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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]*

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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.

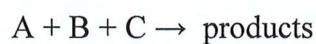
**Appendix:** Fundamental constants in physical chemistry

...2/-

**SECTION A**Answer **ALL** questions.

1. The number of wall collisions for gas molecule A at 25 °C and 1.0 atm is  $2.7 \times 10^{23} \text{ cm}^{-2} \text{ s}^{-1}$ .
- (a) Calculate the molar mass of gas molecule A. (6 marks)
- (b) The time taken for gas molecule B to strike a hole of  $C \text{ cm}^2$  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  $2.4 \text{ \AA}$ . 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



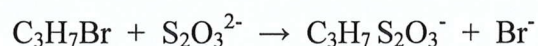
The following data are given:

[A] / mol dm <sup>-3</sup>	[B] / mol dm <sup>-3</sup>	[C] / mol dm <sup>-3</sup>	Initial rate/ mol dm <sup>-3</sup> s <sup>-1</sup>
0.550	0.200	1.15	6.76 x 10 <sup>-6</sup>
0.210	0.200	1.15	9.82 x 10 <sup>-7</sup>
0.210	0.333	1.15	1.68 x 10 <sup>-6</sup>
0.210	0.200	1.77	9.84 x 10 <sup>-7</sup>

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



in aqueous solution at 311 K. The initial concentration of C<sub>3</sub>H<sub>7</sub>Br was 0.0395 mol dm<sup>-3</sup>.

t x 10 <sup>-3</sup> / s	0	1.110	2.010	5.052	11.232
[S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> ] / mol dm <sup>-3</sup>	0.0966	0.0904	0.0863	0.0766	0.0668

Determine the rate constant of this reaction.

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Given that:

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

for the reaction



(12 marks)

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

	<u><math>\Delta H^\circ</math> (kJ mol<sup>-1</sup>)</u>
$\frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{OH}(\text{g})$	38.95
$\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g})$	-241.814
$\text{H}_2(\text{g}) \rightarrow 2\text{H}(\text{g})$	435.994
$\text{O}_2(\text{g}) \rightarrow 2\text{O}(\text{g})$	498.34

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

- (i)  $\text{OH}(\text{g}) \rightarrow \text{H}(\text{g}) + \text{O}(\text{g})$   
 (ii)  $\text{H}_2\text{O}(\text{g}) \rightarrow 2\text{H}(\text{g}) + \text{O}(\text{g})$

assuming ideal gas behaviour.

(10 marks)

- (b) A total of 100 g of  $\text{CO}_2$  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  $\text{CO}_2$  gas behaves as an ideal gas and its heat capacity is given by

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

(10 marks)

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