SK016/2
Chemistry
Paper 2
Semester I
Session 2015/2016
2½ hours

SK016/2
Kimia
Kertas 2
Semester I
Sesi 2015/2016
2½ jam

KEMENTERIAN PENDIDIKAN MALAYSIA

BAHAGIAN MATRIKULASI
MATRICULATION DIVISION

PEPERIKSAAN SEMESTER PROGRAM MATRIKULASI
MATRICULATION PROGRAMME EXAMINATION

KIMIA
Kertas 2
2½ jam

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

Kertas soalan ini mengandungi **15** halaman bercetak.
This question paper consists of **15** *printed pages.*

ARAHAN KEPADA CALON:

Kertas soalan ini mengandungi **Bahagian A** dan **Bahagian B**.

Jawab **semua** soalan dalam **Bahagian A** dan **mana-mana dua** soalan dalam **Bahagian B**. Hanya **dua jawapan pertama** di **Bahagian B** akan diperiksa.

Jawapan kepada kedua-dua bahagian ini hendaklah ditulis pada buku jawapan yang disediakan. Gunakan muka surat baru bagi nombor soalan yang berbeza.

Markah maksimum yang diperuntukkan ditunjukkan dalam kurungan pada hujung setiap soalan atau bahagian soalan.

Kalkulator elektronik boleh digunakan.

INSTRUCTIONS TO CANDIDATE:

This question paper consists of **Section A** and **Section B**.

Answer **all** questions in **Section A** and **any two** questions in **Section B**. Only the **first two answers** in **Section B** will be graded.

Answers to both sections must be written in the answer booklet provided. Use a new page for each question.

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

The use of electronic calculator is permitted.

JISIM ATOM RELATIF UNSUR-UNSUR TERPILIH

Unsur	Simbol	Nombor Atom	Jisim Atom Relatif
Aluminium	Al	13	27.0
Argentum	Ag	47	107.9
Argon	Ar	18	40.0
Arsenik	As	33	74.9
Aurum	Au	79	197.0
Barium	Ba	56	137.3
Berilium	Be	4	9.0
Bismuth	Bi	83	209.0
Boron	B	5	10.8
Bromin	Br	35	79.9
Ferum	Fe	26	55.9
Fluorin	F	9	19.0
Fosforus	P	15	31.0
Helium	He	2	4.0
Hidragirum	Hg	80	200.6
Hidrogen	H	1	1.0
Iodin	I	53	126.9
Kadmium	Cd	48	112.4
Kalium	K	19	39.1
Kalsium	Ca	20	40.1
Karbon	C	6	12.0
Klorin	Cl	17	35.5
Kobalt	Co	27	58.9
Kripton	Kr	36	83.8
Kromium	Cr	24	52.0
Kuprum	Cu	29	63.6
Litium	Li	3	6.9
Magnesium	Mg	12	24.3
Mangan	Mn	25	54.9
Natrium	Na	11	23.0
Neon	Ne	10	20.2
Nikel	Ni	28	58.7
Nitrogen	N	7	14.0
Oksigen	O	8	16.0
Platinum	Pt	78	195.1
Plumbum	Pb	82	207.2
Protaktinium	Pa	91	231.0
Radium	Ra	88	226.0
Radon	Rn	86	222.0
Rubidium	Rb	37	85.5
Selenium	Se	34	79.0
Serium	Ce	58	140.1
Sesium	Cs	55	132.9
Silikon	Si	14	28.1
Skandium	Sc	21	45.0
Stanum	Sn	50	118.7
Stibium	Sb	51	121.8
Strontium	Sr	38	87.6
Sulfur	S	16	32.1
Uranium	U	92	238.0
Wolfrum	W	74	183.9
Zink	Zn	30	65.4

TABLE OF RELATIVE ATOMIC MASSES

Element	Symbol	Atomic 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

SENARAI NILAI PEMALAR TERPILIH

Hasil darab ion bagi air pada 25°C	K_w	=	1.00×10^{-14} mol^2 dm^{-16}
Isipadu molar gas	V_m	=	22.4 dm^3 mol^{-1} pada STP
		=	24 dm^3 mol^{-1} pada suhu bilik
Laju cahaya dalam vakum	c	=	3.0×10^8 m s^{-1}
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}
Nombor Avogadro	N_A	=	6.02×10^{23} mol^{-1}
Pemalar Faraday	F	=	9.65×10^4 C mol^{-1}
Pemalar Planck	h	=	6.6256×10^{-34} J s
Pemalar Rydberg	R_H	=	1.097×10^7 m^{-1}
		=	2.18×10^{-18} J
Pemalar gas molar	R	=	8.314 J K^{-1} mol^{-1}
		=	0.08206 L atm mol^{-1} K^{-1}
Ketumpatan air	ρ	=	1 g cm^{-3}
Takat beku air		=	0.00°C
Tekanan wap air	P_{air}	=	23.8 torr

UNIT DAN FAKTOR PERTUKARAN

Isipadu	1 liter = 1 dm^3
	1 mL = 1 cm^3
Tenaga	1 J = 1 kg m^2 s^{-2} = 1 N m = 10^7 erg
	1 kalori = 4.184 Joule
	1 eV = 1.602×10^{-19} J
Tekanan	1 atm = 760 mm Hg = 760 torr = 101.325 kPa = 101325 N m^{-2}
Lain-lain	1 faraday(F) = 96500 coulomb
	1 newton(N) = 1 kg m s^{-2}

LIST OF SELECTED CONSTANT VALUES

Ionisation constant for water at 25°C	K_w	=	1.00×10^{-14} mol^2 dm^{-16}
Molar volume of gases	V_m	=	22.4 dm^3 mol^{-1} at STP
		=	24 dm^3 mol^{-1} at room temperature
Speed of light in a vacuum	c	=	3.0×10^8 m s^{-1}
Specific heat of water		=	4.18 kJ kg^{-1} K^{-1}
		=	4.18 J g^{-1} K^{-1}
		=	4.18 J g^{-1} °C^{-1}
Avogadro's number	N_A	=	6.02×10^{23} mol^{-1}
Faraday constant	F	=	9.65×10^4 C mol^{-1}
Planck's constant	h	=	6.6256×10^{-34} J s
Rydberg constant	R_H	=	1.097×10^7 m^{-1}
		=	2.18×10^{-18} J
Molar of gases constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.08206 L atm mol^{-1} K^{-1}
Density of water	ρ	=	1 g cm^{-3}
Freezing point of water		=	0.00°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 kg m^2 s^{-2} = 1 N m = 10^7 erg 1 calorie = 4.184 Joule 1 eV = 1.602×10^{-19} 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}

BAHAGIAN A [60 *markah*]

Jawab ***semua*** *soalan dalam bahagian ini.*

1 Sebatian ***Q*** mengandungi karbon, hidrogen dan nitrogen. Pembakaran 0.250 g ***Q*** menghasilkan 0.344 g air, H_2O, dan 0.558 g karbon dioksida, CO_2. Tentukan

(a) formula empirik ***Q***,

[11 *markah*]

(b) jisim molar ***Q*** jika formula molekulnya adalah sama dengan formula empirik dan

[1 *markah*]

(c) bilangan atom hidrogen yang terdapat dalam sampel ***Q*** di atas.

[3 *markah*]

2 Atom ***X*** mempunyai 5 elektron valens. ***X*** bertindak balas dengan gas fluorin membentuk sebatian XF_3 dan XF_5.

(a) Bagi setiap sebatian,

(i) lukiskan struktur Lewis,

(ii) ramalkan geometri pasangan elektron dan geometri molekul dan

(iii) lukiskan geometri molekul dan nyatakan sudut ikatan.

[13 *markah*]

(b) Ramalkan perubahan dalam penghibridan (jika ada) bagi atom ***X*** dalam tindak balas berikut:

$$XF_3 + F_2 \rightarrow XF_5$$

[2 *marks*]

3 (a) Suatu campuran gas mengandungi 82% (w/w) metana, CH_4, dan 18% (w/w) etana, C_2H_6. Jika suatu sampel 15.50 g campuran gas ini ditempatkan dalam bekas berisipadu 15-L pada 20.0°C, hitung

(i) jumlah mol gas,

(ii) jumlah tekanan (atm) dan

(iii) tekanan separa setiap gas di dalam bekas.

[7 *markah*]

$CHN + O_2 \rightarrow CO_2 + H_2O + N$

SECTION A [60 *marks*]

*Answer **all** questions in this section.*

1 Compound ***Q*** contains carbon, hydrogen and nitrogen. Combustion of 0.250 g of ***Q*** produces 0.344 g of water, H_2O, and 0.558 g of carbon dioxide, CO_2. Determine

(a) the empirical formula of ***Q***,

[11 *marks*]

(b) the molar mass of ***Q*** if the molecular formula is the same as the empirical formula and

[1 *marks*]

(c) the number of hydrogen atoms present in the above sample ***Q***.

[3 *marks*]

2 An atom ***X*** has 5 valence electrons. ***X*** reacts with fluorine gas to form XF_3 and XF_5 compounds.

(a) For each compound,

(i) draw the Lewis structure,

(ii) predict the electron pair geometry and the molecular geometry and

(iii) draw the molecular geometry and state the bond angle(s).

[13 *marks*]

(b) Predict the change in hybridization (if any) of the ***X*** atom in the following reaction:

$$XF_3 + F_2 \rightarrow XF_5$$

[2 *marks*]

3 (a) A gas mixture contains 82% (w/w) methane, CH_4, and 18% (w/w) ethane, C_2H_6. If a 15.50 g sample of the gas mixture is placed in a 15-L container at 20.0°C, calculate

(i) the total moles of gases,

(ii) the total pressure (atm) and

(iii) the partial pressure of each gas in the container.

[7 *marks*]

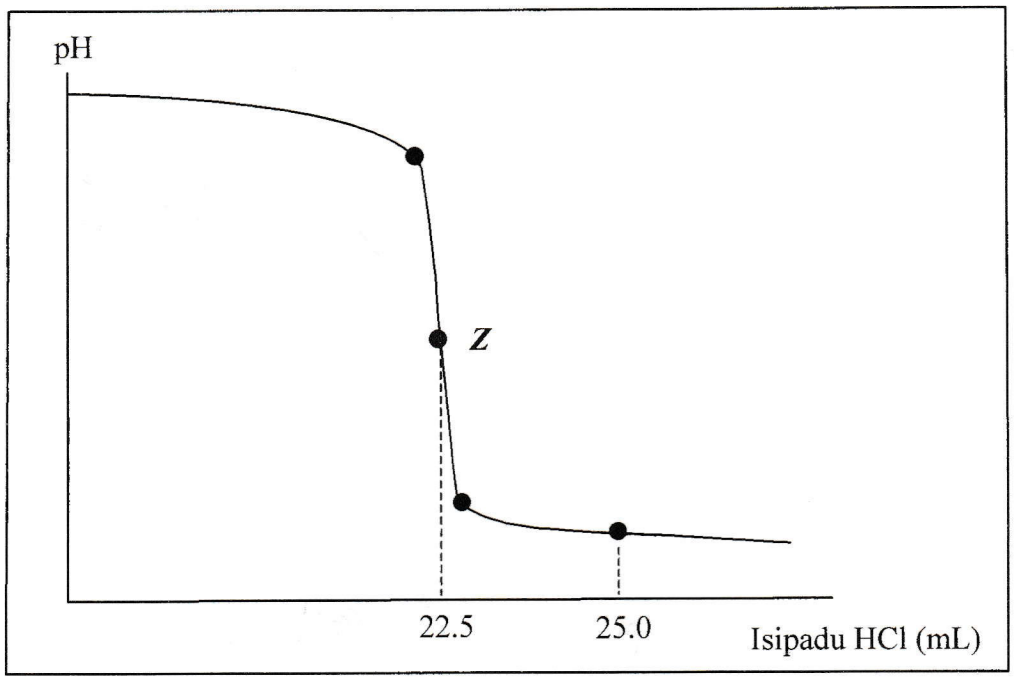
(b) Jelaskan setiap pemerhatian berikut:

(i) Metana, CH_4 (16 g mol^{-1}) mempunyai takat didih yang lebih rendah daripada propana, C_3H_8 (44 g mol^{-1}) manakala air, H_2O (18 g mol^{-1}) mempunyai takat didih yang lebih tinggi daripada hidrogen sulfida, H_2S (34 g mol^{-1}).

(ii) Molekul karbon dioksida, CO_2 dan intan adalah kedua-duanya berikatan kovalen. Bagaimanapun, pepejal CO_2 adalah lebih lembut dan mempamerkan takat lebur yang lebih rendah berbanding dengan intan.

[8 *markah*]

4 (a) **RAJAH 1** menunjukkan suatu keluk pentitratan bagi 20.0 mL larutan NaOH yang tidak diketahui kepekatannya yang dititratkan dengan larutan piawai HCl berkepekatan 1.00 M.



RAJAH 1

(i) Takrifkan larutan piawai, takat kesetaraan dan takat akhir.

(ii) Apakah pH pada takat kesetaraan, ***Z*** bagi pentitratan ini?

(iii) Hitung kemolaran larutan NaOH yang digunakan dalam pentitratan ini.

(iv) Hitung pH larutan selepas penambahan 25.0 mL HCl.

[8 *markah*]

(b) Piridina, C_5H_5N, adalah suatu bes lemah. Bes ini terion dalam air menghasilkan $C_5H_5NH^+$ dan OH^-. Hitung pH larutan piridina berkepekatan 1.00 M jika pemalar penguraian, K_b, bagi piridina adalah 1.50×10^{-9}.

[7 *marks*]

(b) Explain each of the following observations:

(i) Methane, CH_4 (16 g mol^{-1}) has lower boiling point than propane, C_3H_8 (44 g mol^{-1}) whereas water, H_2O (18 g mol^{-1}) has higher boiling point than hydrogen sulphide, H_2S (34 g mol^{-1}).

(ii) Carbon dioxide, CO_2, molecule and diamond are both covalently bonded. However, solid CO_2, is softer and exhibits lower melting point as compared to diamond.

[8 *marks*]

4 (a) **FIGURE 1** shows a titration curve for 20.0 mL of an unknown concentration of NaOH solution titrated against a standard solution of 1.00 M HCl.

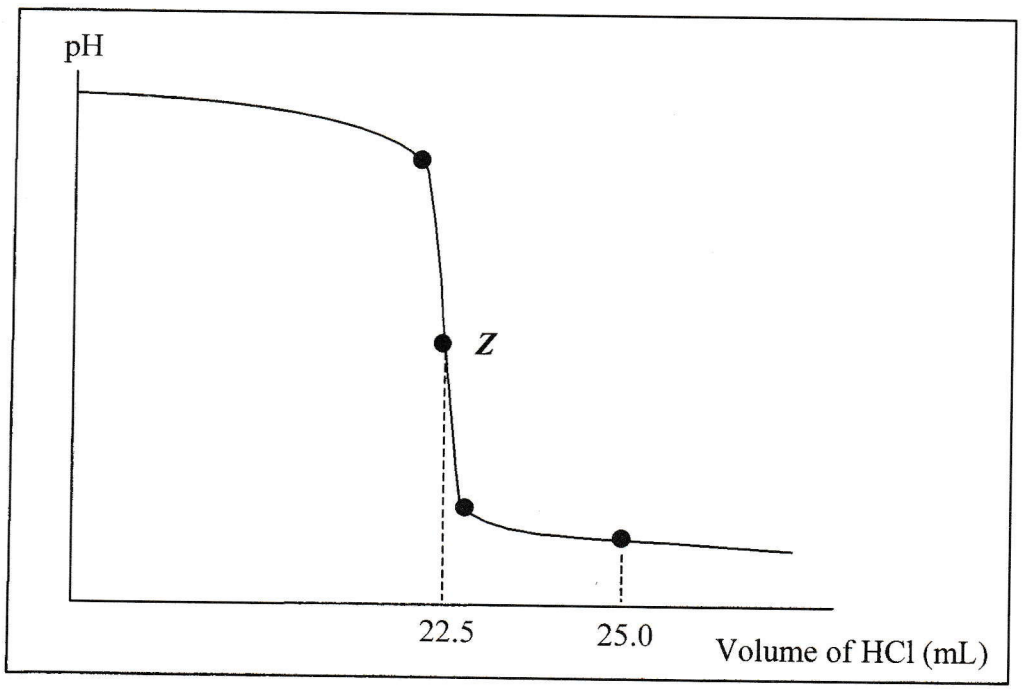


FIGURE 1

(i) Define standard solution, equivalent point and end point.

(ii) What is the pH at equivalent point, ***Z*** for this titration?

(iii) Calculate the molarity of the NaOH solution used in the titration.

(iv) Calculate the pH of the solution after the addition of 25.0 mL of HCl.

[8 *marks*]

(b) Pyridine, C_5H_5N, is a weak base. This base ionises in water to produce $C_5H_5NH^+$ and OH^-. Calculate the pH of a 1.00 M pyridine solution if the dissociation constant, K_b, of pyridine is 1.50×10^{-9}.

[7 *marks*]

BAHAGIAN B [40 *markah*]

*Jawab **dua** soalan sahaja dalam bahagian ini.*

5 (a) Hitung **tiga** panjang gelombang pertama bagi peralihan elektron yang mungkin dalamsiri Paschen bagi suatu atom hidrogen. Tunjukkan panjang gelombang ini dalam lakaran spektrum garis untuk siri pancaran ini. Terangkan bagaimana peralihan ini berlaku.

[10 *markah*]

(b) Data berikut diberi untuk jejari atom dan jejari ionik masing-masing halogen dan halida.

JADUAL 1

	Atom				Ion			
Spesis	F	Cl	Br	I	F^-	Cl^-	Br^-	I^-
Jejari (Å)	0.72	0.99	1.14	1.35	1.36	1.81	1.95	2.16

Bincangkan tren jejari dari segi cas nuklear dan elektron valens spesis.

Jelaskan tren tenaga pengionan dan afiniti elektron bagi spesis ini menuruni kumpulan dalam jadual berkala.

[10 *markah*]

6 Namakan teori pengikatan yang menjelaskan penghibridan orbital. Dengan menggunakan gambar rajah orbital, huraikan penghibridan atom pusat bagi molekul sulfur heksafluorida, SF_6, dan formaldehid, H_2CO. Lukiskan pertindihan orbital setiap molekul dan nyatakan sudut ikatan yang dijangka.

[20 *markah*]

SECTION B [40 *marks*]

Answer only ***two*** *questions in this section.*

5 (a) Calculate the first **three** wavelengths of the possible transitions of an electron in the Paschen series for a hydrogen atom. Show these wavelengths in a sketch of the line spectrum for this emission series. Explain how these transitions occurred.

[10 *marks*]

(b) The following data are given for atomic and ionic radii of halogens and halides respectively.

TABLE 1

	Atom				Ion			
Species	F	Cl	Br	I	F^-	Cl^-	Br^-	I^-
Radii (Å)	0.72	0.99	1.14	1.35	1.36	1.81	1.95	2.16

Discuss the trend of radii in terms of nuclear charge and valence electron of the species.

Explain the ionization energy and electron affinity trends of these species going down the group in the periodic table.

[10 *marks*]

6 Name the bonding theory that explains orbital hybridization.
Using orbital diagram, describe the hybridization of the central atom in sulphur hexafluoride, SF_6, and formaldehyde, H_2CO, molecules. Draw the orbitals overlaps of each molecule and state the expected bond angles.

[20 *marks*]

7 (a) Pepejal berhablur dikelas berdasarkan susunan zarah asas masing-masing. Nyatakan **empat** jenis pepejal berhablur dan bincangkan keadaan susunan zarah dalam setiap jenis pepejal berhablur tersebut. Beri **satu** contoh bagi setiap jenis pepejal berhablur.

[10 *markah*]

(b) Pertimbangkan sistem tindak balas berikut;

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

Sistem ini terdiri daripada 2.0×10^{-3} mol komponen gas setiapnya dalam bekas tertutup berisipadu 2-L. Jika pemalar keseimbangan, K_c, sistem ialah 7.7×10^{7} pada 600 K, buktikan bahawa sistem ini tidak berada dalam keseimbangan pada suhu ini.

Apabila sistem disejukkan kepada 450 K dan dibiarkan mencapai keseimbangan, amaun akhir O_2 dikesan dalam bekas ialah 9.6×10^{-4} M. Hitung pemalar keseimbangan, K_c, bagi sistem pada 450 K.

[10 *markah*]

8 (a) Susu magnesia terdiri daripada larutan tepu $Mg(OH)_2$ dan gelatin $Mg(OH)_2$. Tentukan kemolaran Mg^{2+} dalam larutan tepu $Mg(OH)_2$ dan dalam larutan tepu $Mg(OH)_2$ yang mengandungi NaOH berkepekatan 0.01 M.

[Diberi: K_{sp} $Mg(OH)_2 = 8.9 \times 10^{-12}$]

[6 *markah*]

(b) Suatu larutan penimbal disediakan dengan melarutkan 0.125 mol natrium nitrit, $NaNO_2$, dalam 500 mL asid nitrus, HNO_2, berkepekatan 0.25 M. Apakah pH larutan ini?

Larutan penimbal di atas boleh menghalang perubahan pH apabila sejumlah kecil asid atau bes kuat ditambah ke dalamnya. Jelaskan bagaimana larutan penimbal ini mengekalkan pHnya. Jika sejumlah 0.001 mol NaOH ditambahkan ke dalam larutan ini, tentukan perubahan nilai pH bagi larutan penimbal tersebut.

[Diberi: K_a $HNO_2 = 5.10 \times 10^{-4}$]

[14 *markah*]

KERTAS SOALAN TAMAT

7 (a) Crystalline solid is classified based on the assembly of their respective basic particles. State **four** types of crystalline solid and discuss the nature of the particle assembly in each crystalline solid. Give **one** example for each type of the crystalline solid.

[10 *marks*]

(b) Consider the following reaction system;

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

This system is made up from 2.0×10^{-3} mol of each gaseous component in a 2-L closed vessel. If the equilibrium constant, K_c, for the system is 7.7×10^7 at 600 K, prove that the system is not in equilibrium at this temperature.

When the system is cooled to 450 K and left to reach equilibrium, the final amount of O_2 detected in the vessel is 9.6×10^{-4} M. Calculate the equilibrium constant, K_c, of the system at 450 K.

[10 *marks*]

8 (a) Milk of magnesia consists of saturated solution of $Mg(OH)_2$ and gelatinous $Mg(OH)_2$. Determine the molarity of Mg^{2+} in a saturated solution of $Mg(OH)_2$ and in the saturated solution of $Mg(OH)_2$ containing 0.01 M NaOH.

[Given: K_{sp} $Mg(OH)_2 = 8.9 \times 10^{-12}$]

[6 *marks*]

(b) A buffer solution is prepared by dissolving 0.125 mol of sodium nitrite, $NaNO_2$, in 500 mL of 0.25 M nitrous acid, HNO_2. What is the pH of the solution?

The above buffer solution can resist the changes in pH when a small amount of strong acid or base is added into it. Explain how this buffer solution maintains its pH. If an amount of 0.001 mol of NaOH is added to the solution, determine the change in the pH value of the buffer solution.

[Given: K_a $HNO_2 = 5.10 \times 10^{-4}$]

[14 *marks*]

END OF QUESTION PAPER