UNIVERSITI SAINS MALAYSIA

Final Examination
2015/2016 Academic Session

May/June 2016

JIK 102 – General Chemistry II
[Kimia Am II]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **ELEVEN** printed pages before you begin the examination.

Answer **FIVE** questions. You may answer **either** in Bahasa Malaysia or in English.

All answers must be written in the answer booklet provided.

Each question is worth 20 marks and the mark for each sub question is given at the end of that question.

In the event of any discrepancies in the exam questions, the English version shall be used.

Sila pastikan bahawa kertas peperiksaan ini mengandungi ***SEBELAS*** *muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*

Jawab ***LIMA*** *soalan. Anda dibenarkan menjawab soalan* ***sama ada*** *dalam Bahasa Malaysia atau Bahasa Inggeris.*

Setiap jawapan mesti dijawab di dalam buku jawapan yang disediakan.

Setiap soalan bernilai 20 markah dan markah subsoalan diperlihatkan di penghujung subsoalan itu.

Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.

1. (a) The work done to compress an ideal gas is 74 J. As a result, 26 J of heat is given off to the surroundings. Calculate the change in energy of the gas.

Kerja yang dilakukan untuk memampatkan suatu gas unggul adalah 74 J. Akibatnya, 26 J haba telah dibebaskan ke persekitaran. Kirakan perubahan tenaga gas tersebut.

(4 marks/*markah*)

(b) A 6.22 kg piece of copper metal is heated from 20.5 °C to 324.3 °C. Calculate the heat absorbed (in kJ) by the metal.
[The specific heat of copper is 0.385 J g^{-1} $°C^{-1}$]

Sekeping logam kuprum seberat 6.22 kg dipanaskan dari 20.5 °C hingga 324.3 °C. Kirakan haba yang diserap (dalam kJ) oleh logam berkenaan.
[Haba spesifik kuprum ialah 0.385 J g^{-1} $°C^{-1}$]

(5 marks/*markah*)

(c) A 50.0 g sample of water at 100.00 °C was placed in an insulated cup. Then 25.3 g of zinc metal at 25.00 °C was added to the water. The temperature of the water dropped to 96.68 °C. What is the specific heat of zinc?
[The specific heat of water is 4.18 J g^{-1} $°C^{-1}$]

Suatu sampel air seberat 50.0 g pada suhu 100.00 °C telah diletakkan di dalam sebuah cawan bertebat. Kemudian suatu logam zink seberat 25.3 g pada suhu 25.00 °C telah dimasukkan ke dalam air tersebut. Suhu air menurun kepada 96.68 °C. Apakah haba spesifik zink tersebut?
[Haba spesifik air ialah 4.18 J g^{-1} $°C^{-1}$]

(6 marks/*markah*)

(d) Hydrazine, N_2H_4, is a colorless liquid used as a rocket fuel. What is the enthalpy change for the process in which hydrazine is formed from its elements?

Hidrazin, N_2H_4, adalah cecair tidak berwarna yang digunakan sebagai bahan api roket. Apakah perubahan entalpi untuk proses di mana hidrazin terbentuk daripada unsur-unsurnya?

$$N_2\,(g) + 2H_2\,(g) \longrightarrow N_2H_4\,(l)$$

Use the following reactions and enthalpy changes:

Gunakan tindak balas dan perubahan entalpi berikut:

$$N_2H_4\,(l) + O_2\,(g) \longrightarrow N_2\,(g) + 2H_2O\,(l) \quad \Delta H = -622.2 \text{ kJ mol}^{-1}$$

$$H_2\,(g) + \tfrac{1}{2}O_2\,(g) \longrightarrow H_2O\,(l) \quad \Delta H = -285.8 \text{ kJ mol}^{-1}$$

(5 marks/*markah*)

2. (a) A 10.0 liter flask contains 1.031 g O_2 and 0.572 g CO_2 at 18 °C.

(i) What are the partial pressures of oxygen and carbon dioxide?

(ii) What is the total pressure?

(iii) What is the mole fraction of oxygen in the mixture?

Sebuah kelalang bersaiz 10.0 liter mengandungi gas O_2 seberat 1.031 g dan gas CO_2 seberat 0.572 g pada suhu 18 °C.

(i) Berapakah tekanan separa gas oksigen dan karbon dioksida?

(ii) Berapakah jumlah tekanan keseluruhan?

(iii) Berapakah pecahan mol gas oksigen dalam campuran tersebut?

(6 marks/*markah*)

(b) What kind of attractive forces must be overcome in order to

(i) Melt ice

(ii) Boil molecular bromine

(iii) Dissociate F_2 into F atoms

Apakah jenis daya tarikan perlu diatasi untuk

(i) Mencairkan ais

(ii) Mendidihkan molekul bromin

(iii) Penghuraian F_2 kepada atom F

(6 marks/*markah*)

(c) Chromium forms cubic crystals whose unit cell have an edge length of 288.5 pm. The density of the metal is 7.20 g cm^{-3}. Use these data and the atomic mass to calculate:

(i) The number of atoms in a unit cell (assume all atoms are at lattice points).

(ii) What is the type of cubic lattice of chromium?

Kromium membentuk kristal berbentuk kiub dengan panjang sisi sel unit 288.5 pm. Ketumpatan logam tersebut ialah 7.20 g cm^{-3}. Dengan menggunakan data ini dan jisim atom, kirakan:

(i) Bilangan atom dalam suatu sel unit (anggap semua atom berada pada titik kekisi).

(ii) Apakah jenis kekisi kiub kromium?

(8 marks/*markah*)

3. (a) Draw the structure and give the IUPAC name of an alkane with a molecular formula C_7H_{16} that contains

(i) One quaternary (4°) carbon

(ii) Only primary (1°) and secondary (2°) carbons

(iii) Primary (1°), secondary (2°) and tertiary (3°) hydrogens

Lukiskan struktur dan berikan nama IUPAC bagi suatu alkana dengan formula molekul C_7H_{16} yang mengandungi

(i) Satu karbon kuartenari (4°)

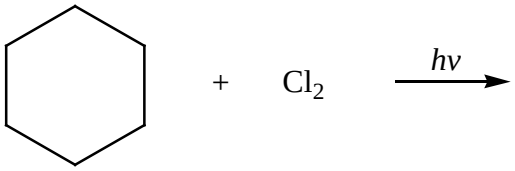
(ii) Hanya karbon primer (1°) dan sekunder (2°)

(iii) Hidrogen primer (1°), sekunder (2°) dan tertier (3°)

(9 marks/*markah*)

(b) Consider the monochlorination reaction of cyclohexane.

Pertimbangkan tindak balas monopengklorinan sikloheksana.



cyclohexane

(i) What product(s) do you expect from this reaction?

(ii) Write the complete mechanism for this reaction.

(i) Hasil apakah yang anda jangkakan?

(ii) Tuliskan mekanisme lengkap bagi tindak balas ini.

(11 marks/*markah*)

4. (a) A flask is charged with 1.500 atm of $N_2O_4(g)$ and 1.00 atm $NO_2(g)$ at 25 °C, and the following equilibrium is achieved:

Suatu kelalang telah diisi dengan $N_2O_4(g)$ bertekanan 1.500 atm dan $NO_2(g)$ bertekanan 1.00 atm pada suhu 25 °C, dan keseimbangan berikut telah dicapai:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

After equilibrium is reached, the partial pressure of NO_2 is 0.512 atm.

(i) What is the equilibrium partial pressure of N_2O_4?

(ii) Calculate the value of K_p for the reaction.

(iii) Calculate K_c for the reaction.

Selepas keseimbangan dicapai, tekanan separa NO_2 ialah 0.512 atm.

(i) Apakah tekanan separa N_2O_4 pada keseimbangan?

(ii) Kira nilai K_p untuk tindak balas tersebut.

(iii) Kira K_c untuk tindak balas tersebut.

(6 marks/*markah*)

(b) Consider the following equilibrium reaction in a closed container:

Pertimbangkan tindak balas berikut pada keseimbangan di dalam bekas tertutup:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g) \quad \Delta H = 178.1 \text{ kJ mol}^{-1}$$

What will happen if:

(i) The volume is increased

(ii) Some CaO is added to the mixture

(iii) Some $CaCO_3$ is removed

(iv) Some CO_2 is added to the mixture

(v) A few drops of HCl solution are added to the mixture (ignore the reaction between CO_2 and water)

(vi) Temperature is increased

Apakah yang akan berlaku jika:

(i) *Isipadu ditingkatkan*

(ii) *Sedikit CaO ditambahkan ke dalam campuran tersebut*

(iii) *Sedikit $CaCO_3$ dikeluarkan*

(iv) *Sedikit CO_2 ditambahkan ke dalam campuran tersebut*

(v) *Beberapa titik larutan HCl ditambahkan ke dalam campuran tersebut (abaikan tindak balas antara CO_2 dan air)*

(vi) *Suhu ditingkatkan*

(8 marks/*markah*)

(c) The equilibrium constant K_c for the reaction

Pemalar keseimbangan K_c untuk tindak balas

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$$

equals 49 at 230 °C. If 0.400 mol each of phosphorus trichloride and chlorine are added to a 4.0 liter reaction vessel, what is the equilibrium composition of the mixture at 230 °C?

adalah 49 pada suhu 230 °C. Jika 0.400 mol fosforus triklorida dan klorin setiap satu ditambah ke dalam tangki tindakbalas bersaiz 4.0 liter, berapakah komposisi campuran pada keseimbangan dan suhu 230 °C?

(6 marks/*markah*)

5. (a) Explain why a mixture of CH_3COOH and CH_3COONa can act as a buffer while a mixture of HCl and NaCl cannot.

Terangkan mengapa campuran CH_3COOH dan CH_3COONa boleh bertindak sebagai penimbal manakala campuran HCl dan NaCl tidak bertindak sebagai penimbal.

(4 marks/*markah*)

(b) A 1.00 liter of buffer solution is made up of 0.80 M CH_3NH_2 and 1.00 M CH_3NH_3Cl.

(i) Calculate the pH of the buffer solution.

(ii) Calculate the pH of the buffer after the addition of 0.070 mol of NaOH. (Assume that there is no change in volume.)

[K_a value of $CH_3NH_3^+$ is 2.3×10^{-11}]

Suatu larutan penimbal berisipadu 1.00 liter terdiri daripada 0.80 M CH_3NH_2 dan 1.00 M CH_3NH_3Cl.

(i) Kira pH larutan penimbal tersebut.

(ii) Kira pH larutan penimbal tersebut selepas 0.070 mol NaOH ditambahkan. (Andaikan bahawa tidak ada perubahan pada isipadu.)

[Nilai K_a $CH_3NH_3^+$ ialah 2.3×10^{-11}]

(8 marks/*markah*)

(c) A solution of Na_2SO_4 is added dropwise to a solution that is 0.010 M in Ba^{2+} and 0.010 M in Sr^{2+}.

(i) Calculate the concentration of SO_4^{2-} necessary to begin precipitation? (Neglect volume changes. K_{sp} of $BaSO_4 = 1.1 \times 10^{-10}$, K_{sp} of $SrSO_4 = 3.2 \times 10^{-7}$).

(ii) Which cation precipitates first?

(iii) Calculate the concentration of SO_4^{2-} when the second cation begins to precipitate?

Suatu larutan Na_2SO_4 ditambah setitik demi setitik ke dalam suatu larutan yang mengandungi 0.010 M Ba^{2+} dan 0.010 M Sr^{2+}.

(i) Kira kepekatan SO_4^{2-} yang diperlukan untuk memulakan pemendakkan? (Abaikan perubahan isipadu. K_{sp} bagi $BaSO_4 = 1.1 \times 10^{-10}$, K_{sp} bagi $SrSO_4 = 3.2 \times 10^{-7}$).

(ii) Kation yang manakah akan termendak dahulu?

(iii) Kira kepekatan SO_4^{2-} apabila kation yang kedua mula termendak?

(8 marks/*markah*)

6. (a) The following names do not follow the IUPAC system, but they represent real structures. Draw each structure and name them correctly according to IUPAC system.

(i) 2,2-Dimethyl-6-ethylheptane

(ii) 4-Ethyl-5,5-dimethylpentane

(iii) *trans*-3-Pentene

(iv) 2-Methylcyclohexene

(v) (*Z*)-3-Chloro-2-butene

Nama-nama berikut tidak mengikut sistem IUPAC, tetapi ia mewakili struktur sebenar. Lukiskan struktur dan berikan nama yang betul mengikut sistem IUPAC.

(i) 2,2-Dimetil-6-etilheptana

(ii) 4-Etil-5,5-dimetilpentana

(iii) trans-3-Pentena

(iv) 2-Metilsikloheksena

(v) (Z)-3-kloro-2-butena

(10 marks/*markah*)

(b) Draw the products formed when cyclohexene is treated with each of the following reagent.

Lukiskan hasil yang terbentuk apabila sikloheksena dirawat dengan setiap reagen berikut.

(i) HBr

(ii) H_2O, H_2SO_4

(iii) 1. BH_3

2. H_2O_2, HO^-

(iv) Cl_2

(v) Br_2, H_2O

(10 marks/*markah*)

FUNDAMENTAL CONSTANTS

Atomic mass unit	1 amu	=	$1.66053873 \times 10^{-24}$ g
	1 g	=	$6.02214199 \times 10^{23}$ amu
Avogadro's number	N_A	=	$6.02214199 \times 10^{23}$ mol^{-1}
Boltzmann's constant	k_b	=	$1.3806503 \times 10^{-23}$ J K^{-1}
Electron charge	e	=	$1.602176462 \times 10^{-19}$ C
Faraday's constant	F	=	9.64853415×10^{4} C mol^{-1}
Gas constant	R	=	0.082058205 L atm K^{-1} mol^{-1}
		=	8.31447 J K^{-1} mol^{-1}
Mass of electron	m_e	=	5.485799×10^{-4} amu
		=	$9.10938188 \times 10^{-28}$ g
Mass of neutron	m_n	=	1.0086649 amu
		=	$1.67492716 \times 10^{-24}$ g
Mass of proton	m_p	=	1.0072765 amu
		=	$1.67262158 \times 10^{-24}$ g
Pi	π	=	3.1415927
Planck's constant	h	=	$6.62606876 \times 10^{-34}$ J s
Rydberg Constant	R_H	=	3.28984×10^{15} s^{-1} (Hz)
Speed of light	c	=	2.99792458×10^{8} m s^{-1}

CONVERSIONS

Energy	1 J	=	1 kg m^2 s^{-2}
	1 J	=	0.2390 cal
	1 cal	=	4.184 J
	1 eV	=	1.602×10^{-19} J

IUPAC Periodic Table of the Elements

Key: atomic number / Symbol / name / standard atomic weight

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** hydrogen [1.007, 1.009]																	2 **He** helium 4.003
3 **Li** lithium [6.938, 6.997]	4 **Be** beryllium 9.012											5 **B** boron [10.80, 10.83]	6 **C** carbon [12.00, 12.02]	7 **N** nitrogen [14.00, 14.01]	8 **O** oxygen [15.99, 16.00]	9 **F** fluorine 19.00	10 **Ne** neon 20.18
11 **Na** sodium 22.99	12 **Mg** magnesium [24.30, 24.31]											13 **Al** aluminium 26.98	14 **Si** silicon [28.08, 28.09]	15 **P** phosphorus 30.97	16 **S** sulfur [32.05, 32.08]	17 **Cl** chlorine [35.44, 35.46]	18 **Ar** argon 39.95
19 **K** potassium 39.10	20 **Ca** calcium 40.08	21 **Sc** scandium 44.96	22 **Ti** titanium 47.87	23 **V** vanadium 50.94	24 **Cr** chromium 52.00	25 **Mn** manganese 54.94	26 **Fe** iron 55.85	27 **Co** cobalt 58.93	28 **Ni** nickel 58.69	29 **Cu** copper 63.55	30 **Zn** zinc 65.38(2)	31 **Ga** gallium 69.72	32 **Ge** germanium 72.63	33 **As** arsenic 74.92	34 **Se** selenium 78.97	35 **Br** bromine [79.90, 79.91]	36 **Kr** krypton 83.80
37 **Rb** rubidium 85.47	38 **Sr** strontium 87.62	39 **Y** yttrium 88.91	40 **Zr** zirconium 91.22	41 **Nb** niobium 92.91	42 **Mo** molybdenum 95.95	43 **Tc** technetium	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
55 **Cs** caesium 132.9	56 **Ba** barium 137.3	57-71 lanthanoids	72 **Hf** hafnium 178.5	73 **Ta** tantalum 180.9	74 **W** tungsten 183.8	75 **Re** rhenium 186.2	76 **Os** osmium 190.2	77 **Ir** iridium 192.2	78 **Pt** platinum 195.1	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium [204.3, 204.4]	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89-103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium	113 **Uut** ununtrium	114 **Fl** flerovium	115 **Uup** ununpentium	116 **Lv** livermorium	117 **Uus** ununseptium	118 **Uuo** ununoctium

57 **La** lanthanum 138.9	58 **Ce** cerium 140.1	59 **Pr** praseodymium 140.9	60 **Nd** neodymium 144.2	61 **Pm** promethium	62 **Sm** samarium 150.4	63 **Eu** europium 152.0	64 **Gd** gadolinium 157.3	65 **Tb** terbium 158.9	66 **Dy** dysprosium 162.5	67 **Ho** holmium 164.9	68 **Er** erbium 167.3	69 **Tm** thulium 168.9	70 **Yb** ytterbium 173.0	71 **Lu** lutetium 175.0
89 **Ac** actinium	90 **Th** thorium 232.0	91 **Pa** protactinium 231.0	92 **U** uranium 238.0	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

INTERNATIONAL UNION OF
PURE AND APPLIED CHEMISTRY

For notes and updates to this table, see www.iupac.org. This version is dated 8 January 2016.