SK015
Chemistry1
Semester I
Session 2023/2024
2 hours

Kimia 1
Semester I
Sesi 2023/2024
2 jam

CHEMISTRY UNIT
KOLEJ MATRIKULASI MELAKA

SMARTCHEM 1.0
CHEMISTRY 1
2 hours

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

INSTRUCTIONS TO CANDIDATE:

This question paper consists of **6** questions.

Answer **all** questions.

All steps must be shown clearly. Use a new page for each question.

Maximum marks awarded are shown in brackets at the end of each question or section.

The use of electronic calculator is permitted.

Kertas soalan ini mengandungi **8** halaman bercetak.
*This booklet consists of **8** printed pages.*

TABLE OF RELATIVE ATOMIC MASSES

Element	Symbol	Proton number	Relative atomic mass
Aluminium	Al	13	27.0
Silver	Ag	47	107.9
Argon	Ar	18	40.0
Arsenic	As	33	74.9
Gold	Au	79	197.0
Barium	Ba	56	137.3
Beryllium	Be	4	9.0
Bismuth	Bi	83	209.0
Boron	B	5	10.8
Bromine	Br	35	79.9
Iron	Fe	26	55.9
Fluorine	F	9	19.0
Phosphorus	P	15	31.0
Helium	He	2	4.0
Mercury	Hg	80	200.6
Hydrogen	H	1	1.0
Iodine	I	53	126.9
Cadmiun	Cd	48	112.4
Potassium	K	19	39.1
Calcium	Ca	20	40.1
Carbon	C	6	12.0
Chlorine	Cl	17	35.5
Cobalt	Co	27	58.9
Krypton	Kr	36	83.8
Chromium	Cr	24	52.0
Copper	Cu	29	63.6
Lithium	Li	3	6.9
Magnesium	Mg	12	24.3
Manganase	Mn	25	54.9
Sodium	Na	11	23.0
Neon	Ne	10	20.2
Nickel	Ni	28	58.7
Nitrogen	N	7	14.0
Oxygen	O	8	16.0
Platinum	Pt	78	195.1
Lead	Pb	82	207.2
Protactinium	Pa	91	231.0
Radium	Ra	88	226.0
Radon	Rn	86	222.0
Rubidium	Rb	37	85.5
Selenium	Se	34	79.0
Cerium	Ce	58	140.1
Cesium	Cs	55	132.9
Silicon	Si	14	28.1
Scandium	Sc	21	45.0
Tin	Sn	50	118.7
Antimony	Sb	51	121.8
Strontium	Sr	38	87.6
Sulphur	S	16	32.1
Uranium	U	92	238.0
Tungsten	W	74	183.9
Zinc	Zn	30	65.4

LIST OF SELECTED CONSTANT VALUES

Ionisation constant for water at 25°C	K_w	$= 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$
Molar volume of gases	V_m	$= 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at STP
		$= 24 \text{ dm}^3 \text{ mol}^{-1}$ at room temperature
Speed of light in a vacuum	c	$= 3.0 \times 10^8 \text{ m s}^{-1}$
Specific heat of water		$= 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$
		$= 4.18 \text{ J g}^{-1} \text{ K}^{-1}$
		$= 4.18 \text{ J g}^{-1} \text{ °C}^{-1}$
Avogadro's number	N_A	$= 6.02 \times 10^{23} \text{ mol}^{-1}$
Faraday constant	F	$= 9.65 \times 10^4 \text{ C mol}^{-1}$
Planck constant	h	$= 6.6256 \times 10^{-34} \text{ J s}$
Rydberg constant	R_H	$= 1.097 \times 10^7 \text{ m}^{-1}$
		$= 2.18 \times 10^{-18} \text{ J}$
Molar of gases constant	R	$= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		$= 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$
Density of water at 25°C	ρ	$= 1 \text{ g cm}^{-3}$
Freezing point of water		$= 0.00 \text{ °C}$
Vapour pressure of water at 25°C	P_{water}	$= 23.8 \text{ torr}$

UNIT AND CONVERSION FACTOR

VOLUME	1 liter $= 1 \text{ dm}^3$
	1 mL $= 1 \text{ cm}^3$
ENERGY	1 J $= 1 \text{ kg m}^2 \text{ s}^{-2} = 1 \text{ N m} = 1 \times 10^7 \text{ erg}$
	1 calorie $= 4.184 \text{ J}$
	1 eV $= 1.602 \times 10^{-19} \text{ J}$
PRESSURE	1 atm $= 760 \text{ mmHg} = 760 \text{ torr} = 101.325 \text{ kPa} = 101\ 325 \text{ N m}^{-2}$
OTHERS	1 faraday (F) $= 96\ 500$ coulomb
	1 newton (N) $= 1 \text{ kg m s}^{-2}$

Answer **all** questions.

1. (a) The mass spectrum of magnesium shows three isotopes, magnesium-24, magnesium-25 and magnesium-26 with the percentage abundance of 79 % , 10% and 11% respectively. Calculate the relative atomic mass of magnesium.
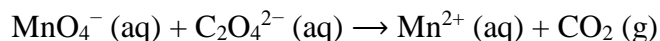
   [3 *marks*]

   (b) Compound **Z** is a hydrocarbon, **C_xH_y**. When 6.84 g of this compound is burnt completely in pure oxygen, 21.5 g of CO_2 and 8.87 g of H_2O are obtained. Determine the empirical formula of compound **Z**. If the molar mass of the compound is 126.0 g mol^{-1}, what is its molecular formula?

   [6 *marks*]

   (c) A bottle of concentrated nitric acid, HNO_3 solution contains 85.00% by mass and has a density of 0.8362 g mL^{-1}. Calculate the molarity of the acid.

   [5 *marks*]

   (d) The following reaction occurs in an acidic condition.

   $$MnO_4^- \text{ (aq)} + C_2O_4^{2-} \text{ (aq)} \longrightarrow Mn^{2+} \text{ (aq)} + CO_2 \text{ (g)}$$

   Write a balanced equation for the above reaction.

   [3 *marks*]

   (e) Manganese dioxide reacts with hydrochloric acid to produce magnesium chloride, water, and chlorine gas as follows:

   $$MnO_2 \text{ (aq)} + 4HCl \text{ (aq)} \longrightarrow MnCl_2 \text{ (aq)} + Cl_2 \text{ (g)} + 2H_2O \text{ (l)}$$

   If 0.86 moles of manganese dioxide react with 48.2 g of hydrochloric acid, determine:
   i) the limiting reactant
   ii) the mass of chlorine gas produced

   [4 *marks*]

2. (a) A photon with the wavelength of 1094 nm is emitted when an electron falls from n=6 to a lower energy level in hydrogen line spectrum.

(i) Determine the transition of the electron.

(ii) Calculate the energy of the electron before it is excited.

(iii) State the series of the respective line spectrum.

[6 *marks*]

(b) The valence electrons of element **X** occupies 3s, $3p_x$ and $3p_z$ orbitals.

(i) Write the set(s) of four quantum numbers for the electron(s) that occupy the highest energy orbital.

(ii) Draw the shape of the highest energy orbital **X**.

(iii) State the total number of electrons which occupy $l=1$ in element X.

[4 *marks*]

3.   Thiocyanate ion, SCN⁻ is an antioxidant and a useful therapeutic agent.

(a)   Draw all possible Lewis structures for SCN⁻ ion.

[3 *marks*]

(b)   Determine the most plausible Lewis structure and explain your answers.

[3 *marks*]

(c)   For the most plausible structure of SCN⁻ ion (in (b)), illustrate the hybridisation of the central atom and the overlapping of the orbitals.

[12 *marks*]

4.   (a)   Ammonium nitrous, NH_4NO_2 decomposes upon heating to form nitrogen gas and water.

$$NH_4NO_2(s) \rightarrow N_2(g) + 2H_2O(l)$$
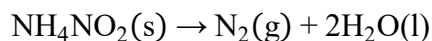
When a sample of NH_4NO_2 was heated and decomposed, 0.511 L of nitrogen gas was collected over water at 26°C and 745 torr. If the vapour pressure of water is 25 torr at 26°C, calculate the mass of nitrogen gas collected.

[5 *marks*]

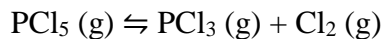(b)   Table 1 shows the vapour pressure of compound A and B at certain temperature.

Compound	Vapour pressure (torr)
A	55.3
B	92.0

TABLE 1

Determine the compound that has the highest boiling point.

[4 *marks*]

5. (a)   In an experiment, phosphorus pentachloride gas, PCl_5 decomposed to produce chlorine

    gas, Cl_2 and phosphorus trichloride gas, PCl_3.

$$PCl_5 \text{ (g)} \leftrightharpoons PCl_3 \text{ (g)} + Cl_2 \text{ (g)}$$

    At 25 ^oC, if 5.00 mol of PCl_5 gas is placed in a 1.00 L container and decomposed to give

    1.23 mol of chlorine gas at equilibrium, determine the equilibrium constant of K_c and K_p.

    [R= 0.08206 atm L $mol^{-1}K^{-1}$]

                                                                                                               [7 *marks*]

    (b)   Consider the following reaction,

$$CO \text{ (g)} + 2H_2 \text{ (g)} \leftrightharpoons CH_3OH \text{ (g)} \qquad \Delta H = \text{-ve}$$

    Based on Le Chatelier's principle, state the change that would occur to the equilibrium

    position if :

    (i)   the temperature is lowered.

    (ii)   the volume of the container is increased.

                                                                                                               [2 *marks*]

6.   (a)   The ionisation constant, K_a of ethanoic acid, CH_3COOH is 1.8×10^{-5}. Calculate the pH of 0.125 M of CH_3COOH.

[5 *marks*]

    (b)   A 30.00 mL buffer solution of pH 5 contains 0.67 M benzoic acid, C_6H_5COOH and sodium benzoate, C_6H_5COONa.

i) Calculate the mass of sodium benzoate in buffer solution.

ii) Explain the changes of pH after addition of a small amount of KOH into the buffer solution. [K_a of Benzoic Acid $= 6.3 \times 10^{-5}$]

[6 *marks*]

    (c)   Calculate the molar solubility of magnesium hydroxide, $Mg(OH)_2$.

[K_{sp} $Mg(OH)_2 = 2.0 \times 10^{-11}$]

[3 *marks*]

END OF QUESTION PAPER