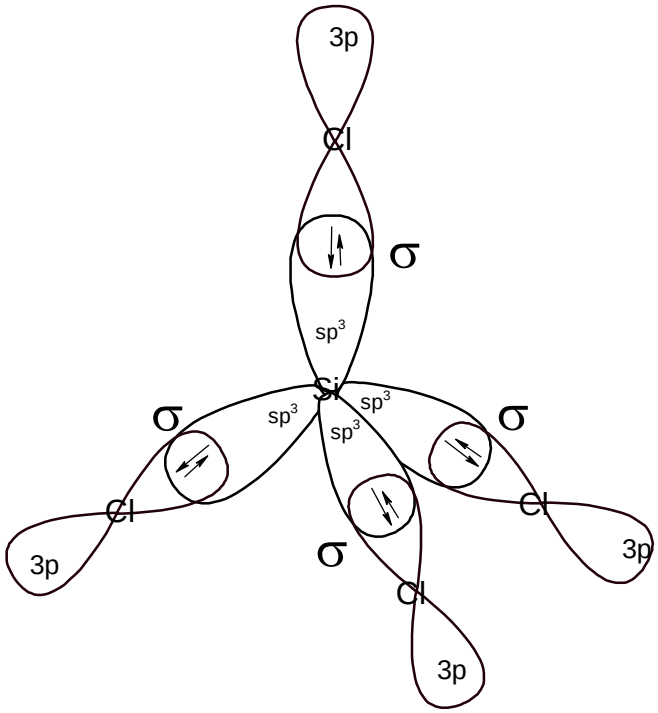
Kertas soalan ini mengandungi 6 halaman bercetak.
This question paper consists of 6 printed pages.

No		Question	Mark
1.	(a)	Isopropyl alcohol, sold as rubbing alcohol is composed of C, H and O. Combustion of 0.255 g of isopropyl alcohol produces 0.561 g of CO_2 and 0.306 g of H_2O. Determine the empirical formula of isopropyl alcohol. (6 marks)	
Answer		Mass of C atom = 12/44 x 0.561 g = 0.152 g Mass of H atom = 2 (1) /18 x 0.306 g = 0.034 g Mass of O atom = 0.255-0.152-0.034 = 0.069 g } all corrects	1 1 1
		Table: Carbon: Mass (g) 0.153; Mole (mol) 0.153/12 = **0.01275 mol**; Simplest mol 0.01275/0.00425 = 2.9 = **3** Hydrogen: Mass (g) 0.034; Mole (mol) 0.034 /1 = **0.034 mol**; Simplest mol 0.034/0.00425= 7.9 = **8** Oxygen: Mass (g) 0.068; Mole (mol) 0.068 /16 = **0.00425 mol**; Simplest mol 0.00431/0.00425 =**1** Empirical formula: **$C_3H_8O_1$**	1 1 1
	(b)	A sample of naturally occurring silicon consists Si-28 (amu = 27.9769), Si-29 (amu = 28.9765) and Si-30 (amu = 29.9738). If the atomic mass of silicon is 28.0855 and the natural abundance of Si-29 is 4.67%, what are the natural abundances of Si-28 and Si-30? (5 marks)	
Answer		Let x = isotopic abundance of Si-28 Let y = isotopic abundance of Si-30 }	1
		Therefore:	
		(27.9769) (x) + (28.9765) (0.0467) + (29.9738) (y) = 28.0855	
		x + 0.0467 + y = 1.000 …… (1)	1
		y = 1.000 − 0.0467 – x …… (2)	1
		Substitute y = 0.9533 – x in the equation (1)	
		X = 0.9222 = **92.22%, Si-28 = 92.22%**	1
		y = 1.00 - 0.9222 - 0.0467 = 0.0311 = **3.11%, Si-30 = 3.11%**	1

	(c)	When benzene, C_6H_6 reacts with bromine, Br_2, bromobenzene, C_6H_5Br is obtained as follows: $C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr$ If 30.0 g of benzene reacts with 65.0 g of bromine, determine the; (10 marks)	
		(i) limiting reactant,	
Answer		Mole of benzene = 30.0 / 78 = **0.3846 mol** (given) Mole of bromine gas = 65.0 / (79.9x2) = **0.4068 mol** (given) From equation 1 mol benzene reacts with 1 mol bromine **0.3846 mol of benzene reacts with 0.3846 mol bromine gas** (needed) **Mol bromine gas needed < mol bromine gas given** Thus **benzene is limiting reactant**	1 1 1 1 1
		(ii) mass of excess remain after the reaction completed,	
Answer		Excess reactant is bromine Mol of excess reactant = **0.4068 – 0.3846** @ = **0.0222 mol** Mass of excess reactant remain = 0.0222 x (79.9x2) = **3.55 g**	 1 1
		(iii) percentage yield if the bromobenzene produced is 42.3 g.	
Answer		From equation 1 mol benzene produce 1 mol bromobenzene Mole of bromobenzene = **0.3846 mol** Mass of bromobenzene = 0.3846 x 156.9 = **60.34 g** $\% \ yield = \frac{Actual\ yield}{\text{theoritical yield}}$ x 100 $= \frac{42.3}{60.34}$ x 100 = **70.10%**	 1 1 1
		Total marks	**21**

2.	(a)	A green laser pointer emits light with a wavelength of 532 nm. Determine; (4 marks)	
		(i) the frequency of the light,	
Answer		$v = c/\lambda$ @ $= 3.0 \times 10^{8} / 532 \times 10^{-9}$ m = **5.639×10^{14} s^{-1} (unit insist)**	1 1
		(ii) the energy of the photon.	
Answer		$E = hv$ @ $= 6.6256 \times 10^{-34}$ J s x 5.639×10^{14} s^{-1} = **3.736×10^{-19} J (unit insist)**	1 1
	(b)	The proton number of element **P** and **Q** are 12 and 17 respectively. Draw the orbital diagram for the valence electron of each element. Suggest the most stable ions for **P** and **Q.** Write their respectively electronic configuration. (4 marks)	
Answer		P = $1s^2\ 2s^2\ 2p^6\ 3s^2$ its valence electron is $3s^2$  Orbital diagram : 3s The most stable ion is P^{2+} Q = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ its valence electron is $3s^2\ 3p^5$  Orbital diagram : 3s 3p The most stable ion is Q^-	1 1 1 1
	(c)	Give the formula when **P** reacts with **Q.** State the type of the bond formed. (2 marks)	
Answer		**PQ_2** , **ionic bond** formed.	1+1
		Total marks	**10**

3.	(a)	What would you expect SiF_4 to be polar or non polar compound? Justify your answer. (4 marks)	
Answer		Lewis Structure :   SiF_4 is a **non polar molecule** because **bond dipoles can cancel each other, μ= 0**	1 1 (show bond dipole) 1 + 1
	(b)	State the hybridisation of the central atom in $SiCl_4$. Draw orbital diagram and draw the overlapping of orbitals in $SiCl_4$. (9 marks)	
Answer		Hybridisation Si in $SiCl_4$ = sp^3 Central atom : Si Electron valence Configuration : $3s^2\ 3p^2$ Orbital diagram :  3s 3p Ground state :  3s 3p Excited state :  Sp^3 Hybridisation state :	1 1 1 1 1

			Shape -1m Overlapping -1m Label of electron & sigma bond – 1m Label of atom and hybrid – 1m
	(c)	Give **TWO** factors that influence the strength of the van der Waals forces. Explain your answers. (4 marks)	
Answer		**Molecular size** - the **larger molecular size, the stronger the Van Der Waals forces**. - this is because the increasing number of electron and increasing polarisability. **Polarity of molecule** - the **more polar molecule, the stronger dipole-dipole forces**. **Molecular shape** - the **larger the surface area** in contact between the molecules, the **stronger van der Waals forces** between the molecules. @ - this is because when the **larger surface area in contact**, will make **van der Waals forces becomes stronger forces.**	1 1 1 1 1 1 (Any two factors)
		Total	**17 marks**

4.	(a)	Two glass flask **R** and **S** connected via a tap. While the tap is closed and there is vacuum in flask **R**, 1.00 dm^3 flask **S** is filled with ammonia gas at 1.00 atm and 300 K. When the tap is opened, ammonia passes into flask **R** and the total pressure in both flask is 0.45 atm. Determine the volume of flask **R**. (2 marks)	
Answer		$P_1V_1 = P_2V_2$ @ $1.00 \times 1.00 = 0.45 \times V_2$ **V_2 = 2.22 dm^3 @ 2.22 L** Volume of flask R = 2.22 – 1.00 = **1.22 dm^3 @ 1.22 L**	1 1 1
	(b)	The reaction of calcium hydride with water represented as $CaH_2(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(s) + 2H_2(g)$ 90.0 mL of hydrogen gas was collected over water at 25 °C and at pressure **T** mmHg. If the partial pressure of hydrogen gas is 731.2 mmHg and the vapour pressure of water is **U** mmHg, determine the mass of calcium hydride decomposed in the reaction. (4 marks)	
Answer		$\boldsymbol{n = \frac{PV}{RT}}$ @ $n = \frac{\frac{731.2}{760} atm \; x \; 0.090 \; L}{0.08206 \; Latm \; mol^{-1}K^{-1} \; x \; 298 \; K}$ **= 3.54 x 10^{-3} mol** 2 mol of H_2 is produced from 1 mol CaH_2 3.54 x 10^{-3} mol is produced from **1.77 x 10^{-3} mol** CaH_2 mass CaH_2 = 1.77 x 10^{-3} x 42.1 = **0.0745 g**	1 1 1 1
	(c)	Explain the process $H_2O(l) \longrightarrow H_2O(s)$ by using kinetic molecular theory. (3 marks)	
Answer		Liquid changes to solid is the **freezing** process. When liquid cooled (temperature is lowered), the **particles lose kinetic energy** and move slowly. **Intermolecular forces become stronger** and particles become fixed in position.	1 1 1
		Total	**10 marks**
		Maximum	**9 marks**

5. 2.0 mol of SO_2 and 1.0 mol of O_2 were allowed to reach equilibrium in a container of 1.0 dm^3 at 450 °C. The equilibrium mixture was found to contain 1.50 mol of SO_3. The reaction is exothermic.

(a) Calculate the equilibrium constant in terms of concentration for the reaction.

(4 marks)

Answer

	$2SO_2(g)$	+ $O_2(g)$ ⇌	$2SO_3(g)$
Initial(M)	2	1	0
Change (M)	-2x	-x	+2x
Equilibrium(M)	**2-2x**	**1-x**	**1.50**

1

2x = 1.50
x = 0.75

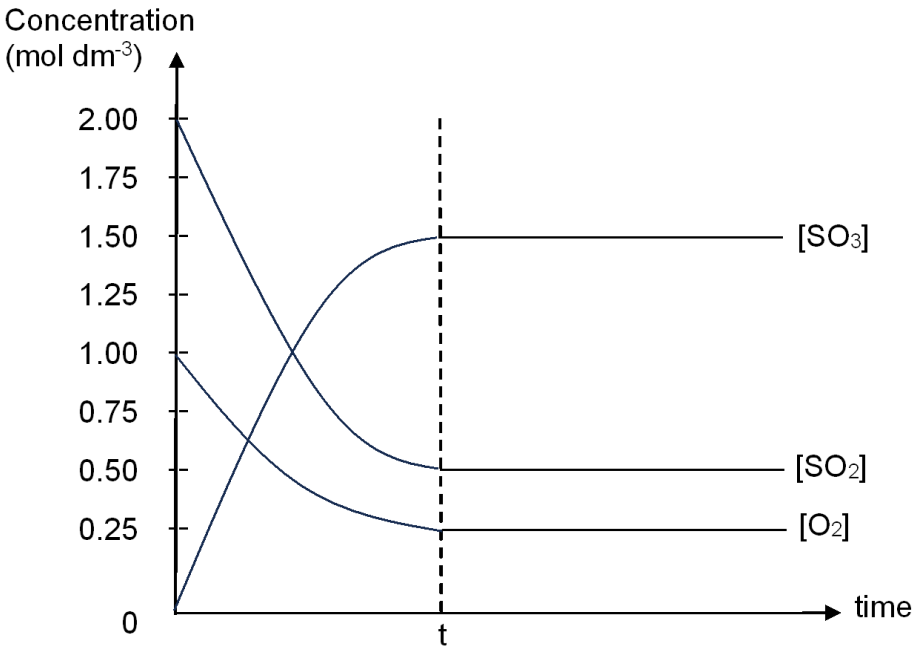
Concentration of SO_2 at equilibrium = 2 – 2x
= 2-1.50 = **0.50 M** 1

Concentration of O_2 at equilibrium = 1 – x
=1-0.75 = **0.25 M** 1

$$\textbf{Kc} = \frac{[SO_3]^2}{[SO_2]^2 x [O_2]}$$

$$= \frac{(1.50)^2}{(0.50)^2 \, x \, 0.25}$$

= 36 1

	(b)	Sketch a graph to show how the concentration changes with time for each of the species before and after the system has achieved equilibrium. (3 marks)	
Answer		 [*t* = time the system achieves equilibrium]	Axes *x* and *y* – 1 Value concentration related with answer in (a) for three species – 1 Curve decreasing and constant after t for SO_2 and O_2 and vice versa for SO_3 - 1
	(c)	Explain the effect of lowering the temperature on the equilibrium constant value. (2 marks)	
Answer		The reaction is exothermic. When temperature is lowered, the equilibrium position will shift to the **right** in order to **release more heat** to the system until new equlibrium is reestablish. Therefore, more [SO_3] will produce, and value of K_c **will increase.**	1 1
		Total	**9 marks**

6 (a) The pH at equivalence point for the titration between ethanoic acid and sodium hydroxide is about 9. Explain qualitatively the sodium ethanoate salt hydrolysis by using hydrolysis equation. (2 marks)

Answer

Sodium ethanoat, CH_3COONa dissociates to form anion and cation.

$CH_3COONa(aq) \longrightarrow Na^+(aq) + Cl^-(aq)$

Na^+ is cation of strong base, NaOH, **Na^+ does not hydrolyzed in water** 1

CH_3COO^- is conjugate base of weak acid, CH_3COOH.

CH_3COO^- is hydrolyzed in water to produce OH^-. 1

$CH_3COO^-(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + OH^-(aq)$

(b) The solubility product of iron(III) hydroxide, $Fe(OH)_3$ at 25 °C is 1.0×10^{-36}.

(i) Calculate the solubility (in g/L) of iron(III) hydroxide. (3 marks)

Answer

	$Fe(OH)_3(s) \rightleftharpoons$	$Fe^{3+}(aq)$ +	$3OH^-(aq)$
Initial(M)	-	0	0
Change (M)	-	+s	+3s
Equilibrium(M)	-	**s**	**3s**

1

$K_{sp} = [Fe^{3+}][OH^-]^3$

$1.0 \times 10^{-36} = (s)(3s)^3$ 1

$s = 4.387 \times 10^{-10}$ M

solubility = 4.387×10^{-10} mol/L x 106.85 g/mol 1

$= 4.69 \times 10^{-8}$ g/L

(ii) Does a precipitate form if 2.0 mL of 0.2 M NaOH is added to 20.0 mL of 0.1 M $Fe(NO_3)_3$. Explain. (6 marks)

Answer

Mole of OH^- = 0.2 x 0.002 = 4.0×10^{-4} mol

Mole of Fe^{3+} = 0.1 x 0.020 = 2×10^{-3} mol

Molarity of OH^- = $\frac{4.0 \times 10^{-4}}{0.022}$ = 0.01818 M 1

Molarity of Fe^{3+} = $\frac{2.0 \times 10^{-3}}{0.022}$ = 0.09090 1

$Q_{sp} = [Fe^{3+}][OH^-]^3$ @ 1

$= (0.09090) \times (0.01818)^3$ 1

$= 5.46 \times 10^{-7}$

$Q_{sp} > K_{sp}$ 1

Solution is supersatured. **Precipitate will form until $Q_{sp} = K_{sp}$.** 1

Reaction proceeds from right to left.

	(c)	A solution with is prepared by mixing NaF and HF in a mole ratio of 0.50:1.0 in 1.0 dm^3 water. The acid dissociation constant of HF is 7.1×10^{-4}. Determine the pH of the solution. (3 marks)	
Answer		$pH = - \log K_a + \log \frac{[F^-]}{[HF]}$	1
		$= - \log 7.1 \times 10^{-4} + \log \frac{0.50}{1.0}$	1
		$= 2.84$	1
		Total	**14 marks**