



UNIVERSITI MALAYSIA TERENGGANU

FINAL EXAMINATION
PEPERIKSAAN AKHIRSEMESTER III 2021/2022 SESSION (STEM FOUNDATION PROGRAMME)
SEMESTER III SESI 2021/2022 (PROGRAM ASASI STEM)

COURSE KURSUS	: CHEMISTRY III KIMIA III
COURSE CODE KOD KURSUS	: ASC1232 ASC1232
DATE TARIKH	: 6 JULY 2022 6 JULAI 2022
VENUE TEMPAT	: DEWAN SULTAN MIZAN(DSM)
TIME MASA	: 09:00-11:00 AM (2 HOUR) 09:00-11:00 PAGI (2 JAM)

MATRIC NO. NO. MATRIK	: _____
PROGRAMME PROGRAM	: _____

INSTRUCTION TO CANDIDATES
ARAHAN KEPADA CALON

- i Answer **ALL** questions.
Jawab **SEMUA** soalan.
- ii Write all answer in **answer booklet** provided.
Tulis semua jawapan di dalam buku jawapan yang disediakan.

DO NOT OPEN THE QUESTION PAPER UNTIL INSTRUCTED
JANGAN BUKA BUKU SOALAN INI SEHINGGA DIBERITAHUTHIS QUESTION PAPER CONSISTS OF 9 PRINTED PAGES
KERTAS SOALAN INI MENGANDUNGI 9 MUKASURAT BERCETAK

QUESTION 1 [20 MARKS]

Entropy is a measure of the dispersal of energy at a specific temperature.

Entropi adalah ukuran penyebaran tenaga pada suhu tertentu

(a) State whether the following conditions will lead to an increase or decrease in entropy. Explain your answer.

Nyatakan sama ada keadaan berikut akan membawa kepada peningkatan atau penurunan entropi. Jelaskan jawapan anda.

(i) Ionic solid dissolves in water.

Ion pepejal melarut di dalam air

(2 marks)

(ii) Forward reaction of $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$

Tindakbalas ke hadapan $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$

(2 marks)

(b) The table shows four processes. For each process, predict the sign (positive or negative) of the entropy change, ΔS° .

Jadual menunjukkan empat proses. bagi setiap proses, jangkakan tanda (positif atau negatif) bagi perubahan entropi, ΔS°

	Reaction <i>Tindakbalas</i>	Entropy change, ΔS° <i>Perubahan Entropi, ΔS°</i>
(i)	$\text{H}_2\text{O}(\text{g}) + \text{C}(\text{s}) \rightleftharpoons \text{H}_2(\text{g}) + \text{CO}(\text{g})$	
(ii)	Liquid water at 80°C is cooled to 60°C <i>Cecair air pada 80°C disejukkan ke 60°C</i>	
(iii)	$\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightleftharpoons \text{NH}_4\text{Cl}(\text{g})$	
(iv)	$2\text{Li}(\text{s}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{LiCl}(\text{s})$	

(4 marks)

(c) Zinc carbonate can be decomposed to produce zinc oxide and carbon dioxide at 298 K. The chemical reaction is as below:

Zink karbonat boleh diuraikan untuk menghasilkan zink oksida dan karbon dioksida 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>	ZnCO ₃	ZnO	CO ₂
S°/ J K ⁻¹ mol ⁻¹	+82.4	+43.6	+213.6

- (i) Define a term entropy.
Jelaskan maksud entropi. **(2 marks)**
- (ii) Calculate the standard entropy change, ΔS° for this reaction.
Kira perubahan entropi piawai, ΔS° bagi tindak balas ini. **(3 marks)**
- (iii) Calculate the standard Gibbs free energy change, ΔG° and state whether the reaction is feasible or not feasible at 298K .
Kirakan perubahan tenaga bebas Gibbs piawai, ΔG° dan nyatakan sama ada bagi tindak balas ini boleh berlaku atau tidak pada 298K. **(4 marks)**
- (iv) State whether the reaction becomes more feasible or less feasible when the temperature is increased. Explain the answer with reference to ΔG° .
Nyatakan sama tindak balas lebih mudah berlaku atau kurang upaya untuk berlaku apabila suhu ditingkatkan. Jelaskan jawapan dengan merujuk kepada ΔG° **(3 marks)**

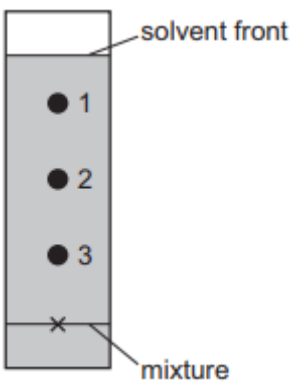
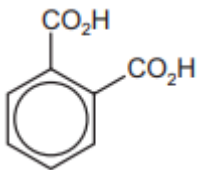

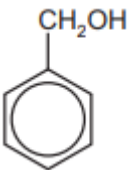
QUESTION 2 [7 MARKS]

Paper chromatography relies on the partition of compounds between mobile and stationary phases.

Kromatografi kertas bergantung pada pembahagian sebatian antara fasa gerak dan fasa pegun.

(a) A mixture of three compounds was analyzed by paper chromatography using a non-polar solvent. The resulting chromatogram is shown.

Campuran tiga sebatian telah di analisa dengan kromatografi kertas yang menggunakan pelarut tak polar. Keputusan kromatogram ditunjukkan di bawah.

Result <i>keputusan</i>	compound <i>sebatian</i>	molecular structure <i>struktur molekul</i>
	P	
	Q	
	R	

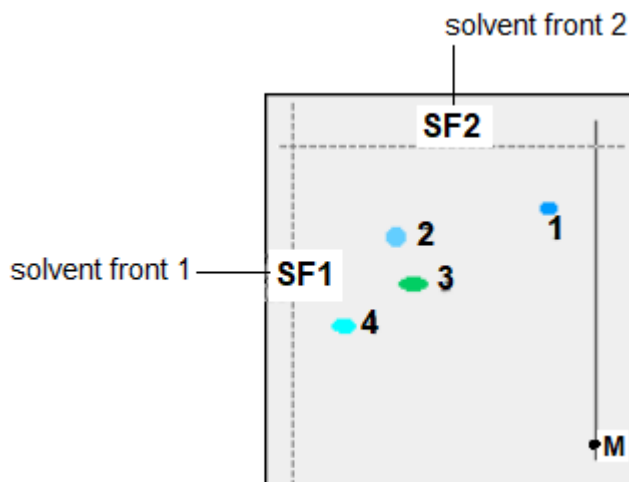
(i) State which compound is responsible for each spot.
Natakan sebatian yang bersesuaian bagi setiap spot.

(3 marks)

(ii) Explain why compound at spot 1 travels furthest.
Jelaskan mengapa sebatian pada spot 1 bergerak lebih cepat.

(2 marks)

(b) The following diagram is a two-way paper chromatography.
Diagram berikut adalah kromatografi dua-arah.



State the spots with the highest retardation factor value, R_f in solvent 1 and 2 respectively.

Nyatakan spot yang tertinggi nilai faktor rencatan, R_f masing-masing di dalam pelarut 1 dan pelarut 2.

(2 marks)

QUESTION 3 [23 MARKS]

(a) The mass spectrum of ethyl propanoate, $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$ is recorded. The peak heights of the M and $M+1$ peaks are 22.65 and 1.25 respectively.

Spektrum jisim etil propanoat, $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$ telah direkodkan. Tinggi puncak M dan $M+1$ masing-masing adalah 22.65 dan 1.25.

(i) There are five carbon atoms present in one molecule of ethyl propanoate. Show your calculation.

Terdapat lima atom karbon yang ada di dalam setiap molekul etil propanoat. Tunjukkan pengiraan anda.

(2 marks)

(ii) The mass spectrum has a peak at $m/e = 57$. Complete the equation to show the fragmentation of ethyl propanoate to produce this peak.

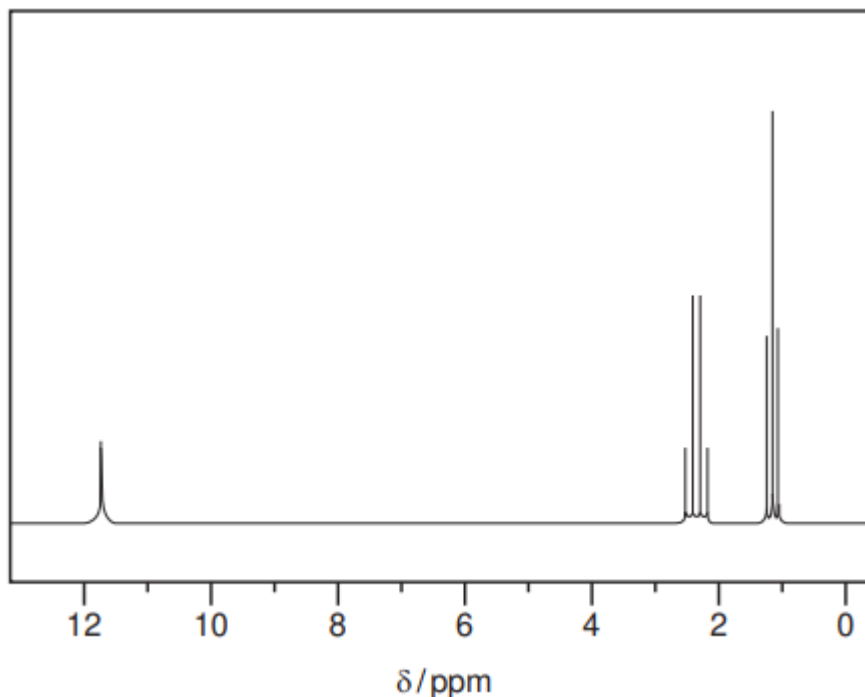
Spektrum jisim mempunyai puncak pada $m/e = 57$. Lengkapkan persamaan berikut bagi menunjukkan pemecahan etil propanoat untuk menghasilkan puncak ini.



(2 marks)

(b) NMR spectroscopy provides a powerful method of analysis for organic compounds. A compound **G** contains 3 carbons in its structure. The NMR spectrum of compound **G** is shown.

Spektroskopi NMR menyediakan kaedah yang berkesan bagi menganalisa sebatian organik. Sebatian G mengandungi tiga karbon di dalam strukturnya. Spectrum NMR sebatian G di tunjukkan di bawah.



- (i) Use the *Data Booklet* and NMR spectroscopy technique to identify the type of proton responsible for each of the three absorptions. *Gunakan Buku Data yang dibekalkan dan teknik spektroskopi NMR untuk mengenal jenis proton yang bersesuaian bagi setiap tiga signal serapan tersebut.*

Absorption, δ /ppm <i>Serapan</i>	type of proton <i>Jenis proton</i>
1.1	
2.2	
11.8	

(3 marks)

- (ii) The addition of D_2O causes one of these absorptions in question (i) to disappear. State which absorption is affected. *Penambahan D_2O menyebabkan salah satu daripada puncak penyerapan dalam soalan (i) lenyap. Nyatakan puncak serapan yang terkesan.*

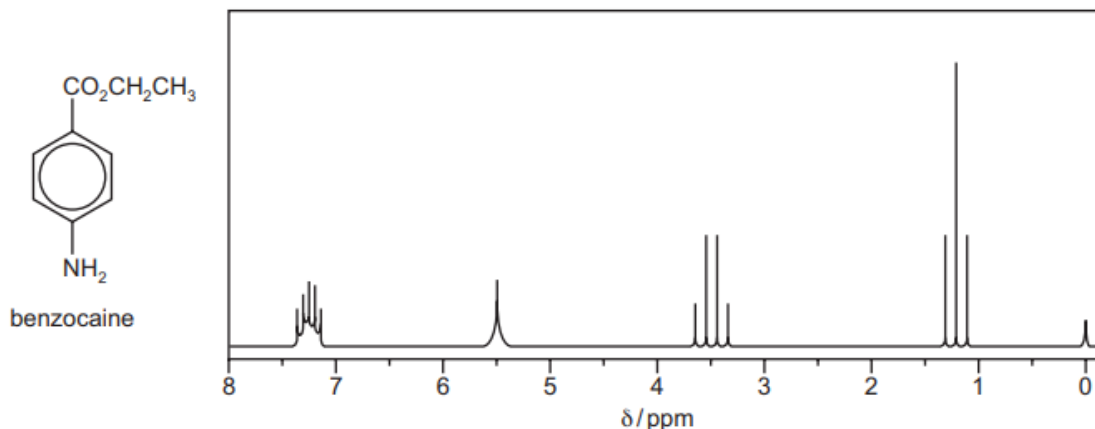
(1 mark)

- (iii) Draw the structure of compound **G**.
Lukiskan struktur sebatian G

(2 marks)

- (c) A structure of benzocaine, shown below, was analyzed by proton NMR and carbon-13 NMR spectroscopy.

Struktur benzocaine yang ditunjukkan di bawah telah dianalisa menggunakan teknik spektroskopi NMR proton dan NMR karbon-13.



- (i) Predict the number of peaks that would be seen in the carbon-13 NMR spectrum.

Jangkakan jumlah puncak yang akan kelihatan di dalam spektrum NMR karbon-13.

(1 marks)

- (ii) Use the *Data Booklet* and the spectrum above to complete the table for the proton NMR spectrum of benzocaine. The actual chemical shifts (δ) for the four absorptions are stated.

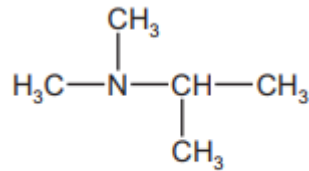
Gunakan Buku Data dan spektrum di atas untuk melengkapkan jadual bagi NMR proton benzocaine. Anjakan kimia sebenar(δ) bagi empat serapan dinyatakan dalam jadual.

δ / ppm	group responsible for the peak <i>kumpulan yang bertanggungjawab terhadap puncak</i>	number of ¹ H atoms responsible for the peak <i>bilangan atom ¹H bertanggungjawab terhadap puncak</i>	splitting pattern <i>corak pemecahan</i>
1.2			
3.5			
5.5			
7.1–7.4	<i>H attached to aromatic /benzene ring</i>		<i>multiplet</i>

(10 marks)

- (d) Compound **K** is a tertiary amine. It has three peaks in its proton NMR spectrum. One of the peaks is a doublet. Redraw compound **K** and circle the protons responsible for the doublet.

*Sebatian **K** adalah amina tertiar. Ia mempunyai tiga puncak di dalam spektrum NMR proton. Satu puncak daripadanya adalah dublet. Lukiskan semula sebatian **K** dan bulatkan proton yang bertanggung jawab bagi dublet tersebut.*



K

(2 marks)

QUESTION 4 [30 MARKS]

(a) Copper is a transition element with atomic number 29.
Kuprum adalah unsur peralihan dengan nombor atom 29.

(i) Define the term transition element.
Jelaskan terma unsur peralihan.

(2 marks)

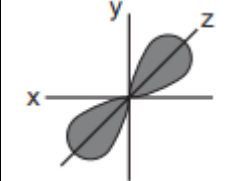
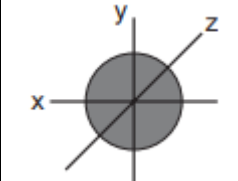
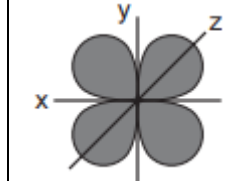
(ii) Write the electronic configurations of a Cu atom and a Cu⁺ ion.
Tuliskan konfigurasi elektronik atom Cu dan ion Cu⁺.

(3 marks)

(iii) Explain the origin of colour in transition element complexes.
Terangkan asal warna dalam kompleks unsur peralihan.

(4 marks)

(b) (i) The shapes of some atomic orbitals are shown in the table below. State the type of the orbital of **L**, **M** and **N** either orbital *s*, *p* or *d*.
*Bentuk beberapa orbital atom ditunjukkan dalam jadual di bawah. Nyatakan jenis orbital **L**, **M** dan **N** sama ada orbital *s*, *p* atau *d*.*

Shape of orbital <i>Bentuk orbital</i>			
Type of orbital <i>Jenis orbital</i>	L	M	N

(3 marks)

(ii) Cadmium has an atomic number of 48. Complete electronic configurations for cadmium atom (Cd) and cadmium ions (Cd²⁺). Explain why cadmium is not a transition element.

Kadmium mempunyai nombor atom 48. Lengkapkan konfigurasi elektronik bagi kadmium (Cd) dan ion Kadmium (Cd²⁺). Terangkan mengapa kadmium bukan unsur peralihan.

Cd: [Kr]₃₆ 4d 5sCd²⁺: [Kr]₃₆ 4d 5s

(3 marks)

(c) Cl⁻ ions and C₂O₄²⁻ are monodentate and bidentate ligands respectively.



Ion Cl^- dan $\text{C}_2\text{O}_4^{2-}$ adalah masing-masing ligan monodentat dan bidentat.

- (i) Define the term ligand.
Jelaskan terma ligan.

(2 marks)

- (ii) Cu^+ ions form a linear complex with Cl^- ions. Draw the structure of this complex and include its overall charge.
Ion Cu^+ membentuk kompleks linear dengan ion Cl^- . Lukiskan struktur kompleks ini termasuk cas keseluruhannya.

(3 marks)

- (iii) $\text{Cr}^{3+}(\text{aq})$ and $\text{C}_2\text{O}_4^{2-}(\text{aq})$ ions form the complex ion $[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]^-$. Draw TWO stereoisomers of this complex ion. You may use  to represent $\text{C}_2\text{O}_4^{2-}$.
Ion Cr^{3+} (ak) dan $\text{C}_2\text{O}_4^{2-}$ (ak) membentuk ion kompleks $[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]^-$. Lukiskan DUA stereoisomer bagi ion kompleks ini. Anda boleh guna  untuk mewakili $\text{C}_2\text{O}_4^{2-}$.



(4 marks)

- (d) Methylamine (CH_3NH_2) is a monodentate ligand. Monodentate ligand can donate one lone pair electron to the central metal ion. It reacts with aqueous cadmium ($[\text{Cd}(\text{H}_2\text{O})_6]^{2+}$) to produce complexes as shown in the following reaction.
Metilamina (CH_3NH_2) adalah ligan monodentat. Ligan monodentat boleh derma satu pasangan elektron pencil kepada pusat ion logam. Ia bertindak balas dengan kadmium berakueous ($[\text{Cd}(\text{H}_2\text{O})_6]^{2+}$) untuk menghasilkan kompleks seperti dalam tindak balas berikut.



- (i) Draw the diagrams to show the cis and trans structures of the complexes, $[\text{Cd}(\text{CH}_3\text{NH}_2)_4(\text{H}_2\text{O})_2]^{2+}$.
Lukiskan diagram untuk menunjukkan struktur cis dan trans bagi kompleks $[\text{Cd}(\text{CH}_3\text{NH}_2)_4(\text{H}_2\text{O})_2]^{2+}$.

(5 marks)

- (ii) Name the shape of the complexes.
Namakan bentuk kompleks tersebut.

(1 mark)

End of Question paper
Kertas Soalan Tamat