UNIVERSITI SAINS MALAYSIA

Final Examination
2016/2017 Academic Session

May/June 2017

JIK 310 – Physical Chemistry II
[Kimia Fizik II]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **NINE** 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 **SEMBILAN** 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.

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Answer **FIVE** questions.
*Jawab **LIMA** soalan.*

1. (a) The adsorption of a gas on a solid surface was found to follow a Langmuir isotherm with K = 3.76 kPa^{-1} at a temperature of 25 °C. Determine the pressure of gas required to achieve a fractional surface coverage of 10%.

Penjerapan gas ke atas permukaan pepejal adalah mengikut isoterma Langmuir dengan K = 3.76 kPa^{-1} pada suhu 25 °C. Tentukan tekanan gas yang diperlukan untuk mencapai penutupan permukaan pecahan sebanyak 10%.

(5 marks/*markah*)

(b) M.-G. Olivier and R. Jadot (J. Chem. Eng. Data 42, 230 (1997)) studied the adsorption of butane on silica gel. They reported the following data:

M.-G. Olivier dan R. Jadot (J. Chem. Eng. Data 42, 230 (1997)) mengkaji penjerapan butana pada gel silika. Mereka melaporkan data seperti berikut :

p/kPa	31.00	38.22	53.03	76.38	101.97	130.47	165.06	182.41	205.75	219.91
n/(mol kg^{-1})	1.00	1.17	1.54	2.04	2.49	2.90	3.22	3.30	3.35	3.36

Fit these data to a Langmuir isotherm, and determine the value of n that corresponds to complete coverage and the constant K.

Sesuaikan data ini menggunakan isoterma Langmuir dan tentukan nilai n yang sepadan dengan penutupan lengkap dan pemalar K.

(15 marks/*markah*)

2. (a) The rate of a first order reaction is 0.04 M/s at 10 minutes and 0.03 M/s at 20 minutes. Find the half-life for the reaction.
Kadar tindak balas tertib pertama adalah 0.04 M/s pada 10 minit dan 0.03 M/s pada 20 minit. Cari setengah-hayat tindak balas tersebut.

(5 marks/*markah*)

(b) The rate constant for the first order decomposition of N_2O_5 at 25 °C is 3×10^{-2} min^{-1}. The initial concentration of N_2O_5 is 2×10^{-3} mol L^{-1}. How long will it take to drop the concentration to 5×10^{-4} mol L^{-1}?
Pemalar kadar bagi penguraian tertib pertama N_2O_5 pada 25 °C adalah 3×10^{-2} min^{-1}. Kepekatan awal N_2O_5 adalah 2×10^{-3} mol L^{-1}. Berapakah masa yang akan diambil untuk kepekatan tersebut menurun kepada 5×10^{-4} mol L^{-1}?

(5 marks/*markah*)

(c) Which reaction will take place faster and why?
Tindak balas yang manakah akan berlaku lebih pantas dan mengapa?

(3 marks/*markah*)

$$C\ (s) + \tfrac{1}{2}\ O_2\ (g) \xrightarrow{500\ °C} CO\ (g)$$

$$C\ (s) + \tfrac{1}{2}\ O_2\ (g) \xrightarrow{1000\ °C} CO\ (g)$$

(d) Determine the overall order of a reaction which has the rate law $R = K [A]^{5/2} [B]^{3/2}$
Tentukan tertib keseluruhan tindak balas yang mempunyai hukum kadar $R = K [A]^{5/2} [B]^{3/2}$

(3 marks/*markah*)

(e) For the chemical decomposition of SO_2Cl_2, its initial concentration is 0.8420 mol L^{-1} and final concentration is 0.215 mol L^{-1} in 2 hours. What is the average rate of this reaction?

Bagi penguraian kimia SO_2Cl_2, kepekatan asalnya ialah 0.8420 mol L^{-1} dan kepekatan akhirnya ialah 0.215 mol L^{-1} dalam tempoh 2 jam. Apakah purata kadar tindak balas ini?

(4 marks/*markah*)

3. (a) Define emulsion.

Definisikan emulsi.

(2 marks/*markah*)

(b) State the two type of emulsion. Give two examples for each type of emulsion.

Nyatakan dua jenis emulsi. Berikan dua contoh bagi setiap jenis emulsi.

(6 marks/*markah*)

(c) Explain how the Derjaguin, Landau, Verwey and Overbeek (DLVO) theory of colloid stability can be used to predict the stability/aggregation of an aqueous dispersion of colloidal particles in

(i) pure water and

(ii) strong electrolytes.

Include diagrams where appropriate.

Terangkan bagaimana teori kestabilan koloid teori Derjaguin, Landau, Verwey and Overbeek (DLVO) boleh digunakan untuk meramalkan kestabilan / pengagregatan penyebaran akueus zarah koloid dalam

(i) air tulen dan

(ii) elektrolit kuat.

Sertakan gambar rajah mengikut kesesuaian.

(6 marks/*markah*)

(d) What is the difference between coalescence and flocculation?
Apakah perbezaan di antara penyatuan dan pengelompokan?

(6 marks/*markah*)

4. (a) What is adsorption? Explain graphically how the amount of gas adsorbed on the solid varies with pressure and temperature of gas.
Apakah penjerapan? Terangkan secara grafik bagaimana jumlah gas yang terjerap pada pepejal berubah dengan tekanan dan suhu gas.

(10 marks/*markah*)

(b) All adsorptions **can be reversed by heating**. Explain.
Semua penjerapan boleh diterbalikkan dengan pemanasan. Jelaskan.

(3 marks/*markah*)

(c) ΔH values for chemisorption are more than physiosorption. Why?
Nilai ΔH untuk penjerapan kimia adalah lebih daripada penjerapan fisikal. Mengapa?

(3 marks/*markah*)

(d) Explain the meaning of the statement "adsorption is a surface phenomenon".
Terangkan maksud kenyataan "penjerapan adalah satu fenomena permukaan".

(4 marks/*markah*)

5. Dinitrogen pentoxide (N_2O_5) decomposes to NO_2 and O_2 at relatively low temperatures in the following reaction:

$$2N_2O_5(aq) \rightarrow 4NO_2(aq) + O_2(g)$$

This reaction is carried out in a CCl_4 solution at 45 °C. The concentrations of N_2O_5 as a function of time are listed in the following table, together with the natural logarithms and reciprocal N_2O_5 concentrations. Plot a graph, determine the rate law and calculate the rate constant.

Dinitrogen pentoksida (N_2O_5) terurai kepada NO_2 dan O_2 pada suhu yang agak rendah dalam tindak balas berikut:

$$2N_2O_5(aq) \rightarrow 4NO_2(aq) + O_2(g)$$

Tindak balas ini dijalankan dalam larutan CCl_4 pada 45 °C. Kepekatan N_2O_5 sebagai fungsi masa disenaraikan dalam jadual di bawah, bersama-sama dengan logaritma asli dan kepekatan salingan N_2O_5. Plotkan graf, tentukan hukum kadar dan kirakan pemalar kadar.

Time (s)	**[N_2O_5] (M)**
0	**0.0365**
600	**0.0274**
1200	**0.0206**
1800	**0.0157**
2400	**0.0117**
3000	**0.00860**
3600	**0.00640**

(20 marks/*markah*)

6. (a) What is the role of adsorption in heterogeneous catalysis?

Apakah peranan penjerapan dalam pemangkinan heterogen?

(5 marks/*markah*)

(b) Name the catalyst used in the following process :

(i) Haber process for the manufacture of NH_3 gas.

(ii) Ostwald process for the manufacture of nitric acid.

(iii) Contact process for manufacture of sulphuric acid.

Namakan pemangkin yang digunakan dalam proses berikut:

(i) proses Haber untuk penghasilan gas NH_3.

(ii) proses Ostwald untuk penghasilan asid nitrik.

(iii) proses Contact untuk penghasilan asid sulfurik.

(3 marks/*markah*)

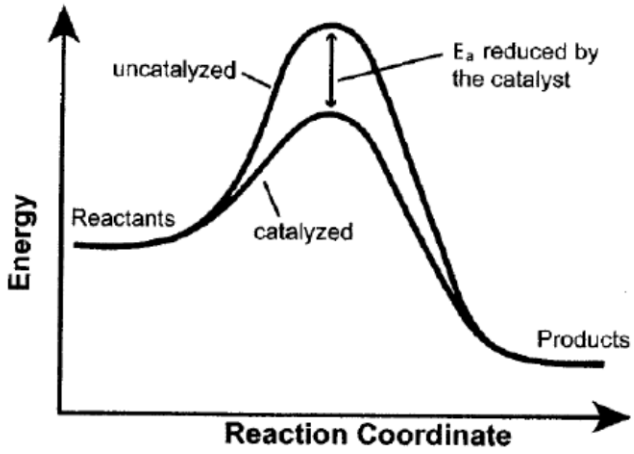
(c) Explain the mechanism of enzyme catalysis using the lock-and-key model.

Terangkan mekanisme pemangkinan enzim menggunakan model mangga-dan-kunci.

(6 marks/*markah*)

(d) A catalyst changes the mechanism of a chemical reaction and lowers its activation energy. The catalyst participates in intermediate steps of the reaction, but it is neither produced nor consumed in the reaction so the balanced reaction equation remains the same.

Suatu pemangkin mengubah mekanisme tindak balas kimia dan menurunkan tenaga pengaktifannya. Pemangkin mengambil bahagian dalam langkah perantaraan sesuatu tindak balas, tetapi ia tidak dihasilkan atau tidak digunakan dalam tindak balas supaya persamaan tindak balas berimbang tetap sama.



What effect does a catalyst have on the:

(i) activation energy of a reaction?

(ii) change in free energy of a reaction?

(iii) the mechanism of a reaction?

Apakah kesan pemangkin pada

(i) tenaga pengaktifan tindak balas?

(ii) perubahan tenaga bebas tindak balas?

(iii) mekanisme tindak balas?

(6 marks/*markah*)

Langmuir isotherm, $\theta = \frac{K_p}{1+ K_p}$; $\theta = \frac{n}{n_\infty}$

Gas Constant, R in various units

$R = 8.314\ JK^{-1}mol^{-1}$

$R = 8.314\ Pa\ m^3K^{-1}mol^{-1}$

$R = 8.314 \times 10^{-2}\ L\ bar\ K^{-1}\ mol^{-1}$

Unit of Pressure and Conversion Factors

Unit of Pressure	Symbol	Numerical Value
Pascal	Pa	$1\ Nm^{-2} = 1\ kgm^{-1}s^{-2}$
Atmosphere	atm	1 atm = 101325 Pa
Bar	Bar	1 bar = 105 Pa
Torr or millimeters of Hg	Torr	1 Torr = 101325/760 = 133.32 Pa

Types of Work

Types of Work	Variables	Equation for Work	Conventional Units
Volume Expansion	Pressure (P), Volume (V)	$w= -\int P_{external} dV$	$Pam^3 = J$
Stretching	Tension (γ), length (l)	$w= -\int \gamma dl$	Nm = J

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