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**UNIVERSITI MALAYSIA PERLIS**

Peperiksaan Akhir Semester Pertama  
Sidang Akademik 2025/2026

Januari – Februari 2026

**KMJ20003 – Materials Physical Chemistry**  
**[Kimia Fizikal Bahan]**

Masa : 3 jam

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Please make sure that this question paper has **EIGHT (8)** printed pages including this front page before you start the examination.

*[Sila pastikan kertas soalan ini mengandungi **LAPAN (8)** muka surat yang bercetak termasuk muka hadapan sebelum anda memulakan peperiksaan ini.]*

This question paper has **SIX (6)** questions. Answer all **FOUR (4)** questions in **PART A** and **ONE (1)** question in **PART B**. Each question contributes 20 marks.

*[Kertas soalan ini mengandungi **ENAM (6)** soalan. Jawab semua **EMPAT (4)** soalan dalam **BAHAGIAN A** dan **SATU (1)** soalan dalam **BAHAGIAN B**. Markah bagi tiap-tiap soalan adalah 20 markah.]*

**PART A:**  
**[BAHAGIAN A]****Question 1**  
**[Soalan 1]**

- (a) A gas is allowed to expand from a volume of 1.0 L to 8.5 L against an external pressure of 0.60 atm. At the same time, the gas absorbs 350 J of heat from the surroundings. Given 1 atm = 101.3 J/L.

*[Satu gas dibenarkan mengembang dari isipadu 1.0 L ke 8.5 L terhadap satu tekanan luar pada 0.60 atm. Pada masa yang sama, gas itu menyerap 350 J haba dari persekitaran. Diberi 1 atm = 101.3 J/L.]*

- (i) Calculate the value of work done ( $W$ ) and internal energy change ( $\Delta E$ ) of the above system.

*[Kirakan nilai kerja ( $W$ ) yang dibuat dan perubahan tenaga dalaman ( $\Delta E$ ) untuk sistem tersebut.]*

(8 Marks / Markah)

- (ii) Justify whether the internal energy increase or decrease by giving a reason.

*[Justifikasikan sama ada tenaga dalaman bertambah atau berkurang dengan memberikan alasan.]*

(2 Mark / Markah)

- (b) (i) Calculate the heat that is needed to raise the temperature of a 3.5 g copper (Cu) from 20°C to 70°C. (Given: Specific heat of Cu = 0.385 J/g.°C)

*[Kirakan haba yang diperlukan untuk menaikkan suhu 3.5 g sekeping dawai kuprum (Cu) daripada 20°C kepada 70°C. (Diberi: Haba spesifik bagi Cu = 0.385 J/g.°C)]*

(3 Marks / Markah)

- (ii) To increase the temperature of an equivalent mass (3.5 g) of aluminum (Al) from 20°C to 70°C, how much heat is needed? (Given: Specific heat of Al = 0.897 J/g.°C)

*[Untuk meningkatkan suhu jisim setara (3.5 g) aluminium (Al) daripada 20°C kepada 70°C, berapa banyak haba yang diperlukan? (Diberi: Haba spesifik bagi Al = 0.897 J/g.°C)]*

(3 Marks / Markah)

....3/-

- (iii) If you were using one of these metals (Cu and Al) to channel heat away from electrical components, which metal would you use? Justify your answer.

*[Jika anda menggunakan salah satu daripada logam ini (Cu dan Al) untuk menyalurkan haba dari komponen elektrik, logam manakah yang akan anda gunakan? Justifikasikan jawapan anda.]*

(2 Marks / Markah)

- (iv) Once heated, which metal (Cu or Al) will cool faster? Justify your answer.

*[Setelah dipanaskan, logam manakah (Cu atau Al) yang akan menyejuk lebih cepat? Justifikasikan jawapan anda.]*

(2 Marks / Markah)

....4/-

**Question 2***[Soalan 2]*

- (a) Given the following reaction and the enthalpy formation of each compound:

*[Diberi tindak balas berikut dan pembentukan entalpi setiap sebatian:]*

Compound <i>[Sebatian]</i>	$\Delta H_f^\circ$ (kJ/mol) <i>[\Delta H_f^\circ (kJ/mol)]</i>	$\Delta S_f^\circ$ (J/mol-K) <i>[\Delta S_f^\circ (J/mol-K)]</i>
NH <sub>4</sub> NO <sub>3</sub> (s)	-365.56	151.08
NH <sub>4</sub> <sup>+</sup> (aq)	-132.51	113.4
NO <sub>3</sub> <sup>-</sup> (aq)	-205.0	146.4

- (i) Calculate the enthalpy (
- $\Delta H_{\text{rxn}}$
- ) and entropy (
- $\Delta S_{\text{rxn}}$
- ) for the above reaction.

*[Kirakan entalpi ( $\Delta H_{\text{rxn}}$ ) dan entropi ( $\Delta S_{\text{rxn}}$ ) untuk tindak balas tersebut.]*

(6 Marks / Markah)

- (ii) Determine the Gibbs free energy (
- $\Delta G_{\text{rxn}}$
- ) for the above reaction at 293K.

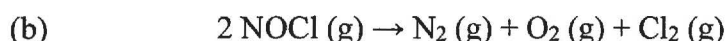
*[Tentukan tenaga bebas Gibbs ( $\Delta G_{\text{rxn}}$ ) untuk tindak balas tersebut pada 293K.]*

(4 Marks / Markah)

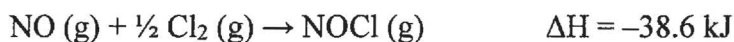
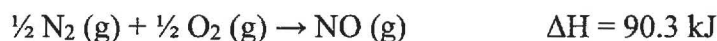
- (iii) Justify whether the reaction is spontaneous at 293K. Give a reason.

*[Justifikasikan sama ada tindak balas itu spontan pada 293K. Berikan satu sebab.]*

(2 Marks / Markah)



- (i) Calculate the enthalpy of reaction,
- $\Delta H_{\text{rxn}}$
- , for the decomposition of NOCl as shown above by using the following data:

*[Kirakan entalpi tindak balas,  $\Delta H_{\text{rxn}}$ , untuk penguraian NOCl seperti yang ditunjukkan di atas dengan menggunakan data berikut:]*

- (ii) Determine whether the reaction is exothermic or endothermic from the
- $\Delta H_{\text{rxn}}$
- obtained.

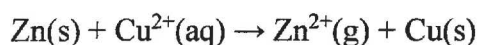
*[Tentukan sama ada tindak balas adalah eksotermik atau endotermik daripada  $\Delta H_{\text{rxn}}$  yang diperolehi.]*

(8 Marks / Markah)

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**Question 3****[Soalan 3]**

- (a) A reaction shown below occurs at 25 °C.  
*[Tindak balas yang ditunjukkan di bawah berlaku pada 25 °C.]*



The concentration of  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$  is 0.010 M and 0.020 M respectively. Given: Faraday's constant,  $F = 96500 \text{ J/V.mol}$ , gas constant,  $R = 8.314 \text{ J/K.mol}$ .

*[Kepekatan  $\text{Cu}^{2+}$  dan  $\text{Zn}^{2+}$  masing-masing ialah 0.010 M and 0.020 M. Diberi: pemalar Faraday,  $F = 96500 \text{ J/V.mol}$ , pemalar gas,  $R = 8.314 \text{ J/K.mol}$ .]*

- (i) Calculate the standard electromotive force (emf) of the cell,  $E^\circ_{\text{cell}}$ .  
*[Kirakan piawai daya gerak elektrik (emf) bagi sel tersebut,  $E^\circ_{\text{cell}}$ .]*  
 (5 Marks / Markah)
- (ii) By using the Nernst equation, calculate the electromotive force (emf) of the cell,  $E_{\text{cell}}$ .  
*[Dengan menggunakan persamaan Nerst, kirakan daya gerak elektrik (emf) bagi sel tersebut,  $E_{\text{cell}}$ .]*  
 (5 Marks / Markah)
- (iii) Justify whether this reaction is spontaneous or non-spontaneous. Clarify your answer.  
*[Justifikasikan samada tindak balas ini ialah spontan atau tidak spontan. Jelaskan jawapan anda.]*  
 (4 Marks / Markah)

- (b) The equilibrium constant  $K_p$  for the reaction  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$  is 80 at 700K. What is the equilibrium pressure of HI if the  $P_{\text{H}_2} = 0.4 \text{ atm}$  and  $P_{\text{I}_2} = 0.7 \text{ atm}$ ?

*[Pemalar keseimbangan  $K_p$  bagi tindak balas  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$  ialah 80 pada suhu 700K. Apakah tekanan keseimbangan HI jika  $P_{\text{H}_2} = 0.4 \text{ atm}$  dan  $P_{\text{I}_2} = 0.7 \text{ atm}$ ?]*

(6 Marks / Markah)

...6/-

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**Question 4***[Soalan 4]*

- (a) 1.25 moles of nitrosyl chloride (NOCl) were placed in a 2.50 L reaction chamber at 427°C. After equilibrium was reached, 1.10 moles of NOCl remained. The reaction is given as follows.

*[1.25 mol nitrosil klorida (NOCl) diletakkan di dalam 2.50 L kebuk tindak balas pada suhu 427°C. Selepas keseimbangan dicapai, 1.10 mol NOCl kekal. Tindak balas diberikan adalah seperti berikut.]*



- (i) By using the ICE table technique, determine the equilibrium concentrations for all species.

*[Dengan menggunakan teknik jadual ICE, tentukan kepekatan keseimbangan bagi semua spesies.]*

(10 Marks / Markah)

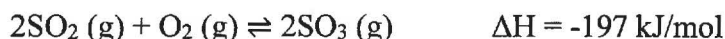
- (ii) Calculate the equilibrium constant,  $K_c$  for the reaction.

*[Kirakan pemalar keseimbangan,  $K_c$  bagi tindak balas tersebut.]*

(4 Marks / Markah)

- (b) The following equilibrium reaction is used in the Contact Process for producing sulfur trioxide from sulfur dioxide and oxygen:

*[Tindak balas keseimbangan yang berikut digunakan dalam Proses Sentuh bagi menghasilkan sulfur trioksida daripada sulfur dioksida dan oksigen.]*



Assess **THREE (3)** conditions in Contact Process to increase the yield of sulfur trioxide.

*[Nilaikan TIGA (3) keadaan dalam Proses Sentuh untuk meningkatkan penghasilan sulfur trioksida.]*

(6 Marks / Markah)

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**PART B:**  
**[BAHAGIAN B:]**

**Question 5**  
**[Soalan 5]**

- (a) (i) Define the process of adsorption with the aid of an illustration.  
*[Takrifkan proses penjerapan dengan bantuan ilustrasi.]*

(4 Marks / Markah)

- (ii) Give **TWO (2)** examples of adsorbent.  
*[Berikan DUA (2) contoh penjerap.]*

(2 Marks / Markah)

- (iii) List **FOUR (4)** differences between chemisorption and physisorption.  
*[Senaraikan EMPAT (4) perbezaan antara penjerapan kimia dan penjerapan fizikal.]*

(8 Marks / Markah)

- (b) Identify the change of entropy ( $\Delta S$ ) for each of the following processes by giving a reason to support your answer:

*[Kenalpastikan perubahan entropi ( $\Delta S$ ) untuk setiap proses berikut dengan memberikan satu sebab untuk menyokong jawapan anda.]*

- (i) Condensation of water vapor.  
*[Pemeluwapan wap air.]*

- (ii)  $\text{PCl}_5 (\text{g}) \rightarrow \text{PCl}_3 (\text{g}) + \text{Cl}_2 (\text{g})$   
*[ $\text{PCl}_5 (\text{g}) \rightarrow \text{PCl}_3 (\text{g}) + \text{Cl}_2 (\text{g})$ ]*

- (iii)  $2\text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow 2\text{H}_2\text{O} (\text{g})$   
*[ $2\text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow 2\text{H}_2\text{O} (\text{g})$ ]*

- (iv) Heating oxygen gas from  $60^\circ\text{C}$  to  $80^\circ\text{C}$   
*[Pemanasan gas oksigen dari  $60^\circ\text{C}$  ke  $80^\circ\text{C}$ .]*

(6 Marks / Markah)

....7/-

**Question 6****[Soalan 6]**

(a) A galvanic cell is an electrochemical system that generates electricity from a spontaneous chemical reaction. It is made up of two half-cells containing different metals (anode and cathode) and electrolytes, connected by a salt bridge and external wire.

(i) Define the anode, cathode and salt bridge in galvanic cell.

*[Takrifkan anod, katod dan titian garam dalam sel galvani.]*

(6 Marks / Markah)

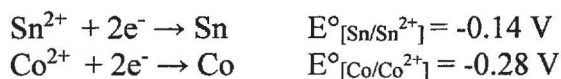
(ii) Draw an appropriate labelled diagram of the galvanic cell and give one practical example for the galvanic cell.

*[Lukis satu gambarajah berlabel yang bersesuaian untuk sel galvani dan berikan satu contoh praktikal bagi sel galvani.]*

(4 Marks / Markah)

(b) Consider the following reactions:

*[Pertimbangkan tindak balas – tindak balas berikut:]*



(i) Write reaction for the anode and cathode.

*[Tuliskan tindak balas untuk anod dan katod.]*

(4 Marks / Markah)

(ii) Build and write the overall galvanic cell reactions.

*[Bina dan tuliskan tindak balas keseluruhan sel galvani.]*

(4 Marks / Markah)

(iii) Develop and write a cell notation for the reactions.

*[Bangun dan tuliskan satu tatacara sel untuk tindak balas itu.]*

(2 Marks / Markah)

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