سلطنة عمان
وزارة التربية والتعليم

مركز القياس والتقويم التربوي
The Center for Educational Assessment and Measurement (CEAM)

امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)

الفصل الدراسي الثاني - الدور الأول

للعام الدراسي ١٤٤٧/١٤٤٦ هـ - ٢٠٢٤ / ٢٠٢٥ م

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٧) صفحة.
- زمن الإجابة: ثلاث ساعات.
- الإجابة في الورقة نفسها.

تعليمات مهمة:

- يجب الحضور إلى قاعة الامتحان قبل عشر دقائق على الأقل من بدء زمن الامتحان.
- يجب إحضار أصل ما يثبت الهوية وإبرازها للعاملين بالامتحانات.
- يجب الالتزام بالزي (الدشداشة البيضاء والمصر أو الكمة للذكور) والزي المدرسي للطالبات ، ويستثنى من ذلك الدارسون من غير العمانيين بشرط الالتزام بالذوق العام، ويمنع على جميع المتقدمات ارتداء النقاب داخل المركز وقاعات الامتحان.
- يحظر على الممتحنين اصطحاب الهواتف النقالة وأجهزة النداء الآلي وآلات التصوير والحواسيب الشخصية والساعات الرقمية الذكية والآلات الحاسبة ذات الصفة التخزينية والمجلات والصحف والكتب الدراسية والدفاتر والمذكرات والحقائب اليدوية والآلات الحادة أو الأسلحة أياً كان نوعها وأي شيء له علاقة بالامتحان.
- يجب على الممتحن الامتثال لإجراءات التفتيش داخل المركز طوال أيام الامتحان.
- يجب على الممتحن التأكد من استلام دفتر امتحانه، مغلفاً بغلاف بلاستيكي شفاف وغير ممزق ، وهو مسؤول عنه حتى يسلمه لمراقبي اللجنة بعد الانتهاء من الإجابة.
- يجب الالتزام بضوابط إدارة امتحانات دبلوم التعليم العام وما في مستواه وأية مخالفة لهذه الضوابط تعرضك للتدابير والإجراءات والعقوبات المنصوص عليها بالقرار الوزاري رقم ٥٨٨ / ٢٠١٥.
- يقوم المتقدم بالإجابة عن أسئلة الامتحان المقالية بقلم الحبر (الأزرق أو الأسود).
- يقوم المتقدم بالإجابة عن أسئلة الاختيار من متعدد بتظليل الشكل (⬭) وفق النموذج الآتي:

س – عاصمة سلطنة عمان هي:

⬭ القاهرة ⬭ الدوحة

⬬ مسقط ⬭ أبوظبي

ملاحظة: يتم تظليل الشكل (⬬) باستخدام القلم الرصاص وعند الخطأ، امسح بعناية لإجراء التغيير.

صحيح ⬬ **غير صحيح** ⬭ ◉ ◒ ⊗ ✓

مُسَوَّدَة، لا يتم تصحيحها

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Question 1: Multiple Choice Items (14 marks)

There are 14 multiple-choice items worth one mark each.
Shade in the bubble (⬭) next to the **correct** answer for each of the following items.

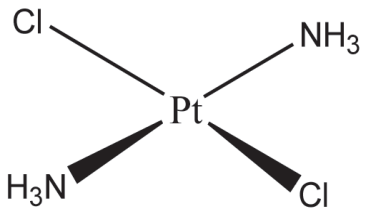
1) Which of the following statements define the term complex compounds?

- ⬭ Molecules formed by a central metal ion surrounded by one or more ligands.
- ⬭ Molecules with the same molecular formula and the same bonds between their atoms.
- ⬭ A species that contains a lone pair of electrons that form an adative bond to a central atom.
- ⬭ A species that contains metal which has a lone pair of electrons that form an adative bond to ligands.

2) Which statement is **<u>not correct</u>** about why the $[CuCl_4]^{2-}$ complex ion forms a colored solution?

- ⬭ The d orbitals split into three non-degenerated sets.
- ⬭ Part of the visible spectrum is absorbed by the solution.
- ⬭ An electron is promoted between two non-degenerated d orbitals.
- ⬭ The orbitals d_{yz}, d_{xz} and d_{xy} have a slightly higher energy than $d_{x^2 - y^2}$ and d_{z^2}.

3) Which statement describes this complex?

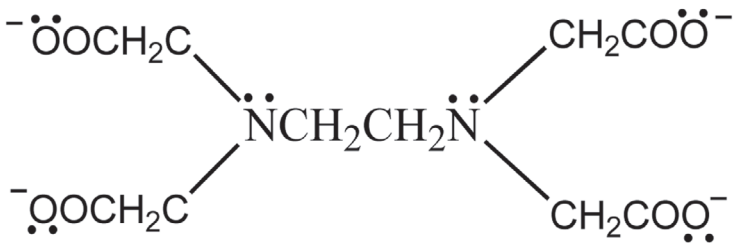


- ⬭ It is a polar complex.
- ⬭ It is a cis-platin isomer.
- ⬭ The oxidation state of Pt is zero.
- ⬭ The pull on the electrons to the metal is balanced.

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Question 1 continued

4) Which statement is **not correct** about the following ligand?



- It is a polydentate ligand.
- It forms a hexadentate chelate.
- It forms two dative bonds with the central ion.
- It has six pairs of electrons which are able to bond to a metal ion.

5) Which of the following statements is **correct** about a first order reaction?

- The rate constant is numerically equal to the reaction rate.
- The half-life is independent of the original concentration of the reactant.
- The plot of reaction rate against the concentration is a horizontal straight line.
- The reaction rate is directly proportional to the square of the reactant's concentration.

6) The rate equation for the decomposition of N_2O_5 is: Rate = $k[N_2O_5]$
The concentration of the N_2O_5, decreases from 0.40 mol dm^{-3} to 0.20 mol dm^{-3} in 100s.
How much time does it take for the concentration to change from 0.10 mol dm^{-3} to 0.025 mol dm^{-3}?

- 50s
- 100s
- 200s
- 400s

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Question 1 continued

7) Consider the reaction and the information in the table below. What is the rate equation for this reaction?

$$2ClO_2(aq) + 2OH^-(aq) \longrightarrow ClO_3^-(aq) + ClO_2^-(aq) + H_2O(l)$$

Experiment	$[ClO_2]$ / mol dm^{-3}	$[OH^-]$ / mol dm^{-3}	Initial rate of reaction / mol dm^{-3} s^{-1}
1	x	x	0.0575
2	$2x$	$2x$	0.460
3	x	$2x$	0.115

- ○ Rate = $k[ClO_2][OH^-]$
- ○ Rate = $k[ClO_2][OH^-]^2$
- ○ Rate = $k[ClO_2]^2[OH^-]$
- ○ Rate = $k[ClO_2]^2[OH^-]^2$

8) Which of the following statements is **correct** if a reaction is endothermic and has a negative entropy change?

- ○ $\Delta G^\ominus$ is always positive.
- ○ $\Delta G^\ominus$ is always negative.
- ○ $\Delta G^\ominus$ is negative above a certain temperature only.
- ○ $\Delta G^\ominus$ is negative below a certain temperature only.

9) Which option is **correct** about the following reaction?

$$MgO(s) + CO_2(g) \longrightarrow MgCO_3(s)$$

	$\Delta S^\ominus_{system}$	Randomness
○	–	decrease
○	+	decrease
○	–	increase
○	+	increase

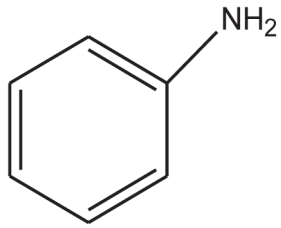
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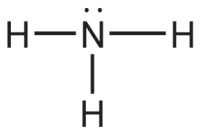
Question 1 continued

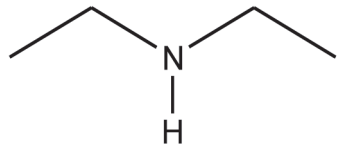
10) Which of the following reactions shows a **decrease** in the standard entropy change, $\Delta S^{\ominus}_{system}$?

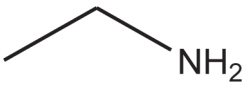
- ○ $H_2O(s) \longrightarrow H_2O(g)$
- ○ $C_6H_{14}(g) \longrightarrow C_6H_{14}(l)$
- ○ $KCl(s) \longrightarrow K^+(aq) + Cl^-(aq)$
- ○ $2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$

11) Which of the following compounds is the weakest base?

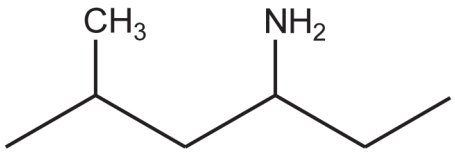
- ○ 

- ○ 

- ○ 

- ○ 

12) How can the following compound be prepared?



- ○ Reacting acyl chloride with an amide.
- ○ Reacting acyl chloride with ammonia.
- ○ Reacting bromoalkane with excess ammonia.
- ○ Reacting bromoalkene with excess ammonia.

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Question 1 continued

13) Which one of the following structures represents an amide?

- ⬭ $CH_3CH_2CH_2NH_2$
- ⬭ $CH_3CH_2CH_2CONH_2$
- ⬭ $CH_3CH_2CH_2CH_2CN$
- ⬭ $CH_3CH_2CH_2CH_2COOH$

14) Which pair of compounds will form $(C_3H_7)_2NH$ when they react with each other under pressure in hot ethanol?

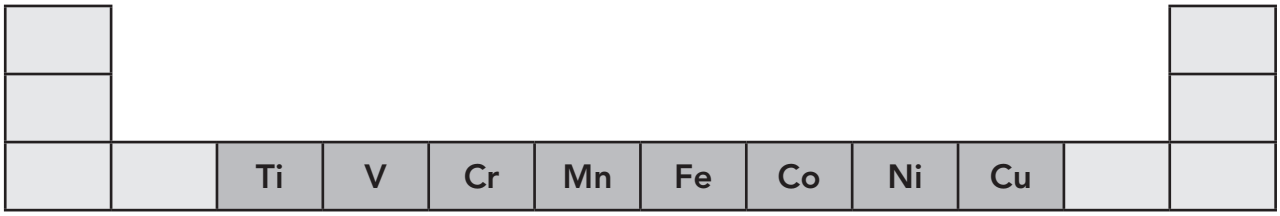
	Compound pair
⬭	$CH_3CH_2NH_2$ and CH_3Br
⬭	CH_3NH_2 and CH_3CH_2Br
⬭	$CH_3CH_2CH_2NH_2$ and NH_3
⬭	$CH_3CH_2CH_2NH_2$ and $CH_3CH_2CH_2Br$

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Question 2: Extended Responses (56 marks)

Write your answer for each of the following questions in the space provided.
Be sure to show all your work, including the correct units where applicable.

15) The figure below shows part of d-block elements. Use it to answer the following questions.



a. What is the scientific term of d-block elements which form one or more stable ions with incomplete d orbitals?

_____ [1]

b. State two chemical properties of these elements.

_____

_____ [2]

c. State the electronic configuration of **Ti** element.

_____ [1]

d. These elements have different oxidation states. Explain.

_____ [1]

16) **a.** Complete the following table that shows some information about complex ions:

Complex ion	Central metal ion	Ligands	Shape of complex
$[Au(NH_3)_2]^+$	Au^+	NH_3	_____
$[Fe(EDTA)]^{2-}$	_____	$EDTA^{4-}$	Octahedral
_____	Co^{3+}	$C_2O_4^{2-}$	Octahedral

[3]

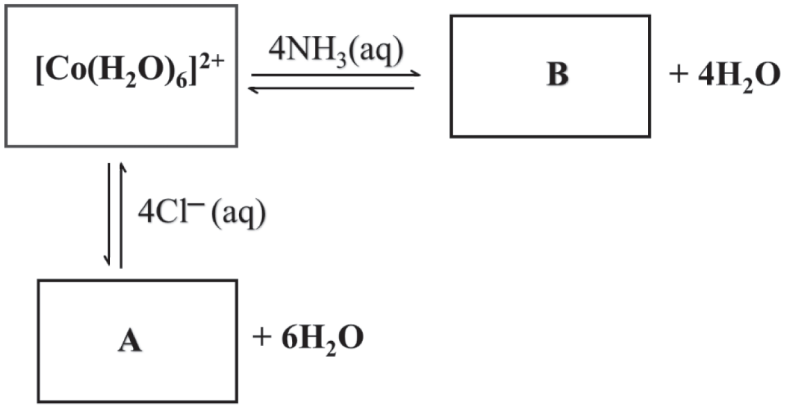
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Question 2 continued

b. Study the following diagram, then answer the questions below.



(i) What is the shape of the complex ion **A**?

_____ [1]

(ii) Write the formula of the complex ion **B**.

_____ [1]

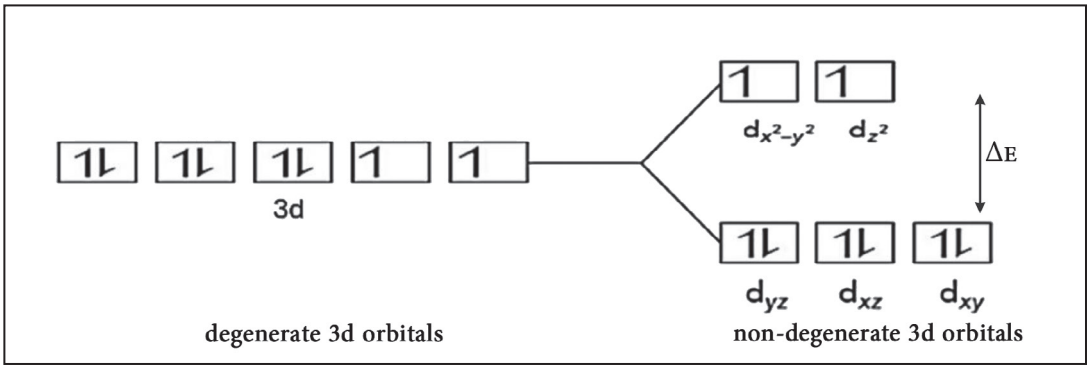
(iii) Draw the 3D shape of the complex ion **B** including its charge.

[2]

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Question 2 continued

17) The following diagram shows the splitting of 3d orbitals in a complex ion.



a. Define the term degenerated d orbitals.

_____

_____ [1]

b. **(i)** What is the **metal ion** in this complex?

_____ [1]

(ii) Write the formula of a complex formed between this metal ion and water?

_____ [1]

c. Sketch the shape of the $\mathbf{d_{z^2}}$ orbital.

[1]

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Question 2 continued

18) a. Explain the following terms:

(i) Rate equation.

_____

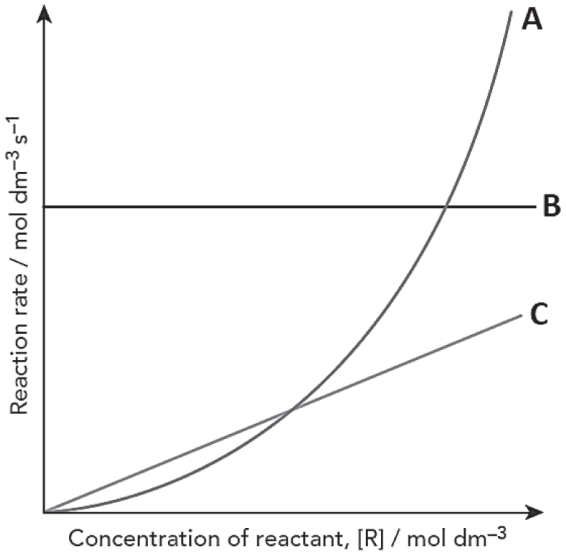
_____ [1]

(ii) Homogeneous catalysis.

_____

_____ [1]

b. The graph below shows the reaction rate against the concentration of reactants for three reactions **A**, **B** and **C**:



(i) Which reaction has a rate independent of the concentration of the reactant?

_____ [1]

(ii) Which one is a second order reaction?

_____ [1]

(iii) Reaction **C** has a half-life of 1500 sec. Calculate the rate constant of this reaction.

_____

_____ [1]

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Question 2 continued

19) a. For the reaction:

$$2ClO_2(g) + F_2(g) \longrightarrow 2ClO_2F(g)$$

The following experimental data was obtained at 25°C.

Experiment	$[ClO_2]$ / mol dm^{-3}	$[F_2]$ / mol dm^{-3}	Initial rate of reaction / mol dm^{-3} s^{-1}
1	0.010	0.10	2.4×10^{-3}
2	0.010	0.40	9.6×10^{-3}
3	0.020	0.40	19.2×10^{-3}

Use the data in the table to:

(i) Deduce the order of the reaction with respect to:

ClO_2: _____ [1]

F_2: _____ [1]

(ii) What is the overall order of this reaction?

_____ [1]

(iii) Write the rate equation for this reaction.

_____ [1]

(iv) How does the value of the rate of this reaction change when the temperature is increased to 35°C?

_____ [1]

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Question 2 continued

b. The hydrolysis of methyl propanoate was studied in acidic conditions at 25°C and the rate equation was found to be:

rate = $k[CH_3CH_2COOCH_3][H^+]$

Use the data below to calculate the value of the **rate constant** and give the **unit**.

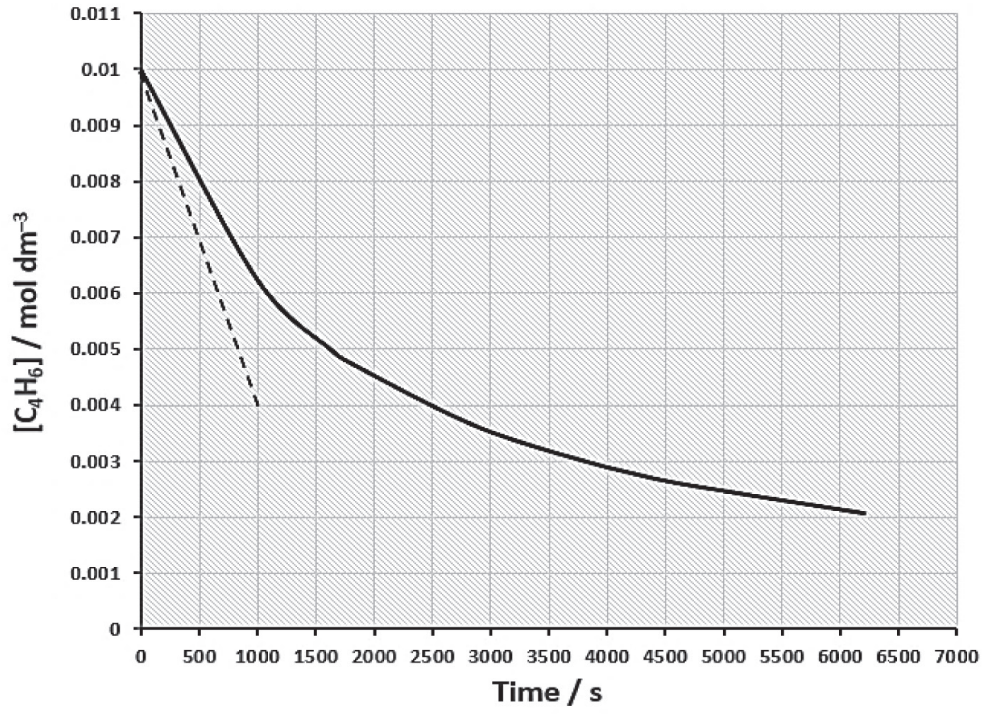
$[CH_3CH_2COOCH_3]$ / mol dm^{-3}	$[H^+]$ / mol dm^{-3}	Initial rate of reaction / mol dm^{-3} s^{-1}
0.30	0.50	2.1×10^{-4}

[2]

20) For the following equation:

$$2C_4H_6(g) \longrightarrow C_8H_{12}(g)$$

The graph below shows the concentration of butadiene against time for this reaction at a given temperature.



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Question 2 continued

a. **Label** the first half-life for this reaction on the curve above? [1]

b. Use the tangent drawn to calculate the initial rate using the points at t = 0 and t = 1000 s.

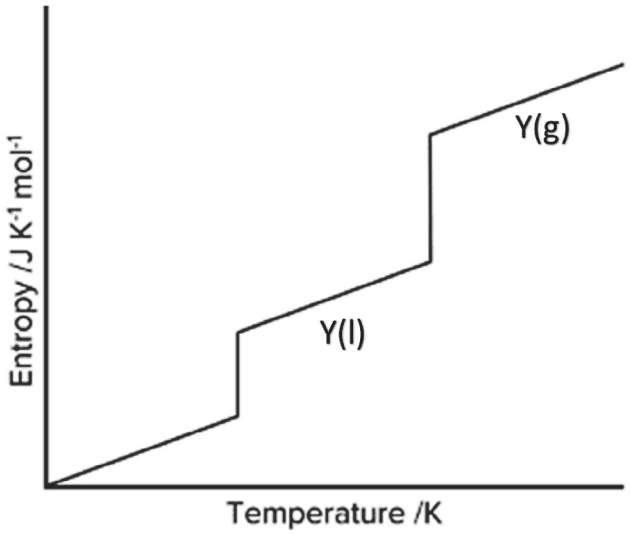
_____

_____ [1]

c. Explain how the given graph is consistent with the reaction being second order with respect to butadiene.

_____ [1]

21) The figure below shows the change in entropy of a molecular substance (Y) that varies with temperature:



a. Explain, in terms of molecules:

(i) The entropy is zero when the temperature is **zero** Kelvin.

_____

_____ [1]

(ii) The gradual increase in entropy going from Y(l) to Y(g) as the temperature increases.

_____

_____ [1]

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Question 2 continued

22) Use the reactions and the data in the table shown below to answer the questions.

Compound	CaO(s)	CO_2(g)	P(s)	O_2(g)	P_4O_{10}(s)
$S^{\ominus}$ / J K^{-1} mol^{-1}	39.7	213.6	41.10	205.0	228.9

For Reaction 1

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$, $\Delta H_r^{\ominus} = +176$ KJ mol^{-1}, $\Delta S^{\ominus}_{system} = +160.4$ J K^{-1} mol^{-1}

a. Calculate the standard entropy $S^{\ominus}$ of $CaCO_3$ at 298 K. Show all your work.

[2]

b. Write an expression showing the relationship between Gibbs free energy, ΔG, enthalpy change, Δ*H* and entropy changes, ΔS.

[1]

c. Calculate the temperature at which the change in Gibbs free energy of this reaction is **zero**. Show all your work.

[2]

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Question 2 continued

d. If the temperature of the reaction is higher than the calculated temperature in part **c**, use the terms of Gibbs equation to explain how this will affect the feasibility of the reaction.

[2]

For Reaction 2

$4P(s) + 5O_2(g) \longrightarrow P_4O_{10}(s)$, $\Delta H_r^{\ominus} = -2984.0$ KJ mol^{-1}, $\Delta S^{\ominus}_{system} = -960.5$ J K^{-1} mol^{-1}

e. Explain the difference in the $S^{\ominus}$ values between P(s) and $P_4O_{10}(s)$.

[1]

f. Calculate the Gibbs free energy change $\Delta G^{\ominus}$ in **kJ mol^{-1}** for the reaction at 298 K. Show all your work.

[2]

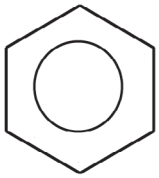
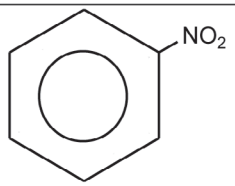
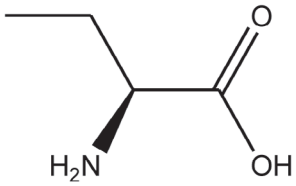
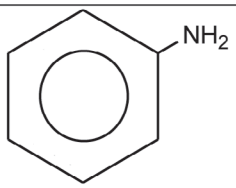
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Question 2 continued

23) Use the following table to answer the questions below:

$Br_2(aq)$ A	 B	 C
C_3H_7COCl D	 E	 F

a. Classify the amine compound (**F**).

_____ [1]

b. State the type of reaction of preparing compound (**C**) from compound (**B**).

_____ [1]

c. What is the name of the nitrogen functional group in compound (**E**).

_____ [1]

d. Draw the following structural formulae:

(i) The organic product of reacting compound (**F**) with 3 moles of (**A**) at room temperature.

[1]

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Question 2 continued

(ii) The organic product of reacting compound (**F**) with compound (**D**).

[1]

e. Draw the following structural formulae:

(i) The zwitterion of compound (**E**).

[1]

(ii) The dipeptide formed from two molecules of compound (**E**).

[1]

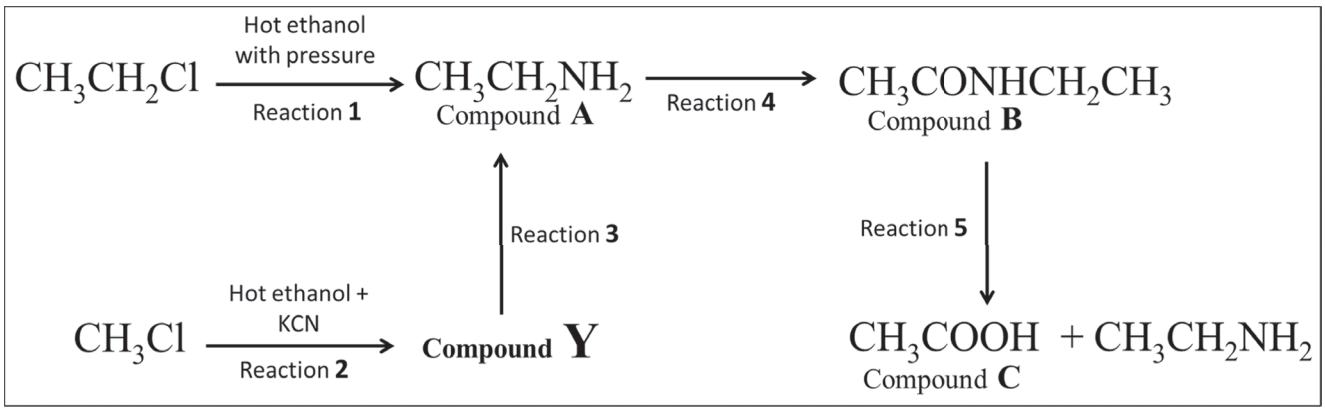
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Question 2 continued

24) A complete reaction scheme is shown below:



a. State the necessary reagent needed in Reaction **1**.

_____ [1]

b. Compound (**A**) can be produced in a two-step reaction from CH_3Cl.
Draw the structure of compound (**Y**).

[1]

c. What is a suitable medium needed for Reaction **5**?

_____ [1]

d. What is the organic product when $LiAlH_4$ is added to compound (**B**)?

_____ [1]

e. Compare between compounds (**A** and **B**) according to their basicity. Explain your answer.

_____

_____

_____ [2]

[End of the Examination]

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Periodic Table

Atomic number — Element symbol — Mass number

1 H 1.01																	2 He 4.00
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 40.00
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La*	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226	89 Ac (227)															

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa (231)	92 U 238	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

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MARKING GUIDE

GENERAL EDUCATION DIPLOMA

BILINGUAL PRIVATE SCHOOLS

SEMESTER TWO - FIRST SESSION

CHEMISTRY

2024 / 2025

Exam Specification for Chemistry (Grade 12 - Bilingual) – Semester two (2024/2025)

Topic of the Units	Weighting %	Multiple Choice (20%)					Extended Response (80%)					Total Mark
		No. of Questions	Marks	Cognitive Levels			No. of Questions	Marks	Cognitive Levels			
				Knowing (30%)	Applying (50%)	Reasoning (20%)			Knowing (30%)	Applying (50%)	Reasoning (20%)	
Chemistry of transition elements	29%	14	4	1	2	1	10	16	6	7	3	20
Quantitative kinetics	26%		3	1	1	1		15	4	8	3	18
Entropy and Gibbs free energy	21%		3	1	2	-		12	3	7	2	15
Nitrogen compounds	24%		4	1	2	1		13	4	6	3	17
Total	100%		14	4	7	3		56	17	28	11	70

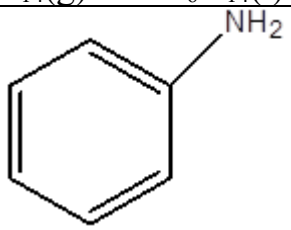
Distribution of cognitive domains and marks.

Serial No	Question number	Item	Mark	Unit	Cognitive domain	Output
1	1	1	1	Chemistry of transition elements	Knowing	5.2.d
2	1	2	1	Chemistry of transition elements	Application	5.3.d
3	1	3	1	Chemistry of transition elements	Application	5.2.g
4	1	4	1	Chemistry of transition elements	Reasoning	5.2.ciii
5	1	5	1	Quantitative Kinetics	Knowing	6.1.i
6	1	6	1	Quantitative Kinetics	Application	6.1.k
7	1	7	1	Quantitative Kinetics	Reasoning	6.1.g
8	1	8	1	Entropy and Gibbs free energy	Knowing	7.2.a
9	1	9	1	Entropy and Gibbs free energy	Applying	7.1.b
10	1	10	1	Entropy and Gibbs free energy	Applying	7.1.bi
11	1	11	1	Nitrogen Compounds	Knowing	8.2c
12	1	12	1	Nitrogen Compounds	Application	8.1b,c
13	1	13	1	Nitrogen Compounds	Application	8.3a
14	1	14	1	Nitrogen Compounds	Reasoning	8.1cii
15	2	15.a	1	Chemistry of transition elements	Knowing	5.1.a
16	2	15.b	2	Chemistry of transition elements	Knowing	5.1.b
17	2	15.c	1	Chemistry of transition elements	Applying	5.1.c
18	2	15.d	1	Chemistry of transition elements	Knowing	5.1.b.i
19	2	16. a	3	Chemistry of transition elements	Applying	5.2.c
20	2	16 b.i	1	Chemistry of transition elements	Applying	5.2.f
21	2	16 b.ii	1	Chemistry of transition elements	Applying	5.2.j
22	2	16 b.iii	2	Chemistry of transition elements	Applying/ Reasoning	5.2.f
23	2	17.a	1	Chemistry of transition elements	Knowing	5.3.a
24	2	17.bi +17.bii	2	Chemistry of transition elements	Reasoning	5.2.i
25	2	17.c	1	Chemistry of transition elements	Knowing	5.3.b
26	2	18.a.i	1	Quantitative Kinetics	Knowing	6.1.a,b
27	2	18.a.ii	1	Quantitative Kinetics	Knowing	6.2.a
28	2	18.b.i	1	Quantitative Kinetics	Knowing	6.1.e
29	2	18.b.ii	1	Quantitative Kinetics	Knowing	6.1.e
30	2	18.b.iii	1	Quantitative Kinetics	Application	6.1.l.ii
31	2	19.a.i	2	Quantitative Kinetics	Reasoning	6.1.d
32	2	19.a.ii	1	Quantitative Kinetics	Application	6.1.a
33	2	19.a.iii	1	Quantitative Kinetics	Application	6.1.g
34	2	19.a.iv	1	Quantitative Kinetics	Application	6.1.m
35	2	19.b	2	Quantitative Kinetics	Application	6.1.l,h

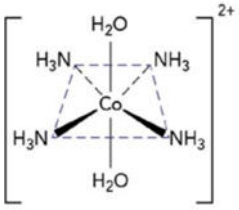
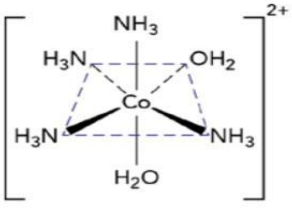
36	2	20.a	1	Quantitative Kinetics	Application	6.1.e
37	2	20.b	1	Quantitative Kinetics	Application	6.1.f
38	2	20.c	1	Quantitative Kinetics	Reasoning	6.1.d
39	2	21.a.i	1	Entropy and Gibbs free energy	Knowing	7.1.b
40	2	21.a.ii	1	Entropy and Gibbs free energy	Knowing	7.1.b
41	2	22.a	2	Entropy and Gibbs free energy	Applying	7.1.c
42	2	22.b	1	Entropy and Gibbs free energy	Knowing	7.2.a
43	2	22.c	2	Entropy and Gibbs free energy	Applying	7.2.b
44	2	22.d	2	Entropy and Gibbs free energy	Reasoning	7.2.d
45	2	22.e	1	Entropy and Gibbs free energy	Applying	7.1.b
46	2	22.f	2	Entropy and Gibbs free energy	Applying	7.2.b
47	2	23.a	1	Nitrogen Compounds	Knowing	8.1a
48	2	23.b	1	Nitrogen Compounds	Knowing	8.2a
49	2	23.c	1	Nitrogen Compounds	knowing	8.4a
50	2	23.di	1	Nitrogen Compounds	Applying	8.2b i
51	2	23.dii	1	Nitrogen Compounds	Applying	8.3b ii
52	2	23.ei	1	Nitrogen Compounds	Reasoning	8.4c
53	2	23.eii	1	Nitrogen Compounds	Applying	8.4e
54	2	24.a	1	Nitrogen Compounds	Knowing	8.1c i
55	2	24.b	1	Nitrogen Compounds	Applying	8.1 c iv
56	2	24.c	1	Nitrogen Compounds	Applying	8.3c i
57	2	24.d	1	Nitrogen Compounds	Applying	8.3c ii
58	2	24.e	2	Nitrogen Compounds	Reasoning	8.3 d

TOTAL PAGES: 7
MARKS: 70
Question One (14 Marks)

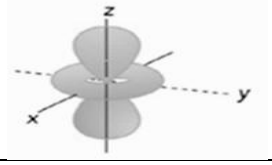
There are 14 multiple-choice items. Each correct answer is worth ONE mark.

Item	Correct option	
1	**A**	Molecules formed by a central metal atom surrounded by one or more ligands
2	**A**	The d orbitals split into three non-degenerated sets.
3	**D**	The pull on the electrons to the metal is balanced.
4	**C**	It forms two dative bonds with the central ion.
5	**B**	The half-life is independent of the original concentration of the reactant.
6	**C**	200 s
7	**B**	Rate = $K[ClO_2]^2[OH^-]$
8	**A**	$\Delta G^{\ominus}$ is always positive.
9	**A**	— , decrease
10	**B**	$C_6H_{14}(g) \rightarrow C_6H_{14}(l)$
11	**A**	
12	**C**	Reacting bromoalkane with excess ammonia
13	**B**	$CH_3CH_2CH_2CONH_2$
14	**D**	$CH_3CH_2CH_2NH_2$ and $CH_3CH_2CH_2Br$

Question Two (56 Marks)

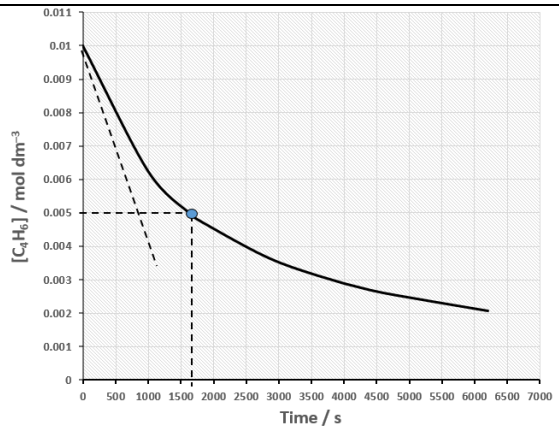
Part	Section	The answer	The mark
15	a	Transition metal **Or** Transition element	1
	b	1. Variable oxidation states. 2. Behave as catalysts. (Accept any 2 correct answers) 3. Form complex ions. 4- Form colored compounds	2
	c	*(Ti): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$* **Or** *(Ti): [Ar] $3d^2\ 4s^2$*	1
	d	The similarity in the energy of the 3d and 4s atomic orbitals. **Or** The difference in energy between 4s and 3d is very small. **Or** they can form one or more stable ions. **Or** they lose electrons of 4s and some or all electrons of 3d.	1
16	a	<table><tr><th>Complex ion</th><th>Central metal ion</th><th>Ligands</th><th>Shape of complex</th></tr><tr><td></td><td></td><td></td><td>Linear</td></tr><tr><td></td><td>Fe^{2+}</td><td></td><td></td></tr><tr><td>$[Co(ox)_3]^{3-}$ Or $[Co(C_2O_4)_3]^{3-}$</td><td></td><td></td><td></td></tr></table> 1 mark for each. (Accept: central ion has the correct charge) (Don't accept: central ion without a charge)	3
16	b.i	Tetrahedral	1
	b.ii	$[Co(NH_3)_4(H_2O)_2]^{2+}$	1
	b.iii	 **Or**  1 mark for the shape, 1 mark for the charge. (Accept: any other shape that shows the correct answer)	2

Question Two Continued. **2**

Part	Section	The answer	The mark
17	a	Atomic orbitals in the same energy level in a given sub- shell.	1
	b i	Ni^{+2}	1
	b ii	$[Ni(H_2O)_6]^{2+}$	1
	c		1

Part	Section	The answer	The mark
18	a.i	Rate equation: an equation showing the relationship between the rate constant and the concentrations of the species that affects the rate of reaction.	1
	a.ii	Homogeneous catalysis: the type of catalysis in which the catalyst and reactants are in the same phase. (Accept: any correct answer)	1
	b.i	**B**	1
	b.ii	**A**	1
	b.iii	k=0.693/ $t_{1/2}$= 0.693/ 1500 s = $4.62 \times 10^{-4}\ s^{-1}$	1
19	a.i	ClO_2 : first order **or** 1st F_2 : first order **or** 1st (1mark each)	2
	a.ii	Second order reaction **or** 2nd	1
	a.iii	Rate = $k[ClO_2][F_2]$	1
	a.iv	Since the temperature increased by 10 °C, so the rate of reaction approximately doubles. **Or** The rate increases as the temperature increases.	1
	b	$k = 2.1 \times 10^{-4}/(0.30)(0.50) = 1.4 \times 10^{-3}\ mol^{-1}\ dm^3\ s^{-1}$ (1mark for the value, 1mark for the unit)	2

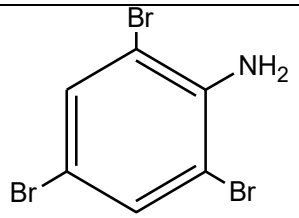
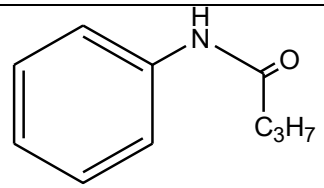
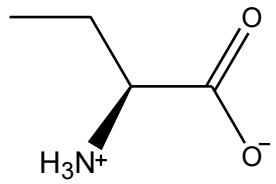
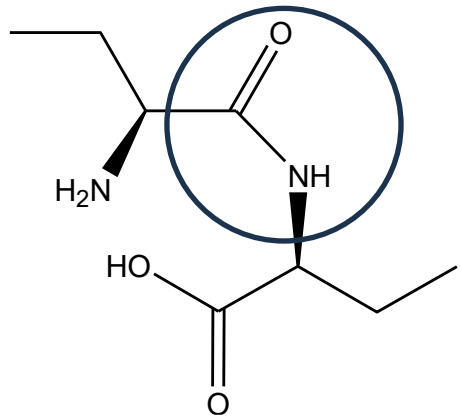
Question Two Continued

Part	Section	The answer	The mark
20	a		1
	b	initial rate= 0.004 — 0.01/1000 — 0 = $\underline{6.0 \times 10^{-6}}$ mol dm^{-3} s^{-1}	1
	c	The graph is a steeper curve going downwards. **Or** The concentration of the reactant decreases more steeply with time. **Or** The reaction has successive half-lives which increase with time.	1

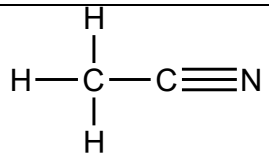
Part	Section	The answer	The mark
21	a.i	At 0K the particles are stationary **or** not vibrating and would have zero energy , or no collisions, or no kinetic energy, disorder decrease	1
	a.ii	Increasing the temperature of Y(l) increases the disorder **or** vibration of particles, **or** changes in the state, **or** increase in kinetic energy, **or** decrease in activation energy E_a	1
22	a	$\Delta S^\ominus = \Sigma S^\ominus$ (products) – $\Sigma S^\ominus$ (reactants) $\Delta S^\ominus_{system} = S^\ominus[CO_2(g)] + S^\ominus[CaO(s)] - S^\ominus[CaCO_3(s)]$ $S^\ominus[CaCO_3(s)] = S^\ominus[CO_2(g)] + S^\ominus[CaO(s)] - \Delta S^\ominus_{system}$ $= (213.6 + 39.7) - (+160.4)$ $= \underline{92.9\ \mathbf{J\ K^{-1}\ mol^{-1}}}$	1 1
	b	$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$	1
	c	$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$ $0 = +176 - (T \times (+0.1604))$ $\underline{= 1097\ \mathbf{K}}$	1 1

	d	The second term of the equation **or** (– $T\Delta S^{\ominus}$) becomes negative enough to overcome the positive value of $\Delta H^{\ominus}$ and so the reaction becomes spontaneous	1 1
	e	Number of atoms of P is less than the number of atoms of P_4O_{10}	1
	f	$\Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus}$ $= -2984.0 - (298 \times -960.5/1000)$ $= -2697.8\ kJ\ mol^{-1}$	1 1

Question Two Continued

Part	Section	The answer	The mark
23	a	Primary amine	1
	b	Nitration **or** electrophilic substitution	1
	c	Amino acid	1
	d. i		1
	d. ii		1
	e .i		1
	e. ii	 Must draw the correct <u>amide bond</u> formed.	1

Question Two Continued

Part	***Section***	***The answer***	***The mark***
24	a	Ammonia (NH_3)	1
	b	 **Or** CH_3CN	1
	c	Acidic **or** with HCl **or** H^+	1
	d	$CH_3CH_2NHCH_2CH_3$ Or: diethylamine Or: N,N-diethylamine	1
	e	A more basic than B **or** B less basic than A (1mark) Because amides are neutral and the presence of electron-withdrawing O atom in amides means less available lone pair in N. (1mark) Or: The donating group in the amine increases the electron density on N and makes it more available to donate e- to H^+	2

This is the end of the Marking Guide





امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)

الفصل الدراسي الثاني- الدور الثاني

للعام الدراسي ١٤٤٦ - ١٤٤٧ هـ - ٢٠٢٤ / ٢٠٢٥ م

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٦) صفحة.
- زمن الإجابة: ثلاث ساعات.
- الإجابة في الورقة نفسها.

تعليمات مهمة:

- يجب الحضور إلى قاعة الامتحان قبل عشر دقائق على الأقل من بدء زمن الامتحان.
- يجب إحضار أصل ما يثبت الهوية وإبرازها للعاملين بالامتحانات.
- يجب الالتزام بالزي (الدشداشة البيضاء والمصر أو الكمة للذكور) والزي المدرسي للطالبات ، ويستثنى من ذلك الدارسون من غير العمانيين بشرط الالتزام بالذوق العام، ويمنع على جميع المتقدمات ارتداء النقاب داخل المركز وقاعات الامتحان.
- يحظر على الممتحنين اصطحاب الهواتف النقالة وأجهزة النداء الآلي وآلات التصوير والحواسيب الشخصية والساعات الرقمية الذكية والآلات الحاسبة ذات الصفة التخزينية والمجلات والصحف والكتب الدراسية والدفاتر والمذكرات والحقائب اليدوية والآلات الحادة أو الأسلحة أياً كان نوعها وأي شيء له علاقة بالامتحان.
- يجب على الممتحن الامتثال لإجراءات التفتيش داخل المركز طوال أيام الامتحان.
- يجب على الممتحن التأكد من استلام دفتر امتحانه، مغلفاً بغلاف بلاستيكي شفاف وغير ممزق ، وهو مسؤول عنه حتى يسلمه لمراقبي اللجنة بعد الانتهاء من الإجابة.
- يجب الالتزام بضوابط إدارة امتحانات دبلوم التعليم العام وما في مستواه وأية مخالفة لهذه الضوابط تعرضك للتدابير والإجراءات والعقوبات المنصوص عليها بالقرار الوزاري رقم ٥٨٨ / ٢٠١٥.
- يقوم المتقدم بالإجابة عن أسئلة الامتحان المقالية بقلم الحبر (الأزرق أو الأسود).
- يقوم المتقدم بالإجابة عن أسئلة الاختيار من متعدد بتظليل الشكل (▭) وفق النموذج الآتي:

س – عاصمة سلطنة عمان هي:

▭ القاهرة ▭ الدوحة

■ مسقط ▭ أبوظبي

ملاحظة: يتم تظليل الشكل (■) باستخدام القلم الرصاص وعند الخطأ، امسح بعناية لإجراء التغيير.

صحيح ■ **غير صحيح** ▭ ◉ ◒ ☒ ☑

مُسَوَّدَة، لا يتم تصحيحها

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Question 1: Multiple Choice Items (14 marks)

There are 14 multiple-choice items worth one mark each.
Shade in the bubble (○) next to the **correct** answer for each of the following items.

1) Which of the following statements is **not correct** about transition elements?

- ○ All of them are metals.
- ○ They behave as catalysts.
- ○ Their atoms tend to gain electrons.
- ○ They have variable oxidation states.

2) Which option is **correct** about the complex $\mathbf{Cu(OH)_2(H_2O)_4}$?

	Charge of central metal ion	Co-ordination number	Shape of complex
○	0	4	Square planner
○	+1	2	Linear
○	+2	6	Octahedral
○	+2	6	Tetrahedral

3) Which one of the following complex ions represents **A**?

$$[Cu(OH)_2(H_2O)_4](s) + 2H_2O(l) \rightleftharpoons^{2OH^-(aq)} \boxed{A} \rightleftharpoons^{4NH_3(aq)} [Cu(NH_3)_4(H_2O)_2]^{2+}(aq) + 4H_2O(l)$$

- ○ $[Cu(H_2O)_4]^+$
- ○ $[Cu(H_2O)_4]^{2+}$
- ○ $[Cu(H_2O)_6]^+$
- ○ $[Cu(H_2O)_6]^{2+}$

4) What is the charge x of the complex ion $\mathbf{[Co(NH_3)_6]^x}$ if the electronic configuration of the metal ion in the complex is: $[Ar]3d^6$?

- ○ +2
- ○ +3
- ○ –2
- ○ –3

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Question 1 continued

5) Which one of the following options is **correct** about a zero-order reaction?

	Rate equation	Successive half lives
☐	rate = k	decrease with time
☐	rate = k	increase with time
☐	rate = k[reactant]	decrease with time
☐	rate = k[reactant]	increase with time

6) The rate equation for the reaction below is: rate = $k[H_2][I_2]$

$$\mathbf{H_2(g) + I_2(g) \longrightarrow 2HI(g)}$$

What will be the rate constant if the concentration of I_2 is increased from (0.10 to 0.30) mol dm^{-3}, keeping the concentration of H_2 and the other conditions constant?

☐ $k/3$ ☐ k

☐ $3k$ ☐ $9k$

7) The rate of reaction between compounds **A** and **B** was studied at a fixed temperature as shown in the table below. Which one of the following is the rate equation for this reaction?

Experiment	[**A**] / mol dm^{-3}	[**B**] / mol dm^{-3}	Initial rate of reaction / mol dm^{-3} s^{-1}
1	0.10	0.10	x
2	0.10	0.20	$2x$
3	0.20	0.20	$4x$

☐ Rate = $k[\mathbf{A}][\mathbf{B}]$ ☐ Rate = $k[\mathbf{A}][\mathbf{B}]^2$

☐ Rate = $k[\mathbf{A}]^2[\mathbf{B}]$ ☐ Rate = $k[\mathbf{A}]^2[\mathbf{B}]^2$

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Question 1 continued

8) Which of the following orders is **correct** in increasing $S^{\ominus}$?

- ☐ $H_2O(l) < H_2O(g) < H_2O(s)$
- ☐ $H_2O(l) < H_2O(s) < H_2O(g)$
- ☐ $H_2O(g) < H_2O(l) < H_2O(s)$
- ☐ $H_2O(s) < H_2O(l) < H_2O(g)$

9) Which one of the following options is **not correct** about the reaction below at 298 K?

$$N_2O(g) \longrightarrow N_2(g) + \frac{1}{2} O_2(g) \quad \Delta S^{\ominus}_{system} = +74.4\ J\,K^{-1}\,mol^{-1}, \Delta H^{\ominus} = -82.0\ KJ\,mol^{-1}$$

- ☐ This reaction is not feasible.
- ☐ The $\Delta G^{\ominus}$ sign of this reaction is negative.
- ☐ The $\Delta S^{\ominus}_{system}$ value shows an increase in the randomness.
- ☐ The $S^{\ominus}$ of the reactant is less than the $S^{\ominus}$ of the products.

10) What is the standard entropy, $S^{\ominus}$ in ($J\,K^{-1}\ mol^{-1}$) of MgO at 298 K in the following reaction?

$$2MgO(s) \longrightarrow 2Mg(s) + O_2(g)\ ,\ \Delta S^{\ominus}_{system} = +216.70\ J\ K^{-1}\ mol^{-1}$$

The standard entropy values are:

$S^{\ominus}[Mg(s)] = 32.70\ J\ K^{-1}\ mol^{-1}$

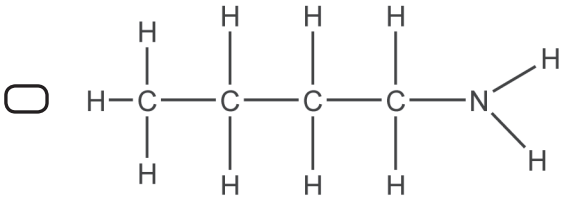
$S^{\ominus}[O_2(g)] = 204.90\ J\ K^{-1}\ mol^{-1}$

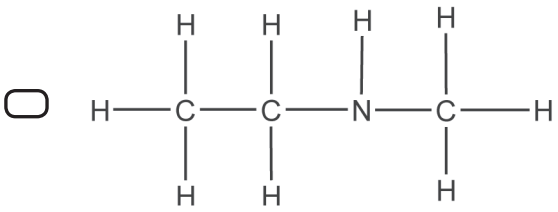
- ☐ 10.5
- ☐ 26.8
- ☐ 53.6
- ☐ 163.1

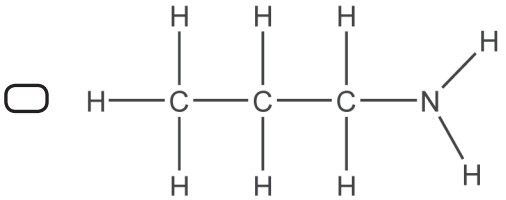
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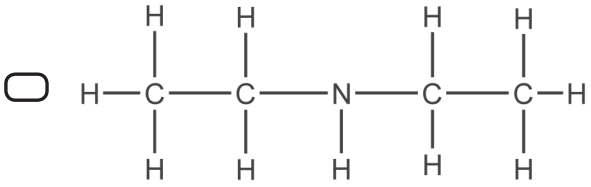
Question 1 continued

11) Which one of the following is the displayed formula for propylamine?









12) For the reaction: $\mathbf{CH_3CH_2Cl} \xrightarrow[\textbf{hot ethanol, pressure}]{\textbf{excess } \mathbf{NH_3}} \mathbf{Y}$

Which one of the following compounds represents **Y**?

- $CH_3CH_2NH_2$
- $(CH_3CH_2)_2NH$
- $(CH_3CH_2)_3N$
- $(CH_3CH_2)_4N^+$

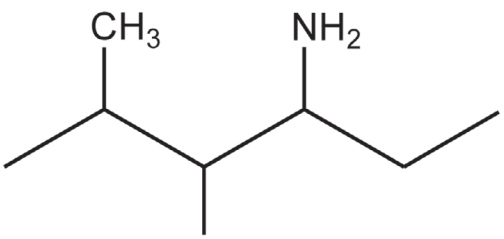
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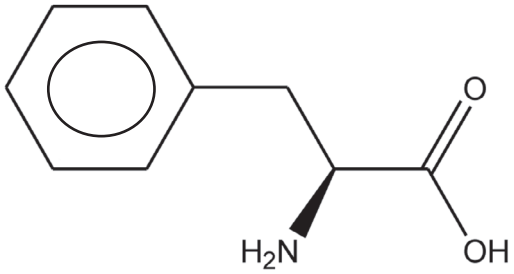
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Question 1 continued

13) Which one of the following options is correct about the nitrogen functional group in each compound?



Compound 1



Compound 2

	Compound 1	Compound 2
☐	Amide	Amide
☐	Amine	Amine
☐	Amide	Amino acid
☐	Amine	Amino acid

14) What is the product of reacting $\mathbf{(CH_3)_2CHNH_2}$ and $\mathbf{C_3H_7Br}$ with each other under pressure in hot ethanol?

- ☐ $CH_3CH_2NHCH_2CH_2CH_3$
- ☐ $(CH_3)_2CHNHCH_2CH_2CH_3$
- ☐ $CH_3CH_2CH_2NHCH_2CH_2CH_3$
- ☐ $CH_3CH_2CH_2CH_2CH_2CH_2NH_2$

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Question 2: Extended Responses (56 marks)

Write your answer for each of the following questions in the space provided.
Be sure to show all your work, including the correct units where applicable.

15) **a.** **Define** the following terms:

(i) Complex ion.

_____ [1]

(ii) Coordination number.

_____ [1]

(iii) Monodentate ligand.

_____ [1]

b. For the complex ion $[Ni(CN)_2(Cl)_2]^{2-}$:

(i) **Draw** the 3D shape of the **polar** geometric isomer.

[2]

(ii) Complete the following equation.

$$[Co(H_2O)_6]^{2+}(aq) + 2OH^-(aq) \longrightarrow \boxed{\qquad\qquad} + 2H_2O(1)$$

[1]

16) The following table shows different ions and complex ions. Use it to answer the following questions:

Ions	Ti^{3+}	V^{5+}	Mn^{2+}	Zn^{2+}
Complex ions	$[CoCl_4]^{2-}$	$[Cr(OH)_6]^{3-}$	$[Co(C_2O_4)_3]^{3-}$	$[Fe(OH)_6]^{3-}$

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Question 2 continued

a. Which complex ion has a bidentate ligand?

_____ [1]

b. Write the formula of a complex ion formed between $\mathbf{Ti^{3+}}$ and $\mathbf{(EDTA)^{4-}}$.

_____ [1]

c. What is the oxidation number of the metal in $\mathbf{[Fe(OH)_6]^{3-}}$ complex ion.

_____ [1]

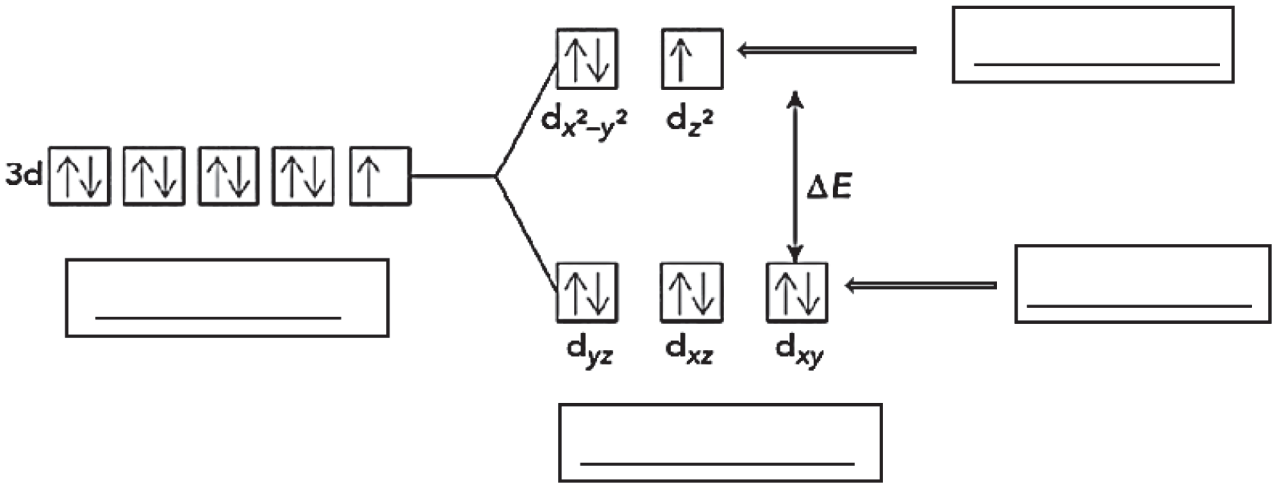
d. Write the electronic configuration of $\mathbf{Mn^{2+}}$.

_____ [1]

e. Which ion will form a colourless solution in its complexes?

_____ [1]

17) The following diagram shows the splitting of 3d orbitals in a complex ion.



a. Label the diagram using these words:

High energy level	degenerated orbitals
Low energy level	non-degenerated orbitals

[2]

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Question 2 continued

b. What is the shape of this complex?

_____ [1]

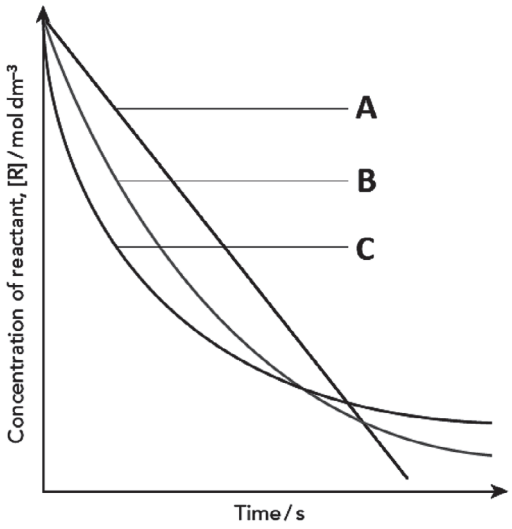
c. What is the metal ion in this complex?

_____ [1]

d. Sketch the shape of a $\mathbf{3d_{xy}}$ orbital.

[1]

18) The graph below shows the concentration of the reactant against time for three reactions **(A)**, **(B)** and **(C)**:



a. Which reaction has a half-life independent of the original concentration of the reactants?

_____ [1]

b. Which one is a second order reaction?

_____ [1]

c. Reaction **(B)** has a rate constant of $5.5 \times 10^{-4}\ s^{-1}$. Calculate the half-life of this reaction.

_____

_____ [1]

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Question 2 continued

19) a. The initial rate of reaction between compound **(A)** and **NaOH(aq)** was measured in a series of experiments at **298 K**. The data obtained is shown below.

Experiment	**[A] / mol dm^{-3}**	**[NaOH] / mol dm^{-3}**	**Initial rate of reaction / mol dm^{-3} s^{-1}**
1	0.040	0.030	4.0×10^{-4}
2	0.040	0.045	6.0×10^{-4}
3	0.080	0.045	24.0×10^{-4}

(i) What is meant by the term order of reaction?

_____

_____ [1]

(ii) Using the data given, complete the table below:

The order of reaction with respect to **(A)**	_____
The order of reaction with respect to **(NaOH)**	_____
The overall order of the reaction	_____
The rate equation for the reaction	_____

[4]

(iii) In experiment 4, at a different temperature, the initial rate of reaction between compound **(A)** and **NaOH(aq)** was found to be 4.8×10^{-3} mol dm^{-3} s^{-1}. What change occurred in the temperature?

_____

_____ [1]

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Question 2 continued

b. The rate equation of the reaction between the gases **NO** and $\mathbf{H_2}$ was determined to be: rate = $k[\mathbf{NO}]^2[\mathbf{H_2}]$

The table below shows the data from two experiments which was conducted at a constant temperature:

Experiment	[NO] / mol dm^{-3}	$[H_2]$ / mol dm^{-3}	Initial rate of reaction / mol dm^{-3} s^{-1}
1	0.030	0.010	1.8×10^{-2}
2	0.030	0.030	x

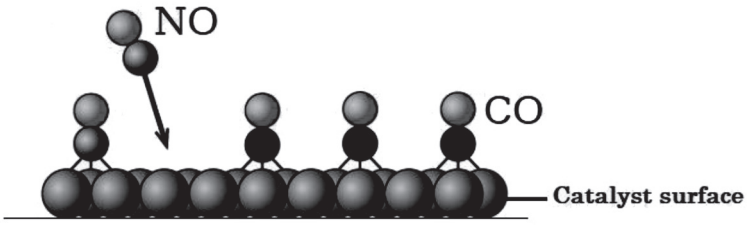
(i) **Calculate** the value of the rate **constant** and give the **units**.

[2]

(ii) Calculate the initial rate (x) of the reaction in Experiment (**2**).

[1]

20) a. The figure below shows a step of a heterogeneous catalysis.



(i) Explain the meaning of heterogeneous catalysis?

[1]

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Question 2 continued

(ii) Describe the mode of action of the catalyst in this step.

_____

_____ [1]

b. In a catalyzed reaction hydrogen peroxide, H_2O_2, decomposes to form water and oxygen, as in the following equation:

$$2H_2O_2(aq) \xrightarrow{Br^-} 2H_2O(l) + O_2(g)$$

What type of catalysis is this?

_____ [1]

21) Use the data in the table shown below, then answer the questions.

Substance	$S^{\ominus}$ (J K^{-1} mol^{-1})
$Fe_2O_3(s)$	**87.4**
C(graphite)	**5.7**
Fe(s)	**27.3**
$CO_2(g)$	**213.6**
$NH_4Cl(s)$	**94.6**
$NH_3(g)$	**193**
HCl(g)	**187**

a. What is the scientific term describes the number of possible arrangement of the particles and their energy in a given system.

_____ [1]

b. Write an expression showing the relationship between Gibbs free energy, ΔG, enthalpy change, ΔH and entropy changes, ΔS.

_____

_____ [1]

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Question 2 continued

c. For Reaction 1:

$$2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$$

Predict the sign of $\Delta S^{\ominus}_{system}$ and explain your answer.

The sign: _____ [1]

Explanation: _____ [1]

d. For Reaction 2:

$$2Fe_2O_3(s) + 3C(graphite) \longrightarrow 4Fe(s) + 3CO_2(g)$$

Explain the difference in the entropy values, $S^{\ominus}$ between $Fe_2O_3(s)$ and $Fe(s)$.

_____

_____ [1]

e. Calculate the standard entropy change, $\Delta S^{\ominus}$ for this reaction at **298 K**.
Show all your work.

_____

_____

_____

_____ [3]

f. For Reaction 3:

$$NH_4Cl(s) \longrightarrow NH_3(g) + HCl(g) \quad , \quad \Delta H_r^{\ominus} = +176 \ (KJ \ mol^{-1})$$

(i) Calculate the Gibbs free energy change, $\Delta G^{\ominus}$ ($K\ J\ mol^{-1}$), at **298 K**.
Show all your work.

_____

_____

_____

_____ [3]

(ii) State whether the reaction is feasible or not.

_____ [1]

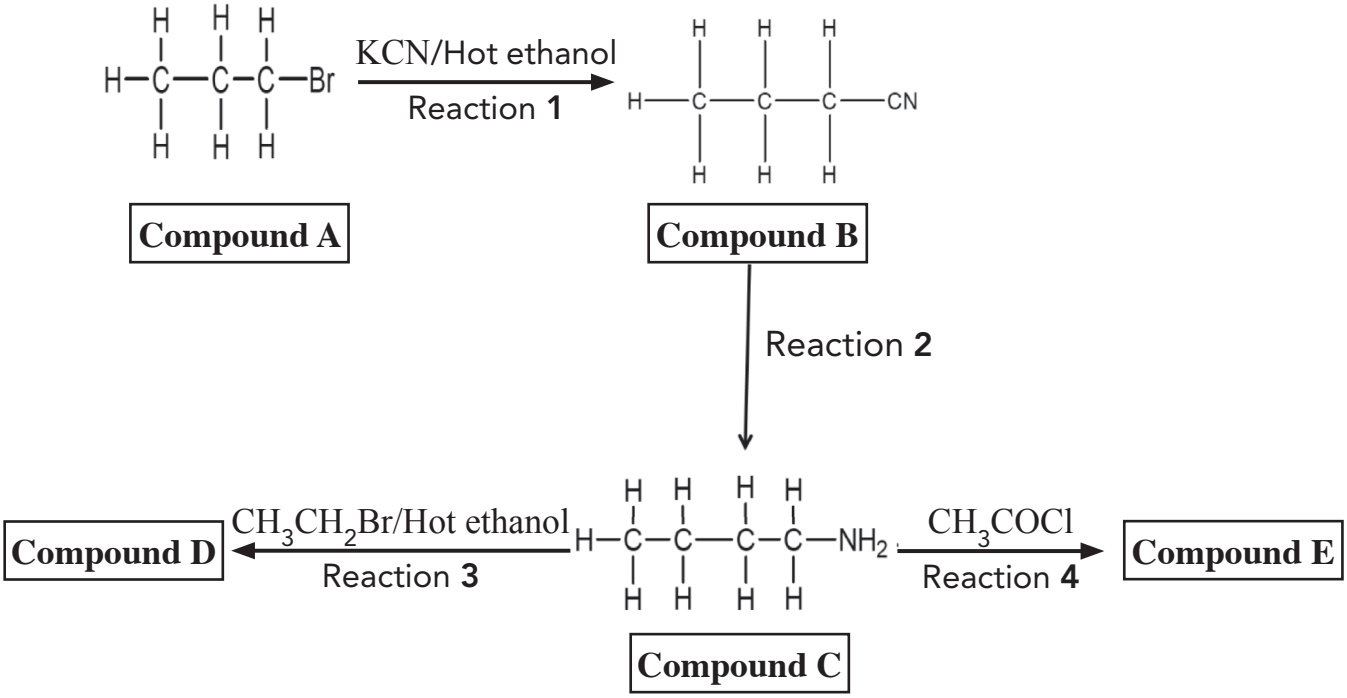
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Question 2 continued

22) Consider the following reaction sequence:



a. For reaction 2:

(i) State the type of reaction.

_____ [1]

(ii) State the reagent needed.

_____ [1]

(iii) What class is the functional group of Compound (**B**).

_____ [1]

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Question 2 continued

b. **Draw** the structure of:

(i) Compound (**D**).

[1]

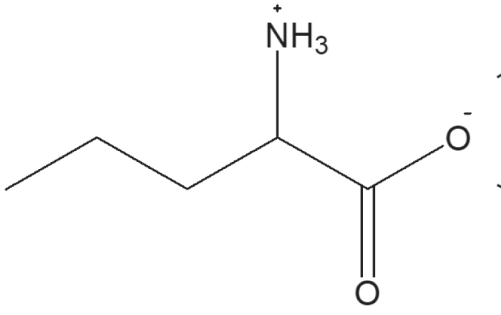
(ii) Compound (**E**).

[1]

c. What is the product when $LiAlH_4$ is added to Compound (**E**)?

_____ [1]

d. The following figure shows the **zwitterion** of 2-Amino-pentanoic acid. Draw the product formed in HCl and NaOH.



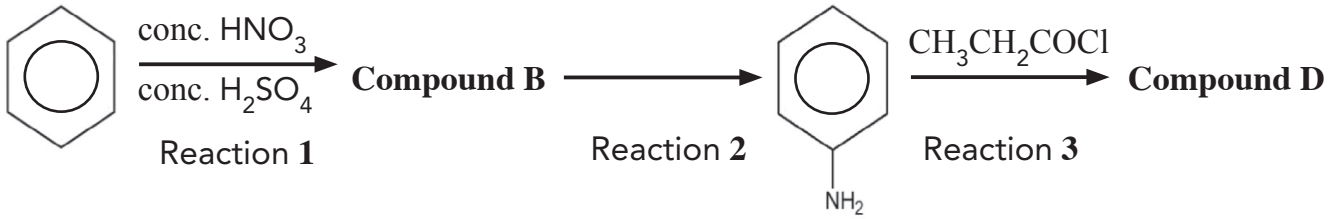
[2]

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Question 2 continued

23) Consider the following reaction sequence:



Compound A **Compound C**

a. State the necessary reagent needed for Reaction **2**.

_____ [1]

b. **Draw** the structure of:

(i) Compound (**B**).

[1]

(ii) Compound (**D**).

[1]

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Question 2 continued

(iii) The product of reacting 3 moles of $\mathbf{Br_2(aq)}$ with Compound (**C**) at room temperature.

[1]

c. Why is Compound (**D**) less basic than Compound (**C**)?

[1]

[End of the Examination]

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Periodic Table

1 H 1.01																	2 He 4.00
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 40.00
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La*	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226	89 Ac (227)															

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa (231)	92 U 238	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

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MARKING GUIDE

GENERAL EDUCATION DIPLOMA

BILINGUAL PRIVATE SCHOOLS

SEMESTER TWO - SECOND SESSION

CHEMISTRY

2024 / 2025

General Education Diploma, Semester One, Second Session
Bilingual Private Schools, Chemistry, 2024/2025

Exam Specification for Chemistry (Grade 12 - Bilingual) – Semester two (2024/2025)

Topic of the Units	Weighting %	Multiple Choice (20%)					Extended Response (80%)					Total Mark
		No. of Questions	Marks	Cognitive Levels			No. of Questions	Marks	Cognitive Levels			
				Knowing (30%)	Applying (50%)	Reasoning (20%)			Knowing (30%)	Applying (50%)	Reasoning (20%)	
Chemistry of transition elements	29%	14	4	1	2	1	10	16	6	7	3	20
Quantitative kinetics	26%		3	1	1	1		15	4	8	3	18
Entropy and Gibbs free energy	21%		3	1	2	-		12	3	7	2	15
Nitrogen compounds	24%		4	1	2	1		13	4	6	3	17
Total	100%		14	4	7	3		56	17	28	11	70

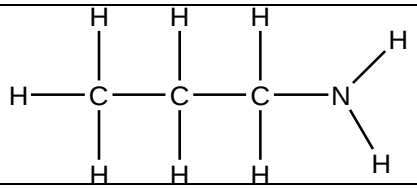
Distribution of cognitive domains and marks.

Serial No	Question number	Item	Mark	Unit	Cognitive domain	Output
1	1	1	1	Chemistry of transition elements	Knowing	5.1b
2	1	2	1	Chemistry of transition elements	Application	5.2 d
3	1	3	1	Chemistry of transition elements	Application	5.2.j
4	1	4	1	Chemistry of transition elements	Reasoning	5.2.i
5	1	5	1	Quantitative Kinetics	Knowing	6.1.a
6	1	6	1	Quantitative Kinetics	Application	6.1.m
7	1	7	1	Quantitative Kinetics	Reasoning	6.1.g
8	1	8	1	Entropy and Gibbs free energy	Knowing	7.1.b
9	1	9	1	Entropy and Gibbs free energy	Application	7.2.a
10	1	10	1	Entropy and Gibbs free energy	Application	7.2.b
	1	11	1	Nitrogen Compounds	Knowing	8.1a
	1	12	1	Nitrogen Compounds	Application	8.1c i
	1	13	1	Nitrogen Compounds	Application	8.4a
	1	14	1	Nitrogen Compounds	Reasoning	8.1c ii
	2	15.ai	1	Chemistry of transition elements	Knowing	5.2.d
	2	15.aii	1	Chemistry of transition elements	Knowing	5.2.h
	2	15.aiii	1	Chemistry of transition elements	Knowing	5.2.c.i
	2	15.b.i	2	Chemistry of transition elements	Application+ Reasoning	5.2.g
	2	15.b.ii	1	Chemistry of transition elements	Application	5.2.i
	2	16.a	1	Chemistry of transition elements	Application	5.2.c.ii
	2	16.b	1	Chemistry of transition elements	Application	5.2.c.iii
	2	16.c	1	Chemistry of transition elements	Application	5.2.i
	2	16.d	1	Chemistry of transition elements	Application	5.1.c
	2	16.e	1	Chemistry of transition elements	Knowing	5.1.d
	2	17.a	2	Chemistry of transition elements	Knowing	5.3.ci
	2	17.b	1	Chemistry of transition elements	Reasoning	5.3ci
	2	17.c	1	Chemistry of transition elements	Reasoning	5.3ci
	2	17.d	1	Chemistry of transition elements	Application	5.3b
	2	18.a	1	Quantitative Kinetics	Knowing	6.1.i
	2	18.b	1	Quantitative Kinetics	Knowing	6.1.e
	2	18.c	1	Quantitative Kinetics	Application	6.1.l.ii
	2	19.a.i	1	Quantitative Kinetics	Knowing	6.1.a
	2	19.a.ii	4	Quantitative Kinetics	Reasoning/ Application	6.1.d,a,g
	2	19.a.iii	1	Quantitative Kinetics	Reasoning	6.1.m
	2	19.b.i	2	Quantitative Kinetics	Application	6.1.l.h
	2	19.b.ii	1	Quantitative Kinetics	Application	6.1.f
	2	20.a.i	1	Quantitative Kinetics	Knowing	6.2.a

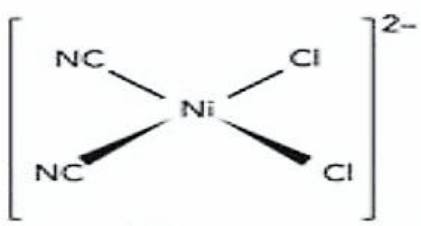
	2	20.a.ii	1	Quantitative Kinetics	Application	6.2.b.ii
	2	20.b	1	Quantitative Kinetics	Application	6.2.a
	2	21.a	1	Entropy and Gibbs free energy	Knowing	7.1.a
	2	21.b	1	Entropy and Gibbs free energy	Reasoning	7.1.b
	2	21.c	2	Entropy and Gibbs free energy	Application	7.1.c
	2	21.d	1	Entropy and Gibbs free energy	Application	7.1.b
	2	21.e	3	Entropy and Gibbs free energy	Knowing	7.2.a
	2	21.f.i	3	Entropy and Gibbs free energy	Application	7.2.b, c
	2	21.f.ii	1	Entropy and Gibbs free energy	Application	
	2	22.a i	1	Nitrogen Compounds	Knowing	8.1c iv
	2	22.a ii	1	Nitrogen Compounds	Knowing	8.1 c iv
	2	22.a iii	1	Nitrogen Compounds	Knowing	8.4a
	2	22.b i	1	Nitrogen Compounds	Applying	8.1c ii
	2	22.b ii	1	Nitrogen Compounds	Applying	8.1d , 8.3b ii
	2	22.c	1	Nitrogen Compounds	Reasoning	8.1c iv
	2	22.d	2	Nitrogen Compounds	Reasoning	8.4b
	2	23.a	1	Nitrogen Compounds	Knowing	8.2a
	2	23.b i	1	Nitrogen Compounds	Applying	8.2a
	2	23.b ii	1	Nitrogen Compounds	Applying	8.1d , 8.3b ii
	2	23.b iii	1	Nitrogen Compounds	Applying	8.2b i
	2	23.c	1	Nitrogen Compounds	Applying	8.3c i

TOTAL PAGES: 7
MARKS: 70
Question One (14 Marks)

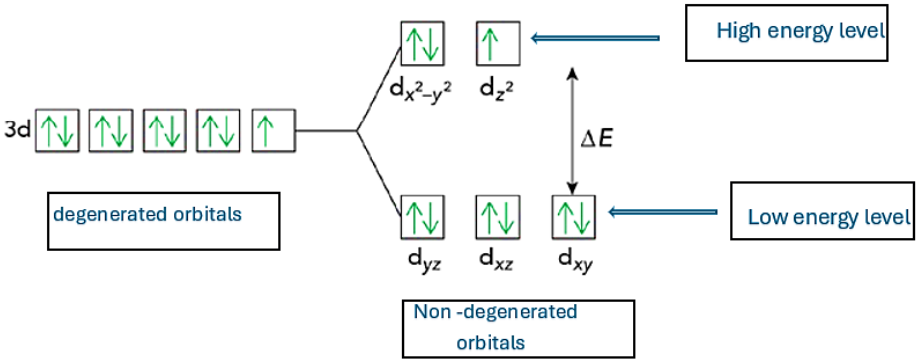
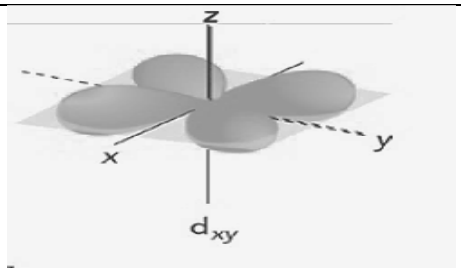
There are 14 multiple-choice items. Each correct answer is worth ONE mark.

Item	Correct option	
1	**B**	Their atoms tend to gain electrons.
2	**C**	+2 | 6 | octahedral
3	**D**	$[Cu(H_2O)_6]^{2+}$
4	**B**	+3
5	**A**	rate = k decrease with time
6	**B**	*k*
7	**A**	Rate = *k* [**A**][**B**]
8	**D**	$H_2O(s) < H_2O(l) < H_2O(g)$
9	**A**	This reaction is not feasible.
10	**B**	26.8
11	**C**	
12	**A**	$CH_3CH_2NH_2$
13	**D**	Amine | Amino acid
14	**B**	$(CH_3)_2CHNHCH_2CH_2CH_3$

Question Two (56 Marks)

Part	Section	The answer	The mark
15	a.i	Complex ion: a central transition metal ion surrounded by ligands, bonded to the central ion by dative (also called co-ordinate) covalent bonds.	1
	a.ii	Coordination number: the number of co-ordinate bonds formed by ligands with a transition element ion in a complex.	1
	a.iii	Monodentate ligand: a ligand forming one co-ordinate bond (dative bond) with a transition element ion in a complex.	1
15	b.i	 Cis-isomer 1 mark for the shape, 1 mark for the charge.	2
	b.ii	$Co(OH)_2(H_2O)_4$ (s)	1
16	a	$[Co(ox)_3]^{3-}$ **OR** $[Co(C_2O_4)_3]^{3-}$	1
	b	$[Ti(EDTA)]^-$	1
	c	+3	1
	d	$[Ar]3d^5$ **OR** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	1
	e	Zn^{2+}	1

Question Two Continued

Part	Section	The answer	The mark
17	a	 **2** marks: if all answers are correct. **1** mark: if three or two answers are correct. **Zero**: if one answer is correct or all answers are wrong.	2
	b	Octahedral	1
	c	Cu^{2+}	1
	d		1

Question Two Continued

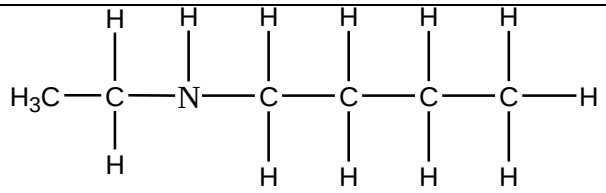
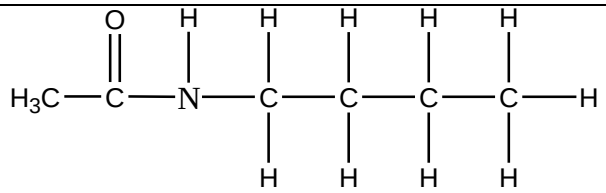
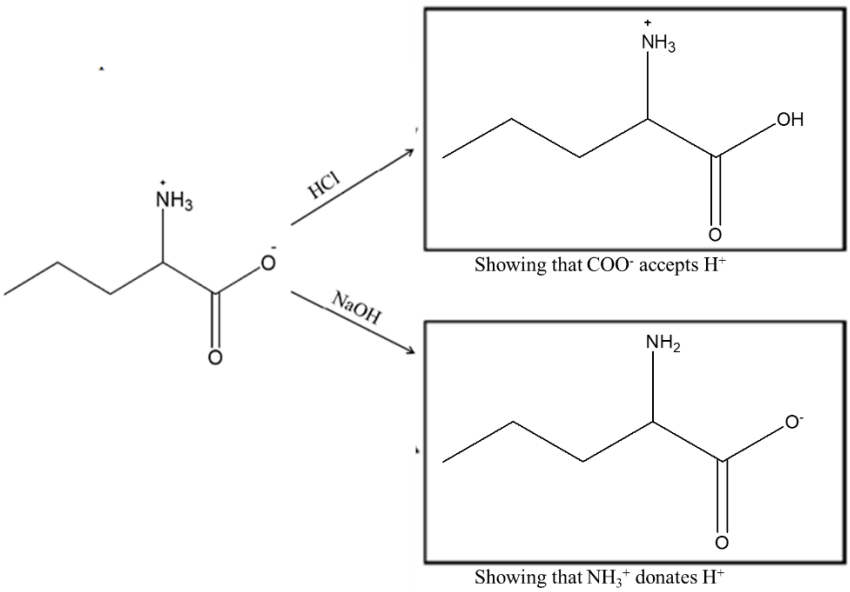
Part	Section	The answer	The mark
18	a	**B**	1
	b	**C**	1
	c	$k = 5.5 \times 10^{-4}\ s^{-1}$ $t_{1/2}=0.693/k = 0.693/ 5.5 \times 10^{-4}\ s^{-1} =$ 1260 s	1
19	a.i	The power to which the concentration of the reactant is raised in the rate equation.	1
	a.ii	The order of reaction with respect to (A): second order **OR** 2 The order of reaction with respect to (NaOH): first order **OR** 1 The overall order of the reaction: Third order reaction **OR** 3 The rate equation for the reaction: Rate = $k[\mathbf{A}]^2[\mathbf{NaOH}]$ (1mark each)	4
	a.iii	Since the rate doubled so the temperature increases by 10K **OR** 308K.	1
	b.i	$k = 1.8 \times 10^{-2}/(0.030)^2(0.010)=$ 2000 $mol^{-2}\ dm^6\ s^{-1}$ (1mark for value, 1mark for the unit)	2
	b.ii	rate = $k[NO]^2[H_2]= 2000(0.030)^2(0.030)= 5.4 \times 10^{-2}$ mol $dm^{-3}\ s^{-1}$ **Or** rate in experiment **(2) =** rate in experiment **(1)** × 3 = 5.4×10^{-2} mol $dm^{-3}\ s^{-1}$	1

Part	Section	The answer	The mark
20	a.i	Heterogeneous catalysis: the type of catalysis in which the catalyst is in a different phase to the reactants.	1
	a.ii	Adsorption of nitrogen oxides and carbon monoxide onto the catalyst surface.	1
	b	Homogeneous catalysis.	1

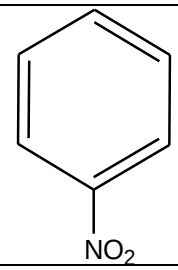
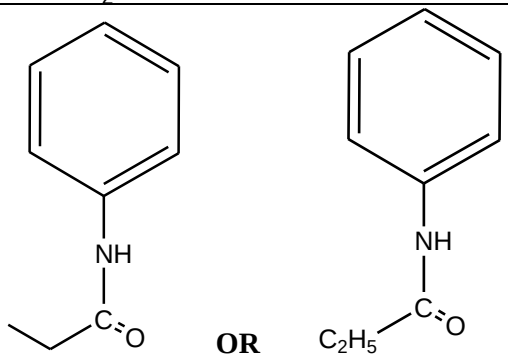
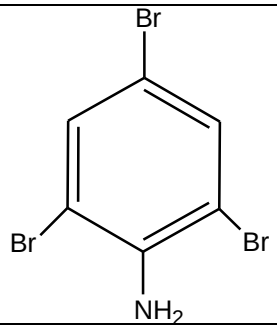
Question Two Continued

Part	Section	The answer	The mark
21	a.i	Entropy **OR** S	1
	b	$\Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus}$	1
	c	(-) **OR** negative 1 mark Because there is less number of moles of gas molecules in the products (2 moles) than in the reactants (3 moles) 1 mark	2
	d	Number of atoms of F is less than the number of atoms of $Fe_2O_3(s)$	1
	e	$\Delta S^{\ominus} = \Sigma S^{\ominus}$ (products) – $\Sigma S^{\ominus}$ (reactants) 1 mark $\Delta S^{\ominus}_{system}$=3x $S^{\ominus}[CO_2(g)]$+ 4x$S^{\ominus}$[Fe(s)] –2x $S^{\ominus}[Fe_2O_3(s)$+3x $S^{\ominus}$[C(s,graphite)] 1 mark = (3x 213.6)+ (4x 27.3) – (2x 87.4+ 3x 5.7) = (640.8+ 109.2) – (174.8 + 17.1) = +558.1 J K^{-1} mol^{-1} 1 mark	3
	f.i	$\Delta S^{\ominus} = \Sigma S^{\ominus}$ (products) – $\Sigma S^{\ominus}$ (reactants) = $S^{\ominus}[NH_3(g)]$+$S^{\ominus}$[HCl(g)]- $S^{\ominus}[NH_4Cl(s)]$ 1 mark = (193 + 187) – 94.6 = + 285.4 J K^{-1} mol^{-1} 1 mark $\Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus}$ = +176 – (298 x +285.4/1000) = + 91 kJ mol^{-1} 1 mark	3
	f.ii	The reaction is not feasible	1

Question Two Continued

Part	Section	The answer	The mark
22	a i	Reduction	**1**
	a ii	$LiAlH_4$ **Or** H_2/ Ni	**1**
	a iii	Nitrile	**1**
	b i	 $CH_3CH_2NHCH_2CH_2CH_2CH_3$ **OR** $C_2H_5NHC_4H_9$	**1**
	b ii	 $CH_3CONHCH_2CH_2CH_2CH_3$ **OR** $CH_3CONHC_4H_9$	**1**
	c	$CH_3CH_2NHCH_2CH_2CH_2CH_3$	**1**
	d	 Showing that COO^- accepts H^+ Showing that NH_3^+ donates H^+	**2** **1 Mark for each structure**

Question Two Continued

Part	Section	The answer	The mark
23	a	Hot Sn/ conc. HCl **OR** 6[H]	**1**
	b i		**1**
	b ii	 **OR**	**1**
	b iii		**1**
	c	Less basic because compound D is a <u>neutral amide</u> While compound C is a <u>basic amine</u> **OR** Compound D contains an <u>electron-withdrawing group and an electron-donating group</u> **OR** The <u>lone pair</u> on the nitrogen atom of an <u>amide</u> is <u>not available to donate</u> to electron-deficient species such as H+ ions.	**1**

<u>This is the end of the Marking Guide</u>