



**UNIVERSITI MALAYSIA TERENGGANU**

**FINAL EXAMINATION  
PEPERIKSAAN AKHIR**

**SEMESTER III SESSION 2022/2023 (STEM FOUNDATION PROGRAMME)  
SEMESTER III SESI 2022/2023 (ASASI STEM)**

**COURSE : CHEMISTRY III  
KURSUS : KIMIA III**

**COURSE CODE : ASC1232  
KOD KURSUS**

**DURATION : 2 HOURS  
TEMPOH : 2 JAM**

**MATRIC NO. :  
NO. MATRIK**

**PROGRAMME :  
NAMA PROGRAM**

**SEAT NO. :  
NO. MEJA**

**INSTRUCTION TO CANDIDATES  
ARAHAN KEPADA CALON**

- i. Answer all questions.  
*Sila jawab semua soalan.*
- ii. All answer must be written in in answer booklet provided.  
*Semua jawapan hendaklah ditulis di dalam buku jawapan yang disediakan.*

**DO NOT OPEN THE QUESTION PAPER UNTIL INSTRUCTED  
JANGAN BUKA BUKU SOALAN INI SEHINGGA DIBERITAHU**

THIS QUESTION PAPER CONSISTS OF NINE (9) PRINTED PAGES  
KERTAS SOALAN INI MENGANDUNGI SEMBILAN (9) MUKASURAT BERCETAK

**Please answer all question.**

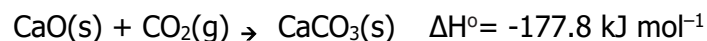
***Sila jawab semua soalan.***

**QUESTION 1 / SOALAN 1 (22 marks) / 22 markah)**

1. Entropy is a measure of the dispersal of energy at a specific temperature.  
*Entropi adalah ukuran penyebaran tenaga pada suhu tertentu.*
  - a. Predict whether the following process will lead to an increase or decrease in entropy. Explain your answer.  
*Jangkakan sama ada proses berikut akan membawa kepada peningkatan atau penurunan entropi. Jelaskan jawapan anda.*
    - i. Ice melts. (2 marks)  
*Ais mencair. (2 markah)*
    - ii. Forward reaction of  $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$ . (2 marks)  
*Tindakbalas ke hadapan  $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$ . (2 markah)*
    - iii. Reaction of  $2\text{Na}(\text{s}) + \text{Br}_2(\text{g}) \rightarrow 2\text{NaBr}(\text{s})$ . (2 marks)  
*Tindakbalas  $2\text{Na}(\text{s}) + \text{Br}_2(\text{g}) \rightarrow 2\text{NaBr}(\text{s})$ . (2 markah)*
    - iv. Ionization of  $\text{NaBr}(\text{s}) \rightarrow \text{Na}^+(\text{l}) + \text{Br}^-(\text{l})$ . (2 marks)  
*Pengionan  $\text{NaBr}(\text{s}) \rightarrow \text{Na}^+(\text{l}) + \text{Br}^-(\text{l})$ . (2 markah)*
    - v. Cooling process of  $\text{H}_2\text{O}(\text{l}) 60^\circ\text{C} \rightarrow \text{H}_2\text{O}(\text{l}) 30^\circ\text{C}$ . (2 marks)  
*Proses penyejukan  $\text{H}_2\text{O}(\text{l}) 60^\circ\text{C} \rightarrow \text{H}_2\text{O}(\text{l}) 30^\circ\text{C}$ . (2 markah)*
    - vi. Reaction of  $\text{C}_3\text{H}_8(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{C}_3\text{H}_6(\text{g}) + \text{H}_2\text{O}(\text{g})$ . (2 marks)  
*Tindakbalas  $\text{C}_3\text{H}_8(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{C}_3\text{H}_6(\text{g}) + \text{H}_2\text{O}(\text{g})$ . (2 markah)*

- b. Calcium carbonate ( $\text{CaCO}_3$ ) can be prepared from calcium oxide ( $\text{CaO}$ ) and carbon dioxide ( $\text{CO}_2$ ) at 298 K. The chemical reaction is as below.

*Kalsium karbonat ( $\text{CaCO}_3$ ) boleh dihasilkan daripada kalsium oksida ( $\text{CaO}$ ) dan karbon dioksida ( $\text{CO}_2$ ) pada 298 K. Tindakbalas kimia adalah seperti di bawah:*



Some relevant standard entropies are given in the table.

*Beberapa entropi piawai diberikan di dalam jadual*

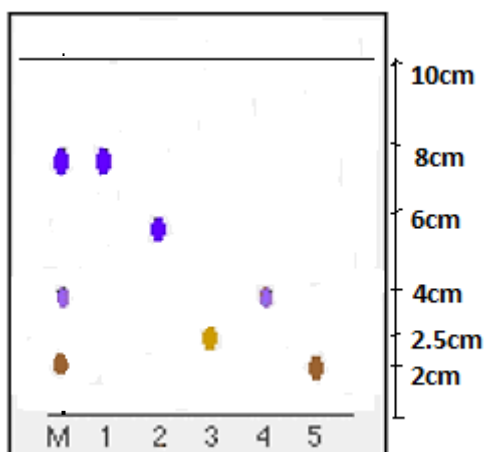
substance <i>bahan</i>	$\text{CaCO}_3$	$\text{CaO}$	$\text{CO}_2$
$S^\circ / \text{J K}^{-1}\text{mol}^{-1}$	+92.9	+39.7	+213.6

- Define entropy. (2 marks)  
*Takrifkan entropi. (2 markah)*
- Calculate the standard entropy change,  $\Delta S^\circ$ , for this reaction. (2 marks)  
*Kira perubahan entropi piawai,  $\Delta S^\circ$  bagi tindak balas ini. (2 markah)*
- Calculate the standard Gibbs free energy change,  $\Delta G^\circ$  and state whether the reaction is feasible or not feasible at 298 K. Give a reason. (4 marks)  
*Kirakan perubahan tenaga bebas Gibbs piawai,  $\Delta G^\circ$  dan nyatakan sama ada tindak balas ini boleh berlaku atau tidak pada 298 K. Berikan alasan. (4 markah)*
- Predict whether the reaction becomes more feasible or less feasible when the temperature is increased. Explain the answer with reference to  $\Delta G^\circ$ . (2 marks)  
*Jangkakan sama tindak balas lebih mudah berlaku atau kurang upaya untuk berlaku apabila suhu ditingkatkan. Jelaskan jawapan dengan merujuk kepada  $\Delta G^\circ$ . (2 markah)*

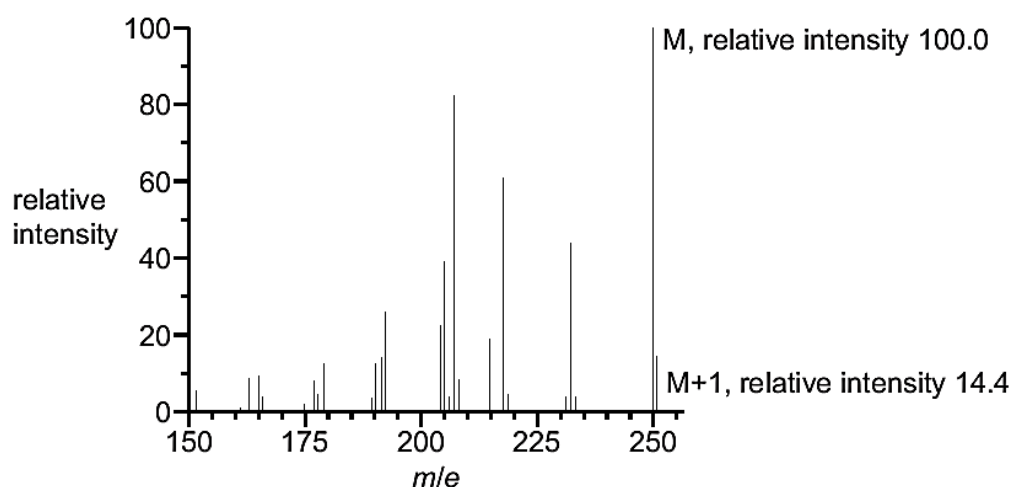
QUESTION 2 / SOALAN 2 (32 marks / 32 markah)

2. a. A mixture of amino acids (**M**) was tested against five known amino acids (1 to 5) and the following chromatogram was made:

*Campuran asid amino (**M**) telah diuji terhadap lima acid amino yang diketahui (1 hingga 5) dan kromatogram berikut telah diperolehi:*



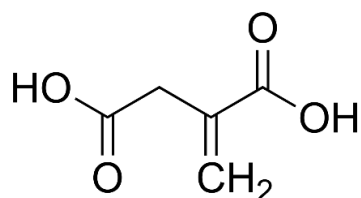
- i. Identify the amino acid which does/do not exist in the mixture of amino acid M. (2 marks)  
*Kenal pasti asid amino yang tidak wujud di dalam campuran asid amino M. (2 markah)*
- ii. Calculate the  $R_f$  value for amino acid 2. (2 marks)  
*Kirakan nilai  $R_f$  bagi asid amino 2. (2 markah)*
- b. The mass spectrum of compound **K**( $C_xH_yO_z$ ) is given below. The M and M+1 peaks are labelled, along with their relative intensities.  
*Spektrum jisim sebatian **K**( $C_xH_yO_z$ ) diberikan di bawah. Puncak M dan M+1 dilabelkan dengan masing-masing intensiti relatifnya.*



Calculate the number of carbon atoms(**x**) present in compound **K**. (2 marks)  
*Kirakan jumlah atom karbon(**x**) yang hadir dalam sebatian **K**. (2 markah)*

- c. A sample of itaconic acid is analysed with nuclear magnetic resonance (NMR) spectrometer.

*Sampel asid itakonik di analisa dengan spektrometer resonan magnetik nuklear (NMR).*



- i. Redraw the structure of itaconic acid and label (circle) all the environments would be observed in the  $^{13}\text{C}$  NMR spectrum. (5 marks)

*Lukiskan semula struktur asid itakonik dan labelkan (bulatkan) semua keadaan yang akan dicerap dalam spektrum  $^{13}\text{C}$  NMR. (5 markah)*

- ii. Write the expected chemical shift range ( $\delta$ ) at each labelled environment in the structure. (5 marks)

*Tuliskan julat anjakan kimia( $\delta$ ) yang dijangkakan pada setiap keadaan yang dilabelkan di dalam stukturanya. (5 markah)*

- d. There are **four (4)** different carbocations with the same formula,  $\text{C}_4\text{H}_9^+$  (structure 1 to 4). State the number of peaks that would be observed in the  $^{13}\text{C}$  NMR spectrum of each of the structures. (4 marks)

*Terdapat **empat (4)** karbokation berbeza dengan formula yang sama,  $\text{C}_4\text{H}_9^+$  (struktur 1 hingga 4) dengan formula  $\text{C}_{10}\text{H}_{14}$ . Nyatakan bilangan puncak yang akan dicerap di dalam spektrum  $^{13}\text{C}$  NMR bagi setiap struktur. (4 markah)*

	Number of peaks		Number of peaks
Structure 1 		Structure 3 	
Structure 2 		Structure 4 	

- e. Nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry (MS) are used in the detection of certain molecules, particularly those containing hydrogen atoms.

*Spektroskopi Resonan Magnetik Nuklear (NMR) dan spektrometri jisim (MS) digunakan dalam penentuan molekul tertentu terutamanya molekul yang mengandungi atom atom hidrogen.*

- i. Explain how the proton NMR spectrum of butanoic acid ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ ) would be different from that of ethyl ethanoate ( $\text{CH}_3\text{COOCH}_2\text{CH}_3$ ). (4 marks)

*Terangkan bagaimana spektrum NMR proton bagi asid butanoik ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ ) akan berbeza daripada spektrum etil etanoat ( $\text{CH}_3\text{COOCH}_2\text{CH}_3$ ). (4 markah)*

- ii. Redraw and fill in the table below with the correct chemical shift range and splitting pattern for butanoic acid ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ ). (8 marks)

*Lukiskan semula dan penuhkan jadual di bawah dengan julat anjakan kimia yang betul dan corak pemecahan puncak bagi asid butanoik ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ ). (8 markah)*

$\delta$ / ppm	group responsible for the peak <i>kumpulan yang bertanggungjawab terhadap puncak</i>	number of $^1\text{H}$ atoms responsible for the peak <i>bilangan atom <math>^1\text{H}</math> bertanggungjawab terhadap puncak</i>	splitting pattern <i>corak pemecahan</i>
1.1		3	
1.9	$\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-}$		
2.5		2	
11.8		1	

**QUESTION 3 (23 marks) / SOALAN 3 (23 markah)**

3. a. Iron is a transition element in the fourth period. Iron forms compounds containing the ions  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$ .  
*Besi adalah unsur peralihan dalam kala keempat. Besi membentuk sebatian yang mengandungi ion  $\text{Fe}^{2+}$  dan  $\text{Fe}^{3+}$ .*
- Define transition elements. (3 marks)  
*Takrifkan unsur peralihan. (3 markah)*
  - Complete the electronic configuration of  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  ion. (2 marks)  
*Lengkapkan konfigurasi elektronik bagi ion  $\text{Fe}^{2+}$  dan  $\text{Fe}^{3+}$ . (2 markah)*
  - Aqueous  $\text{Fe}^{3+}$  ions form coloured complexes. Explain the origin of the colour in transition element complexes. (4 marks)  
*Ion akueas  $\text{Fe}^{3+}$  membentuk kompleks berwarna. Terangkan bagaimana warna terhasil bagi kompleks unsur peralihan. (4 markah)*
- b. When an excess of  $\text{CN}^{-}(\text{aq})$  ions is added to green  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$  ions, yellow  $[\text{Fe}(\text{CN})_6]^{4-}$  complex ions are formed.  
Heating  $[\text{Fe}(\text{CN})_6]^{4-}$  with dilute nitric acid and then neutralising the product with  $\text{Na}_2\text{CO}_3(\text{aq})$  produces red crystals, containing the  $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$  complex ion.  
NO is a neutral, monodentate ligand.  
*Apabila ion  $\text{CN}^{-}(\text{aq})$  berlebihan ditambahkan kepada ion  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$  berwarna hijau, ion kompleks  $[\text{Fe}(\text{CN})_6]^{4-}$  berwarna kuning terbentuk.  
Pemanasan  $[\text{Fe}(\text{CN})_6]^{4-}$  dengan asid nitrik dan kemudian produk dineutralkan dengan  $\text{Na}_2\text{CO}_3(\text{aq})$  menghasilkan kristal yang mengandungi kompleks ion  $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$ .  
NO adalah neutral dan logam monodentat.*
- State the name of the shape of  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$  complex ion. (1 mark)  
*Nyatakan nama bagi bentuk ion kompleks  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$ . (1 mark)*
  - Write the equation for the reaction between  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$  ions and an excess of  $\text{CN}^{-}(\text{aq})$  ions. (3 marks)  
*Tuliskan persamaan bagi tindak balas antara ion  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$  dan ion  $\text{CN}^{-}(\text{aq})$  yang berlebihan. (3 markah)*
  - Deduce the oxidation states of iron in: (4 marks)  
*Rungkaikan keadaan pengoksidaan besi dalam: (4 markah)*
    - $[\text{Fe}(\text{CN})_6]^{4-}$
    - $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$
  - Define monodentate ligand. (2 marks)  
*Takrifkan ligan monodentat. (2 markah)*

- v. Redraw and complete the diagram to show the three-dimensional structure of the  $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$  complex ion. (2 marks)  
*Lukis semula dan lengkapkan diagram bagi menunjukkan struktur tiga-dimensi ion kompleks  $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$ . (2 markah)*



- vi. Complex ions  $[\text{Fe}(\text{CN})_6]^{4-}$  and  $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$  are having different colours. Explain this statement. (2 marks)  
*Kompleks ion  $[\text{Fe}(\text{CN})_6]^{4-}$  dan  $[\text{Fe}(\text{CN})_5\text{NO}]^{2-}$  mempunyai warna yang berbeza. Jelaskan pernyataan ini. (2 markah)*

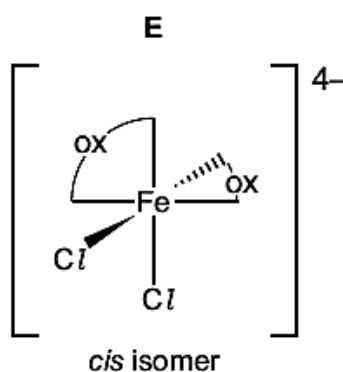


- c. **E** is a complex ion,  $[\text{Fe}(\text{C}_2\text{O}_4)_2\text{Cl}_2]^{4-}$ , containing  $\text{Fe}^{2+}$  with a coordination number of 6.

***E** adalah ion kompleks  $[\text{Fe}(\text{C}_2\text{O}_4)_2\text{Cl}_2]^{4-}$  yang mengandungi  $\text{Fe}^{2+}$  dengan nombor koordinatan 6.*

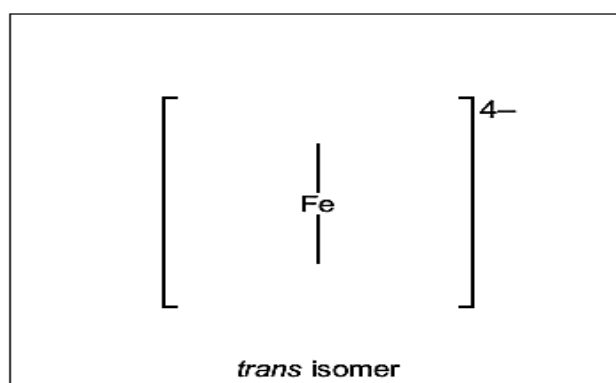
- i. Define coordination number. (2 marks)  
*Jelaskan nombor koordinatan. (2 markah)*

- ii. Complex ion **E** shows both optical isomerism and cis-trans isomerism.  
 One isomer of **E** is shown. The  $\text{C}_2\text{O}_4^{2-}$  ion is represented as —ox—  
*Ion kompleks **E** menunjukkan keisomeran optik dan keisomeran cis-trans.*  
*Satu isomer **E** ditunjukkan di bawah. Ion  $\text{C}_2\text{O}_4^{2-}$  diwakili sebagai —ox—*



Redraw the complex ion in the boxes, and complete the three-dimensional diagrams to show the trans isomer of **E**. (1 mark)

*Lukiskan semula ion kompleks di dalam kotak di bawah dan lengkapkan diagram tiga dimensi bagi menunjukkan isomer trans bagi **E**. (1 markah)*



**End of Question Paper**  
*Kertas Soalan Tamat*