TEST 3
SK015
Chemistry 1
Semester 1
Session 2023/2024

/ 100	**Grade:**

CHEMISTRY UNIT
PAHANG MATRICULATION COLLEGE

TEST 3
CHAPTER 1, 2, 4, 5, 6 & 7
(2 HOURS)

NAME : _____

CLASS : _____

LECTURER : _____

QUESTION	MARKS
1	/ 21
2	/ 10
3	/ 17
4	/ 9
5	/ 9
6	/ 14
TOTAL	**/ 80**

This question paper consists of **7** printed pages.

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RELATIVE ATOM MASSES OF SELECTED ELEMENTS
JISIM ATOM RELATIF UNSUR-UNSUR TERPILIH

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
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
SENARAI NILAI PEMALAR TERPILIH

Ionization constant for water at 25°C *Hasil darab ion bagi air pada 25℃*	K_w	=	1.00×10^{-14} mol^2 dm^{-6}
Molar volume of gases *Isi padu molar gas*	V_m	= =	22.4 dm^3 mol^{-1} at STP 24 dm^3 mol^{-1} at room temperature
Speed of light in a vacuum *Laju cahaya dalam vakum*	c	=	$3.0 \cdot 10^8$ m s^{-1}
Specific heat of water *Muatan haba tentu air*		= = =	4.18 kJ kg^{-1} K^{-1} 4.18 J g^{-1} K^{-1} 4.18 J g^{-1} °C^{-1}
Avogadro's number *Nombor Avogadro*	N_A	=	6.02×10^{23} mol^{-1}
Faraday constant *Pemalar Faraday*	F	=	9.65×10^4 C mol^{-1}
Planck constant *Pemalar Planck*	*h*	=	6.6256×10^{-34} J s
Rydberg constant *Pemalar Rydberg*	R_H	= =	1.097×10^7 m^{-1} 2.18×10^{-18} J
Ideal gas constant *Pemalar gas molar*	R	= =	8.314 J K^{-1} mol^{-1} 0.08206 L atm mol^{-1} K^{-1}
Density of water at 25°C *Ketumpatan air*	ρ	=	1 g cm^{-3}
Freezing point of water *Takat beku air*		=	0.00 °C
Vapour pressure of water *Tekanan wap air*	P_{water}	=	23.8 torr

UNIT AND CONVERSION FACTOR
UNIT DAN FAKTOR PERTUKARAN

Volume *Isi padu*	1 liter = 1 dm^3 1mL = 1 cm^3
Energy *Tenaga*	1 J = 1 kg m^2 s^{-2} = 1 N m = 10^7 erg 1 calorie = 4.184 Joule 1eV = 1.602×10^{-19} J
Pressure *Tekanan*	1 atm = 760 mm Hg = 760 torr = 101.325 k Pa = 101 325 N m^{-2}
Others *Lain-lain*	1 Faraday (F) = 96 500 coulomb 1 Newton (N) = 1 kg m s^{-2}

Answer all the questions

1. (a) **Table 1** shows the isotopes of magnesium, Mg with its percentage abundance and isotopic mass.

Isotope	Percentage abundance (%)	Isotopic mass (u)
^{24}Mg	78.99	23.985
^{25}Mg	***X***	24.986
^{26}Mg	11.01	25.983

Table 1

If the average atomic mass of Mg is 24.31, calculate the percentage abundance, ***X*** of ^{25}Mg.

[2 *marks*]

(b) A sample of vitamin C, which also known as ascorbic acid consists of carbon, hydrogen and oxygen. If the complete combustion of 1.001 g of the compound produced 1.503 g of CO_2 and 0.414 g of H_2O, determine the empirical formula of the compound.

[4 *marks*]

(c) Hydrobromic acid, HBr solution contains 47.5 % HBr by mass and has a density of 1.30 g cm^{-3} at room temperature. Calculate the molarity of the HBr solution.

[4 *marks*]

(d) The following reaction takes place in acidic condition.

$$MnO_4^-(aq) + SO_3^{2-}(aq) \rightarrow MnO_2(aq) + SO_4^{2-}(aq)$$

Write a balance equation for the above reaction.

[3 *marks*]

(e) The fertiliser urea, $(NH_2)_2CO$ is prepared by reacting ammonia, NH_3 with carbon dioxide, CO_2 according to the following equation.

$$2NH_3(g) + CO_2(g) \rightarrow (NH_2)_2CO(aq) + H_2O(\iota)$$

In an experiment, 0.62 mole of NH_3 was added to 0.56 mole of CO_2.

(i) Determine the limiting reactant.

(ii) Determine the amount (in gram) of $(NH_2)_2CO$ formed.

(iii) Calculate the mass of excess reactant after the reaction.

[8 *marks*]

2. (a) **Figure 1** below shows the line spectrum of hydrogen atom in the ultraviolet region.

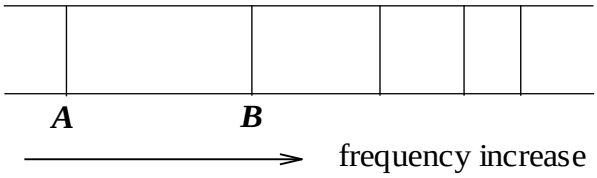

Figure 1

(i) Calculate the wavelength (in nm) of photon emitted to produce line ***B***.

(ii) Calculate the energy of an electron at its excited state before it drops to produce line ***A***.

[4 *marks*]

(b) The electronic configuration of an atom ***C*** is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$.

(i) Write a possible set of quantum numbers for the 12^{th} electron.

(ii) Draw the shape of orbitals for the valence electron.

(iii) Determine the rule used to arrange the 6^{th} and 7^{th} electron in the 2p orbitals.

[4 *marks*]

(c) State the actual electronic configuration of copper. Explain why the expected electronic configuration of copper is different from the actual electronic configuration.

[2 *marks*]

3. (a) The suprachiasmatic nucleus, SCN is a bilateral structure use as the central pacemaker of the circadian timing system and regulates most circadian rhythms in the body. Two possible Lewis structure of SCN are given below:

I **II**

(i) Show formal charge on each atom of structure **I** and **II**.

(ii) Determine the most plausible structure. Explain.

[3 *marks*]

(b) Illustrate the hybridization process in ozone, O_3 and determine its molecular shape. Draw and label the overlapping of the orbital.

[10 *marks*]

(c) **Table 2** shows the molar mass and boiling point of NCl_3 and BCl_3.

Compound	Molar mass (g mol^{-1})	Boiling point (^0C)
NCl_3	120.5	71.0
BCl_3	117.3	12.6

Table 2

Explain the difference in boiling point of the two compounds.

[2 *marks*]

(d) Copper, Cu is a good electrical conductor while carbon, C in its diamond allotropes is a poor electrical conductor. Discuss this statement based on band theory.

[2 *marks*]

4. (a) A vessel of 120 mL capacity contains a certain amount of gas ***D*** at 35 ^{o}C and 1.2 atm. The gas ***D*** is transferred to another vessel of volume 180 mL at the same temperature. Calculate the pressure of the gas ***D*** at the new vessel.

[2 *marks*]

(b) A piece of solid carbon dioxide, CO_2 with a mass of 5.50 g is placed in a 10.0 L vessel that already contains air at 705 torr and 297.15 K. Determine the partial pressure of CO_2 and the total pressure, P_T in the container at 297.15 K after the CO_2 has totally vaporized.

[2 *mark*]

(c) **Table 3** shows the boiling point for a few liquids.

Liquid	Ethanal, CH_3CHO	Ethanol, CH_3CH_2OH	Methanol, CH_3OH
Boiling point / ^{O}C	20	78	65

Table 3

(i) Based on **Table 3**, arrange these liquids in order of increasing vapour pressure.
(ii) State the relationship between intermolecular forces and vapour pressure.

[2 *marks*]

(d) **Figure 2** and **Figure 3** shows the phase diagram of water, H_2O and carbon dioxide, CO_2.

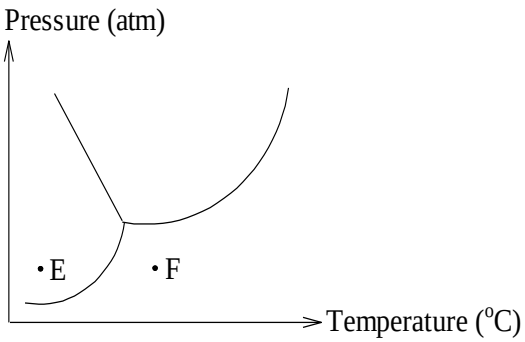

Figure 2: H_2O

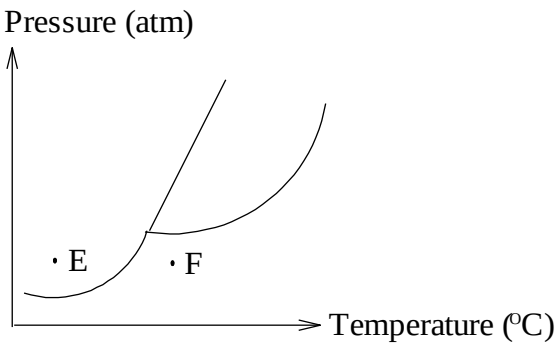

Figure 3: CO_2

(i) Compare the freezing/melting curve between H_2O and CO_2.
(ii) Explain the anomalous behavior of H_2O.
(iii) State the kinetic energy changes from point ***F*** to ***E***.

[3 *marks*]

5. A mixture of sulphur dioxide, SO_2 and oxygen, O_2 gas in a 1.0 L reaction vessel was allowed to react at 700 K and produce sulphur trioxide, SO_3 gas as the following equation.

$$2SO_2\,(g) + O_2\,(g) \rightleftharpoons 2SO_3\,(g) \qquad \Delta H = -\,202.0\ kJ$$

At any instant of mixing, the amount of SO_2, O_2 and SO_3 are 0.010 mol, 0.010 mol and 10 mol respectively and the temperature maintained at 700 K. The equilibrium constant, K_c for this reaction is 4.3×10^6.

(a) Determine whether the reaction is at equilibrium at this temperature. If not, predict to which direction will the reaction proceed.

[7 *marks*]

(b) Describe the effect of equilibrium position if temperature of the system is decrease.

[2 *marks*]

6. (a) Nitrous acid, HNO_2 is used to make diazonium salts, which are widely used in the preparation of azo dyes.

(i) An aqueous solution of 0.235 M HNO_2 has a pH of 1.85. Calculate the dissociation constant, K_a of this solution.

(ii) The pH of a buffer solution containing 0.235 M HNO_2 and 0.240 M of sodium nitrite, $NaNO_2$ is 3.05. Calculate the pH when 0.01 mol of sodium hydroxide, NaOH is added to 1.0 L of this buffer solution.

[8 *marks*]

(b) A student carried out a titration experiment at 25 ^oC by adding 0.1 M KOH into conical flask containing 25 cm^3 0.1 M HClO. Sketch a graph and label the equivalence point on the graph.

[2 *marks*]

(c) The concentration of the Ag^+ ion in a saturated solution of silver sulphate, Ag_2SO_4 at 298 K is 1.5×10^{-2} M. Calculate the solubility product, K_{sp} of Ag_2SO_4 at the same temperature.

[4 *marks*]

END OF QUESTION PAPER