

---

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.*

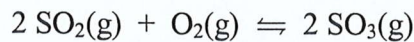
*Setiap soalan bernilai 20 markah dan markah subsoalan diperlihatkan di penghujung subsoalan itu.*

1. (a) Sodium acetate ( $\text{CH}_3\text{COONa}$  or  $\text{NaAc}$ ) has applications in photographic development and textiles dyeing. What is the pH of 0.25 M  $\text{NaAc}$ ?  $K_a$  of acetic acid ( $\text{HAc}$ ) is  $1.8 \times 10^{-5}$ .

*Natrium asetat ( $\text{CH}_3\text{COONa}$  atau  $\text{NaAc}$ ) digunakan dalam proses fotografi dan mewarna kain. Apakah pH bagi 0.25 M  $\text{NaAc}$ ?  $K_a$  asid asetik ( $\text{HAc}$ ) ialah  $1.8 \times 10^{-5}$ .*

(6 marks)

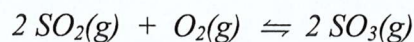
- (b) Consider the following equilibrium, for which  $\Delta H < 0$  :



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

- (i)  $\text{O}_2(\text{g})$  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)  $\text{SO}_3(\text{g})$  is removed from the system.

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



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

- (i)  $\text{O}_2(\text{g})$  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)  $\text{SO}_3(\text{g})$  dikeluarkan dari sistem.

(6 marks)

- (c) The dissociation constant for benzoic acid ( $\text{HC}_7\text{H}_5\text{O}_2$ ) is  $6.3 \times 10^{-5}$ . Calculate the equilibrium concentrations of  $\text{H}_3\text{O}^+$ ,  $\text{C}_7\text{H}_5\text{O}_2^-$ , and  $\text{HC}_7\text{H}_5\text{O}_2$  in the solution if the initial concentration of  $\text{HC}_7\text{H}_5\text{O}_2$  is 0.050 M.

*Pemalar penguraian asid benzoik ( $\text{HC}_7\text{H}_5\text{O}_2$ ) ialah  $6.3 \times 10^{-5}$ . Kira kepekatan keseimbangan bagi  $\text{H}_3\text{O}^+$ ,  $\text{C}_7\text{H}_5\text{O}_2^-$ , dan  $\text{HC}_7\text{H}_5\text{O}_2$  dalam larutan jika kepekatan awal  $\text{HC}_7\text{H}_5\text{O}_2$  ialah 0.050 M.*

(8 marks)

2. (a) A scuba diver's tank contains 0.29 kg of  $\text{O}_2$  compressed into a volume of 2.3 L.

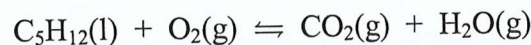
- (i) Calculate the gas pressure inside the tank at  $9^\circ\text{C}$ .  
 (ii) What volume would this oxygen occupy at  $26^\circ\text{C}$  and 0.95 atm?

*Suatu tangki penyelam skuba mengandungi 0.29 kg  $\text{O}_2$  yang dimampatkan kepada isipadu 2.3 L.*

- (i) *Kira tekanan gas di dalam tangki pada suhu  $9^\circ\text{C}$ .*  
 (ii) *Apakah isipadu gas oksigen ini pada  $26^\circ\text{C}$  dan 0.95 atm?*

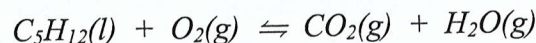
(6 marks)

- (b) Consider the following unbalanced chemical equation :



What volume of oxygen gas, measured at  $23^\circ\text{C}$  and 0.980 atm, is needed to react with 2.50 g of  $\text{C}_5\text{H}_{12}$ ? What volume of each product is produced under the same conditions?

*Pertimbangkan persamaan kimia tak berimbang berikut :*



*Apakah isipadu gas oksigen pada  $23^\circ\text{C}$  dan 0.980 atm yang diperlukan untuk bertindak balas dengan 2.50 g  $\text{C}_5\text{H}_{12}$ ? 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<sub>2</sub>, 7.17 g of N<sub>2</sub>, and 1.32 g of H<sub>2</sub>?
- (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<sub>2</sub>, 7.17g N<sub>2</sub>, dan 1.32 g H<sub>2</sub>?*
- (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<sub>3</sub>?
- $K_a$  of acetic acid is  $1.8 \times 10^{-5}$ .

*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<sub>3</sub> dicampur ke dalam larutan.*
- $K_a$  asid asetik ialah  $1.8 \times 10^{-5}$ .

(10 marks)

4. (a) Calculate  $\Delta E$ , 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  $\Delta E$  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  $\Delta H$  (in kJ/mol) for the solution process.



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

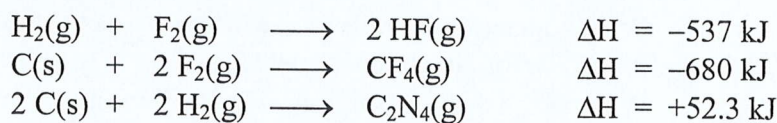
*Apabila suatu sampel natrium hidroksida pepejal seberat 9.55 g dilarutkan di dalam 100.00 g air dalam kalorimeter styrofoam, suhu meningkat dari 23.6°C ke 47.4°C. Kira  $\Delta H$  (kJ/mol) bagi proses pemelarutan.*



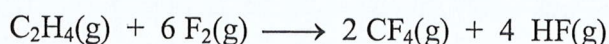
*Anggap haba spesifik larutan sama seperti air tulen,  $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$ .*

(8 marks)

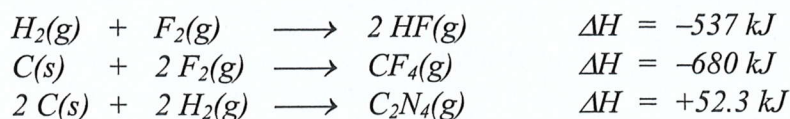
- (c) From the enthalpies of reaction



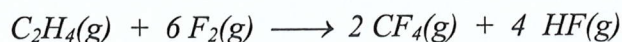
Calculate  $\Delta H$  for the reaction of ethylene with  $\text{F}_2$  :



Daripada entalpi tindakbalas



Kira  $\Delta H$  untuk tindakbalas etilena dengan  $F_2$ :



(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  $1.8 \times 10^{-5}$ .

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  $1.8 \times 10^{-5}$ .

(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  $\text{Na}_2\text{SO}_4$  ditambah setitik demi setitik ke dalam larutan yang mengandung  $0.019 \text{ M Ba}^{2+}$  dan  $0.010 \text{ M Sr}^{2+}$ .

- (i) Apakah kepekatan  $\text{SO}_4^{2-}$  yang diperlukan untuk memulakan pemendakan?
- (ii) Kation manakah yang akan termendak terlebih dahulu?
- (iii) Apakah kepekatan  $\text{SO}_4^{2-}$  apabila kation kedua mula termendak?

(Abaikan sebarang perubahan isipadu.  $\text{BaSO}_4$ :  $K_{sp} = 1.1 \times 10^{-10}$ ;  $\text{SrSO}_4$ :  $K_{sp} = 3.2 \times 10^{-7}$ ).

(8 marks)

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

- (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  $\text{A} + \text{B} \longrightarrow \text{C}$  mematuhi hukum kadar berikut :  $\text{Rate} = k[\text{B}]^2$ .

- (i) Jika A digandaukan, 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 :



This rapid reaction gives the following rate data :

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

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

### FUNDAMENTAL CONSTANTS\*

Atomic mass unit	$1 \text{ amu} = 1.66053873 \times 10^{-24} \text{ g}$
	$1 \text{ g} = 6.02214199 \times 10^{23} \text{ amu}$
Avogadro's number	$N = 6.02214199 \times 10^{23} / \text{mol}$
Boltzmann's constant	$k = 1.3806503 \times 10^{-23} \text{ J/K}$
Electron charge	$e = 1.602176462 \times 10^{-19} \text{ C}$
Faraday's constant	$F = 9.64853415 \times 10^4 \text{ C/mol}$
Gas constant	$R = 0.082058205 \text{ L-atm/ mol-K}$
Mass of electron	$m_e = 5.485799 \times 10^{-4} \text{ amu}$
	$= 9.10938188 \times 10^{-28} \text{ g}$
Mass of neutron	$m_n = 1.0086649 \text{ amu}$
	$= 1.67492716 \times 10^{-24} \text{ g}$
Mass of proton	$m_p = 1.0072765 \text{ amu}$
	$= 1.67262158 \times 10^{-24} \text{ g}$
Pi	$\pi = 3.1415927$
Planck's constant	$h = 6.62606876 \times 10^{-34} \text{ J-s}$
Speed of light	$c = 2.99792458 \times 10^8 \text{ m/s}$





# WebElements: the periodic table on the world-wide web

www.webelements.com

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

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

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

\*lanthanoids

\*\*actinoids

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 aluminium 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.

©2007 Dr Mark J Winter IWebElements Ltd and University of Sheffield. [webelements@sheffield.ac.uk](http://www.webelements.com/nexus/Printable_Periodic_Table). All rights reserved. For updates to this table see [http://www.webelements.com/nexus/Printable\\_Periodic\\_Table](http://www.webelements.com/nexus/Printable_Periodic_Table) (Version date: 21 September 2007).