SK016/2
Chemistry
Paper 2
Semester 1
Session 2013/2014
2 hours

SK016/2
Kimia
Kertas 2
Semester I
Sesi 2013/2014
2 jam

BAHAGIAN MATRIKULASI
KEMENTERIAN PENDIDIKAN MALAYSIA
MATRICULATION DIVISION
MINISTRY OF EDUCATION MALAYSIA

PEPERIKSAAN SEMESTER PROGRAM MATRIKULASI
MATRICULATION PROGRAMME EXAMINATION

KIMIA
Kertas 2
2 jam

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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
Flourin	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
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

SENARAI NILAI PEMALAR TERPILIH

Hasil darab ion bagi air pada 25ºC	K_w	$=$	$1.00 \times 10^{-14} \, mol^2 \, dm^{-16}$
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	$=$	$3.0 \times 10^8 \, m \, s^{-1}$
Muatan haba tentu air		$=$	$4.18 \, kJ \, kg^{-1} \, K^{-1}$
		$=$	$4.18 \, J \, g^{-1} \, K^{-1}$
		$=$	$4.18 \, J \, g^{-1} \, ºC^{-1}$
Nombor Avogadro	N_A	$=$	$6.02 \times 10^{23} \, mol^{-1}$
Pemalar Faraday	F	$=$	$9.65 \times 10^4 \, C \, mol^{-1}$
Pemalar Planck	h	$=$	$6.6256 \times 10^{-34} \, J \, s$
Pemalar Rydberg	R_H	$=$	$1.097 \times 10^7 \, m^{-1}$
		$=$	$2.18 \times 10^{-18} \, J$
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		$=$	$0.00ºC$
Tekanan wap air	P_{air}	$=$	$23.8 \, torr$

UNIT DAN FAKTOR PERTUKARAN

Isipadu	$1 \, liter = 1 \, dm^3$
	$1 \, mL = 1 \, cm^3$
Tenaga	$1 \, J = 1 \, kg \, m^2 \, s^{-2} = 1 \, N \, m = 10^7 \, erg$
	$1 \, kalori = 4.184 \, Joule$
	$1 \, eV = 1.602 \times 10^{-19} \, J$
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   (a)   Vinil klorida, C_2H_3Cl, disediakan melalui tindak balas gas etuna, C_2H_2, dan asid hidroklorik, HCl. Dalam satu penyediaan vinil klorida, 70.0 g C_2H_2 ditindakbalaskan dengan 102.0 g HCl.

         (i)   Tuliskan persamaan kimia berimbang bagi tindak balas tersebut.

         (ii)   Kenal pasti bahan penghad dalam tindak balas tersebut.

         (iii)   Hitung jisim hasil tindak balas.

         (iv)   Hitung jisim bahan tindak balas yang berlebihan.

                                                     [10 *markah*]

    (b)   Magnesium adalah suatu unsur dengan nombor proton 12. Dalam satu sampel magnesium, didapati atom-atom magnesium mempunyai tiga nombor nukleon yang berbeza, iaitu 24, 25 dan 26.

         (i)   Tuliskan simbol bagi salah satu daripada tiga atom tersebut yang menunjukkan nombor proton dan nombor nukleonnya.

         (ii)   Satu sampel magnesium mengandungi 78.6% atom dengan nombor nukleon 24, 10.1% atom dengan nombor nukleon 25 dan 11.3% atom dengan nombor nukleon 26. Hitung jisim atom relatif bagi magnesium.

         (iii)   Lakar dan labelkan spektrum jisim yang dijangkakan bagi magnesium.

                                                     [5 *markah*]

2   (a)   Ammonia, NH_3, adalah gas tanpa warna yang berbau busuk.

         (i)   Menggunakan simbol titik Lewis tunjukkan pembentukan ammonia daripada masing-masing unsur.

         (ii)   Ramalkan penghibridan atom pusat ammonia dan lukis suatu rajah molekul yang menunjukkan pertindihan orbitalnya.

         (iii)   Huraikan kekutuban molekul ammonia.

                                                     [9 *markah*]

    (b)   Guna teori penolakan pasangan elektron petala valens (VSEPR) untuk menjelaskan perbezaan sudut ikatan antara pasangan sebatian/ion berikut.

         (i) CO_2 dan CO_3^{2-}

         (ii) PCl_3 dan H_2O

                                                     [6 *markah*]

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SECTION A [60 *marks*]

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

1   (a)   Vinyl chloride, C_2H_3Cl, is prepared by the reaction of ethyne gas, C_2H_2, with hydrochloric acid, HCl. In a preparation of vinyl chloride, 70.0 g of C_2H_2 is reacted with 102.0 g of HCl.

        (i)   Write a balanced chemical equation for the reaction.

        (ii)   Identify the limiting reagent in the reaction.

        (iii)   Calculate the mass of the product.

        (iv)   Calculate the mass of the excess reactant.

[10 *marks*]

    (b)   Magnesium is an element with a proton number of 12. In a sample of magnesium, it was found that magnesium atoms have three different nucleon numbers which are 24, 25 and 26.

        (i)   Write the symbol for one of these three atoms, showing its proton number and nucleon number.

        (ii)   A sample of magnesium contains 78.6% of atoms with a nucleon number of 24, 10.1% of atoms with a nucleon number of 25 and 11.3% of atoms with a nucleon number of 26. Calculate the relative atomic mass of magnesium.

        (iii)   Sketch and label the expected mass spectrum of the magnesium.

[5 marks]

2   (a)   Ammonia, NH_3, is a colourless gas with a characteristic pungent smell.

        (i)   Using Lewis dot symbols show the formation of ammonia from the respective elements.

        (ii)   Predict the hybridisation of the central atom of ammonia and draw a diagram of the molecule showing the overlapping of the orbitals.

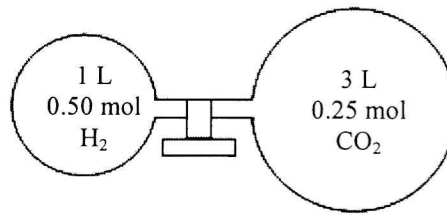   (iii)   Describe the polarity of the ammonia molecule.

[9 *marks*]

    (b)   Use the valence shell electron pair repulsion (VSEPR) theory to explain the difference in the bond angles between the following pairs of compound/ion.

        (i) CO_2 and CO_3^{2-}

        (ii) PCl_3 and H_2O

[6 *marks*]

3 (a) (i) Takrifkan tekanan wap keseimbangan.

(ii) Terangkan bagaimana suhu mempengaruhi tekanan wap suatu cecair.

[4 *markah*]

(b) (i) Nyatakan hukum tekanan separa Dalton.

(ii) **RAJAH 1** menunjukkan dua bekas bersambungan yang mengandungi gas berbeza. Apabila injap antara dua bekas tersebut dibuka, kedua-dua gas dibiarkan bercampur. Hitung tekanan separa bagi setiap gas dan tekanan akhir campuran pada 25°C dengan mengabaikan isipadu injap.
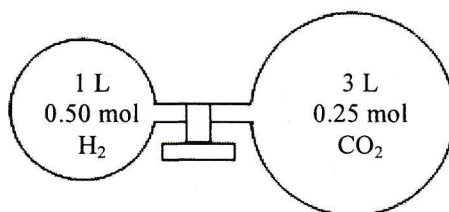

RAJAH 1

[5 *markah*]

(c) Bezakan antara pepejal berhablur dengan pepejal amorfus dari segi susunan zarahnya. Lukis struktur dan nyatakan jenis hablur bagi intan dan natrium klorida.

[6 *markah*]

4 (a) Takrifkan larutan penimbal.

[2 *markah*]

(b) Jelaskan bagaimana pH bagi suatu campuran ammonium klorida akueus dan ammonia akueus kekal sama apabila sedikit bes kuat ditambahkan. Berikan persamaan yang sesuai dalam penjelasan anda.

[4 *markah*]

(c) Suatu larutan penimbal dengan pH 4.84 telah disediakan secara melarutkan sejumlah tertentu natrium etanoat dalam 1 dm^3 asid etanoik 0.2 M.

(i) Hitung jisim natrium etanoat yang diperlukan bagi menyediakan larutan penimbal di atas.

(ii) Tentukan perubahan pH apabila 1.0 cm^3 asid hidroklorik 1.0 M ditambahkan kepada 100 cm^3 larutan penimbal.

[K_a bagi CH_3COOH = 1.8 x 10^{-5} M]

[9 *markah*]

3   (a)   (i)   Define equilibrium vapour pressure.

      (ii)   Explain how temperature affects the vapour pressure of a liquid.

[4 *marks*]

     (b)   (i)   State Dalton's law of partial pressure.

      (ii)   **FIGURE 1** shows two connecting vessels containing different gases. When the valve between the vessels is opened, the gases are allowed to mix. Ignoring the volume taken by the valve, calculate the partial pressure of each gas and the final pressure of the mixture at 25°C.

FIGURE 1

[5 *marks*]

     (c)   Differentiate between a crystalline solid and an amorphous solid in terms of their particle arrangement. Draw the structures and state the types of crystal for diamond and sodium chloride.

[6 *marks*]

4   (a)   Define buffer solution.

[2 *marks*]

     (b)   Explain how the pH of a mixture of aqueous ammonium chloride and aqueous ammonia remains constant when a small amount of strong base is added. Give suitable equations in your explanation.

[4 *marks*]

     (c)   A buffer solution of pH 4.84 was prepared by dissolving a certain amount of sodium ethanoate in 1 dm^3 of 0.2 M ethanoic acid.

      (i)   Calculate the mass of sodium ethanoate needed to prepare the above buffer solution.

      (ii)   Determine the change in pH when 1.0 cm^3 of 1.0 M hydrochloric acid is added to 100 cm^3 of the buffer solution.

[K_a for CH_3COOH = 1.8 x 10^{-5} M]

[9 *marks*]

BAHAGIAN B [40 *markah*]

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

5   (a)   Bohr telah menggunakan maklumat daripada spektrum garis atom hidrogen bagi menjelaskan struktur sistem satu elektron. Suatu garis biru dalam spektrum atom hidrogen hasil daripada peralihan dari petala keempat ke petala kedua atom tersebut telah dicerap. Apakah yang dimaksudkan dengan suatu spektrum garis? Hitung panjang gelombang dan tenaga bagi garis biru ini. Nyatakan dua postulat Bohr.

[8 *markah*]

(b)   Tenaga pengionan (kJ mol^{-1}) pertama hingga kelima bagi atom X dan Y dalam kala 3 jadual berkala adalah seperti berikut:

JADUAL 1

Atom \ TP	Pertama	Kedua	Ketiga	Keempat	Kelima
X	738	1450	7730	10500	13600
Y	578	1820	2750	11600	14800

Takrifkan tenaga pengionan. Jelaskan kenapa tenaga pengionan pertama X adalah lebih tinggi daripada Y. Ramalkan bilangan elektron valens bagi X dan Y dan tulis konfigurasi elektron masing-masing. Tuliskan set empat nombor kuantum (n, l, m, s) bagi elektron yang terluar.

[12 *markah*]

6   (a) CO_2 dan BeH_2 adalah molekul kovalen triatom. Huraikan dengan lengkap pembentukan ikatan kovalen dalam molekul ini dan terangkan mengapa CO_2 mematuhi peraturan oktet manakala BeH_2 adalah sebaliknya.

[10 *markah*]

(b)   Cas formal adalah suatu panduan berguna dalam menentukan struktur terbaik atau struktur pilihan. Jelaskan pernyataan ini dengan menggunakan ion $[OCN]^-$ sebagai contoh.

[10 *markah*]

SECTION B [40 *marks*]

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

5   (a)   Bohr used the information from a line spectrum of a hydrogen atom to explain the electronic structure of a one-electron system. A blue line in the spectrum of hydrogen atom was observed as a result of a transition of electron from the fourth to the second shells of an atom. What is meant by a line spectrum? Calculate the wavelength and energy for this blue line. State two of Bohr's postulates.

[8 *marks*]

(b)   The first five ionisation energies (kJ mol^{-1}) of atoms X and Y in period 3 of the periodic table are as follows:

TABLE 1

IE ⟍ Atom	First	Second	Third	Fourth	Fifth
X	738	1450	7730	10500	13600
Y	578	1820	2750	11600	14800

Define ionisation energy. Explain why the first ionisation energy of X is higher than that of Y. Predict the number of electron valence for X and Y and write their respective electronic configuration. Write the set of four quantum numbers (n, l, m, s) for the outermost electron(s).

[12 *marks*]

6   (a) CO_2 and BeH_2 are triatomic covalent molecules. Describe in detail the formation of the covalent bonds in these molecules and explain why CO_2 obeys the octet rule while BeH_2 does not.

[10 *marks*]

(b)   Formal charge is a useful guide in determining the best or preferred structure. Explain this statement using $[OCN]^-$ ion as example.
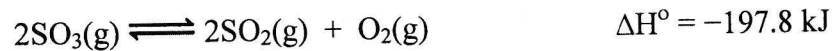
[10 *marks*]

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7 (a) Nyatakan hubungan isipadu suatu gas unggul dengan masing-masing tekanan, suhu mutlak dan amaun gas tersebut.

Seorang pelajar mencampurkan sejumlah larutan asid hidroklorik kepada suatu sampel batuan dan mendapati bunyi desiran yang menunjukkan pembebasan suatu gas. Pada 25°C, gas yang dikumpul dalam suatu bekas bulat 0.220 L ialah 0.300 g dan pada tekanan 0.757 atm. Hitung jisim molar dan ketumpatan gas ini.

[12 markah]

(b) Sulfur trioksida, SO_3, di dalam bekas tertutup 1 L dibiarkan mengurai menurut persamaan di bawah:

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g) \qquad \Delta H° = -197.8 \text{ kJ}$$

Terbitkan hubungan antara K_c dan K_p bagi tindak balas di atas.

Ramalkan kedudukan keseimbangan tindak balas tersebut di bawah keadaan yang berasingan berikut; suhu dinaikkan, tekanan diturunkan, dan SO_2 disingkirkan.

[8 markah]

8 Dalam suatu eksperimen pentitratan pada 25°C, sejumlah 30 mL NaOH 0.1 M telah ditambah titis demi titis ke dalam kelalang kon yang mengandungi 25 mL HCl 0.1 M dan beberapa titik penunjuk. Tunjukkan variasi pH bagi larutan sebelum penambahan NaOH, pada titik separa kesetaraan, pada titik kesetaraan dan pada isipadu akhir pentitratan. Lakarkan graf pH melawan isipadu NaOH.

[Diberi: K_w pada 25°C = 1 x 10^{-14}]

Apakah penunjuk asid-bes? Merujuk kepada **JADUAL 2** di bawah, cadangkan penunjuk yang paling sesuai untuk digunakan dalam pentitratan di atas dan berikan alasannya.

JADUAL 2

Penunjuk	Julat pH
Fenoftalein	8.3 – 10.0
Kresol merah	7.0 – 8.8
Bromotimol biru	6.0 – 7.6
Litmus	4.7 – 8.3

[20 markah]

KERTAS SOALAN TAMAT
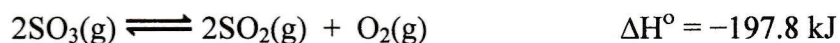
7 (a) State the relationships of the volume of an ideal gas with its pressure, absolute temperature and the amount of gas respectively.

A student added an amount of hydrochloric acid to a rock sample and observed the fizzing action indicating a gas being released. At 25°C, the gas collected in a 0.220 L gas bulb was 0.300 g and at a pressure of 0.757 atm. Calculate the molar mass and the density of this gas.

[12 *marks*]

(b) Sulphur trioxide, SO_3, in a 1 L closed container was left to dissociate according to the equation below:

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g) \qquad\qquad \Delta H° = -197.8 \text{ kJ}$$

Derive the relationship between K_c and K_p for the above reaction.

Predict the equilibrium position of the reaction under the following separate conditions; temperature is increased, pressure is decreased, and SO_2 is removed.

[8 *marks*]

8 In a titration experiment at 25°C, a total of 30 mL of 0.1 M NaOH was added dropwise into a conical flask containing 25 mL of 0.1 M HCl and a few drops of an indicator. Show the variation of pH of the solution before the addition of NaOH, at half equivalence point, at equivalence point and at the final volume of the titration. Sketch a graph of pH against the volume of NaOH.

[Given: K_w at 25°C = 1×10^{-14}]

What is acid-base indicator? By referring to **TABLE 2** below, suggest the most suitable indicator to be used in the titration above and give reasons.

TABLE 2

Indicator	pH range
Phenophthalein	8.3 – 10.0
Cresol red	7.0 – 8.8
Bromothymol blue	6.0 – 7.6
Litmus	4.7 – 8.3

[20 *marks*]

END OF QUESTION PAPER