UNIVERSITI SAINS MALAYSIA

Final Examination
2016/2017 Academic Session

May/June 2017

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. Answer the questions in English. You may also answer the questions in Bahasa Malaysia, but not a mix of both languages.

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. Jawab soalan-soalan dalam Bahasa Inggeris. Anda juga dibenarkan menjawab soalan dalam Bahasa Malaysia, tetapi campuran antara kedua-dua bahasa ini tidak dibenarkan.*

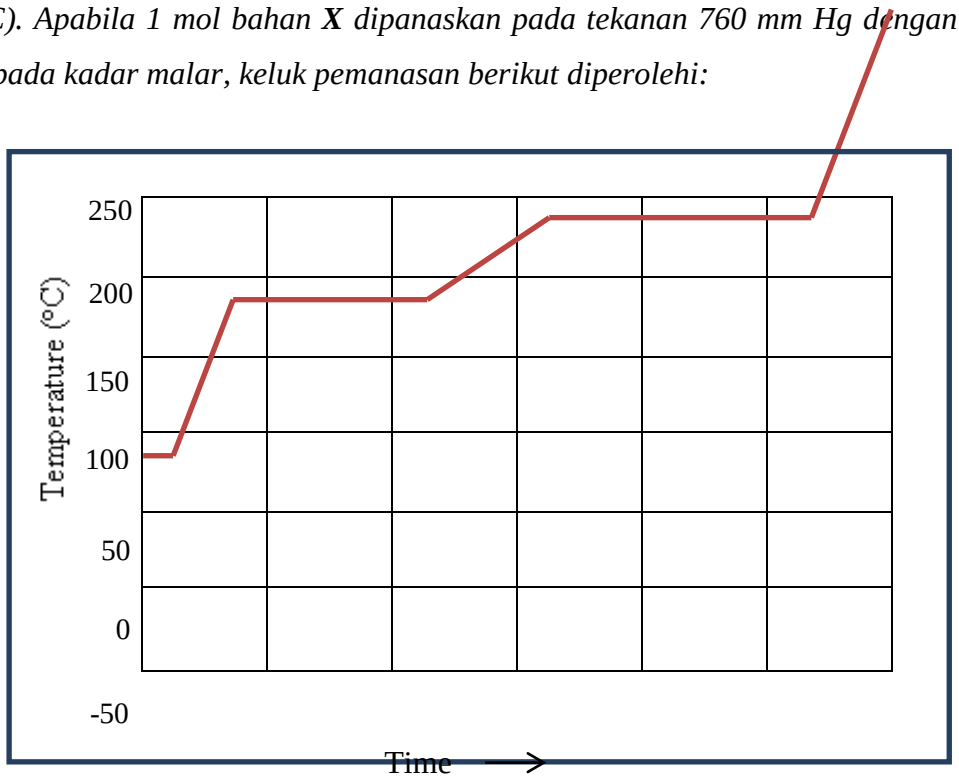
Setiap jawapan mesti dijawab di dalam buku jawapan yang disediakan.

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. Substance **X** has a vapor pressure of 100 mm Hg at its triple point (48 °C). When 1 mol of **X** is heated at 760 mm Hg pressure with a constant rate of heat input, the following heating curve is obtained:

*Bahan **X** mempunyai tekanan wap sebanyak 100 mm Hg pada takat ganda tiga (48 °C). Apabila 1 mol bahan **X** dipanaskan pada tekanan 760 mm Hg dengan input haba pada kadar malar, keluk pemanasan berikut diperolehi:*



(a) Sketch the phase diagram for **X**, including labels for different phases, triple point, melting point and boiling point.

*Lakarkan gambarajah fasa untuk **X**, termasuk label untuk fasa berlainan, takat ganda tiga, takat lebur dan takat didih.*

(10 marks/ *markah*)

(b) Based on your phase diagram, choose which phase of **X** (solid, liquid or gas) fits following the description:
*Berdasarkan gambar rajah fasa anda, pilih fasa **X** (pepejal, cecair atau gas) yang padan dengan keterangan berikut:*

(i) least dense at 50 °C
paling kurang tumpat pada 50 °C

(ii) most dense at 50 °C
paling tumpat pada 50 °C

(iii) has the greatest specific heat
mempunyai haba spesifik yang paling tinggi

(iv) predominates at 80 °C and 760 mm Hg
menonjol pada 80 °C dan 760 mm Hg

(v) can have a vapor pressure of 20 mm Hg.
boleh mempunyai tekanan wap 20 mm Hg.

(5 marks/*markah*)

(c) Which sample contains more molecules, 15.0 L of steam (gaseous H_2O) at 123 °C and 0.93 atm pressure or 10.5 g ice cube at -5.0 °C ?
Sampel yang manakah mengandungi lebih banyak molekul, 15.0 L stim (gas H_2O) pada 123 °C dan bertekanan 0.93 atm atau 10.5 g ketulan ais pada -5.0 °C ?

(5 marks/*markah*)

2. (a) Hess's law can be used to calculate reaction enthalpies for hypothetical processes that can't be carried out in the laboratory. Set up a Hess's cycle that will let you calculate ΔH^o for the conversion of methane to ethylene:
Hukum Hess boleh digunakan untuk mengira entalpi tindak balas untuk proses-proses hipotetikal yang tidak boleh dijalankan di dalam makmal. Bentukkan kitaran Hess yang membolehkan anda mengira ΔH^o untuk penukaran metana kepada etilena:

$$2CH_4\,(g) \longrightarrow C_2H_4\,(g) + 2\,H_2\,(g)$$

You can use the following information:
Anda boleh menggunakan maklumat berikut:

$2\,C_2H_6\,(g) + 7\,O_2\,(g) \longrightarrow 4\,CO_2\,(g) + 6\,H_2O\,(l)$ $\Delta H^o = -3119.4$ kJ

$CH_4\,(g) + 2\,O_2\,(g) \longrightarrow CO_2\,(g) + 2\,H_2O\,(l)$ $\Delta H^o = -890.3$ kJ

$C_2H_4\,(g) + H_2\,(g) \longrightarrow C_2H_6\,(g)$ $\Delta H^o = -137.0$ kJ

$H_2O\,(l)$ $\Delta H^o_f = -285.8$ kJ

(10 marks/*markah*)

(b) Assume that 100.0 mL of 0.200 M CsOH and 50.0 mL of 0.400 M HCl are mixed in a calorimeter. The solutions start out at 22.5 ^oC, and the final temperature after reaction is 24.28 ^oC. The densities of the solutions are all 1.00 g mL^{-1}, and the specific heat of the mixture is 4.2 J g^{-1} $^oC^{-1}$. What is

the enthalpy change for the neutralization reaction of 1.00 mol of CsOH in kJ?

Andaikan 100.0 mL CsOH berkepekatan 0.200 M dan 50.0 mL HCl berkepakatan 0.400 M dicampurkan dalam sebuah kalorimeter. Suhu awal larutan tersebut ialah 22.5 ^{o}C, dan suhu akhir selepas tindak balas ialah 24.28 ^{o}C. Ketumpatan larutan tersebut kesemuanya ialah 1.00 g mL^{-1}, dan haba spesifik campuran ialah 4.2 J g^{-1} $^{o}C^{-1}$. Berapakah perubahan entalpi untuk tindak balas peneutralan 1.00 mol CsOH dalam kJ?

(10 marks/*markah*)

[JIK 102]

3. (a) Draw the structure that corresponds with each of the following name:

(i) 2,3-dimethyl-4-propylnonane
(ii) pentylcyclohexane
(iii) *cis*-1-bromo-3-chlorocyclohexane
(iv) *cis*-3-methylhex-3-ene
(v) (*Z*)-2-bromopent-2-ene

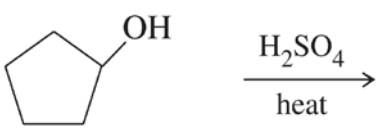
Lukiskan struktur yang sepadan dengan setiap nama berikut:

(i) 2,3-dimetil-4-propilnonana
(ii) pentilsikloheksana
(iii) cis-1-bromo-3-klorosikloheksana
(iv) cis-3-metilheks-3-ena
(v) (Z)-2-bromopent-2-ena

(10 marks/*markah*)

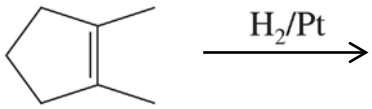
(b) Draw the major product of the following reactions:
Lukiskan hasil utama bagi tindak balas berikut:

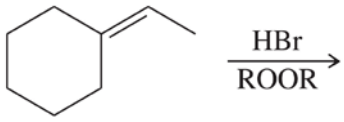
(i)

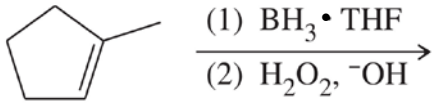


(ii)

[JIK 102]

(iii) 

(iv) 

(v) 

(10 marks/*markah*)

4. (a) The reaction of iron(III) oxide with carbon monoxide occurs in a blast furnace when iron ore is reduced to iron metal:
Tindak balas iron(III)oksida dengan karbon monoksida berlaku dalam sebuah relau bagas apabila bijih besi diturunkan kepada logam besi:

$$Fe_2O_3(s) + 3\,CO(g) \rightleftharpoons 2\,Fe(s) + 3\,CO_2(g)$$

Apply Le Chatelier's principle to predict the direction of net reaction when an equilibrium mixture is disturbed by:

Gunakan prinsip Le Chatelier untuk menjangkakan arah tindak balas apabila suatu campuran keseimbangan diganggu oleh:

(i) Adding Fe_2O_3
Penambahan Fe_2O_3

(ii) Removing CO_2
Penyingkiran CO_2

(iii) Removing CO
Penyingkiran CO

(10 marks/*markah*)

[JIK 102]

(b) The equilibrium constant K_p for the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is 3.81×10^2 at 600 K and 2.69×10^3 at 700 K.
Pemalar keseimbangan K_p untuk tindakbalas $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ ialah 3.81×10^2 pada 600 K dan 2.69×10^3 pada 700 K.

(i) Is the reaction endothermic or exothermic? Explain.
Adakah tindak balas tersebut endotermik atau eksotermik? Terangkan.

(ii) How are the equilibrium amounts of reactants and products affected by an increase in volume? Explain.
Bagaimanakah jumlah keseimbangan bahan tindak balas dan hasil tindak balas terkesan dengan peningkatan isipadu? Terangkan.

(10 marks/*markah*)

5. (a) Write the balanced net ionic equation and the corresponding equilibrium equation for dissociation of the following weak acids:

(i) Hydrazoic acid, HN_3

(ii) Benzoic acid, $C_6H_5CO_2H$

(iii) Hydrogen peroxide, H_2O_2

Tuliskan persamaan ionik seimbang dan persamaan keseimbangan untuk perceraian asid-asid lemah berikut:

(i) *Asid hidrazoik, HN_3*

(ii) *Asid benzoik, $C_6H_5CO_2H$*

(iii) *Hidrogen peroksida, H_2O_2*

(9 marks/*markah*)

(b) Aqueous solutions of hydrogen sulphide contains H_2S, HS^-, S^{2-}, H_3O^+, OH^-, and H_2O in varying concentrations. Which of these species can act
Larutan akueus hidrogen sulfida mengandungi H_2S, HS^-, S^{2-}, H_3O^+, OH^-, dan H_2O dalam kepekatan yang pelbagai. Spesies yang manakah boleh bertindak:

(i) only as an acid
sebagai asid sahaja

(ii) only as a base
sebagai bes sahaja

(iii) both as an acid and base
sebagai kedua-dua asid dan bes

(6 marks/*markah*)

(c) Classify each of the following salt solutions as acidic, basic or neutral:
Kelaskan setiap larutan-larutan garam berikut sebagai asid, bes atau neutral:

(i) KBr

(ii) $NaNO_2$

(iii) NH_4Br

(iv) $ZnCl_2$

(v) NH_4F

(5 marks/*markah*)

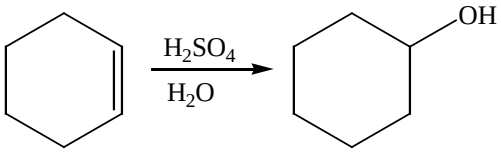
6. (a) Radical chlorination of alkanes is not generally useful because mixtures of products often result when more than one kind of C–H bond is present in the substrate. Draw all monochloro substitution products $C_6H_{13}Cl$ you might obtain by reaction of 2-methylpentane with Cl_2.

Pengklorinan radikal alkana umumnya tidak begitu sesuai kerana menghasilkan campuran produk apabila terdapat lebih daripada satu ikatan C–H dalam substrat. Lukiskan ke semua produk penukargantian monokloro $C_6H_{13}Cl$ yang mungkin anda dapat dengan tindak balas antara 2-metilpentana dan Cl_2.

(10 marks/*markah*)

[JIK 102]

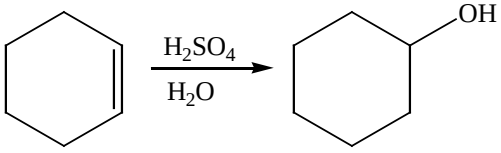
(b) (i) Write a mechanism for the following reaction.



(ii) What general conditions would you use to ensure a good yield of the product?

(iii) What general conditions would you use to carry out the reverse reaction, i.e., the dehydration of cyclohexanol to produce cyclohexene?

(i) Tuliskan satu mekanisme untuk tindak balas berikut.



(ii) Apakah keadaan-keadaan umum yang akan anda gunakan untuk memastikan hasil produk yang baik?

(iii) Apakah keadaan-keadaan umum yang akan anda gunakan untuk menjalankan tindak balas berbalik, iaitu, dehidrasi sikloheksanol untuk menghasilkan sikloheksena?

(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}
		=	8.314 Pa $m^3K^{-1}mol^{-1}$
		=	8.314×10^{-2} L bar 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	=	$3.28984 \times 10^{15}\ s^{-1}$ (Hz)
Specific heat capacity	C_p	=	$4.19\ J\ g^{-1}\ K^{-1}$
Speed of light	c	=	$2.99792458 \times 10^{8}\ m\ s^{-1}$

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

1																	18
1 H hydrogen [1.007, 1.009]	2		Key: atomic number **Symbol** name standard atomic weight									13	14	15	16	17	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]	3	4	5	6	7	8	9	10	11	12	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 ferovium	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.