UNIVERSITI SAINS MALAYSIA

Final Examination
Academic Session 2007/2008

April 2008

JIK 102 – GENERAL CHEMISTRY II
[KIMIA AM II]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN 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 questions is worth 20 marks and the marks for each sub question is given at the end of that question.

Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH 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.

1. (a) Sodium acetate (CH_3COONa or NaAc) has applications in photographic development and textiles dyeing. What is the pH of 0.25 M NaAc? K_a of acetic acid (HAc) is 1.8×10^{-5}.

Natrium asetat (CH_3COONa atau NaAc) digunakan dalam proses fotografi dan mewarna kain. Apakah pH bagi 0.25 M NaAc? K_a asid asetik (HAc) ialah 1.8×10^{-5}.

(6 marks)

(b) Consider the following equilibrium, for which $\Delta H < 0$:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

How will each of the following changes affect an equilibrium mixture of the three gases?

(i) $O_2(g)$ is added to the system
(ii) the reaction mixture is heated
(iii) the volume of the reaction mixture is doubled
(iv) a catalyst is added to the mixture
(v) the total pressure of the system is increased by adding a noble gas
(vi) $SO_3(g)$ is removed from the system.

Pertimbangkan keseimbangan berikut, yang mana $\Delta H < 0$:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

Bagaimanakah perubahan berikut mempengaruhi keseimbangan campuran ketiga-tiga gas tersebut?

(i) *$O_2(g)$ ditambah kepada sistem*
(ii) *campuran tindakbalas dipanaskan*
(iii) *isipadu campuran tindakbalas ditambah dua kali ganda*
(iv) *suatu mangkin ditambah kedalam campuran*
(v) *tekanan keseluruhan sistem ditingkatkan dengan menambah suatu gas adi*
(vi) *$SO_3(g)$ dikeluarkan dari sistem.*

(6 marks)

(c) The dissociation constant for benzoic acid ($HC_7H_5O_2$) is 6.3×10^{-5}. Calculate the equilibrium concentrations of H_3O^+, $C_7H_5O_2^-$, and $HC_7H_5O_2$ in the solution if the initial concentration of $HC_7H_5O_2$ is 0.050 M.

Pemalar penguraian asid benzoik ($HC_7H_5O_2$) ialah 6.3×10^{-5}. Kira kepekatan keseimbangan bagi H_3O^+, $C_7H_5O_2^-$, dan $HC_7H_5O_2$ dalam larutan jika kepekatan awal $HC_7H_5O_2$ ialah 0.050 M.

(8 marks)

2. (a) A scuba diver's tank contains 0.29 kg of O_2 compressed into a volume of 2.3 L.

(i) Calculate the gas pressure inside the tank at 9°C.
(ii) What volume would this oxygen occupy at 26°C and 0.95 atm?

Suatu tangki penyelam skuba mengandungi 0.29 kg O_2 yang dimampatkan kepada isipadu 2.3 L.

(i) Kira tekanan gas di dalam tangki pada suhu 9°C.
(ii) Apakah isipadu gas oksigen ini pada 26°C dan 0.95 atm?

(6 marks)

(b) Consider the following unbalanced chemical equation :

$$C_5H_{12}(l) + O_2(g) \rightleftharpoons CO_2(g) + H_2O(g)$$

What volume of oxygen gas, measured at 23°C and 0.980 atm, is needed to react with 2.50 g of C_5H_{12}? What volume of each product is produced under the same conditions?

Pertimbangkan persamaan kimia tak berimbang berikut :

$$C_5H_{12}(l) + O_2(g) \rightleftharpoons CO_2(g) + H_2O(g)$$

Apakah isipadu gas oksigen pada 23°C dan 0.980 atm yang diperlukan untuk bertindak balas dengan 2.50 g C_5H_{12}? Kira isipadu setiap hasil dalam keadaan yang sama.

(8 marks)

(c) (i) What are the mole fractions of each component in a mixture of 5.08 g of O_2, 7.17 g of N_2, and 1.32 g of H_2?

(ii) What is the partial pressure in atm of each component of this mixture if it is held in a 12.40 L vessel at 15°C?

(i) Kira pecahan mol bagi setiap komponen dalam campuran 5.08 g O_2, 7.17g N_2, dan 1.32 g H_2?

(ii) Apakah tekanan separa dalam unit atm bagi setiap komponen jika campuran tersebut disimpan dalam bekas berukuran 12.40 L pada suhu 15°C?

(6 marks)

3. (a) (i) What is the common ion effect?

(ii) Calculate the percent ionization of 0.0075 M butanoic acid ($K_a = 1.5 \times 10^{-5}$).

(iii) Calculate the percent ionization of 0.0075 M butanoic acid in a solution containing 0.085 M sodium butanoate.

(i) Apakah kesan ion sepunya?

(ii) Kira peratus pengionan bagi 0.0075 M asid butanoik ($K_a = 1.5 \times 10^{-5}$).

(iii) Kira peratus pengionan 0.0075 M asid butanoik dalam suatu larutan yang mengandungi 0.085 M natrium butanoat.

(10 marks)

(b) A 1.00 L buffer solution contains 0.12 mol of acetic acid and 0.13 mol of sodium acetate.

(i) What is the pH of this buffer?

(ii) Calculate the pH of the buffer after the addition of 0.02 mol of KOH.

(iii) What is the pH of the buffer after the addition of 0.02 mol HNO_3?

K_a of acetic acid is 1.8×10^{-5}.

Suatu larutan penimbal berisipadu 1.00 L mengandungi 0.12 mol asid asetik dan 0.13 mol natrium asetat.

(i) Apakah pH larutan tersebut?

(ii) Kira pH larutan selepas 0.02 mol KOH dicampurkan ke dalam larutan.

(iii) Apakah pH larutan selepas 0.02 mol HNO_3 dicampur ke dalam larutan.

K_a asid asetik ialah 1.8×10^{-5}.

(10 marks)

4. (a) Calculate ΔE, and determine whether the process is endothermic or exothermic for the following cases :

(i) A system absorbs 86 kJ of heat from its surroundings while doing 29 kJ of work on the surroundings.
(ii) q = 1.50 kJ and w = -657 J.
(iii) The system releases 57.5 kJ of heat while doing 13.5 kJ of work on the surroundings.

Kira ΔE dan tentukan sama ada proses berikut ialah endotermik atau eksotermik :

(i) Suatu sistem menyerap 86 kJ haba daripada persekitaran sambil melakukan kerja 29 kJ ke atas persekitaran.
(ii) q =1.50 kJ dan w = -657 J.
(iii) Sistem tersebut membebaskan tenaga sebanyak 57.5 kJ sambil melakukan kerja sebanyak 13.5 kJ ke atas persekitaran.

(6 marks)

(b) When a 9.55 g sample of solid sodium hydroxide dissolves in 100.00 g of water in a styrofoam calorimeter, the temperature rises from 23.6°C to 47.4°C. Calculate ΔH (in kJ/mol) for the solution process.

$$NaOH(s) \longrightarrow Na^+(aq) + OH^-(aq)$$

Assume that the specific heat of the solution is the same as that of pure water, 4.18 J g^{-1} $°C^{-1}$.

Apabila suatu sampel natrium hdroksida pepejal seberat 9.55 g dilarutkan di dalam 100.00 g air dalam kalorimeter styrofoam, suhu meningkat dari 23.6°C ke 47.4°C. Kira ΔH (kJ/mol) bagi proses pemelarutan.

$$NaOH(s) \longrightarrow Na^+(aq) + OH^-(aq)$$

Anggap haba spesifik larutan sama seperti air tulen, 4.18 J g^{-1} $°C^{-1}$.

(8 marks)

(c) From the enthalpies of reaction

$$H_2(g) + F_2(g) \longrightarrow 2\,HF(g) \qquad \Delta H = -537 \text{ kJ}$$
$$C(s) + 2\,F_2(g) \longrightarrow CF_4(g) \qquad \Delta H = -680 \text{ kJ}$$
$$2\,C(s) + 2\,H_2(g) \longrightarrow C_2N_4(g) \qquad \Delta H = +52.3 \text{ kJ}$$

Calculate ΔH for the reaction of ethylene with F_2 :

$$C_2H_4(g) + 6\,F_2(g) \longrightarrow 2\,CF_4(g) + 4\,HF(g)$$

Daripada entalpi tindakbalas

$$H_2(g) + F_2(g) \longrightarrow 2\,HF(g) \qquad \Delta H = -537\ kJ$$
$$C(s) + 2\,F_2(g) \longrightarrow CF_4(g) \qquad \Delta H = -680\ kJ$$
$$2\,C(s) + 2\,H_2(g) \longrightarrow C_2N_4(g) \qquad \Delta H = +52.3\ kJ$$

Kira ΔH untuk tindakbalas etilena dengan F_2 :

$$C_2H_4(g) + 6\,F_2(g) \longrightarrow 2\,CF_4(g) + 4\,HF(g)$$

(6 marks)

5. (a) A 35.0 mL sample of 0.150 M acetic acid ($HC_2H_3O_2$) is titrated with 0.150 M NaOH solution. Calculate the pH after the following volumes of base have been added :

(i) 0 mL
(ii) 17.5 mL
(iii) 35.0 mL
(iv) 50.0 mL

K_a acetic acid is 1.8×10^{-5}.

Suatu sampel 0.150 M asid asetik ($HC_2H_3O_2$) berisipadu 35.0 mL dititratkan dengan 0.150 M larutan NaOH. Kira pH selepas bes yang berisipadu seperti berikut ditambah :

(i) 0 mL
(ii) 17.5 mL
(iii) 35.0 mL
(iv) 50.0 mL

K_a asid asetik ialah is 1.8×10^{-5}.

(12 marks)

(b) 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) What concentration of SO_4^{2-} is necessary to begin precipitation?
(ii) Which cation precipitates first?
(iii) What is the concentration of SO_4^{2-} when the second cation begins to precipitate?

(Neglect any volume changes. $BaSO_4$: $K_{sp} = 1.1 \times 10^{-10}$; $SrSO_4$: $K_{sp} = 3.2 \times 10^{-7}$).

Suatu larutan Na_2SO_4 ditambah setitik demi setitik ke dalam larutan yang mengandungi 0.019 M Ba^{2+} dan 0.010 M Sr^{2+}.

(i) Apakah kepekatan SO_4^{2-} yang diperlukan untuk memulakan pemendakan?
(ii) Kation manakah yang akan termendak terlebih dahulu?
(iii) Apakah kepekatan SO_4^{2-} apabila kation kedua mula termendak?

(Abaikan sebarang perubahan isipadu. $BaSO_4$: $K_{sp} = 1.1 \times 10^{-10}$; $SrSO_4$: $K_{sp} = 3.2 \times 10^{-7}$).

(8 marks)

6. (a) A reaction A + B $\longrightarrow$ C obeys the following rate law : Rate = $k[B]^2$.

(i) If A is doubled, how will the rate change? Will the rate constant change? Explain.
(ii) What are the reaction orders for A and B? What is the overall reaction order?

Suatu tindakbalas A + B $\longrightarrow$ C mematuhi hukum kadar berikut : Rate = $k[B]^2$.

(i) Jika A digandaduakan, bagaimanakah kadar akan berubah? Adakah pemalar kadar akan berubah? Terangkan.
(ii) Apakah tertib tindakbalas bagi A dan B? Apakah tertib tindakbalas keseluruhan?

(10 marks)

(b) The iodide ion reacts with hypochlorite ion in the following way :

$$OCl^- + I^- \longrightarrow OI^- + Cl^-$$

This rapid reaction gives the following rate data :

$[OCl^-]$, M	$[I^-]$, M	Rate, Ms^{-1}
1.5×10^{-3}	1.5×10^{-3}	1.36×10^{-4}
3.0×10^{-3}	1.5×10^{-3}	2.72×10^{-4}
1.5×10^{-3}	3.0×10^{-3}	2.72×10^{-4}

(i) Write the rate law for this reaction.
(ii) Calculate the rate constant.
(iii) Calculate the rate when $[OCl^-] = 2.0 \times 10^{-3}$ M and $[I^-] = 5.5 \times 10^{-4}$ M.

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	=	$6.02214199 \times 10^{23}$ / mol
Boltzmann's constant	k	=	$1.3806503 \times 10^{-23}$ J/K
Electron charge	e	=	$1.602176462 \times 10^{-19}$ C
Faraday's constant	F	=	9.64853415×10^{4} C/mol
Gas constant	R	=	0.082058205 L-atm/ mol-K
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
Speed of light	c	=	2.99792458×10^{8} m/s

WebElements: the periodic table on the world-wide web

www.webelements.com

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.38	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.96	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 **	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [267]	dubnium 105 **Db** [268]	seaborgium 106 **Sg** [271]	bohrium 107 **Bh** [272]	hassium 108 **Hs** [270]	meitnerium 109 **Mt** [276]	darmstadtium 110 **Ds** [281]	roentgenium 111 **Rg** [280]	ununbium 112 **Uub** [285]	ununtrium 113 **Uut** [284]	ununquadium 114 **Uuq** [289]	ununpentium 115 **Uup** [288]	ununhexium 116 **Uuh** [293]	ununseptium 117 **Uus** —	ununoctium 118 **Uuo** [294]

Key:

element name
atomic number
symbol
atomic weight (mean relative mass)

*lanthanoids	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.06
**actinoids	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

Symbols and names: the symbols and names of the elements, and their spellings are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org/). Names have yet to be proposed for the most recently discovered elements beyond 112 and so those used here are IUPAC's temporary systematic names. In the USA and some other countries, the spellings **aluminum** and **cesium** are normal while in the UK and elsewhere the common spelling is **sulphur.**
Group labels: the numeric system (1–18) used here is the current IUPAC convention.
Atomic weights (mean relative masses): Apart from the heaviest elements, these are the IUPAC 2007 values and given to 5 significant figures. Elements for which the atomic weight is given within square brackets have no stable nuclides and are represented by the element's longest lived isotope reported at the time of writing.

[APPENDIX JIK 102]