

SK015

Chemistry 1

Semester 1

Session 2023/2024

2 hours

SK015

Kimia 1

Semester I

Sesi 2023/2024

2 jam



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KEMENTERIAN PENDIDIKAN MALAYSIA

PRE PSPM
SET 2

JANGAN BUKA SOALAN INI SEHINGGA DIBERITAHU.
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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
Flourine	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
Cadmium	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
Manganese	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	=	$1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-16}$
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		=	$4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$
		=	$4.18 \text{ J g}^{-1} \text{ K}^{-1}$
		=	$4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$
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	ρ	=	1 g cm^{-3}
Freezing point of water		=	$0.00 \text{ }^\circ\text{C}$
Vapour pressure of water	P_{water}	=	23.8 torr

UNIT AND CONVERSION FACTOR

Volume	1 liter = 1 dm^3 1 mL = 1 cm^3
Energy	1 J = $1 \text{ kg m}^2 \text{ s}^{-2}$ = 1 N m = 10^7 erg 1 calorie = 4.184 Joule 1 eV = $1.602 \times 10^{-19} \text{ J}$
Pressure	1 atm = 760 mm Hg = 760 torr = 101.325 kPa = 101325 N m^{-2}
Others	1 faraday(F) = 96500 coulomb 1 newton(N) = 1 kg m s^{-2}

Answer **all** questions.

1 (a) Anion X^{2-} has 18 electrons and 16 neutrons.

(i) State the proton number and nucleon number of element X .

(ii) Write the isotopic notation for ion X .

[2 marks]

(b) Terephthalic acid is an important chemical used in the manufacturing of polyesters and plasticizers. It contains only carbon, hydrogen, and oxygen. Combustion of 19.81 g terephthalic acid produces 41.98 g CO_2 and 6.45 g H_2O . If 0.250 mole of terephthalic acid has a mass of 41.5 g, determine the molecular formula of terephthalic acid.

[6 marks]

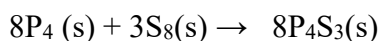
(c) A sulphuric acid solution containing 571.6 g of H_2SO_4 per liter of solution has a density of 1.329 g ml^{-1} . Calculate the

(i) mass percentage and

(ii) molality of the sulphuric acid solution.

[6 marks]

(d) Tetraphosphorus trisulfide, P_4S_3 , is used in the manufacturing of “strike anywhere” matches. Elemental phosphorus and sulphur react directly to form P_4S_3 according to the following equation:



(i) How many grams of S_8 are needed to produce 120 g of P_4S_3 if the reaction has a 78.1 % yield?

(ii) If 1.2 mol of P_4 react with S_8 in 1(d)(i), calculate the number of mole of P_4 left after the reaction.

[7 marks]

- 2 (a) FIGURE 1 shows the energy level diagram of the hydrogen atom that represents the Balmer series.

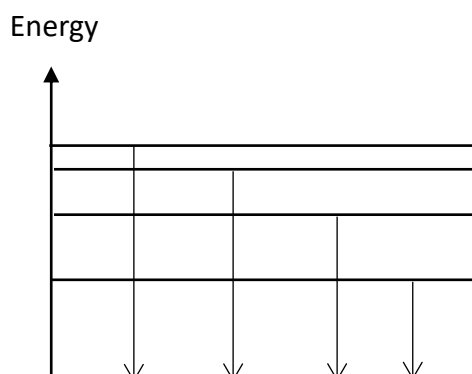


FIGURE 1

- (i) Calculate the energy emitted from the transition of electron that produces photon with the shortest wavelength.
- (ii) State the spectrum region for the Balmer series. [3 marks]
- (b) Atom X has four valence electrons. Two of the valence electrons have the following set of quantum numbers:
 $(n, l, m, s) = (3, 2, 0, +\frac{1}{2})$
 $(n, l, m, s) = (3, 2, +1, +\frac{1}{2})$
- (i) Identify and draw the orbitals occupied by these two electrons.
- (ii) Write the electronic configuration for atom X. [4 marks]
- (c) Describe the anomalous electronic configuration of chromium atom. [3 marks]

- 3 (a) Thiocyanate ion, SCN^- has numerous applications in serving as the starting materials for the synthesis of certain dyes and in pharmaceuticals.
- (i) Draw all the possible Lewis structures for thiocyanate ion, SCN^- .
- (ii) Based on the formal charge concept, determine the most plausible structure, and give your reason.
- (iii) Predict the molecular geometry and bond angle of SCN^- according to the VSEPR theory.
- (iv) State the hybrid orbital for the central atom and draw the orbital overlapping diagram of SCN^- .

[12 marks]

(b) Explain why water is denser than ice. [2 marks]

(c) A metallic bond is a bond resulting from attractions between positively charged metal ions and surrounding mobile electrons.

(i) Draw and label the electron sea model for magnesium.

(ii) Explain why the metallic bond in aluminium is stronger than sodium. [3 marks]

4 (a) A sample of potassium chlorate, KClO_3 was decomposed upon heating, producing potassium chloride, KCl and oxygen gas, O_2 . The volume of gas collected by displacement of water was 250 mL at 26 °C and a pressure of 770 mmHg. Given that the water vapour pressure at the same temperature is 35.5 mmHg, calculate,

(i) the partial pressure of O_2 in atm.

(ii) the mass of KClO_3 decomposed

[6 marks]

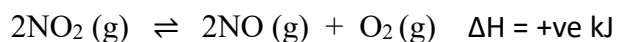
(b) Which of the compounds in **TABLE 1** has higher vapour pressure. Explain.

Compound	Boiling Point (°C)
Propanol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	97
Propanone, CH_3COCH_3	56

TABLE 1

[3 marks]

5 The nitrogen dioxide, NO_2 gas decomposed to nitric oxide, NO gas and O_2 gas according to the following equation:



An amount of 0.50 mol of nitrogen dioxide, NO_2 gas was added to a 5.0 L container and heated to 100 °C. When equilibrium was reached, the mixture contains 0.20 mol of NO_2 gas.

(a) Determine the equilibrium constant (K_C) for the reaction

[3 marks]

(b) Calculate the degree of dissociation of NO_2

[2 marks]

(c) Suggest two (2) ways to increase the yield of NO . Explain your suggestions.

[4 marks]

- 6 (a) 25.00 mL of 0.1 M NH_3 is titrated with 0.1 M HCl.
- (i) Calculate the pH before the titration.
 - (ii) Explain qualitatively the pH of the solution after the addition 25 mL HCl.
 - (iii) Sketch the titration curve for the neutralisation above.
($K_b \text{ NH}_3 = 1.8 \times 10^{-5}$)
- [9 marks]
- (b) Given the solubility product, K_{sp} of BaF_2 is 1.7×10^{-6} , will precipitate formed when 20 mL of 0.025 M of $\text{Ba}(\text{NO}_3)_2$ and 30 mL of 0.03 M NaF are mixed?
- [5 marks]

END OF QUESTION PAPER