First Semester

Chemistry

(الكيمياء)

(Questions)



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)

للعام الدراسي ١٤٤٦/١٤٤٥ هـ - ٢٠٢٣ / ٢٠٢٤ م

الدور الأول - الفصل الدراسي الأول

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٤) 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 correct about a weak acid?

- ○ It accepts protons easily.
- ○ Its K_a value is very high.
- ○ Its pH is greater than 7.
- ○ It dissociates partially in water.

Use the following data to answer questions (2 and 3):

Acid's symbol (conc. 0.1 mol dm^{-3})	K_a at 25°C (mol dm^{-3})
X	4.5×10^{-7}
Y	1.3×10^{-10}
Z	6.3×10^{-5}
W	1.7×10^{-5}

2) Which acid has the strongest conjugate base?

- ○ X
- ○ Y
- ○ Z
- ○ W

3) What is the correct order for these acids according to their strength from the strongest to the weakest?

- ○ Y > X > W > Z
- ○ Z > W > X > Y
- ○ W > Z > X > Y
- ○ Y > X > Z > W

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Question 1 continued

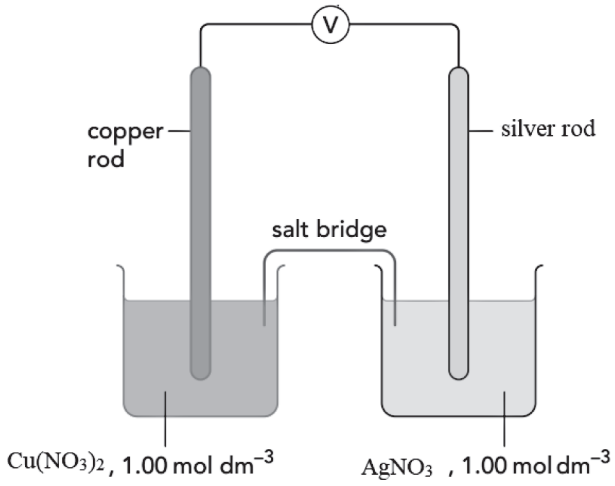
4) Which of following values is the solubility product K_{sp}, for zinc hydroxide $Zn(OH)_2$? Given that the solubility of $Zn(OH)_2 = 2.0 \times 10^{-17}$ mol dm^{-3}.

- ☐ 4.0×10^{-17}
- ☐ 8.0×10^{-17}
- ☐ 8.0×10^{-51}
- ☐ 3.2×10^{-50}

5) Which of the following statements is correct about the electrolysis cell?

- ☐ The cathode is the positive electrode.
- ☐ The electrons move from the cathode to the anode.
- ☐ The electrodes are made from either carbon or metal.
- ☐ During electrolysis, the cations move to the anode.

6) Which of the following statements is correct for the voltage cell below at standard conditions?



- ☐ The copper will be the cathode.
- ☐ The mass of the silver rod will decrease.
- ☐ Ag^+ ions will be reduced to Ag metal.
- ☐ Electrons will flow from the Ag rod to the Cu rod.

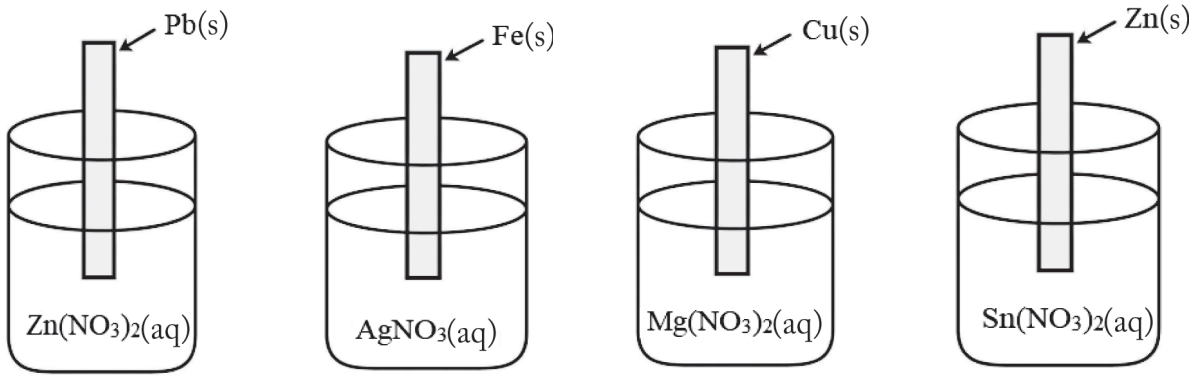
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Question 1 continued

7) Which of the following reactions are feasible in the beakers below?



(1) (2) (3) (4)

- ☐ (1) and (2)
- ☐ (1) and (3)
- ☐ (2) and (4)
- ☐ (2) and (3)

8) Which of the following values is the electrode potential at 298 K of $Cu^{2+}(aq) / Cu(s)$ electrode that has a concentration of $Cu^{2+}(aq)$ ions of 0.0050 mol dm^{-3}?

- ☐ +0.65
- ☐ +0.27
- ☐ −0.11
- ☐ −0.41

9) Which of the following is the symbol for the enthalpy change when one mole of a specified gaseous ion dissolves in sufficient water to form a very dilute solution under standard conditions?

- ☐ $\Delta H^{\theta}_{\text{latt}}$
- ☐ $\Delta H^{\theta}_{\text{at}}$
- ☐ $\Delta H^{\theta}_{\text{sol}}$
- ☐ $\Delta H^{\theta}_{\text{hyd}}$

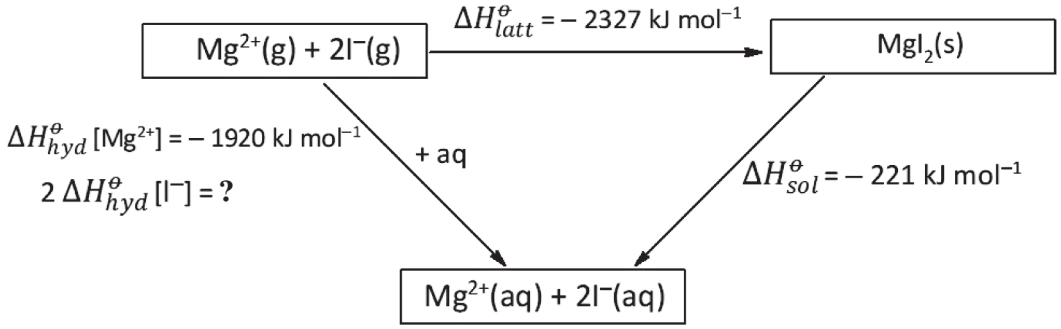
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Question 1 continued

10) Which of the following chemical equations describe the standard enthalpy change of solution for lithium fluoride?

- ☐ $LiF(s) \longrightarrow Li^+(aq) + F^-(aq)$
- ☐ $LiF(s) \longrightarrow Li^+(g) + F^-(g)$
- ☐ $Li^+(aq) + F^-(aq) \longrightarrow LiF(s)$
- ☐ $Li^+(g) + F^-(g) \longrightarrow LiF(s)$

11) Using the energy cycle shown below. What is the enthalpy change value of hydration of an iodide ion in kJ mol^{-1}?



- ☐ – 186
- ☐ – 314
- ☐ – 402
- ☐ – 628

12) If chloroethane and chlorobenzene are tested separately by hydrolysis and boiling in aqueous sodium hydroxide, what would you expect to occur?

- ☐ Chloroethane and chlorobenzene would both be hydrolysed.
- ☐ Chloroethane would be hydrolysed, but chlorobenzene would not do so.
- ☐ Neither chloroethane nor chlorobenzene would be hydrolysed.
- ☐ Chloroethane would not be hydrolysed, but chlorobenzene would do so.

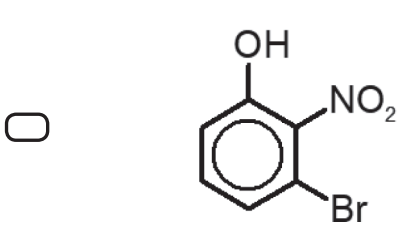
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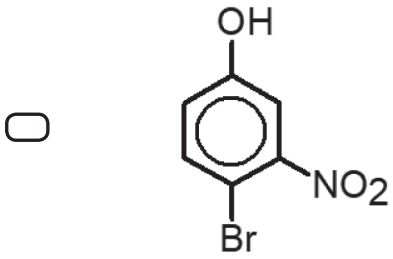
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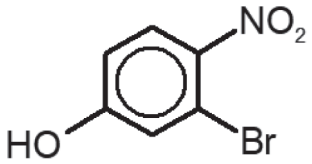
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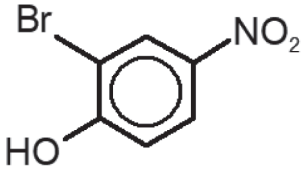
Question 1 continued

13) Which of the following structural formulae is 3-bromo-4-nitrophenol?

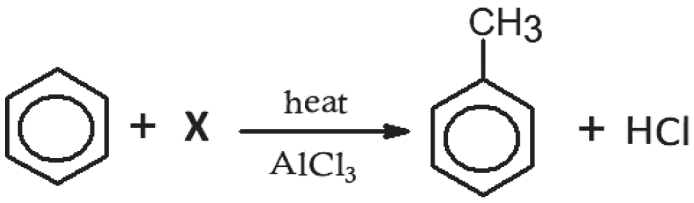








14) For the following reaction:



Which of the options below is correct for reagent (X) and the type of reaction?

	Reagent (X)	Type of reaction
☐	CH_3COCl	Electrophilic substitution
☐	CH_3COCl	Addition-elimination
☐	CH_3Cl	Electrophilic substitution
☐	CH_3Cl	Addition-elimination

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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) K_a is called the acid dissociation constant.

a. Write the general K_a expression for HA acid. (1 mark)

b. Silicic acid, dissociates in water according to the equation below:

$$SiO_2(aq) + H_2O(l) \rightleftharpoons H^+(aq) + HSiO_3^-(aq)$$

(i) Which one of the products is a conjugate base? (1 mark)

(ii) Calculate the value of K_a for silicic acid, if a 0.70 mol dm^{-3} solution of silicic acid has a pH of (4.30). (2 marks)

16) The buffer solution plays an important role in nature and in many industrial processes.

a. Define the term buffer solution. (1 mark)

b. What are the components of the buffer solution? (1 mark)

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Question 2 continued

c. A buffer solution containing 0.10 mol dm^{-3} methanoic acid HCOOH and 0.20 mol dm^{-3} sodium methanoate, (K_a of methanoic acid = 1.60 $\times 10^{-4}$ mol dm^{-3}).

(i) Calculate the pH of this buffer solution. Show all your work. (3 marks)

(ii) What would happen to the pH of this buffer if a few drops of (KOH) are added? (3 marks)

☐ Increase ☐ Decrease ☐ No significant change

(Shade your answer)

Explain your answer.

17) a. For the reaction shown below:

$$Mg(s) + CuSO_4(aq) \longrightarrow MgSO_4(aq) + Cu(s)$$

(i) What is the type of this reaction? (1 mark)

(ii) Identify the following from the reaction above: (2 marks)

The oxidizing agent: _____

The reducing agent: _____

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Question 2 continued

b. Use the data in the table below, to answer the following questions.

Standard electrode potentials	E^{θ} (V)
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	– 0.76
$Pt^{2+}(aq) + 2e^- \rightleftharpoons Pt(s)$	+1.20

For the reaction shown below:

$$Pt(s) + Zn^{2+}(aq) \longrightarrow Pt^{2+}(aq) + Zn(s)$$

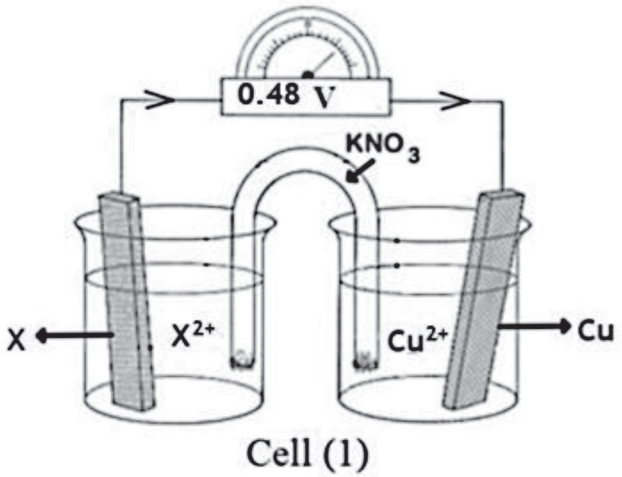
(i) Calculate E^{θ} cell for this reaction. (1 mark)

(ii) Is the forward reaction feasible? (1 mark)

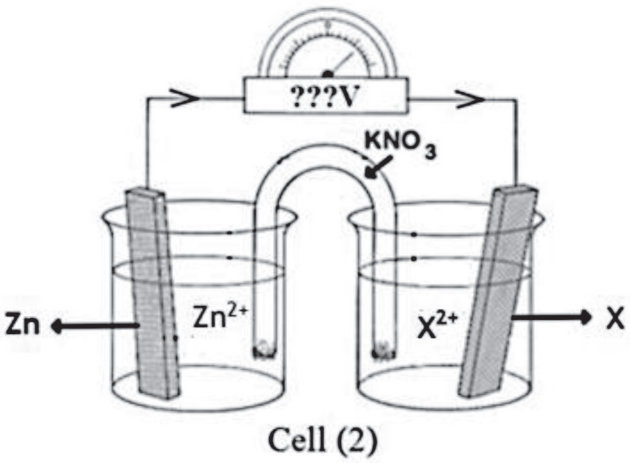
☐ Yes ☐ No **(Shade your answer)**

18) Study the table below and the two electrochemical cell diagrams set up under standard conditions to answer the following questions.

Cell (1) consists of (Cu) electrode and an unknown electrode represented by (X).
Cell (2) consists of (Zn) electrode and the same unknown electrode represented by (X).



Cell (1)



Cell (2)

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Question 2 continued

Standard electrode potentials	E^{θ} (V)
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	– 0.76
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34

a. What are the standard conditions for temperature and solution concentration? (2 marks)

b. What is the purpose of the salt bridge in the cells? (1 mark)

c. For cell (1):

(i) Which one is the cathode electrode in cell (1)? (1 mark)

(ii) Write the balanced equation for the overall cell reaction in cell (1). (1 mark)

d. For cell (2):

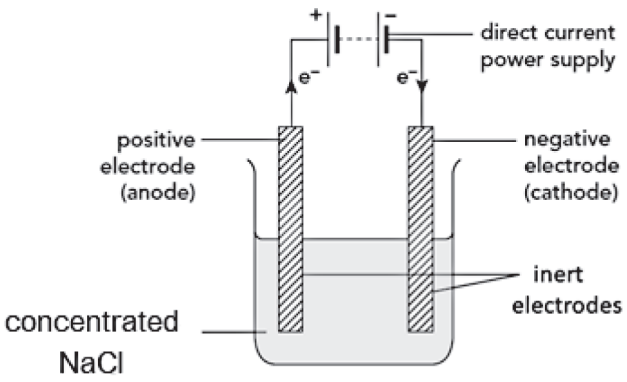
(i) Write the half-cell oxidation reaction that occurs in cell (2). (1 mark)

(ii) Calculate the E^{θ} for cell (2). (2 marks)

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Question 2 continued

19) A concentrated NaCl was electrolyzed using inert electrodes as shown below:



a. Identify the ions which will be oxidized and reduced in the: (2 marks)

Anode: _____

Cathode: _____

b. Write the half-equations for the reaction that occur in the: (2 marks)

Anode: _____

Cathode: _____

c. Calculate the volume of chlorine gas produced at r.t.p., when NaCl was electrolyzed for (1 h) using a current of (0.70 A). Show all your calculations ($F = 96500\ C\ mol^{-1}$, 1 mole of gas occupies 24.0 dm^3 at r.t.p.) (3 marks)

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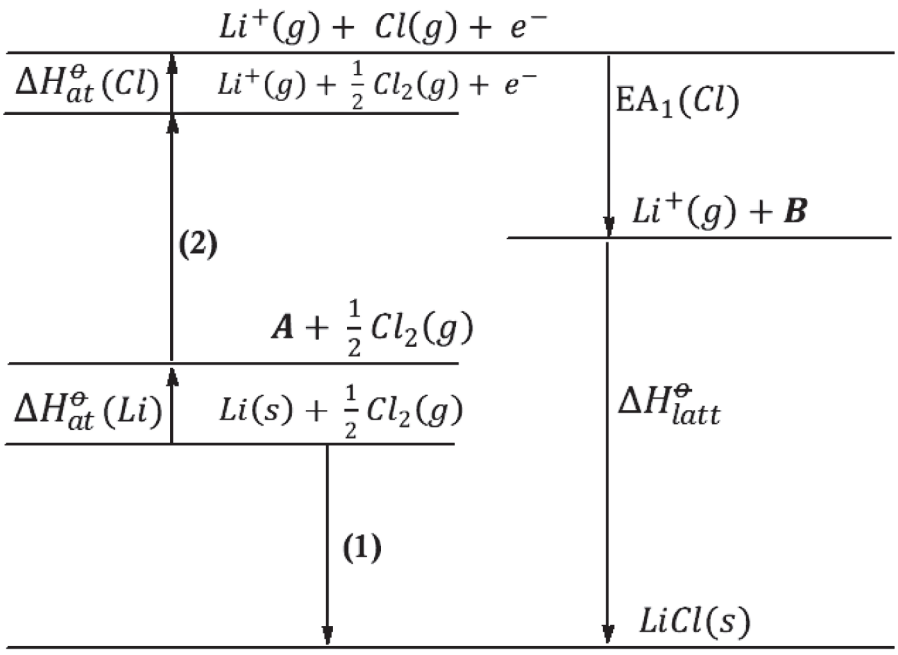
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Question 2 continued

20) The Born-Haber cycle for lithium chloride is shown below.



a. Define the term lattice energy. (1 mark)

_____

_____

b. Lattice energy is always: (1 mark)

☐ Endothermic ☐ Exothermic **(Shade your answer)**

c. State two factors of ions that affect the value of lattice enthalpy. (2 marks)

_____

_____

d. From the Born-Haber cycle for lithium chloride:

(i) Identify the species (**A**) and (**B**) in the cycle, including the appropriate state symbols: (2 marks)

A: _____

B: _____

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Question 2 continued

(ii) Identify the enthalpy changes labelled numbers (**1**) and (**2**) in the cycle. (2 marks)

1: _____

2: _____

(iii) Calculate the lattice energy for lithium chloride, given that: (2 marks)

ΔH_f^{θ}[LiCl] = –391 kJ mol^{-1} , ΔH_{at}^{θ}[Li] = +161 kJ mol^{-1} ,

ΔH_{at}^{θ}[Cl] = +122 kJ mol^{-1} , IE_1[Li] = + 520 kJ mol^{-1} ,

EA_1[Cl] = –348 kJ mol^{-1}

(Show your calculations)

_____

_____

_____

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e. Which one has a greater lattice energy? (2 marks)

☐ LiCl ☐ MgO **(Shade your answer)**

Explain your answer: _____

_____

_____

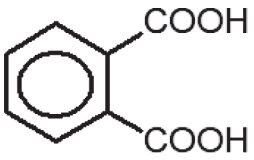
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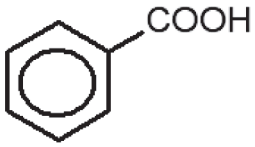
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Question 2 continued

21) a. Two alkylarenes A and B with the formula C_8H_{10} were refluxed with alkaline potassium manganite(VII), and then acidified with dilute acid as shown in the reactions below:

A $\xrightarrow[2.\ H^+_{(aq)}]{1.\ KMnO_4,\ \text{heat with } OH^-}$ 

B $\xrightarrow[2.\ H^+_{(aq)}]{1.\ KMnO_4,\ \text{heat with } OH^-}$ 

(i) What happened to the alkylarenes in these reactions? (1 mark)

_____

(ii) Draw the structural formula of A and B: (2 marks)

A: _____

B: _____

b. Chlorobenzene is used as an intermediate in the production of insecticide.

(i) Draw the equation for the reaction of chlorobenzene production from benzene. (2 marks)

_____

(ii) Explain how the presence of chlorine affects the reactivity of chlorobenzene. (1 mark)

_____

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Question 2 continued

22) Benzene and phenol are raw materials used in the production of many organic compounds.

a. Which one benzene or phenol will react with bromine water reagent without a catalyst at room temperature? (2 marks)

▢ Benzene ▢ Phenol **(Shade your answer)**

Give the reason for your choice. _____

_____

_____

b. Draw the equation for the reaction of the hydrogenation of methylbenzene. (2 marks)

_____

c. Which compound is more acidic? (2 marks)

▢ Ethanol ▢ Phenol **(Shade your answer)**

Explain your answer: _____

_____

_____

[End of the Examination]

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Selected standard electrode potentials

Electrode reaction	$E^{\ominus}$/V
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2.87
$S_2O_8^{2-} + 2e^- \rightleftharpoons 2SO_4^{2-}$	+2.01
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1.77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.52
$PbO_2 + 4H^+ + 2e^- \rightleftharpoons Pb^{2+} + 2H_2O$	+1.47
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.33
$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1.23
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.07
$ClO^- + H_2O + 2e^- \rightleftharpoons Cl^- + 2OH^-$	+0.89
$NO_3^- + 10H^+ + 8e^- \rightleftharpoons NH_4^+ + 3H_2O$	+0.87
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2 + H_2O$	+0.81
$Ag^+ + e^- \rightleftharpoons Ag$	+0.80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.77
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0.54
$O_2 + 2H_2O + 4e^- \rightleftharpoons 4OH^-$	+0.40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2 + 2H_2O$	+0.17
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0.15
$S_4O_6^{2-} + 2e^- \rightleftharpoons 2S_2O_3^{2-}$	+0.09
$2H^+ + 2e^- \rightleftharpoons H_2$	0.00
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	–0.13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	–0.14
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	–0.44
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	–0.76
$2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$	–0.83
$V^{2+} + 2e^- \rightleftharpoons V$	–1.20
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	–2.38
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	–2.87
$K^+ + e^- \rightleftharpoons K$	–2.92

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مُسَوَّدَة

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امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)

للعام الدراسي ١٤٤٥ - ١٤٤٦ هـ - ٢٠٢٣ / ٢٠٢٤ م

الدور الثاني - الفصل الدراسي الأول

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٤) 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 is correct about the expression for the dissociation constant, K_a for (HA) acid?

- ○ $K_a = [H^+][HA] / [A^-]$
- ○ $K_a = [H^+][A^-] / [HA]$
- ○ $K_a = [A^-][HA] / [H^+]$
- ○ $K_a = [H^+] / [A^-]$

2) What is the pH of a buffer solution containing 0.0400 mol dm^{-3} benzoic acid (C_6H_5COOH) and 0.0700 mol dm^{-3} sodium benzoate (C_6H_5COONa) ?

(K_a of benzoic acid = 6.3×10^{-5} mol dm^{-3})

- ○ 1.65
- ○ 3.04
- ○ 3.96
- ○ 4.44

3) The table below shows the K_a values for three acids that have the same concentration.

What is the correct order of the conjugate bases from the strongest to the weakest?

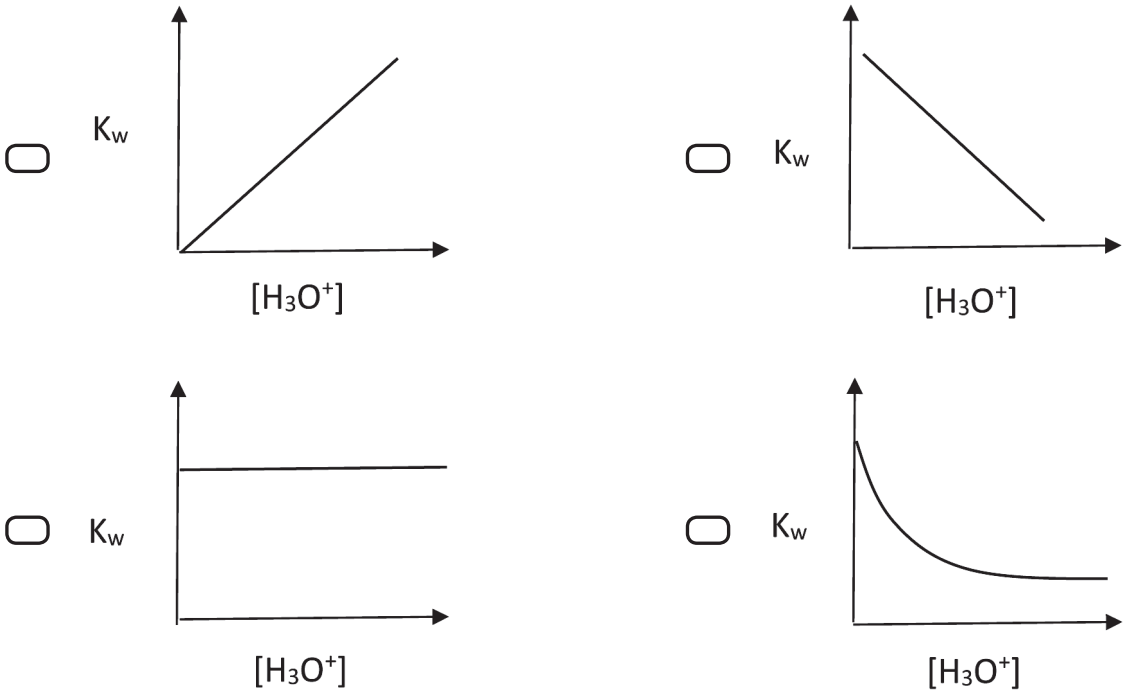
Acids (conc. 0.10 mol dm^{-3})	K_a at 25°C (mol dm^{-3})
HX	4.7×10^{-4}
HY	1.3×10^{-10}
HZ	4.5×10^{-7}

- ○ $Z^- > Y^- > X^-$
- ○ $X^- > Z^- > Y^-$
- ○ $Y^- > X^- > Z^-$
- ○ $Y^- > Z^- > X^-$

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Question 1 continued

4) Which figure shows the relationship between $[H_3O^+]$ and the value of (K_w) in an aqueous solution at 298 K ?



5) Which of the following statements is correct about the salt bridge in voltage cells?

- It is not necessary in order for the cell to work.
- It allows a charge balance to be maintained in the cell.
- It drives free electrons from one half-cell to another.
- It is tightly plugged with firm agar gel through which ions cannot pass.

6) Which of the following is the correct order for the oxidizing agents from the strongest to the weakest?

- $Ag^+ > Cu^{2+} > Mg^{2+}$
- $Cu^{2+} > Ag^+ > Mg^{2+}$
- $Mg^{2+} > Ag^+ > Cu^{2+}$
- $Cu^{2+} > Mg^{2+} > Ag^+$

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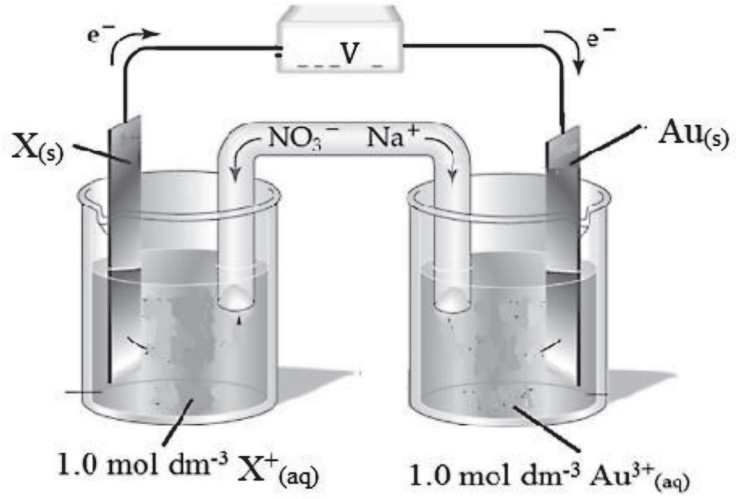
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Question 1 continued

7) Which one of the following reactions will be feasible under standard conditions?

- ☐ $Mg^{2+} + Sn^{2+} \longrightarrow Mg + Sn^{4+}$
- ☐ $Br_2 + 2Ag \longrightarrow 2Br^- + 2Ag^+$
- ☐ $2Fe^{3+} + 2Cl^- \longrightarrow 2Fe^{2+} + Cl_2$
- ☐ $Pb^{2+} + Cu \longrightarrow Pb + Cu^{2+}$

8) Which of the following statements is correct about this cell?



- ☐ X gets oxidized.
- ☐ The Au electrode loses electrons.
- ☐ Au is a stronger reducing agent than X.
- ☐ The X electrode has a higher tendency to accept electrons.

9) Which of the following is a symbol for the enthalpy change when one mole of gaseous atoms is formed from its element under standard conditions?

- ☐ ΔH^{θ}_{latt}
- ☐ ΔH^{θ}_{at}
- ☐ ΔH^{θ}_{sol}
- ☐ ΔH^{θ}_{hyd}

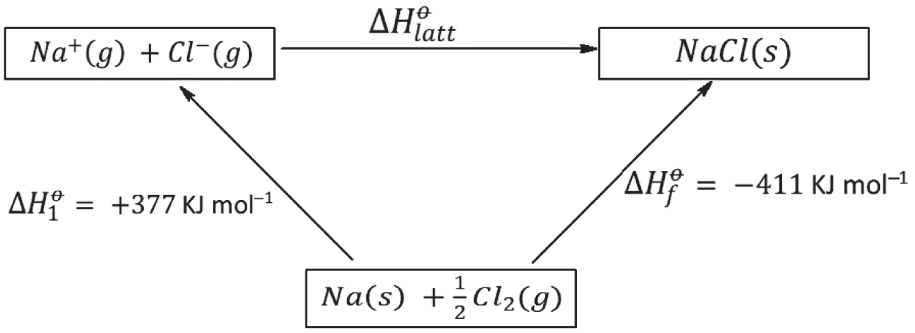
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Question 1 continued

10) Which of the following equations describe the standard enthalpy change of ionisation for sodium?

- ☐ $Na(s) \longrightarrow Na(g)$
- ☐ $Na(s) \longrightarrow Na(aq)$
- ☐ $Na(g) \longrightarrow Na^+(g) + e^-$
- ☐ $Na^+(g) + aq \longrightarrow Na^+(aq)$

11) Using the energy cycle shown below.



What is the lattice energy value of sodium chloride in kJ mol^{-1}?

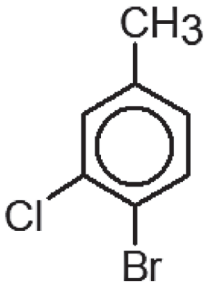
- ☐ + 34
- ☐ – 34
- ☐ + 788
- ☐ – 788

12) What is produced when diazonium salt is warmed with water?

- ☐ Benzene
- ☐ Phenol
- ☐ Nitrobenzene
- ☐ Phenylamine

13) What is the name for the compound shown below?

- ☐ 4-bromo-3-chloromethylbenzoic
- ☐ 4-bromo-5-chloromethylbenzoic
- ☐ 4-bromo-3-chloromethylbenzene
- ☐ 4-bromo-5-chloromethylbenzene



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Question 1 continued

14) If phenol and benzene are tested separately with bromine water without a catalyst at room temperature, what would you expect to see?

- ▢ Benzene and phenol would both decolorize the bromine water.
- ▢ Neither benzene nor phenol would decolorize the bromine water.
- ▢ Benzene would decolorize the bromine water, but phenol would not do so.
- ▢ Benzene would not decolorize the bromine water, but phenol would do so.

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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) Calcium fluoride CaF_2 is a slightly soluble salt ($K_{sp} = 4.5 \times 10^{-11}$ mol^3 dm^{-9})

a. What are the terms that describe the following definitions?

(i) The product of the concentrations of each ion in a saturated solution of a slightly soluble salt at 298 K, raised to the power of their relative concentrations. (1 mark)

(ii) The reduction of the solubility of a dissolved salt by adding a compound that has an ion in common with the dissolved salt. (1 mark)

b. Calculate the solubility of calcium fluoride CaF_2 in:

(i) Pure water (2 marks)

(ii) An aqueous solution of 0.040 mol dm^{-3} sodium fluoride NaF. (2 marks)

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Question 2 continued

(iii) Explain the different solubility of calcium fluoride in your answer in part (bi) and (bii). (2 marks)

16) Carbon dioxide combines with water in the blood to form a solution containing hydrogen ions. The equilibrium between carbon dioxide and hydrogen carbonate is the most important buffering system in the blood.

$$CO_2(aq) + H_2O(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$$

a. Identify the conjugate acid and the conjugate base on the right-hand side in the equilibrium equation given above. (2 marks)

Conjugate acid: _____

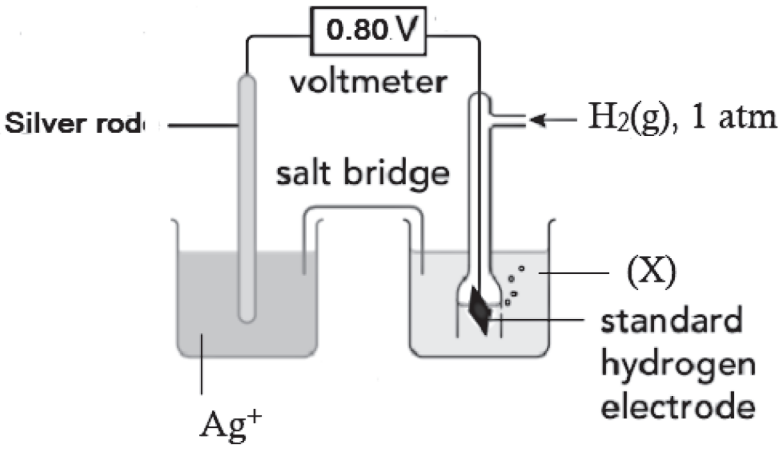
Conjugate base: _____

b. Explain how the carbon dioxide / hydrogen carbonate work as a buffer in your body when H^+ ion is added. (2 marks)

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Question 2 continued

17) An electrochemical cell was set up under standard conditions as shown below:



a. What are the standard conditions for temperature and solution concentration? (2 marks)

b. Define standard electrode potential. (1 mark)

c. Write the name of the ions in the beaker labeled (X). (1 mark)

d. The silver rod is: (2 marks)

☐ Anode ☐ Cathode **(Shade your answer)**

Explain your answer.

e. What is the direction of electron flow in this electrochemical cell? (1 mark)

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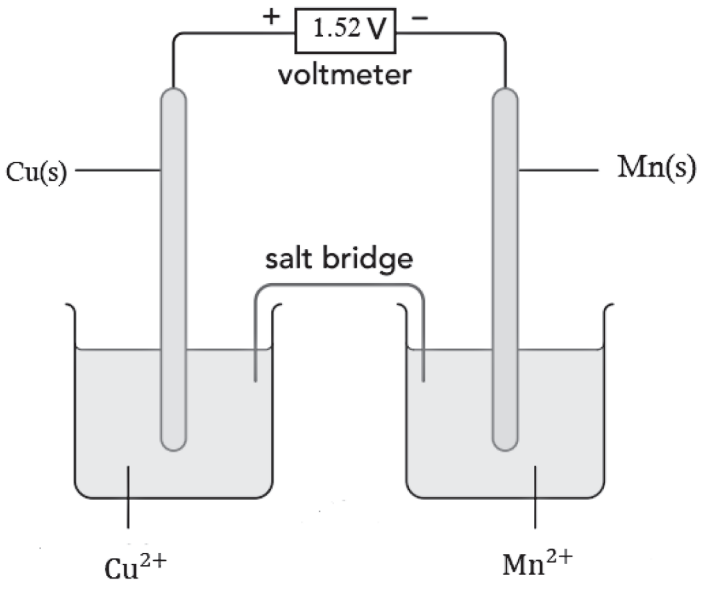
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Question 2 continued

f. Calculate the value of the electrode potential at 298 K of the $Ag^+(aq)/Ag(s)$ electrode that has a concentration of Ag^+ (aq) = 0.0010 mol dm^{-3}.

($Ag^+(aq) + e^- \longrightarrow Ag(s)$ $\quad E^\theta = +0.80$ V) (2 marks)

18) The electrochemical cell below consists of (Cu) half-cell and (Mn) half-cell at standard conditions. The reading on the voltmeter is +1.52 V. Study the diagram and answer the following questions.



a. Identify the oxidizing agent and reducing agent in this electrochemical cell (2 marks)

Oxidizing agent: _____

Reducing agent: _____

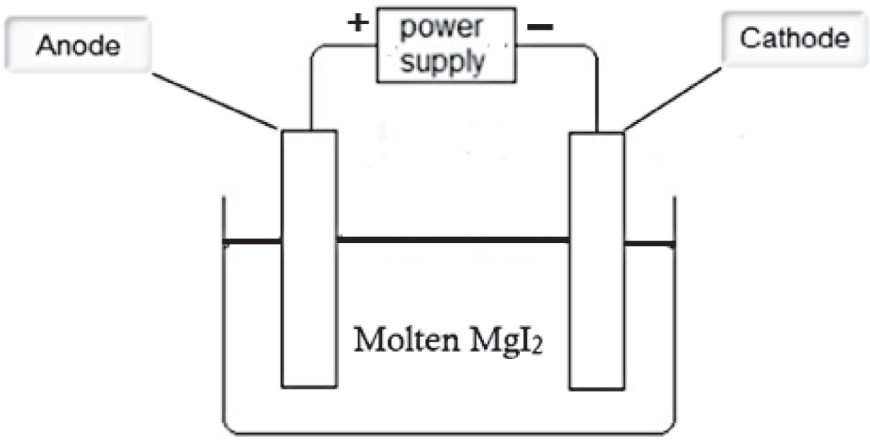
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Question 2 continued

b. Calculate the standard electrode potential (E^{θ}/V) of the (Mn^{2+}(aq)/Mn(s)).

Show your calculations. (2 marks)

19) A molten Magnesium iodide was electrolyzed using inert electrodes as shown below:



a. Write the half-equations for the reactions that occur in the anode and in the cathode. (2 marks)

In the anode: _____

In the cathode: _____

b. What substance is formed during this electrolysis in the: (2 marks)

Anode: _____

Cathode: _____

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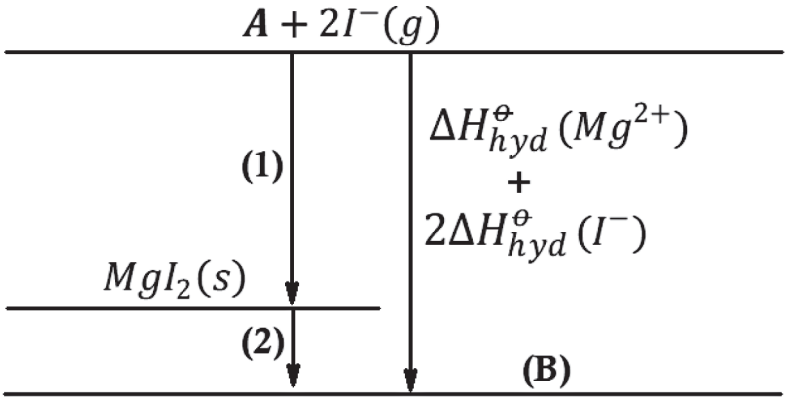
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Question 2 continued

c. Calculate the mass of magnesium deposited at the electrode during electrolysis when a current of 1.80 A flows through the molten magnesium iodide for 45.0 min.

(A_r value: [Mg] = 24, F = 96500 C mol^{-1}) (3 marks)

20) The energy cycle for magnesium iodide is shown below.



a. Define the term standard enthalpy change of hydration. (1 mark)

b. The enthalpy change of hydration is always: (1 mark)

☐ Endothermic ☐ Exothermic **(Shade your answer)**

c. State two factors of ions that affect the value of enthalpy change of hydration. (2 marks)

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Question 2 continued

d. From the energy cycle for the magnesium iodide:

(i) Identify the species (**A**) and (**B**) in the cycle, including the appropriate state symbols: (2 marks)

A: _____

B: _____

(ii) Identify the enthalpy changes labelled numbers (**1**) and (**2**) in the cycle. (2 marks)

1: _____

2: _____

(iii) Calculate the enthalpy of hydration for the magnesium ion given that: (2 marks)

ΔH^{θ}_{latt} [MgI_2] = –2327 kJ mol^{-1}

ΔH^{θ}_{sol} [MgI_2] = –221 kJ mol^{-1}

ΔH^{θ}_{hyd} [I^-] = –314 kJ mol^{-1}

_____

_____

_____

e. Which ion has a greater enthalpy change of hydration ? (2 marks)

☐ Mg^{2+} ☐ Li^{+} **(Shade your answer)**

Explain your answer: _____

_____

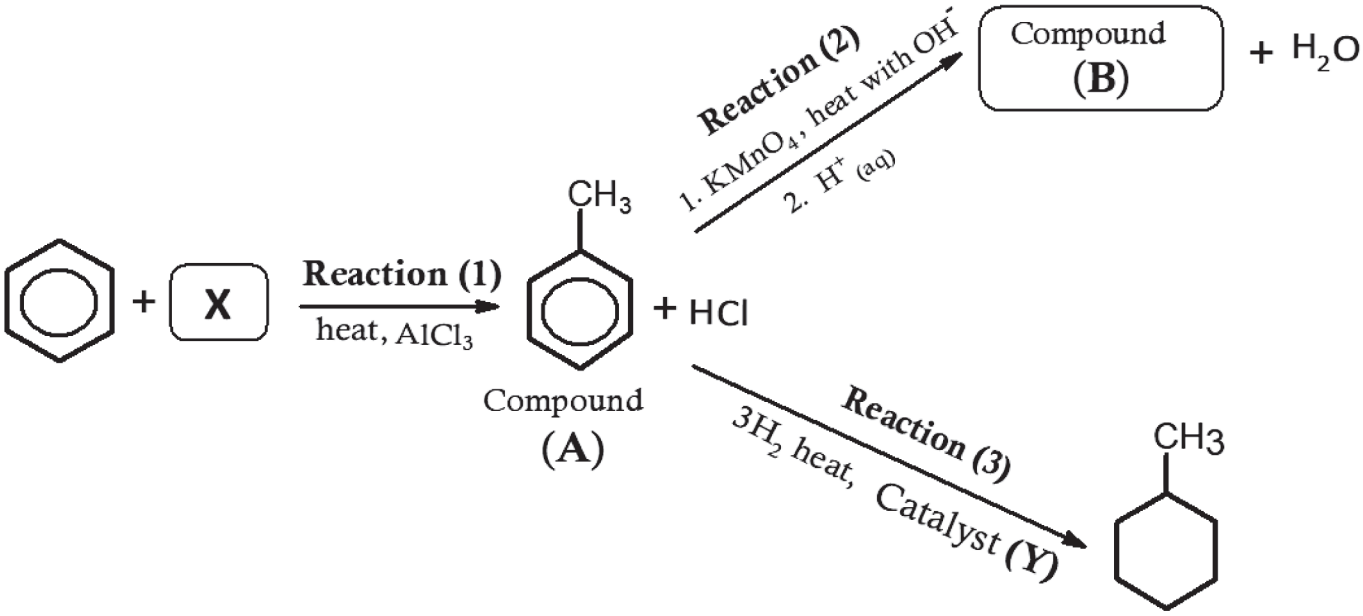
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Question 2 continued

21) Starting from benzene, study the reaction sequences below, then answer the following questions:



a. Name the Compound (A). (1 mark)

_____

b. Write the formula of the:

(i) Reagent (X): _____ (1 mark)

(ii) Catalyst (Y): _____ (1 mark)

c. Draw the structural formula of Compound (**B**). (1 mark)

_____

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Question 2 continued

d. Benzene reacts with bromine in the presence of an anhydrous aluminium bromide catalyst. The products of this reaction are bromobenzene and hydrogen bromide.

(i) What type is this reaction? (1 mark)

(ii) Which one is much less reactive? (2 marks)

☐ Bromoethane ☐ Bromobenzene **(Shade your answer)**

Explain your answer:

22) Phenol is a raw material used in the production of many organic compounds.

a. What are the reagents used to produce phenol? (2 marks)

b. Draw the equation for the reaction of phenol with 3 moles of bromine water. (2 marks)

c. Explain why phenol is more acidic than ethanol. (1 mark)

[End of the Examination]

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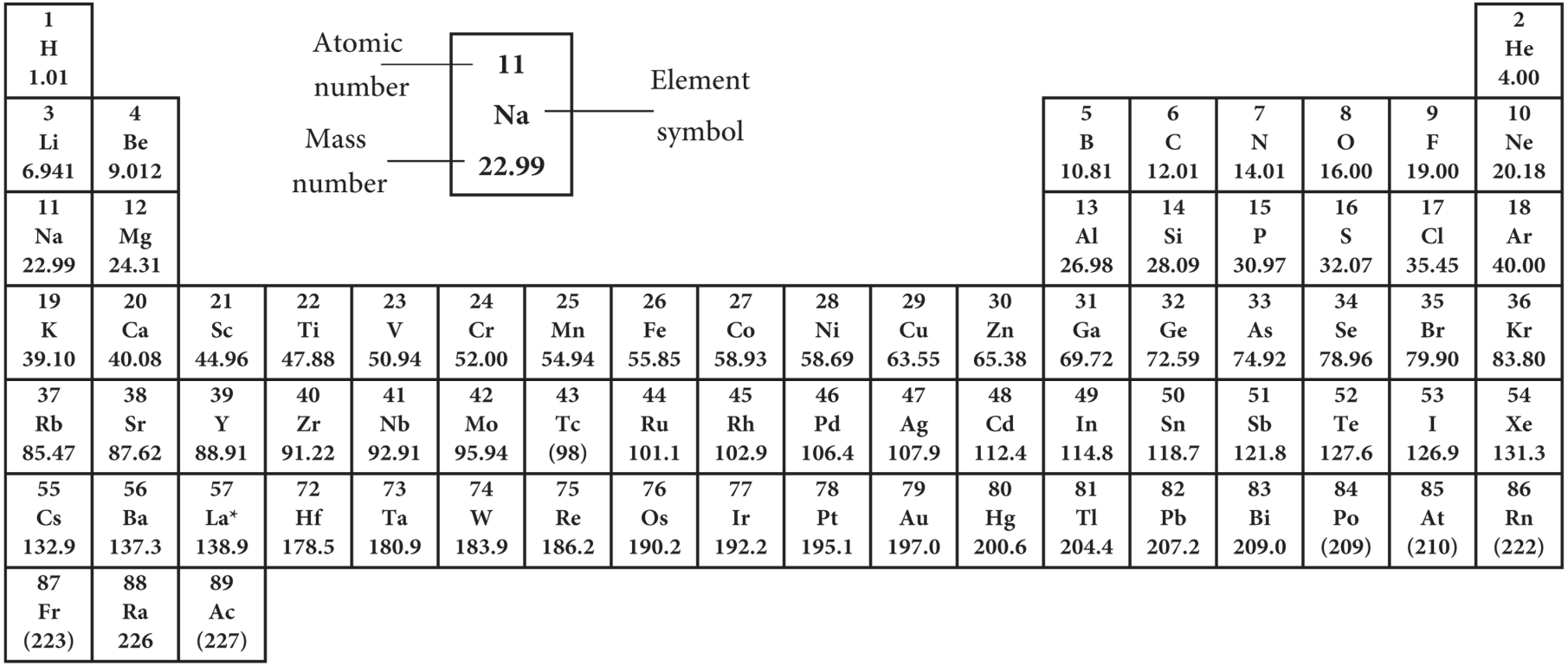
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Selected standard electrode potentials

Electrode reaction	$E^{\ominus}$/V
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2.87
$S_2O_8^{2-} + 2e^- \rightleftharpoons 2SO_4^{2-}$	+2.01
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1.77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.52
$PbO_2 + 4H^+ + 2e^- \rightleftharpoons Pb^{2+} + 2H_2O$	+1.47
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.33
$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1.23
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.07
$ClO^- + H_2O + 2e^- \rightleftharpoons Cl^- + 2OH^-$	+0.89
$NO_3^- + 10H^+ + 8e^- \rightleftharpoons NH_4^+ + 3H_2O$	+0.87
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2 + H_2O$	+0.81
$Ag^+ + e^- \rightleftharpoons Ag$	+0.80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.77
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0.54
$O_2 + 2H_2O + 4e^- \rightleftharpoons 4OH^-$	+0.40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2 + 2H_2O$	+0.17
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0.15
$S_4O_6^{2-} + 2e^- \rightleftharpoons 2S_2O_3^{2-}$	+0.09
$2H^+ + 2e^- \rightleftharpoons H_2$	0.00
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	–0.13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	–0.14
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	–0.44
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	–0.76
$2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$	–0.83
$V^{2+} + 2e^- \rightleftharpoons V$	–1.20
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	–2.38
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	–2.87
$K^+ + e^- \rightleftharpoons K$	–2.92

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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* 138.9	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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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)

للعام الدراسي ١٤٤٤ هـ - ٢٠٢٢ / ٢٠٢٣ م

الدور الأول - الفصل الدراسي الأول

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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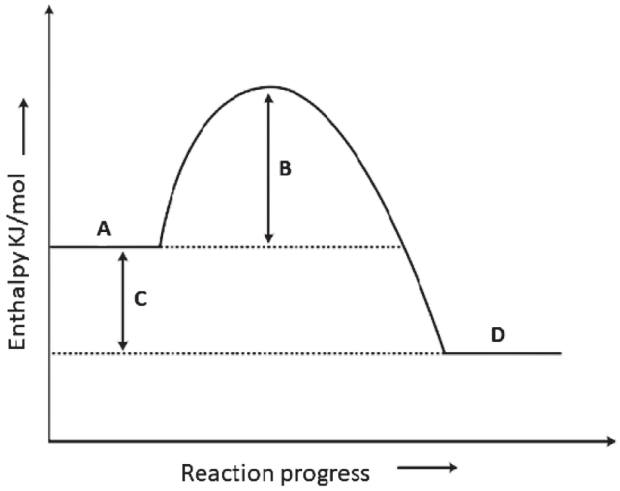
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Question 1: Multiple Choice Items (14 marks)

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.

Use the diagram below to answer questions 1 and 2.



1) Which statement about this reaction is correct?

- ○ It is exothermic, and the energy is released.
- ○ It is exothermic, and the energy is absorbed.
- ○ It is endothermic, and the energy is released.
- ○ It is endothermic, and the energy is absorbed.

2) Which letter represents the activation energy barrier?

- ○ A
- ○ B
- ○ C
- ○ D

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Question 1 continued

3) The table below shows the standard enthalpy of combustion of four hydrocarbons.

Hydrocarbon	Mr ($g.mol^{-1}$)	ΔH_c° ($kJ.mol^{-1}$)
Ethyne	26	– 1300
Propyne	40	– 1940
Propene	42	– 2060
Propane	44	– 3334

Which one from the above hydrocarbons releases 151.5 kJ when 2.0 g is combusted completely?

- ☐ Ethyne
- ☐ Propyne
- ☐ Propene
- ☐ Propane

4) Given the following data

$C\ (s) + 2H_2\ (g) \longrightarrow CH_4\ (g)$ $\Delta H = -90\ kJ\ mol^{-1}$

$H_2\ (g) \longrightarrow 2H\ (g)$ $\Delta H = +500\ kJ\ mol^{-1}$

Which one of the following is the enthalpy change in $kJ\ mol^{-1}$ of the reaction below?

$CH_4\ (g) \longrightarrow C\ (s) + 4H\ (g)$

- ☐ +410
- ☐ +590
- ☐ +910
- ☐ +1090

5) Which statement **is not correct** about the stability of benzene?

- ☐ The π bonds delocalize
- ☐ All C-C bonds are equal
- ☐ It is planar, regular hexagonal shape
- ☐ It undergoes normal addition reaction

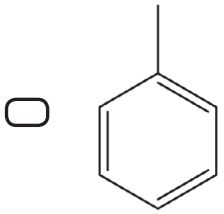
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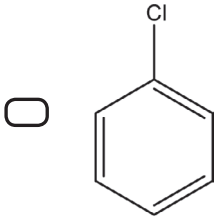
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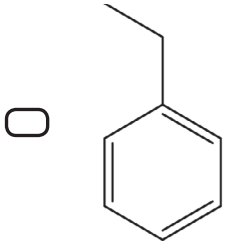
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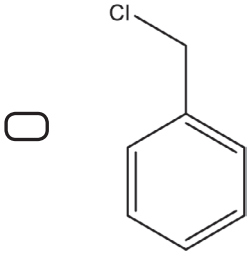
Question 1 continued

6) Which of the following compounds is produced by the reaction of a chloroethane and benzene in the presence of aluminum chloride under heating?

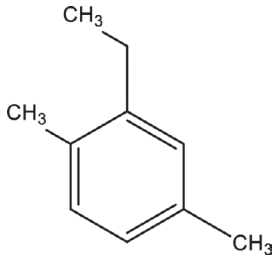








7) What is the name for the compound shown below according to IUPAC system?

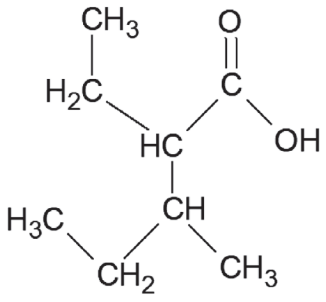


- 1-ethyl-1,4-dimethylbenzene
- 2-ethyl-1,4-dimethylbenzene
- 5-ethyl-2,4-dimethylbenzene
- 6-ethyl-2,4-dimethylbenzen

8) Which of the following reagent reacts with ethanoic acid to produce a salt and hydrogen gas?

- Potassium
- Potassium hydroxide
- Potassium manganate (VII)
- Potassium carbonates

9) What is the IUPAC name for the compound shown below?



- 2,3-diethylbutanoic acid
- 2,3-diethylpentanoic acid
- 2-ethyl-3-methylbutanoic acid
- 2-ethyl-3-methylpentanoic acid

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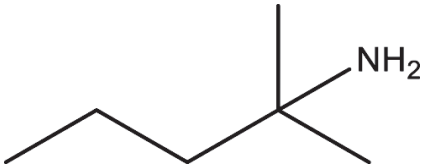
Question 1 continued

10) The pK_a of difluoroethanoic acid is (1.24). What pK_a would you expect for trifluoroethanoic acid?

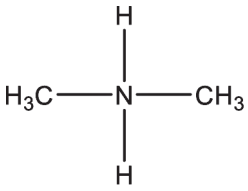
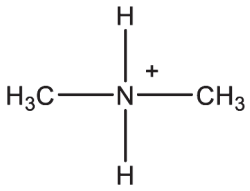
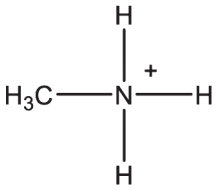
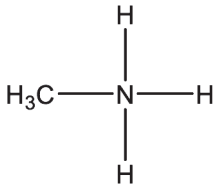
- ☐ 3.75
- ☐ 2.87
- ☐ 1.28
- ☐ 0.52

11) Which of the following statements **is not correct** about the compound below?

- ☐ It is tertiary amine
- ☐ It can act as a base
- ☐ It is 2-methyle-2-penta amine
- ☐ Its molecular formula is $C_6H_{15}N$



12) Which of the following represents correctly how methylamine would exist when dissolved in an acidic solution?

- ☐ 
- ☐ 
- ☐ 
- ☐ 

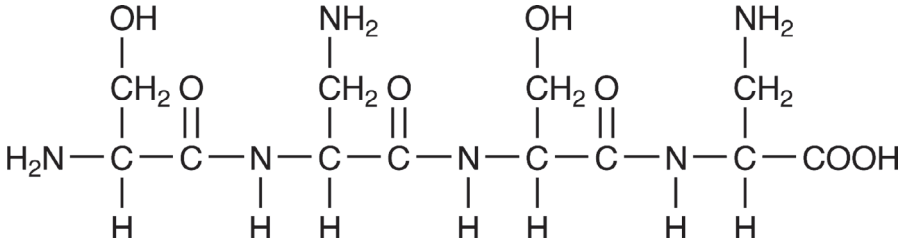
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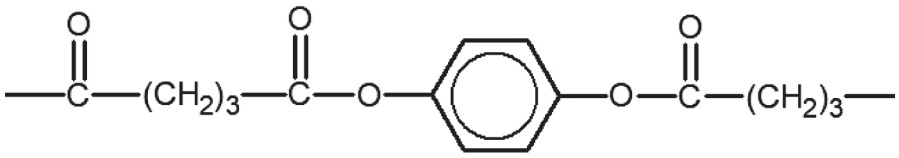
Question 1 continued

13) What are the structural formulae of the monomers that are used to produce the following compound?



	Monomer A	Monomer B
○	$NH_2CH(CH_2OH)\ CH_2OH$	$NH_2CH(CH_2NH_2)\ COOH$
○	$NH_2CH(CH_2OH)\ COOH$	$NH_2CH(CH_2NH_2)\ CH_2OH$
○	$NH_2CH(CH_2OH)\ COOH$	$NH_2CH(CH_2NH_2)\ COOH$
○	$NH_2CH(CH_2OH)\ CH_2OH$	$NH_2CH(CH_2NH_2)\ CH_2OH$

14) For the polymer shown below, which of the following options is correct?



	Type of the polymerisation	Type of the polymer
○	Condensation	Polyester
○	Addition	Polyester
○	Condensation	Polyamide
○	Addition	Polyamide

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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) An experiment was conducted to determine the enthalpy of combustion of liquid butanol. The energy obtained from burning 5 g of butanol was used to heat 200 g of water. The temperature of the water rose from 290 K to 360 K. (The specific heat capacity of water is 4.18 J K^{-1} g^{-1}, molar mass (M_r) of butanol = 74.12 g/mol)

a. Define the term standard enthalpy of combustion.

b. Calculate the value for the enthalpy of combustion of one mole of liquid butanol.

16) Study the following endothermic reaction below and answer the following questions.

$$CaCO_3\,(s) \longrightarrow CaO\,(s) + CO_2\,(g) \qquad \Delta H = +572\ kJ\ mol^{-1}$$

a. What is meant by the endothermic reaction?

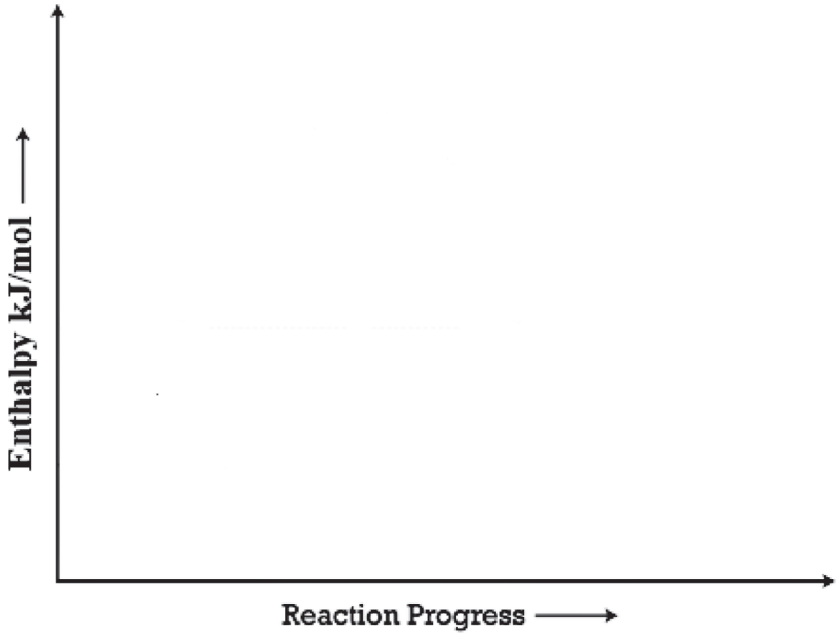
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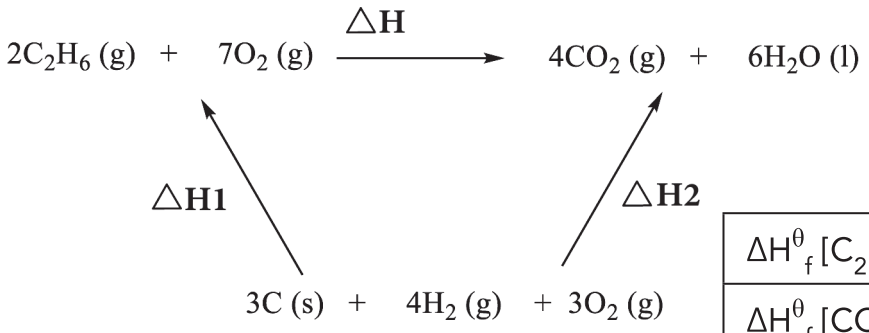
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Question 2 continued

b. Complete the energy level diagram below showing the reactants and products energy level and ΔH.



17) Study the following enthalpy cycle for the combustion of ethane. Use the information in the table and answer the questions below:



$\Delta H^{\theta}_{f}[C_2H_6\ (g)]$	=	−84.68 kJ mol^{-1}
$\Delta H^{\theta}_{f}[CO_2\ (g)]$	=	−393 kJ mol^{-1}
$\Delta H^{\theta}_{f}[H_2O\ (l)]$	=	−286 kJ mol^{-1}

a. State Hess's law.

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Question 2 continued

b. What name is given to the symbol ΔH^{θ}_{f}? Define ΔH^{θ}_{f}.

Name of ΔH^{θ}_{f} : _____

Definition: _____

_____

c. Calculate ΔH of the equation below

$$2C_2H_6\,(g) + 7O_2\,(g) \longrightarrow 4CO_2(g) + 6H_2O(g)$$

_____

_____

_____

_____

_____

_____

_____

d. What type of reaction is this?

☐ Exothermic ☐ Endothermic (Shade your answer)

Explain: _____

e. The energy flows:

☐ To the surrounding ☐ From the surrounding (Shade your answer)

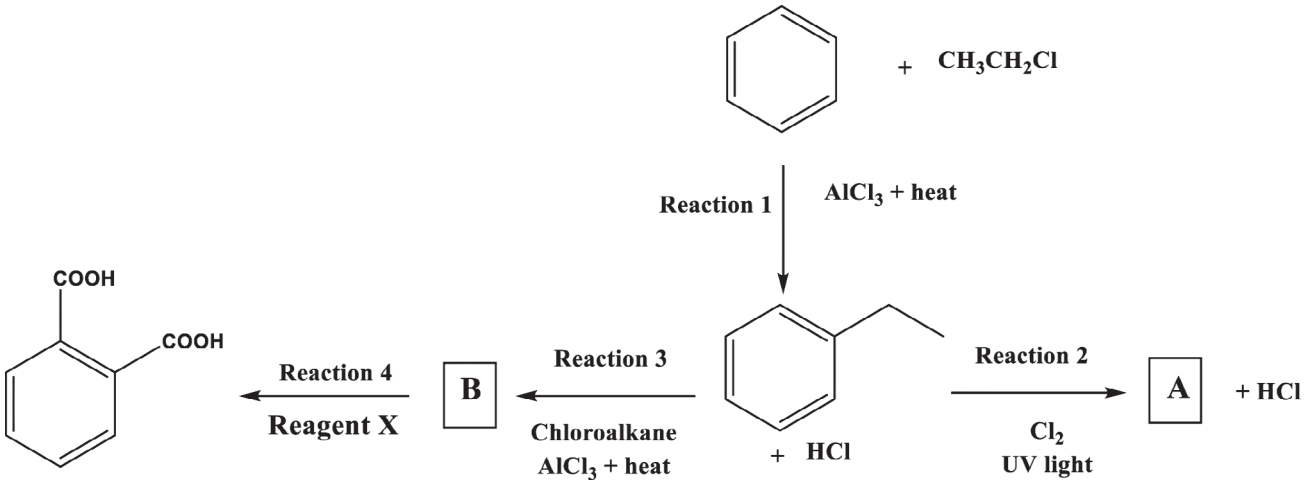
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Question 2 continued

18) A series of chemical reactions starting from benzene was carried out as follows. Study the scheme and answer the following question



a. For reaction (1):

(i) What is the type of **reaction 1**?

(ii) Write the mechanism step for **reaction 1**, which describes the production of electrophile (the intermediate carbocation).

b. For reaction (2):

(i) Draw the structural formula of compound (**A**).

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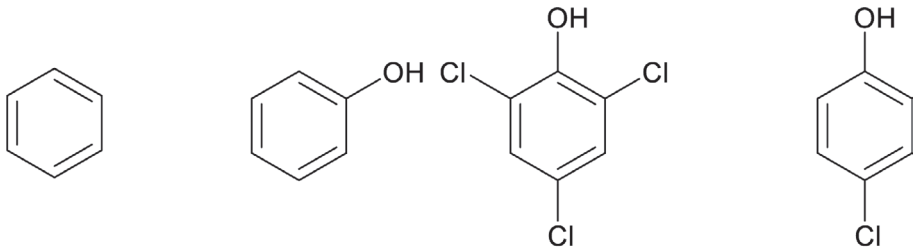
Question 2 continued

(ii) Draw the structural formula of the predicted organic product if warm $AlCl_3$ is used instead of UV light.

c. Draw the structure of the organic compound (**B**) with the formula C_9H_{12}.

d. What is the **reagent X** used in **reaction 4**?

19) Study the following compounds and answer the questions below.



a. Which compound is formed when phenol reacts with the 3 moles of an aqueous chlorine?

b. Which one is more reactive with electrophilic, compound (A) or compound (B)?

☐ A ☐ B (Shade your answer)

Explain your answer:

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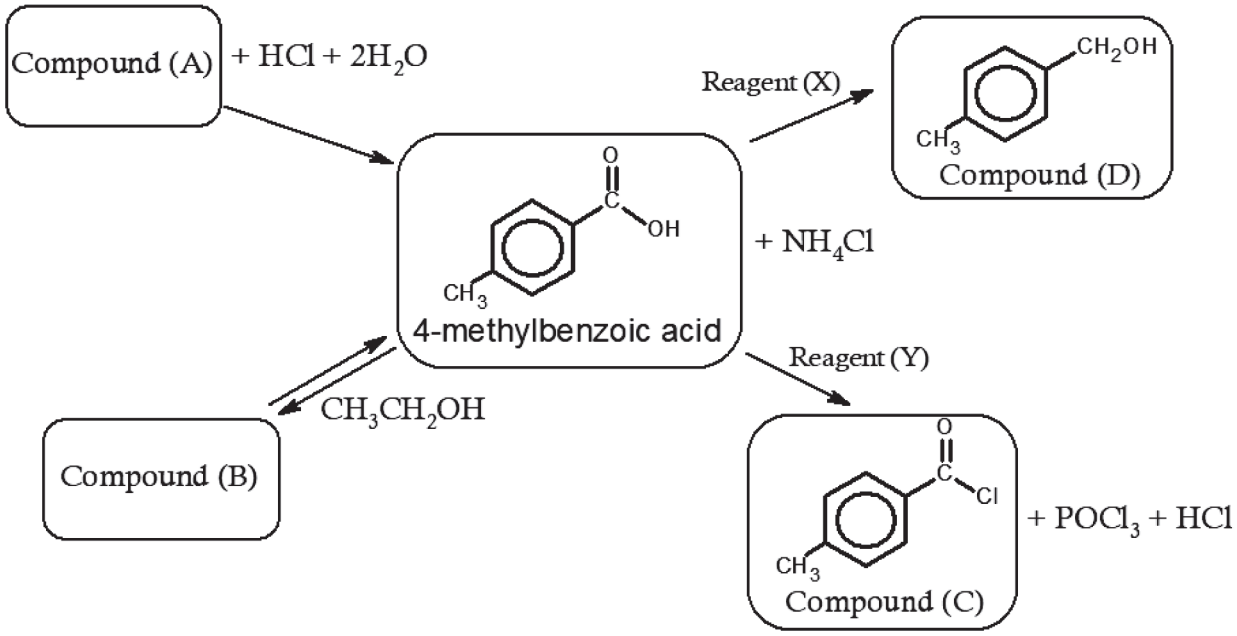
Question 2 continued

20) Compare acyl chlorides and chloroalkanes in terms of:

a. Boiling point.

b. Rate of hydrolysis:

21) Study the reactions sequence shown below. Then answer the following questions:



a. Draw the formula of the:

(i) Compound (A)

(ii) Compound (B)

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Question 2 continued

b. Write the formula of the:

(i) Reagent (X) _____

(ii) Reagent (Y) _____

c. If compound (C) reacts with compound (D):

(i) What is the type of this reaction?

_____

(ii) Draw the structural formula of the organic product.

_____

d. If compound (C) undergoes hydrolysis:

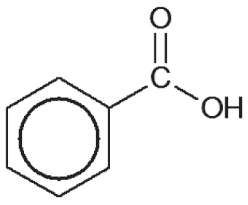
(i) What is the condition for this hydrolysis?

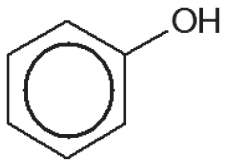
_____

(ii) Draw the structural formula of the organic product.

_____

e. Which one is more acidic:





☐ Benzoic acid ☐ Phenol (Shade your answer)

Explain your answer: _____

_____

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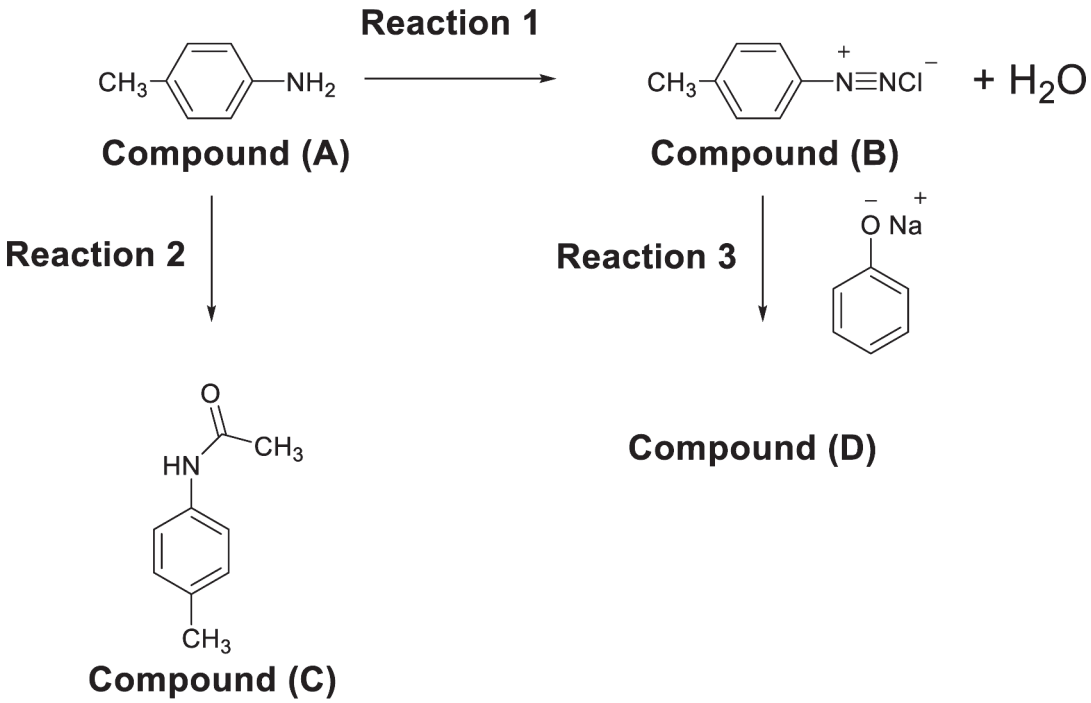
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Question 2 continued

22) A sequence of chemical reactions was carried out as follows. Study it and answer the following questions.



a. For **reaction 1**:

(i) What is the class of amine of **compound (A)**?

_____

(ii) What are the required reagents and condition for **reaction 1**?

_____

(iii) Name **compound (A)**.

_____

b. Draw the structural formula of the **compound (D)**.

_____

_____

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Question 2 continued

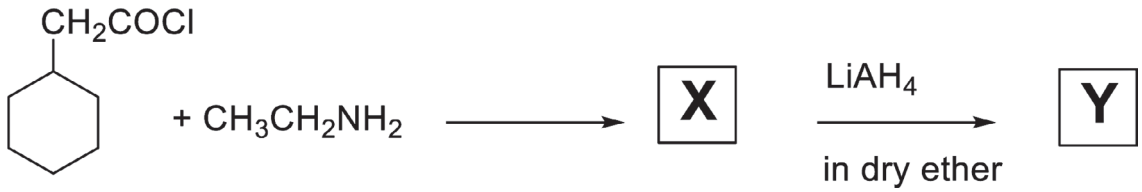
c. For the **compound (C)**:

(i) Draw the hydrogen bonding formed between two molecules in this compound.

(ii) What is the nitrogen functional group in **compound (C)**?

(iii) Draw the products for the hydrolysis of the **compound (C)** in NaOH.

23) The scheme below shows reactions of nitrogen compounds. Study them and answer the following questions.



a. Draw the structural formula of the compound:

(i) X

(ii) Y

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Question 2 continued

b. Which one is more basic, alanine or ethylamine?

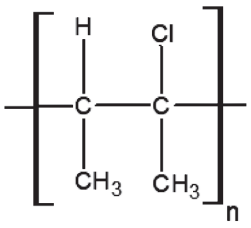
○ Alanine ○ Ethylamine (Shade your answer)

Explain your answer: _____

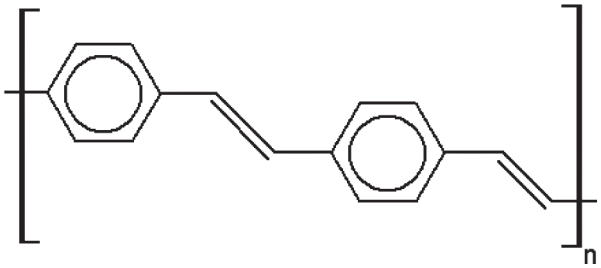
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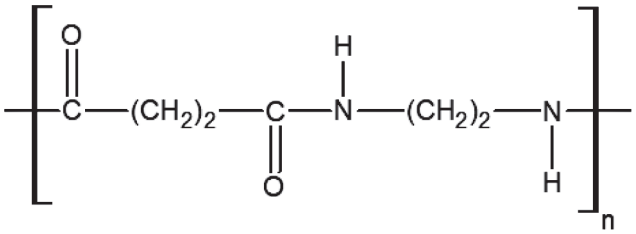
24) The repeat unit of three polymers are shown below:



Polymer (A)



Polymer (B)



Polymer (C)

a. For the polymer (A):

(i) Name the type of polymerization involved.

_____

(ii) Draw the structure of the monomer used to form this polymer.

_____

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Question 2 continued

b. For the polymer (C):

(i) What is the type of this polymer?

_____

(ii) What is the intermolecular forces between adjacent chains of this polymer?

_____

c. Which one from the polymers above is a conducting polymer? Explain your answer.

○ Polymer (A) ○ Polymer (B) ○ Polymer (C) (Shade your answer)

Explanation _____

[End of the Examination]

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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)

للعام الدراسي ١٤٤٤ هـ - ٢٠٢٢ / ٢٠٢٣ م

الدور الثاني - الفصل الدراسي الأول

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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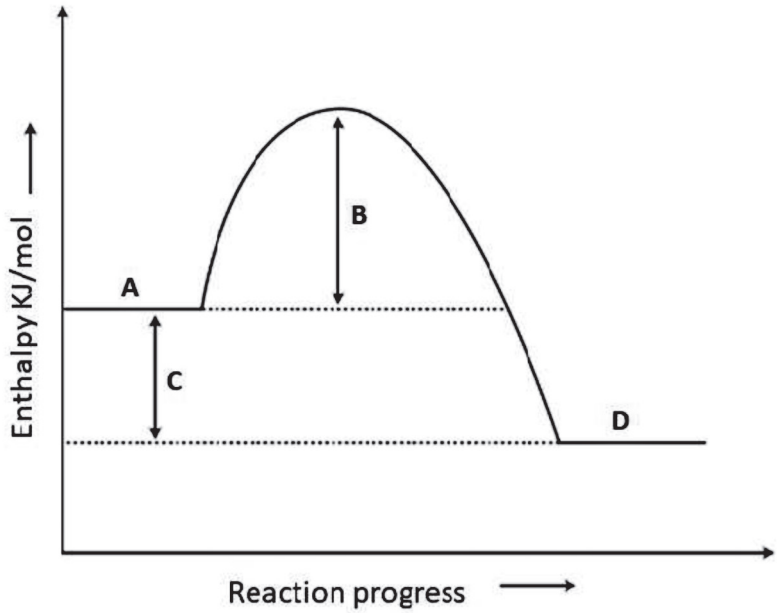
Question 1: Multiple Choice Items (14 marks)

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) The enthalpy change when one mole of a product is formed from its elements, under standard conditions is defined as:

- ○ The enthalpy change of formation
- ○ The enthalpy change of combustion.
- ○ The enthalpy change of neutralization.
- ○ The enthalpy change of atomization.

2) Which letter represents the enthalpy change ΔH?



- ○ A
- ○ B
- ○ C
- ○ D

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Question 1 continued

3) Enthalpy data for the following chemical equation is given in the table below.

$$CO\ (g) + H_2O(g) \longrightarrow CO_2(g) + H_2(g)$$

Substance	CO(g)	$H_2O(g)$	$CO_2(g)$	$H_2(g)$
ΔH^{θ}_{f} **kJ mol^{-1}**	−110	−242	−394	0

What is the standard enthalpy change for this reaction?

- ☐ −42 kJ mol^{-1}
- ☐ +42 kJ mol^{-1}
- ☐ −262 kJ mol^{-1}
- ☐ +262 kJ mol^{-1}

4) What is the enthalpy change of combustion of propane in kJ mol^{-1}, when 0.10 g of propane was burned if quantity of heat evolved was 5.0 kJ?
(Mr of propane 44 g mol^{-1})

- ☐ −800
- ☐ −1500
- ☐ −2200
- ☐ −2900

5) Which statement is not correct about the electrophilic substitution reaction of benzene reactions?

- ☐ In nitration, benzene reacts with NaOH.
- ☐ Bromination produces 2,4,6-tribromophenol.
- ☐ $AlCl_3$ is used with heat in acylation reactions.
- ☐ An intermediate carbocation is formed only in alkylation.

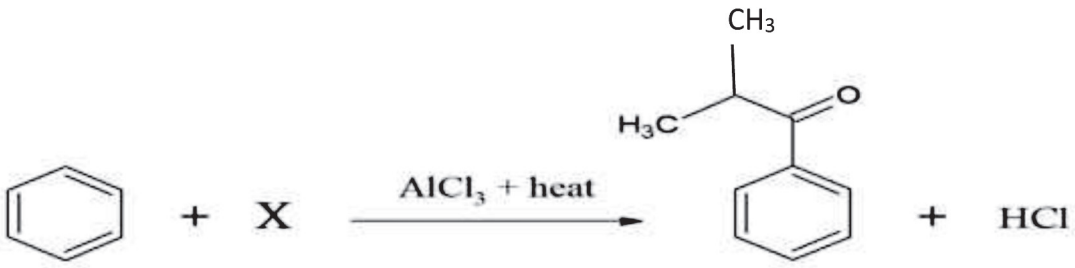
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Question 1 continued

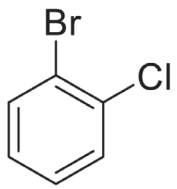
6) For the reaction below:

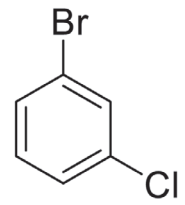


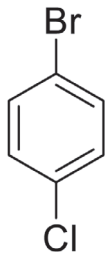
Which of the following options is correct about the type of the reaction and the reagent (X)?

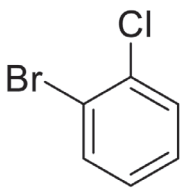
	Type of reaction	Reagent X
☐	Alkylation	$(CH_3)_2CHCH_2Cl$
☐	Acylation	$(CH_3)_2CHCH_2Cl$
☐	Alkylation	$(CH_3)_2CHCOCl$
☐	Acylation	$(CH_3)_2CHCOCl$

7) Which of the following structural formulae is m-chlorobromobenzene?

☐ 

☐ 

☐ 

☐ 

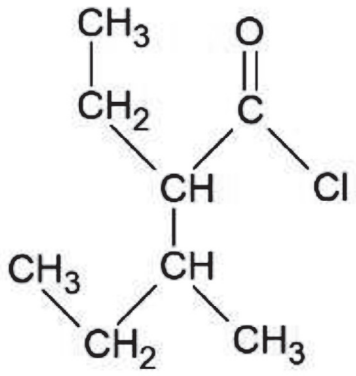
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Question 1 continued

8) Which of the following reacts with ethanoic acid to produce an ester?

- ☐ Methanol.
- ☐ Tollens' reagent.
- ☐ Potassium carbonates.
- ☐ Potassium manganate (VII).

9) What is the IUPAC name for the compound shown below?



- ☐ 2,3-diethylbutanoyl chloride
- ☐ 2,3-diethylpentanoyl chloride
- ☐ 2-ethyl-3-methylbutanoyl chloride
- ☐ 2-ethyl-3-methylpentanoyl chloride

10) The K_a of difluoroethanoic acid is (57.5×10^{-3}).

What Ka would you expect for trifluoroethanoic acid?

- ☐ 0.18×10^{-3}
- ☐ 1.35×10^{-3}
- ☐ 52.5×10^{-3}
- ☐ 302.0×10^{-3}

11) Which of the following mixtures could form an amide?

- ☐ $CH_3CH_2NH_2$ with HNO_2
- ☐ $CH_3CH_2CH_2COCl$ with NH_3
- ☐ $CH_3CH_2CH_2Br$ with $CH_3CH_2NH_2$
- ☐ CH_3CH_2COCl with $LiAlH_4$

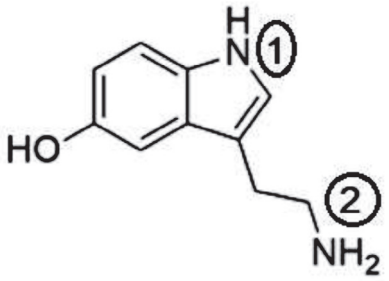
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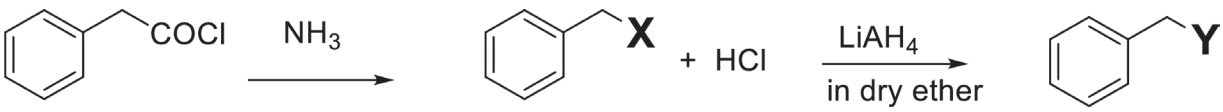
Question 1 continued

12) What is the class of amine labeled 1 and 2 in the compound shown below?



	1	2
○	Primary amine	Secondary amine
○	Secondary amine	Primary amine
○	Tertiary amine	Primary amine
○	Secondary amine	Secondary amine

13) For the reaction sequence below:



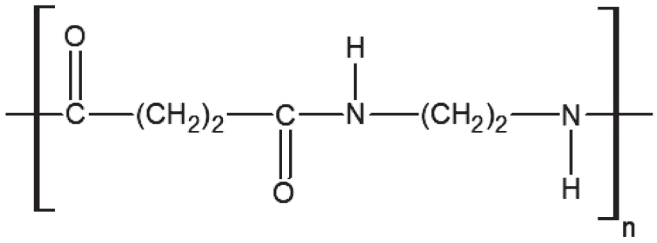
Which of the following options represents substituents (X) and (Y)?

	X	Y
○	— $CONH_2$	— CH_2NH_2
○	— CH_2NH_2	— $CONH_2$
○	— $CONH_2$	— COOH
○	— CH_2NH_2	— COOH

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Question 1 continued

14) A polymer is shown below:



Which of the following options about this polymer is correct?

	Type of the polymerization	Type of the polymer
☐	Condensation	Polyester
☐	Addition	Polyester
☐	Condensation	Polyamide
☐	Addition	Polyamide

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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 student mixed 30.0 cm^3 of 2.0 mol dm^{-3} potassium hydroxide solution with 30.0 cm^3 of 2.0 mol dm^{-3} hydrochloric acid in a polystyrene cup.

$$HCl\ (aq) + KOH\ (aq) \longrightarrow KCl\ (aq) + H_2O\ (l)$$

The temperature rose by 10.0 °C. Assume no heat was lost to the surroundings.

The final mixture had a specific heat capacity of 4.18 J g^{-1} $°C^{-1}$

a. Define the term standard enthalpy of neutralization.

b. Calculate the molar enthalpy change for the reaction (show your calculations).

c. Is this an endothermic or exothermic reaction? Explain your answer.

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Question 2 continued

16) Study the following chemical reactions and answer the questions below:

$H_2(g) + ½O_2(g) \longrightarrow H_2O(l)$ $\Delta H = -300$ kJ

$N_2O_5(g) + H_2O(l) \longrightarrow 2HNO_3(l)$ $\Delta H = -90$ kJ

$N_2(g) + 3O_2(g) + H_2(g) \longrightarrow 2HNO_3(l)$ $\Delta H = -348.2$ kJ

a. State Hess's law.

b. Calculate the ΔH for the following reaction showing all the steps for the calculation:

$$2N_2(g) + 5O_2(g) \longrightarrow 2N_2O_5(g)$$

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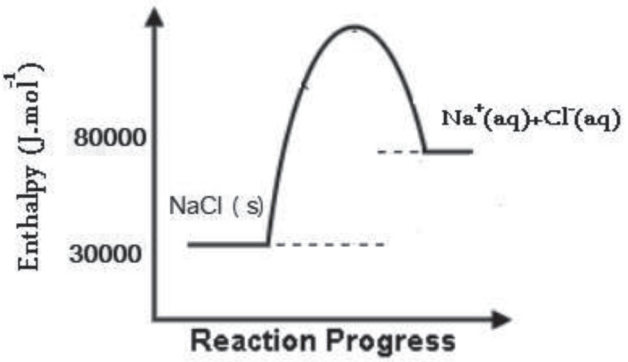
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Question 2 continued

17) The diagram shows the enthalpy change of dissolving 8 g sodium chloride (NaCl) in water to form 600 g solution. (Mr of NaCl =58.5 g/mol, c = 4.18 J $.g^{-1}.°C^{-1}$)

Study it and answer the questions below.



a. What is the type of enthalpy change (ΔH) shown in the diagram?

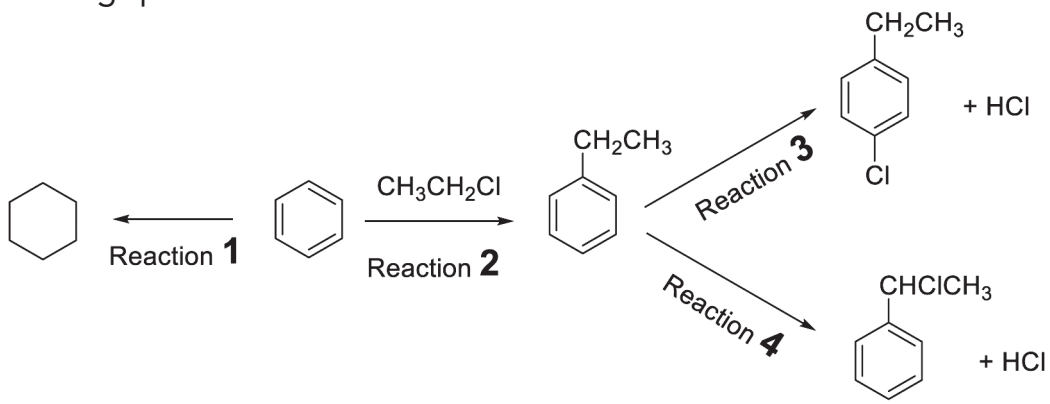
○ ΔH_{sol} ○ ΔH_f (Shade the correct answer)

b. Calculate the final temperature in °C if the initial temperature was 30 °C.

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Question 2 continued

18) The following diagram shows some reactions series of benzene. Study it and answer the following questions.



a. What are the required reagents and conditions for:

(i) Reaction **1** _____

(ii) Reaction **3** _____

(iii) Reaction **4** _____

b. Why do all the carbon-carbon bonds in benzene have the same length?

_____

_____

c. Draw the structural formula of the product if CH_3CH_2COCl is used instead of CH_3CH_2Cl in reaction **2**.

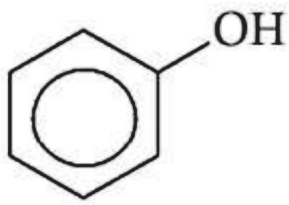
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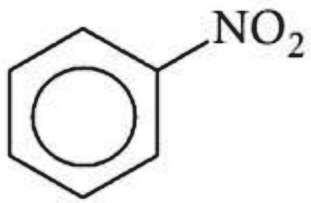
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Question 2 continued

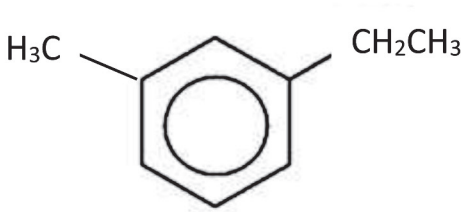
19) Study the compounds below and answer the following questions.



A



B



C

a. A dilute solution of 3 moles of bromine in water is added to compound (A) at room temperature. Draw the structure of the product.

b. Which one is more reactive with chlorine (Cl_2)?

☐ Compound (A) ☐ Compound (B) (Shade the correct answer)

Explain you answer._____

_____

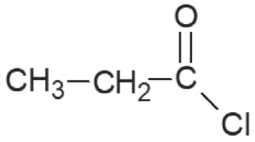
c. Draw the structural formula of the product when compound (C) is oxidized by $KMnO_4$.

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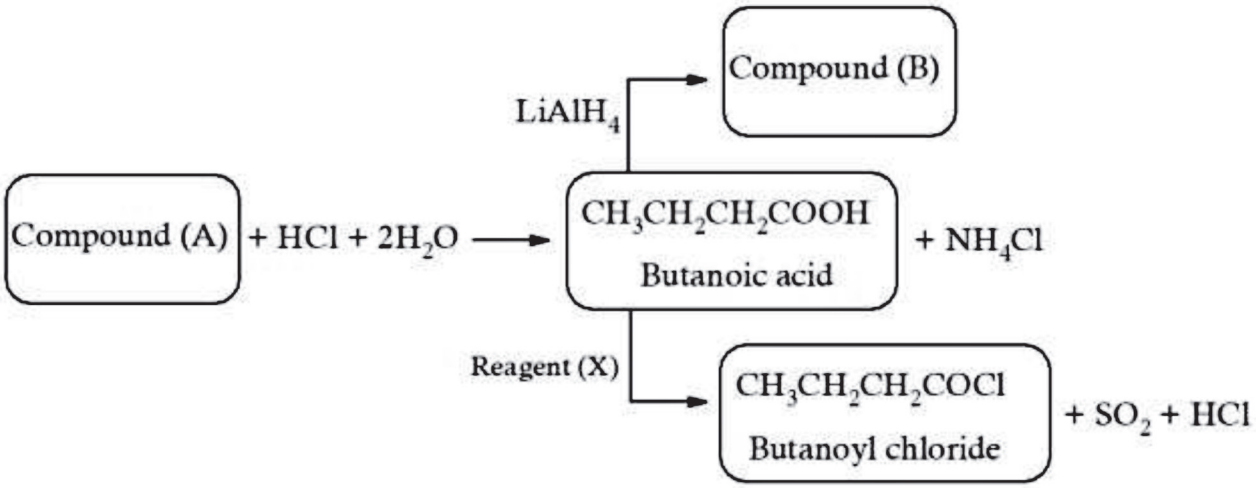
Question 2 continued

20) Hydrolysis involves the reaction of an organic compound with water.

Compare between the hydrolysis of propanoyl chloride and 1-chloropropane in the table below:

Compound		$CH_3-CH_2-CH_2Cl$
Conditions for the hydrolysis	_____	_____
Rate of the hydrolysis	_____	_____
Organic product	_____	_____

21) Study the reactions sequence below, then answer the following questions:



a. Write the formula of the:

(i) Compound (A) _____

(ii) Compound (B) _____

(iii) Reagent (X) _____

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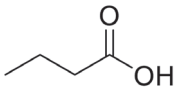
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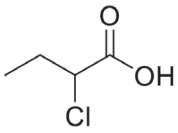
Question 2 continued

b. What is the type of the reaction of butanoyl chloride with ammonia (NH_3)?

_____

c. Which one is more acidic ?



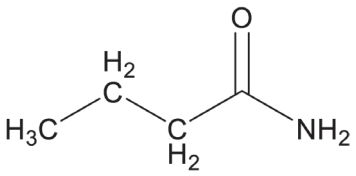


☐ Butanoic acid ☐ 2-chlorobutanoic acid (Shade the correct answer)

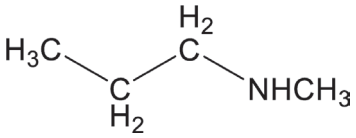
Explain your answer:_____

_____

22) a. Name the following compounds:

(i) 

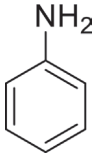
_____

(ii) 

_____

b. Classify the following amines:

(i) $(CH_3CH_2)_2NH$: _____

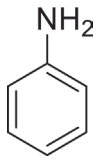
(ii) 

_____

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Question 2 continued

c. **(i)** Which one is more basic? Explain your answer

○ $(CH_3CH_2)_2NH$ ○ 

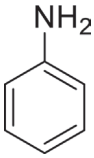
(Shade the correct answer)

Explanation: _____

_____

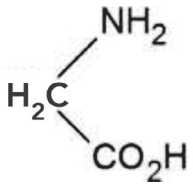
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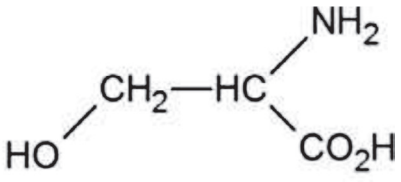
(ii) Show by drawing the effect of benzene ring in basicity of 

.

23) Glycine and Serine are naturally occurring compounds.



Glycine (Gly)



Serine (Ser)

a. Explain why Gly has acid and base properties.

_____

_____

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Question 2 continued

b. Draw the structure of the zwitterion formed by Glycine.

c. What type of reaction do amino acids undergo to form proteins?

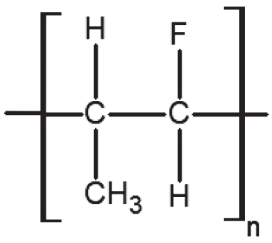
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d. **Draw** the structure formula of the dipeptide Ser-Ser and **label** the peptide bond on your structure.

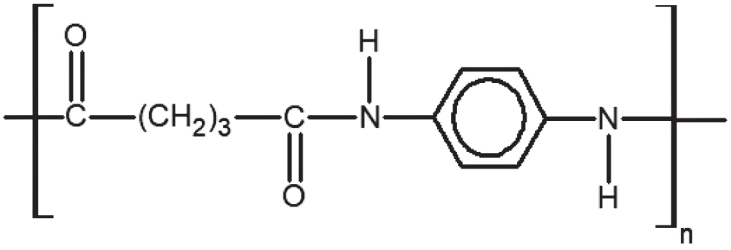
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Question 2 continued

24) The repeat unit of two polymers are shown below:



Polymer (A)



Polymer (B)

a. For the polymer (A):

(i) Name the type of polymerisation involved.

_____

(ii) Draw the structure of the monomer used to form this polymer.

b. For the polymer (B):

(i) What is the type of this polymer?

_____

(ii) Draw the structure of the monomer(s) used to form this polymer.

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Question 2 continued

c. Explain why polymer (B) is stronger than polymer (A).

[End of the Examination]

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مُسَوَّدَة

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امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)

للعام الدراسي ١٤٤٣ هـ - ٢٠٢١ / ٢٠٢٢ م

الدور الأول - الفصل الدراسي الأول

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٥) 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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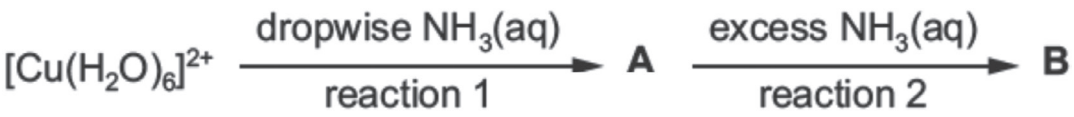
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Question 1: Multiple Choice Items (14 marks)

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) The scheme below shows two steps reaction:



Which of the following options is correct for these steps?

	Colour of compound A	The complex ion of Compound B
⬭	blue	$[Cu(NH_3)_4(H_2O)_2]^{2+}$
⬭	purple	$[Cu(H_2O)_4(OH)_2]$
⬭	purple	$[Cu(NH_3)_4(H_2O)_2]^{2+}$
⬭	blue	$[Cu(H_2O)_4(OH)_2]$

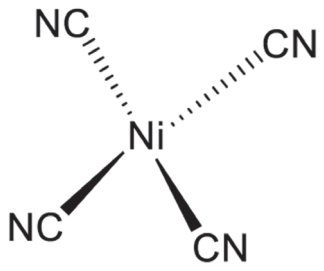
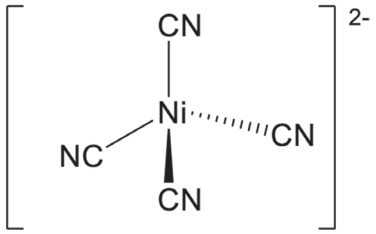
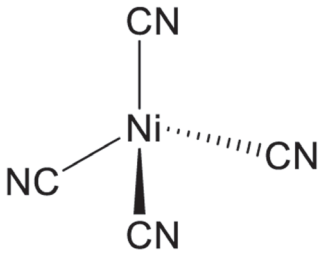
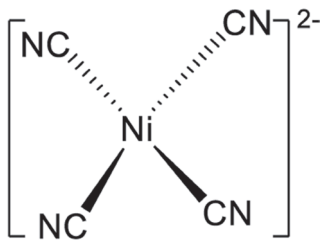
2) Which of the following options about the complex ions is **correct**?

	Geometrical Shapes	
	$[Ag(NH_3)_2]^+$	$[Cr(H_2O)_6]^{3+}$
⬭	linear	tetrahedral
⬭	octahedral	tetrahedral
⬭	linear	octahedral
⬭	octahedral	octahedral

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Question 1 continued

3) A cation Ni^{2+} forms a complex ion with four CN^-. Which of the following options is correct? (Atomic number of Ni = 28)

	Structure of the complex ion	Electronic configuration of Ni^{2+}
☐		$[Ar]3d^8 4s^2$
☐		$[Ar]3d^8 4s^2$
☐		$[Ar]3d^8$
☐		$[Ar]3d^8$

4) Which statements about the Fridel-Craft reactions **is not correct?**

- ☐ Acylation produces a ketone.
- ☐ In acylation, benzene reacts with acyl chloride.
- ☐ Uses $AlCl_3$ with heat in both alkylation and acylation reactions.
- ☐ Formation of an intermediate carbocation occurs only in alkylation.

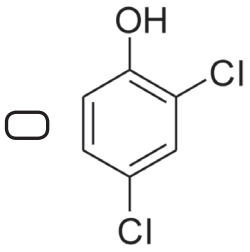
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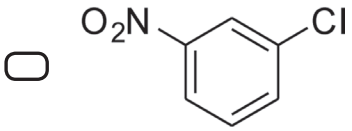
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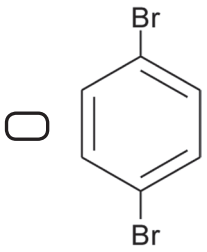
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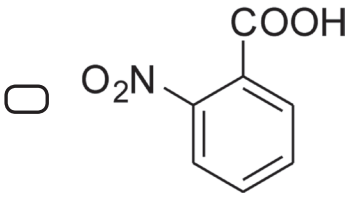
Question 1 continued

5) Which of the following represents the meta substitution in those compounds?

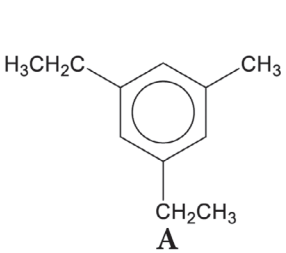




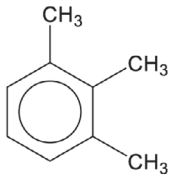




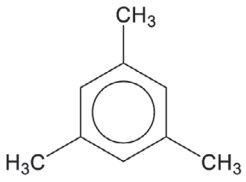
6) Identify the compounds that can form the same product when added to $KMnO_4$ and heated with a basic solution:



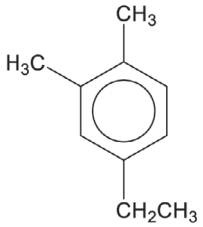
A



B



C



D

- ☐ A and C
- ☐ B and C
- ☐ B, C and D
- ☐ A, B and D

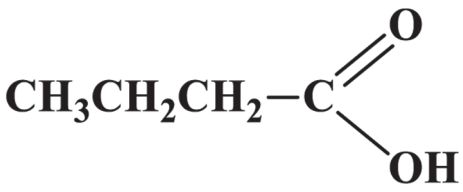
7) Which of the following properties about carboxylic acids is **correct**?

- ☐ All carboxylic acids can not be further oxidised.
- ☐ Electron-withdrawing groups decrease their acid strength.
- ☐ They form salts when they react with metals, alkalis and carbonates.
- ☐ Their acid strength increases by electron-donating groups.

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Question 1 continued

8) Which of the following statements about the compound below is **correct**?

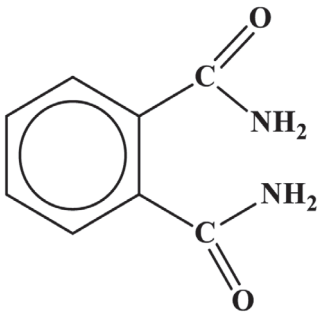
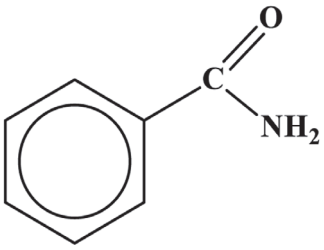
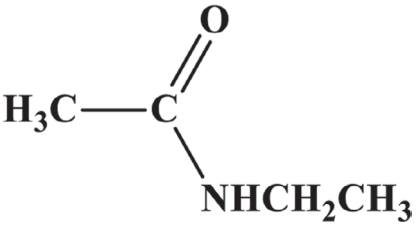
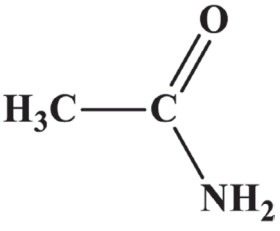


- ☐ It can be formed from $CH_3CH_2CH_2C \equiv N$.
- ☐ It forms $H_2(g)$ when it reacts with carbonates.
- ☐ Its acidity strength is increased by the alkyl group.
- ☐ It is oxidized to $CH_3CH_2CH_2CH_2OH$ by the use of $LiAlH_4$.

9) A compound R has the following properties:

It is an aryl compound and is produced by reacting an acyl chloride with 1 mole of NH_3.

Which structure could represent R?

- ☐ 
- ☐ 
- ☐ 
- ☐ 

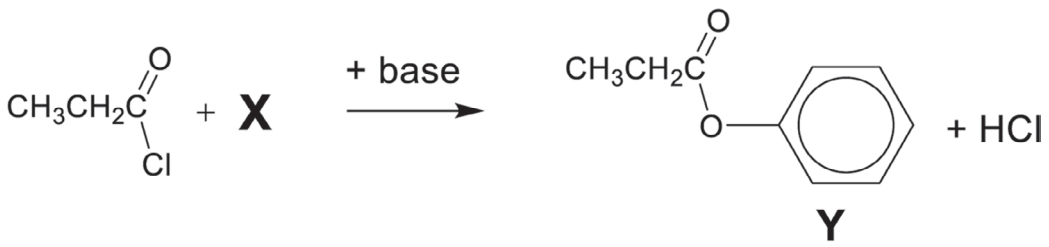
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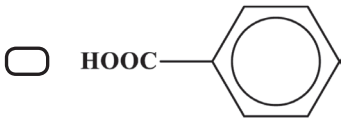
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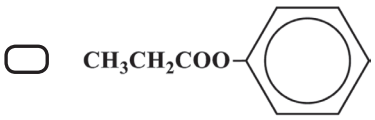
10) A compound X can be converted into compound Y in a single step.

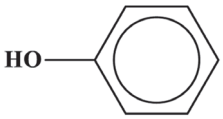


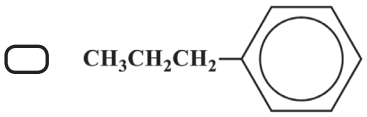
Y

Which option could be X?





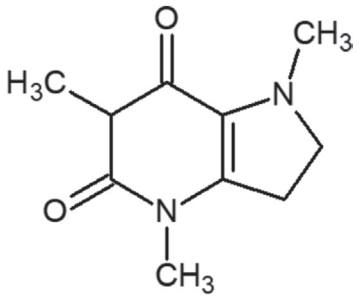




11) Which of the following statements about amines is **not correct**?

- They are basic.
- They are soluble in water.
- They react with acids to form salts.
- They react with water to produce H^+.

12) Which nitrogen functional groups are present in the compound shown below?

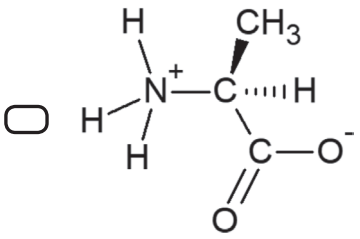


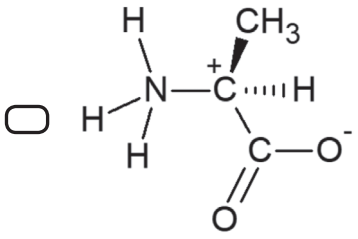
- Secondary amine and amino acid.
- Tertiary amine and amide.
- Secondary amine and amide.
- Tertiary amine and amino acid.

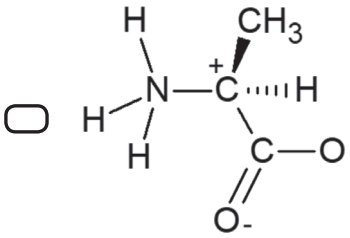
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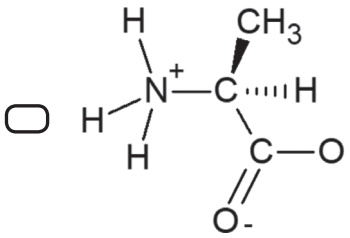
Question 1 continued

13) Which of the following is the zwitterion for alanine?

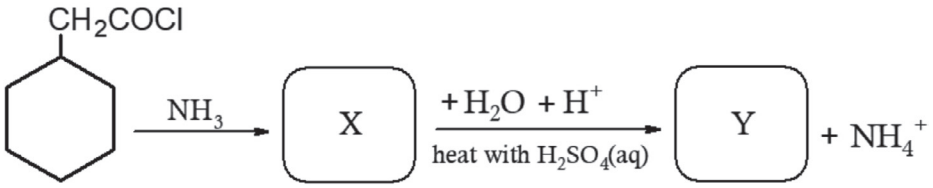




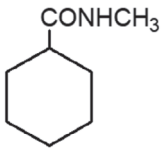
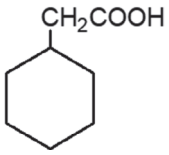
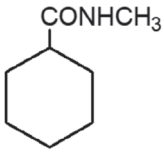
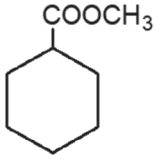
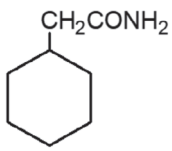
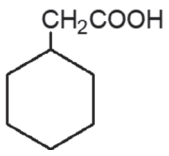
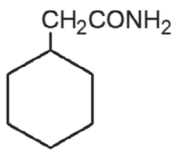
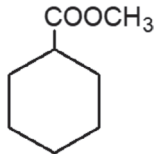




14) For the series reactions below:



Which of the following options represents (X) and (Y)?

	X	Y
○		
○		
○		
○		

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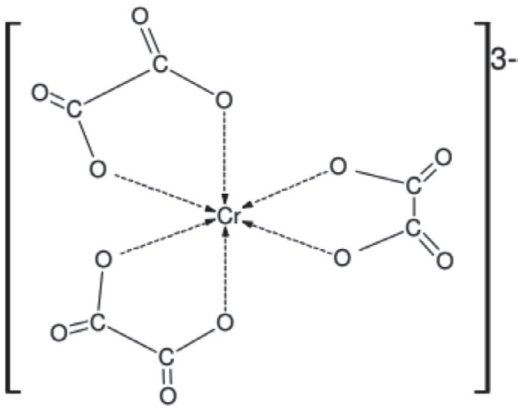
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Question 2: Extended responses (56 marks)

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) Chromium is a transition metal with the atomic number 24. Study the complex ion shown below, then answer the following questions.



a. From which d-block does the chromium atom belong?

_____

b. Write the electronic configuration of a chromium atom and a chromium ion using [Ar] to represent the argon core.

Chromium atom _____

Chromium ion _____

c. Explain why chromium is an exception in the general trend when filling the electrons in the subshells.

_____

d. State two characteristics of the metal Cr as a transition metal.

_____ , _____

e. Write the molecular formula of this complex ion. _____

f. How many dative bonds (co-ordinate bonds) are formed in this complex ion?

_____

Do not write in this space

Question 2 continued

g. What is the charge of the central metal in this complex ion?

_____

h. What is the type of ligand in this complex ion (monodentate or bidentate)?

Explain your answer. _____

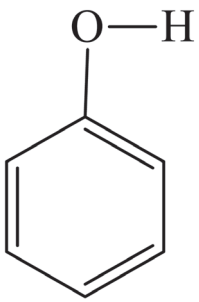
_____

i. How many pairs of electrons are donated by all ligands in this complex ion?

_____

j. What is the ligand in this complex ion? _____

16) Phenol is an aromatic compound that has the structure below:



a. Write the equation of a phenol reaction with:

(i) NaOH

_____

_____

(ii) 3 moles of Br_2

_____

_____

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Do not write in this space

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Question 2 continued

b. What type is reaction **(ii)**?

_____

c. Name of the compound produced in reaction **(ii)**

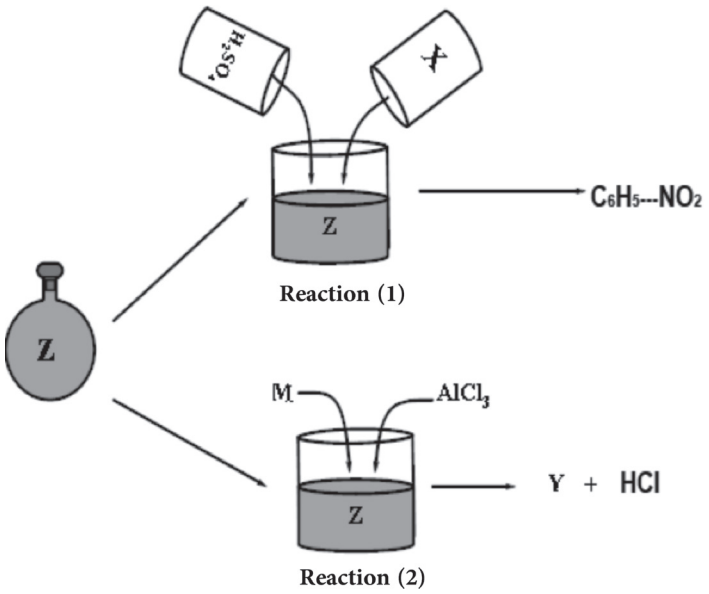
_____

d. Which compound, phenol or benzene, is more reactive?

_____

Explain: _____

17) A solution of aryl compound (Z) undergoes two reactions (1 and 2) as shown below:



a. Write the formula of X:

_____

b. Draw the structure of compound C_6H_5 — NO_2

_____

c. Write the equation for reacting 3 moles of H_2 with compound Z.

_____

Do not write in this space

Question 2 continued

d. Complete the table below for compounds Y if using different reagents of M in reaction 2.

M	Y
Cl_2	_____
CH_3CH_2COCl	_____

18) Both chloroalkanes and acyl chlorides react with water, but only acyl chlorides produce steamy fume in moist air.

a. Identify the product that causes the fumes in the reaction of acyl chlorides with water.

_____

b. Which one is more reactive chloroalkanes or acyl chlorides, and which one's rate of hydrolysis is faster?

_____

c. Explain why the reactivities of chloroalkanes and acyl chlorides differ.

_____

_____

_____

d. Which would you expect to have a higher boiling point, chloroalkanes or acyl chlorides?

_____

_____

_____

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Question 2 continued

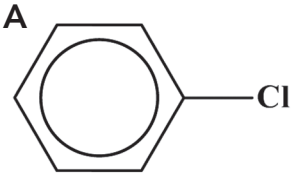
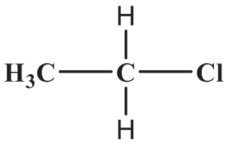
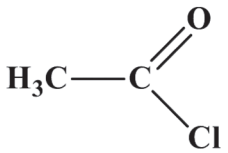
e. Complete the following table for the two reactions.

The reaction	The condition	Type of the organic products
Hydrolysis of acyl chlorides	_____	Carboxylic acid
Hydrolysis of chloroalkanes	Heat under pressure at 100° C	_____

f. Draw the structural formula for an acyl chloride with four carbons.

_____

19) Write the symbol of the correct compound given in the table below in the spaces provided for the following statements:

A	B	C
		

a. It has the least rate of hydrolysis. (_____)

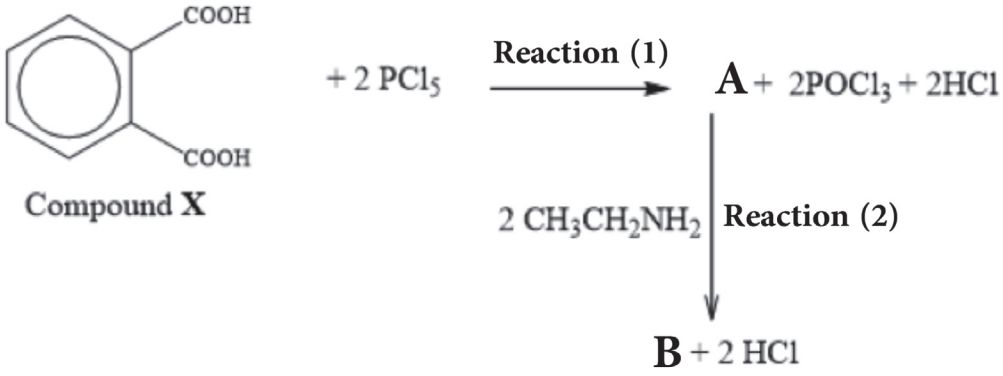
b. It forms amide by its reaction with ammonia. (_____)

c. It is a derivative of carboxylic acid and has the least value of pka. (_____)

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Question 2 continued

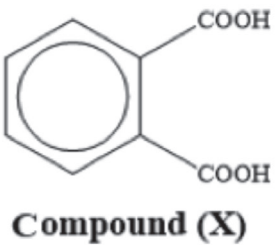
20) A series of two chemical reactions starting from compound X was carried out as follows. Study it and answer the following questions.



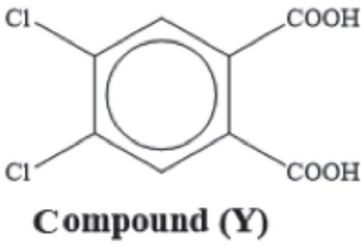
a. Draw the structural formulae of compounds (A) and (B) in the table below.

Compound (A)	Compound (B)

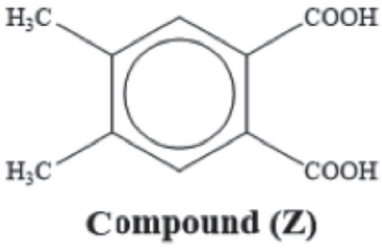
b. Arrange compounds (X), (Y) and (Z) according to their acidity in the following table from the least acidic to the most acidic.



Compound (X)



Compound (Y)



Compound (Z)

The weakest acid (The least acidic)	The medium acid (The medium acidic)	The strongest acid (The most acidic)
_____	_____	_____

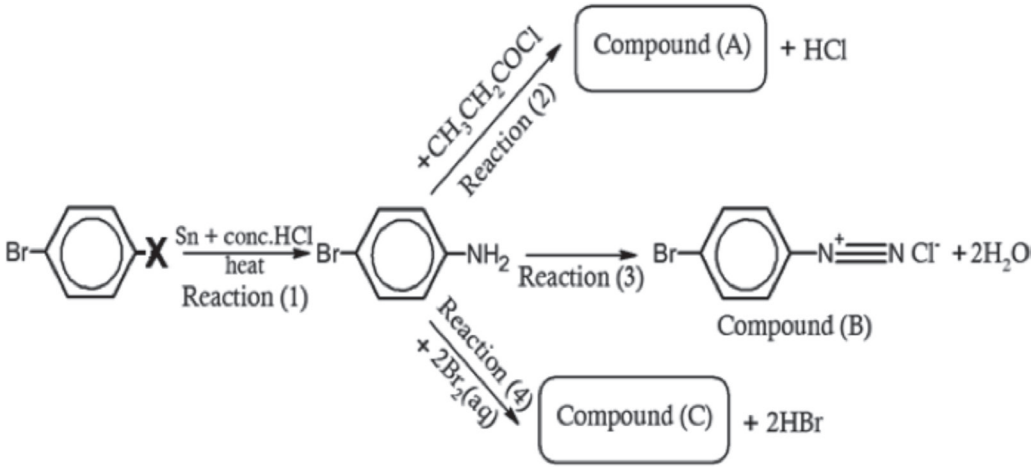
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Question 2 continued

21) Four chemical reactions were carried out as shown below. Study them and answer the following questions.



a. For reaction (1):

(i) What type is this reaction?

_____

(ii) Identify the substituent (X).

_____

b. Draw the structural formula of compounds (A) and (B):

(i) Compound (A)

_____

(ii) Compound (C)

_____

c. Identify the following:

(i) The name of the nitrogen functional group formed in reaction (2).

_____

(ii) The reagents and conditions for reaction (3).

_____

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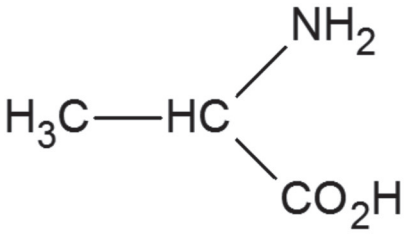
Question 2 continued

d. When a solution of compound (B) is added to an alkaline solution of a phenol, an electrophilic substitution reaction takes place.

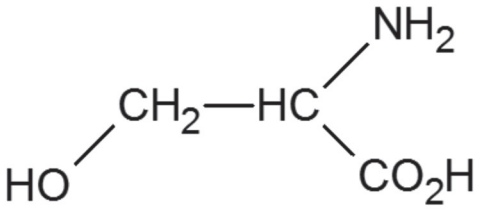
(i) What is the name of this reaction?

(ii) Write the equation of this reaction.

22) Proteins are present in all living organisms. The structures of two amino acids are shown below. Study them and answer the following questions.



Alanine, Ala



Serine, Ser

a. What type is the reaction that amino acids undergo to form proteins?

b. **Draw** the structure formula of the dipeptide Ala-Ser and **label** the peptide bond on your structure.

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Question 2 continued

c. Which one is more basic?

Alanine Diethylamine (shade your answer)

Explain your answer in term of the basicity of each compound.

[End of Examination]

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مُسَوَّدَة

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امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)

للعام الدراسي ١٤٤٣ هـ - ٢٠٢١ / ٢٠٢٢ م

الدور الثاني - الفصل الدراسي الأول

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٣) 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 transition elements has the lowest oxidation state in its complexes?

⬭ Zn ⬭ Cu

⬭ Mn ⬭ Cr

2) Which of the following about $[Cr(C_2O_4)_3]^{3-}$ complex ion is **correct**?

⬭ Five-membered rings formed between ligand $C_2O_4^{2-}$ and chromium ion

⬭ Three dative covalent bonds are formed in this complex ion

⬭ The $C_2O_4^{2-}$ is a monodentate ligand

⬭ The oxidation number of the Cr in this complex ion is +2

3) Which of the following represents the correct option for this complex $[Co(NH_3)_4(H_2O)Cl]Cl_2$?

	Oxidation state of Co	Shape of the complex ion	Overall charge of the complex in
⬭	+2	Octahedral	+2
⬭	+ 2	Tetrahedral	+1
⬭	+3	Octahedral	+2
⬭	+3	Tetrahedral	+1

4) Benzene can undergo addition reaction when it reacts with:

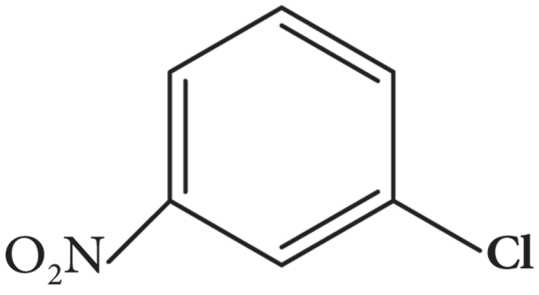
⬭ $Cl_2(AlCl_3/warm)$ ⬭ $H_2(Ni/200^{\circ}C, 30\ atm)$

⬭ $HNO_3(conc.H_2SO_4, T < 55^{\circ}C)$ ⬭ $CH_3Cl\ (AlCl_3/heat)$

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Question 1 continued

5) What is the name of the compound below?



- ☐ m-chloronitrobenzene
- ☐ m-nitrochlorobenzene
- ☐ p-nitrochlorobenzene
- ☐ p-chloronitrobenzene

6) Which of the following can give the same product when added to methylbenzene and ethylbenzene separately?

- ☐ Cl_2 + $AlCl_3$ with heat
- ☐ Conc.HNO_3 + conc.H_2SO_4
- ☐ $3H_2$ + Ni (200°C and 30 atm)
- ☐ $KMnO_4$(heated with OH^-) + H^+

7) The compound CH_3CH_2COCl is classified as:

- ☐ alkyl chloride
- ☐ acyl chloride
- ☐ aryl chloride
- ☐ chloroalkene

8) Which of the following statements about the reactions of ethanoic acid is **incorrect**?

- ☐ Less acidic than ethanol
- ☐ Can form ester when reacts with ethanol
- ☐ Can form salts when reacts with alkalis
- ☐ Can be further oxidized by warm acidified manganite (VII)

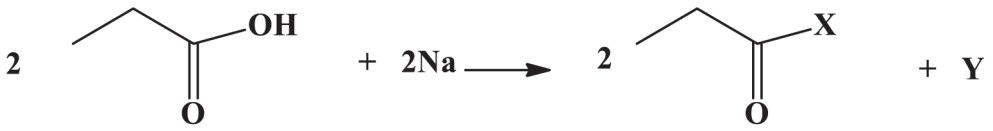
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Question 1 continued

9) For the reaction below.



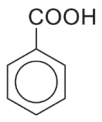
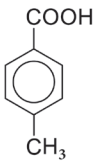
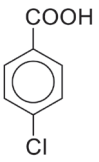
Which option is correct about **X** and **Y**?

	X	Y
○	Na	$CO_{2(g)}$
○	Na	$H_{2(g)}$
○	$O^- Na^+$	$H_{2(g)}$
○	$O^- Na^+$	$CO_{2(g)}$

10) The table below shows the consuming of three compounds in 5 minutes when they react with water.

Compound	Percentage dissociation in ($1.0\ moldm^{-3}$) aqueous solution
A	0.80%
B	0.73%
C	1.0%

The correct choice for the three compound is:

			
○	B	C	A
○	C	A	B
○	A	B	C
○	B	A	C

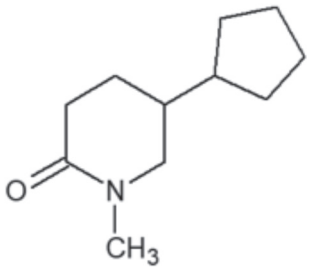
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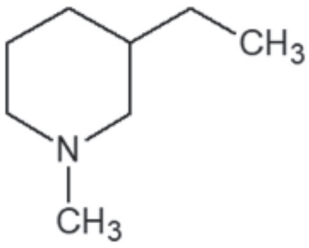
Question 1 continued

11) Which of the following statements about ethylamine is **incorrect**?

- ☐ It is a basic compound
- ☐ It is a secondary amine
- ☐ It is soluble in water
- ☐ It reacts with acids to form salts

12) Which of the following options about the nitrogen functional groups of each compound is **correct**?





☐	amine	amine
☐	amine	amide
☐	amide	amine
☐	amide	amide

13) Which of the following is not a dipeptide?

- ☐ $H_2NCH(CH_3)CO_2H$
- ☐ $H_2NCH_2CONHCH(CH_3)CO_2H$
- ☐ $H_2NCH(CH_3)CONHCH_2CO_2H$
- ☐ $H_2NCH(CH_3)CONHCH(CH_3)CO_2H$

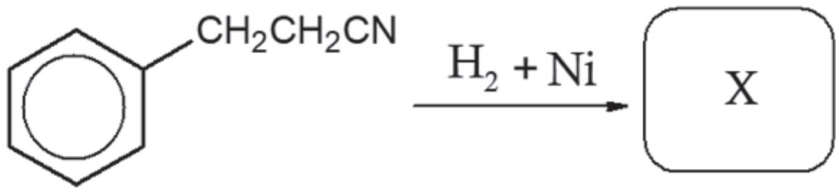
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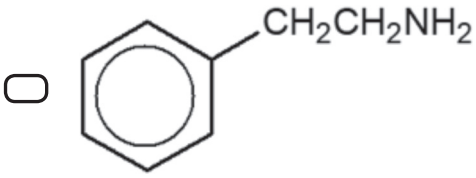
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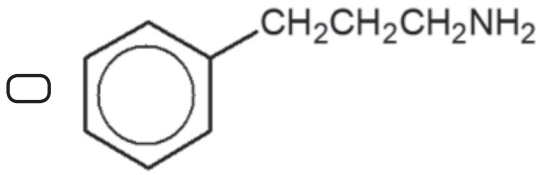
Question 1 continued

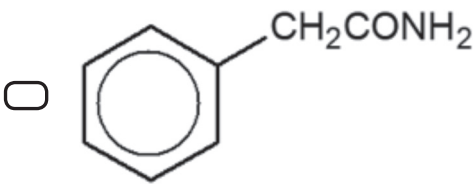
14) For the reaction below:

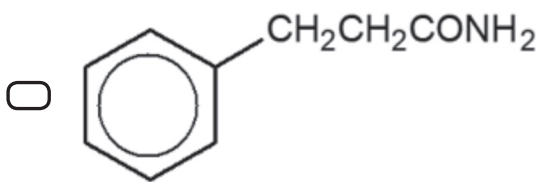


Which of the following options is the product (X)?









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Question 2: Extended response (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 transition metal ion Cu^{2+} can form a complex ion with six H_2O ligands.

a. What is meant by transition metal?

b. Which one, copper or calcium metal has a higher density?

c. Which one, zinc or copper has a higher melting point?

d. Write the electronic configuration of a copper (Cu) atom and a copper (Cu^{2+}) ion using [Ar] to represent the argon core. The atomic number of copper is 29.

Cu atom _____

Cu^{2+} ion _____

e. How many pairs of electrons are donated by the six H_2O ligands for the expected complex ion?

f. What is the type of ligand (monodentate or bidentate) in this complex ion?

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Question 2 continued

g. Draw the three-dimensional shape of the complex ion formed by one Cu^{2+} ion with six H_2O ligands and include the overall charge.

h. What is the colour of this complex ion?

i. If all ligands (H_2O) of this complex ion are replaced with three $C_2O_4^{2-}$ ligands to form new complex ion with copper ion Cu^{2+}.

(i) Write the replacement reaction of $C_2O_4^{2-}$ with Cu^{2+} ion.

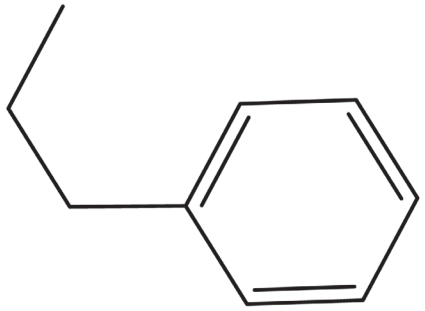
(ii) How many dative bonds (co-ordinate bonds) are formed in the new complex ion?

(iii) What is overall charge of the complex ion?

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Question 2 continued

16) Propylbenzene is a type of alkylbenzene and has the structure below:



a. Write the equation for the reaction of propylbenzene with:

(i) Cl_2 + UV light.

(ii) $KMnO_4$ heated with OH^- and then H^+ is added.

b. When Br_2 reacts with benzene, in the presence of $AlCl_3$; write the mechanism step, which describes the production of electrophile (the bromine cation).

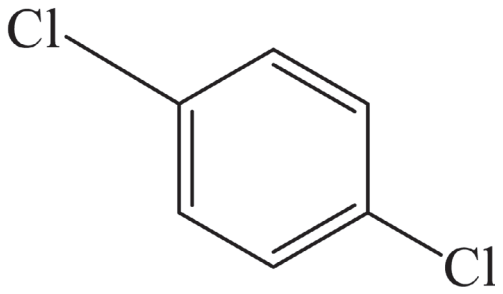
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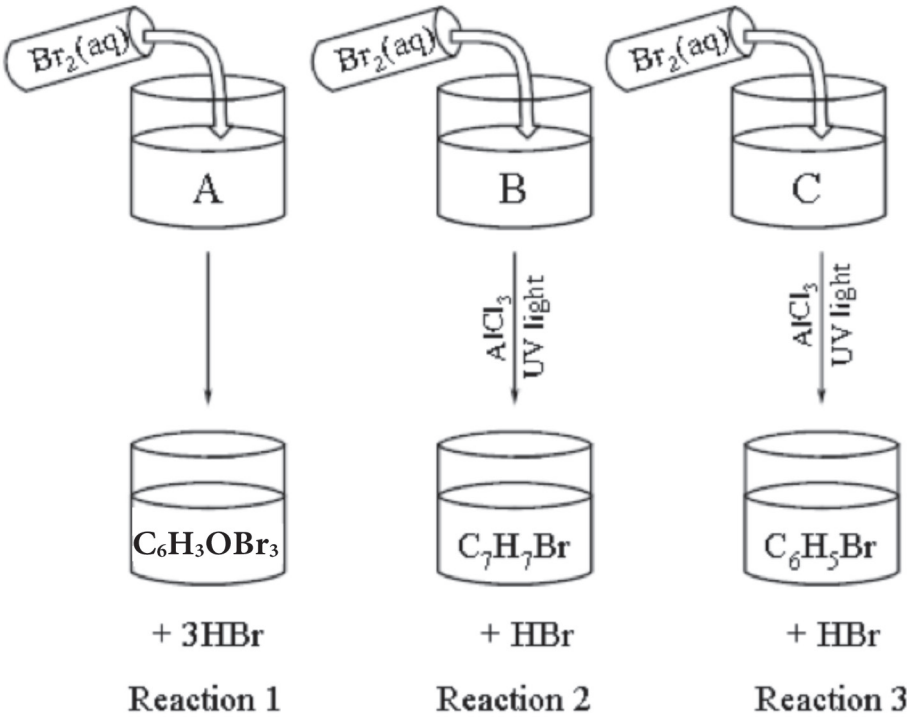
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Question 2 continued

c. Name of the compound below:



17) Study the scheme below and answer the following questions:



a. What type is the above reactions?

b. Which compound (A, B, or C) represents benzene?

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Question 2 continued

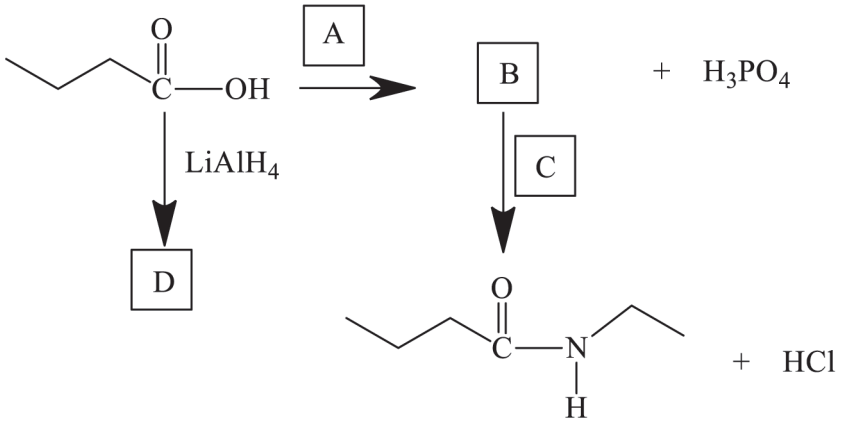
c. Which reaction (1, 2 or 3) needs 3 moles of Br_2?

_____

d. Draw the structures of compounds that are produced in reactions 1 and 2 in the table below.

Compound	$C_6H_3OBr_3$	C_7H_7Br
Structure		

18) A series of three chemical reactions starting from butanoic acid was carried out as follows. Study it and answer the following questions.



a. Which agent represents A?

▢ PCl_3 ▢ $SOCl_2$ (shade your answer)

b. Draw the structure of compounds (B) and (C)

(i) B: _____ **(ii) C:** _____

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Question 2 continued

c. What is the reaction name that produces the compound D?

_____

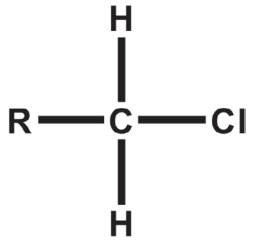
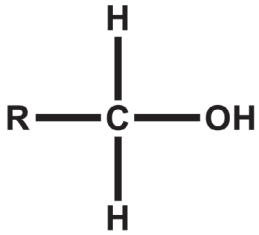
d. Name the compound B.

_____

e. If we want to return compound (B) back to butanoic acid, which reagent is used?

_____

19) The following grid shows the formulae of four organic compounds with the same alkyl chain (R). Study it and then answer the following questions below.

A	B	C	D
			

a. Write the symbol of the correct compound given in the grid above in the spaces provided for the following statements:

(i) Which one reacts readily with phenols to form ester (_____)

(ii) Which one (A or B) has faster rate of hydrolysis (_____)

b. Which one (A or C) boils at higher temperature?

_____

Explain:

_____

_____

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Question 2 continued

c. What type of organic compounds that is produced when compound (B) reacts with:

(i) Ammonia: _____

(ii) Alcohols: _____

d. Show the mechanism of the reaction of compound (C) with ammonia.

_____

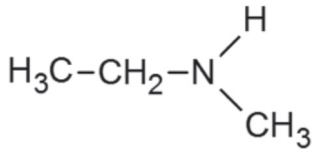
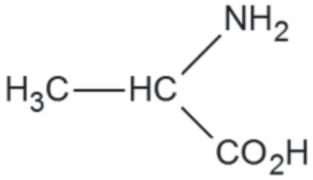
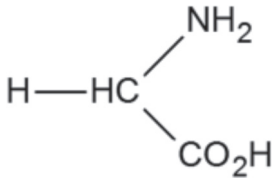
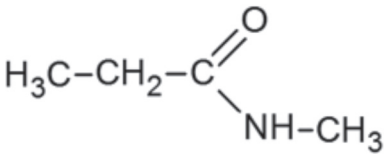
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e. Name the compound (B) if (R = $CH_2CH_2CH_2CH_3$).

_____

20) The following grid shows the formulae of four nitrogen compounds. Study it and then answer the following questions below.

A 	**B** 
C 	**D** 

a. Classify the following:

(i) Compound A: _____

(ii) Compound C: _____

b. Name the following:

(i) Compound A: _____

(ii) Compound D: _____

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Question 2 continued

c. Write the equation for reaction of:

(i) Compound A with water:

_____

(ii) Hydrolysis of compound D under basic condition.

_____

(iii) Compound A with ethanoyl chloride (CH_3COCl).

_____

d. If compound B reacts with compound C:

(i) What type is this reaction?

_____

(ii) Name the bond formed between them.

_____

(iii) Draw the structure formula of the product.

_____

e. Which one is more basic:

▢ Compound B ▢ Ethylamine (shade your answer)

Explain your answer in term of the basicity of each compound.

_____

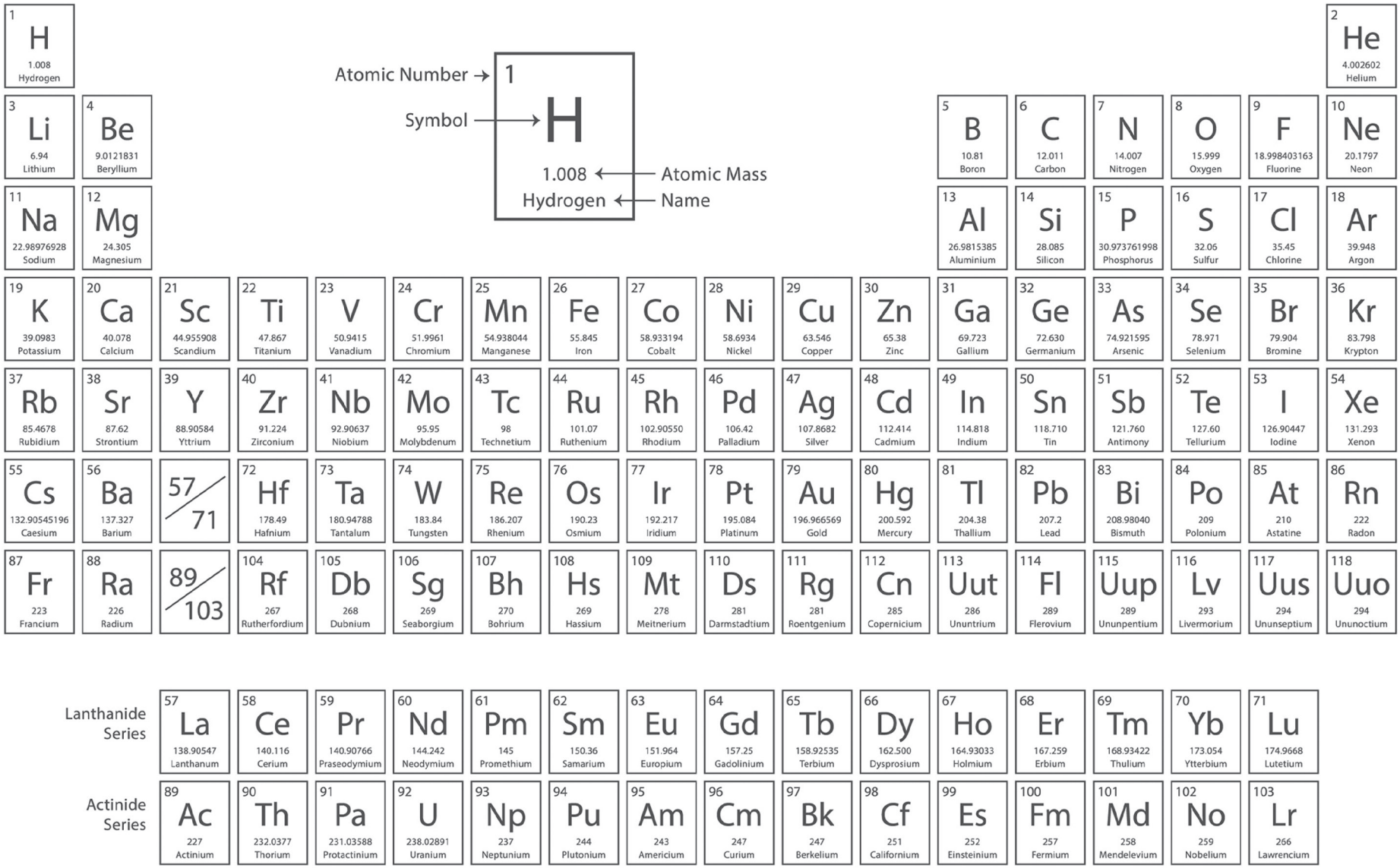
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PERIODIC TABLE OF THE ELEMENTS



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