

SK016/2
Chemistry
Paper 2
Semester I
Session 2014/2015
2½ hours

SK016/2
Kimia
Kertas 2
Semester I
Sesi 2014/2015
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.

SHAHIDI BIN MASHRI
Pensyarah
Unit Kimia
Kolej Matrikulasi Perlis

Kertas soalan ini mengandungi **15** halaman bercetak.

This question paper consists of 15 printed pages.

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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.

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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

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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	=	$1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-16}$
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	=	$3.0 \times 10^8 \text{ m s}^{-1}$
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	=	$6.02 \times 10^{23} \text{ mol}^{-1}$
Pemalar Faraday	F	=	$9.65 \times 10^4 \text{ C mol}^{-1}$
Pemalar Planck	h	=	$6.6256 \times 10^{-34} \text{ J s}$
Pemalar Rydberg	R_H	=	$1.097 \times 10^7 \text{ m}^{-1}$
		=	$2.18 \times 10^{-18} \text{ J}$
Pemalar gas molar	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$
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	=	$1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$
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		=	$4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ = $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ = $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$
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's 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°C
Vapour pressure of water	P_{water}	=	23.8 torr

UNIT AND CONVERSION FACTOR

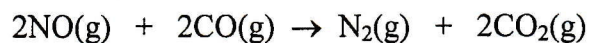
Volume	1 liter = 1 dm^3 1 mL = 1 cm^3
Energy	1 J = $1 \text{ kg m}^2 \text{ s}^{-2}$ = 1 N m = 10^7 erg 1 calorie = 4.184 Joule 1 eV = $1.602 \times 10^{-19} \text{ J}$
Pressure	1 atm = 760 mm Hg = 760 torr = 101.325 kPa = 101325 N m^{-2}
Others	1 faraday(F) = 96500 coulomb 1 newton(N) = 1 kg m s^{-2}

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BAHAGIAN A [60 markah]

Jawab *semua* soalan dalam bahagian ini.

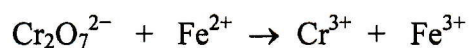
- 1 (a) Pertimbangkan tindak balas berikut:



Jika 300.00 g CO bertindak balas, hitung peratus jisim, % w/w, CO_2 dalam campuran hasil tindak balas.

[5 markah]

- (b) Sebanyak 30.00 mL larutan natrium dikromat, $\text{Na}_2\text{Cr}_2\text{O}_7$, 0.025 M telah dititratkan dengan larutan ferum(II) sulfat, Fe_2SO_4 , berasid menurut tindak balas berikut:



Pentitratan ini memerlukan 40.00 mL larutan Fe_2SO_4 untuk mencapai takat akhir.

- (i) Imbangkan persamaan redoks.

[3 markah]

- (ii) Hitung jisim $\text{Na}_2\text{Cr}_2\text{O}_7$ yang diperlukan untuk menyediakan larutan 0.025 M di dalam kelalang isipadu 50 mL.

[3 markah]

- (iii) Tentukan kemolaran larutan Fe^{2+} .

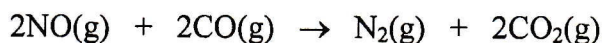
[4 markah]

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SECTION A [60 marks]

Answer *all* questions in this section.

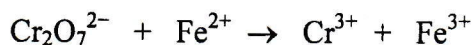
- 1 (a) Consider the following reaction:



If 300.00 g of CO has reacted, calculate the mass percentage, % w/w, of CO₂ in the mixture of product.

[5 marks]

- (b) A 30.00 mL of 0.025 M sodium dichromate, Na₂Cr₂O₇, solution is titrated with iron(II) sulphate, Fe₂SO₄ solution in acidic condition, according to the following reaction:



The titration requires 40.00 mL of Fe₂SO₄ solution to reach the end point.

- (i) Balance the redox equation. [3 marks]
- (ii) Calculate the mass of Na₂Cr₂O₇ needed to prepare a 0.025 M solution in a 50 mL volumetric flask. [3 marks]
- (iii) Determine the molarity of the Fe²⁺ solution. [4 marks]

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- 2 (a) Formula asid formik adalah HCO_2H . Salah satu daripada panjang ikatan karbon-oksigen dalam molekul ini ialah 1.36 \AA manakala satu lagi ialah 1.23 \AA . Lukis struktur Lewis molekul ini dan labelkan ikatan tersebut. [5 markah]
- (b) Xenon boleh berikat secara kovalen dengan fluorin dan oksigen untuk membentuk sebatian xenon, XeF_4 dan XeO_2F_2 . Bagi kedua-dua sebatian,
- (i) tentukan bilangan pasangan elektron pengikatan dan pasangan elektron terencil di sekeliling atom pusat xenon. [4 markah]
- (ii) nyatakan geometri molekul. [2 markah]
- (iii) tentukan penghibridan atom xenon. [2 markah]
- (iv) ramalkan kekutubannya. [2 markah]
- 3 (a) Batu kapur, CaCO_3 , terurai kepada pepejal kalsium oksida dan gas karbon dioksida apabila dipanaskan pada suhu tinggi. Pada 30°C , sejumlah 107.3 mL gas telah dikumpul melalui penyesaran air dengan jumlah tekanan 1 atm .
Hitung;
- (i) bilangan mol karbon dioksida terhasil. [5 markah]
- (ii) jisim batu kapur terurai. [4 markah]
[Tekanan wap bagi air pada 30°C ialah 31.8 mmHg]
- (b) Jelaskan secara ringkas tiga jenis pepejal hablur berdasarkan daya antara zarah. [6 markah]

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- 2 (a) The formula of formic acid is HCO_2H . One of the carbon-oxygen bond lengths in this molecule is 1.36 \AA while the other is 1.23 \AA . Draw the Lewis structure of this molecule and label these bonds. [5 marks]
- (b) Xenon can be covalently bonded to fluorine and oxygen to form xenon compounds, XeF_4 and XeO_2F_2 . For both compounds,
- (i) determine the number of bonding electron pair(s) and lone electron pair(s) around the central atom xenon. [4 marks]
- (ii) state the molecular geometry. [2 marks]
- (iii) determine the hybridisation of xenon atom. [2 marks]
- (iv) predict their polarity. [2 marks]
- 3 (a) Limestone, CaCO_3 , decomposed to solid calcium oxide and carbon dioxide gas when heated at high temperature. At 30°C , a volume of 107.3 mL of the gas was collected by displacement of water with a total pressure of 1 atm . Calculate;
- (i) the number of moles of carbon dioxide produced. [5 marks]
- (ii) the mass of limestone decomposed. [4 marks]
- [Vapor pressure of water at 30°C is 31.8 mmHg]
- (b) Briefly describe three types of crystalline solids in terms of their interparticle forces. [6 marks]

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- 4 (a) HA adalah asid lemah dengan pemalar penguraian asid, $K_a = 2.95 \times 10^{-8}$. Jika kepekatan asid ialah 1.12 M, hitung
- (i) pH larutan. [6 markah]
- (ii) peratus penguraian. [2 markah]
- (b) Pemalar hasil darab keterlarutan, K_{sp} , bagi kalsium fosfat, $Ca_3(PO_4)_2$, di dalam air tulen ialah 1.2×10^{-26} pada $25^\circ C$.
- (i) Tulis ungkapan pemalar hasil darab keterlarutan. [2 markah]
- (ii) Hitung keterlarutan molar kalsium fosfat dan kepekatan setiap ion. [5 markah]

BAHAGIAN B [40 markah]

Jawab *dua* soalan sahaja dalam bahagian ini.

- 5 Ion atom *X* mempunyai 8 elektron terluar dan 10 elektron dalam dengan cas -1. Bincang semua aturan dan prinsip yang digunakan untuk menempatkan elektron di dalam orbital atom *X*. Jelaskan perubahan jejari atom *X* apabila ianya berubah daripada atom neutral kepada ion bercas negatif.
- Atom *X*, *Y* dan *Z* masing-masing terletak dalam kala *n*, *n*+1 dan *n*+2. Atom ini juga berada dalam kumpulan yang sama. Bincangkan tren keelektronegatifan yang dipamerkan oleh ketiga-tiga atom ini. [20 markah]
- 6 Lukis dan jelaskan struktur BH_3 , NH_3 dan PH_3 menggunakan teori penolakan pasangan elektron valens. Juga, tunjukkan pertindihan orbital dalam molekul PH_3 .
- Takat didih BH_3 , NH_3 dan PH_3 masing-masing ialah 173 K, 240 K dan 185 K. Jelaskan mengapa takat didih PH_3 lebih besar daripada BH_3 tetapi lebih rendah daripada NH_3 . [20 markah]

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- 4 (a) HA is a weak acid with an acid dissociation constant, $K_a = 2.95 \times 10^{-8}$. If the concentration of the acid is 1.12 M, calculate
- (i) pH of the solution. [6 marks]
- (ii) percent dissociation. [2 marks]
- (b) The solubility product constant, K_{sp} , of calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$, in pure water is 1.2×10^{-26} at 25°C .
- (i) Write the expression for the solubility product constant. [2 marks]
- (ii) Calculate the molar solubility of calcium phosphate and concentration of each ion. [5 marks]

SECTION B [40 marks]

Answer only two questions in this section.

- 5 The ion of atom **X** has 8 outermost electrons and 10 inner electrons with a charge of -1. Discuss all the rule(s) and principle(s) used to fill the electrons in the orbital of atom **X**. Explain the change in the radius of atom **X** as it changes from a neutral atom to a negatively charged ion.

Atoms **X**, **Y** and **Z** are in periods n , $n+1$ and $n+2$, respectively. These atoms are also in the same group. Discuss the trend in electronegativity exhibited by these atoms.

[20 marks]

- 6 Draw and explain the structures of BH_3 , NH_3 and PH_3 using valence shell electron pair repulsion theory. Also, show the overlapping of orbitals in the PH_3 molecule.

The boiling points of BH_3 , NH_3 and PH_3 are 173 K, 240 K and 185 K, respectively. Explain why the boiling point of PH_3 is greater than BH_3 but lower than NH_3 .

[20 marks]

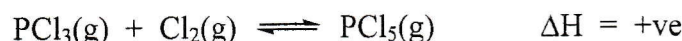
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- 7 (a) Takat lebur C_2H_6 , CH_3OH , $NaCl$ dan Si meningkat mengikut tertib seperti yang ditunjukkan di bawah. Jelaskan tren ini.



[5 markah]

- (b) Satu bekas 10.00-L mengandungi 0.0681 mol fosforus triklorida, PCl_3 , dan 0.2056 mol klorin, Cl_2 , pada $250^\circ C$. Jika 0.0316 mol fosforus pentaklorida, PCl_5 , terhasil pada keseimbangan, hitung K_p bagi tindak balas ini.



Bincangkan **empat** faktor yang boleh meningkatkan amaun PCl_5 terhasil.

[15 markah]

- 8 Suatu sampel 0.1000 g $NaOH$ dilarutkan dalam 25 mL air dan dititratkan langkah demi langkah sehingga 30 mL larutan HCl 0.100 M ditambah. Dengan menggunakan data ini, jelaskan proses titratan dari awal hingga akhir. Lakarkan graf untuk menunjukkan keluk pentitratan bagi proses ini.

Jika HCl digantikan dengan suatu asid monoprotik lemah, HY , lakarkan keluk pentitratan yang dijangka dalam graf yang sama seperti di atas.

[20 markah]

KERTAS SOALAN TAMAT

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- 7 (a) The melting points of C_2H_6 , CH_3OH , $NaCl$ and Si increase in the order as shown below. Explain the trend.



[5 marks]

- (b) A 10.00-L vessel contains 0.0681 mol phosphorous trichloride, PCl_3 , and 0.2056 mol chlorine, Cl_2 , at $250^\circ C$. If 0.0316 mol phosphorous pentachloride, PCl_5 , is produced at equilibrium, calculate K_p for this reaction.



Discuss **four** factors that can increase the amount of PCl_5 produced.

[15 marks]

- 8 A sample of 0.1000 g of $NaOH$ is dissolved in 25 mL of water and titrated stepwise until 30 mL of 0.100 M HCl is added. Using these data, describe the titration process from beginning till the end. Sketch a graph showing the titration curve for this process.

If HCl is replaced by a weak monoprotic acid, HY , sketch the expected titration curve on the same graph as above.

[20 marks]

END OF QUESTION PAPER