UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2007/2008

April 2008

KFT 131 – Physical Chemistry I
[Kimia Fizik I]

Duration: 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **SEVENTEEN** printed pages before you begin the examination.

Instructions:

Answer **FIVE** (5) questions. Part A is **COMPULSORY**. Answer any **TWO** (2) questions from Part B. All questions carry the same marks.

Answer to each question on a new page.

You may answer either in Bahasa Malaysia or in English.

If a candidate answers more than five questions, only the answers to the first five questions in the answer sheet will be graded.

Appendix: Fundamental constants in physical chemistry

...2/-

SECTION A

Answer **ALL** questions.

1. The number of wall collisions for gas molecule A at 25 °C and 1.0 atm is 2.7×10^{23} $cm^{-2} s^{-1}$.

   (a) Calculate the molar mass of gas molecule A.

   (6 marks)

   (b) The time taken for gas molecule B to strike a hole of C cm^2 is three times longer than gas molecule A at the same temperature and pressure. Determine the molar mass of gas molecule B.

   (4 marks)

   (c) The collision diameter, d, for gas molecule A is 2.4 Å. Calculate the mean free path of gas molecule A.

   (4 marks)

   (d) Will the mean free path of gas molecule A change when the temperature is increased to 596 K at constant volume? Explain.

   (2 marks)

   (e) Use the mean free path value obtained in (d) to calculate the collision density of gas molecule A.

   (4 marks)

2. (a) A reaction obeys the equation

$$A + B + C \rightarrow \text{products}$$

The following data are given:

[A] / mol dm^{-3}	[B] / mol dm^{-3}	[C] / mol dm^{-3}	Initial rate/ mol $dm^{-3}s^{-1}$
0.550	0.200	1.15	6.76×10^{-6}
0.210	0.200	1.15	9.82×10^{-7}
0.210	0.333	1.15	1.68×10^{-6}
0.210	0.200	1.77	9.84×10^{-7}

Determine the order with respect to A, B and C and the rate constant of the reaction.

(8 marks)

(b) The following data were obtained for the second order reaction

$$C_3H_7Br + S_2O_3^{2-} \rightarrow C_3H_7S_2O_3^{-} + Br^{-}$$

in aqueous solution at 311 K. The initial concentration of C_3H_7Br was 0.0395 mol dm^{-3}.

t x 10^{-3} / s	0	1.110	2.010	5.052	11.232
[$S_2O_3^{2-}$] / mol dm^{-3}	0.0966	0.0904	0.0863	0.0766	0.0668

Determine the rate constant of this reaction.

Given that:

$$\frac{1}{a[B]_0 - b[A]_0} \ell n \frac{[B]/[B]_0}{[A]/[A]_0} = kt$$

for the reaction

$$aA + bB \rightarrow \text{products}$$

(12 marks)

3. (a) Given the following data at 25 °C,

	$\Delta H°$ (kJ mol^{-1})
$\frac{1}{2}H_2(g) + \frac{1}{2}O_2(g) \rightarrow OH(g)$	38.95
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$	-241.814
$H_2(g) \rightarrow 2H(g)$	435.994
$O_2(g) \rightarrow 2O(g)$	498.34

Calculate $\Delta H°$ and $\Delta U°$ for the following reactions:

(i) $OH(g) \rightarrow H(g) + O(g)$

(ii) $H_2O(g) \rightarrow 2H(g) + O(g)$

assuming ideal gas behaviour.

(10 marks)

(b) A total of 100 g of CO_2 gas is heated from 300 to 400 K. Calculate the amount of heat required if the process is carried out at

(i) constant pressure, and

(ii) constant volume.

Assume that CO_2 gas behaves as an ideal gas and its heat capacity is given by

$$\overline{C}_p = (29.3 + 3.0 \times 10^{-2} T - 7.78 \times 10^{-6} T^2) \text{ J K}^{-1} \text{mol}^{-1}$$

(10 marks)