



امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)

الفصل الدراسي الأول - الدور الأول

للعام الدراسي ١٤٤٧/١٤٤٦ هـ - ٢٠٢٤ / ٢٠٢٥ م

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

تعليمات مهمة:

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

س - عاصمة سلطنة عمان هي:

▭ القاهرة ▭ الدوحة

■ مسقط ▭ أبوظبي

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

صحيح ■ **غير صحيح** ▭ ◉ ◒ ⊗ ☑

مُسَوَّدَة، لا يتم تصحيحها

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Question 1: Multiple Choice Items (14 marks)

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

1) Which of the following statements is correct about an acidic buffer solution?

⬭ It resists changes in the pH in alkaline regions.

⬭ Its pH does not depend on the ratio of [HA] / [A^-].

⬭ It is a mixture of a weak acid and its conjugate base.

⬭ An example of an acidic buffer solution is NH_3 with ammonium chloride.

2) Consider the following reaction and statements for the forward reaction:

HCO_3^- (aq) + $H_2PO_4^-$ (aq) $\rightleftharpoons$ HPO_4^{2-} (aq) + H_2CO_3 (aq)

I. HCO_3^- is an acid and H_2CO_3 its conjugate base.

II. HCO_3^- is a base and H_2CO_3 its conjugate acid.

III. $H_2PO_4^-$ is an acid and HPO_4^{2-} its conjugate base.

IV. $H_2PO_4^-$ is a base and HPO_4^{2-} its conjugate acid

Which statements are correct?

⬭ I and III ⬭ I and IV

⬭ II and III ⬭ II and IV

3) What is the solubility product K_{sp} in $mol^3\ dm^{-9}$ for a saturated solution of calcium hydroxide $Ca(OH)_2$ that contains $[OH^-] = 4.47 \times 10^{-2}$ mol dm^{-3} ?

⬭ 1.23×10^{-3} ⬭ 2.05×10^{-3}

⬭ 4.46×10^{-5} ⬭ 8.97×10^{-5}

4) Which of the following solutions will not affect the solubility of Iron(II) carbonate ($FeCO_3$)?

⬭ $MgCO_3$(aq) ⬭ NaCl(aq)

⬭ K_2CO_3(aq) ⬭ $FeCl_2$(aq)

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Question 1 continued

5) Which of the following terms describes the combining of two half-cells?

- ☐ Electrodes
- ☐ Electrolytic cell
- ☐ Salt bridge
- ☐ Voltage cell

6) Which one of the following is the value of an electrode potential for a half cell containing Ag(s)/Ag^+(aq) at 298 K and a concentration of 0.050 mol dm^{-3} of Ag^+(aq) ions?

- ☐ 0.27 V
- ☐ 0.72 V
- ☐ 0.80 V
- ☐ 0.88 V

7) Which of the following options is correct about an electrochemical cell consisting of a Mn^{2+} / Mn half - cell and a Sn^{2+} / Sn half – cell?

	Positive electrode	Cell voltage
☐	Sn	–1.04
☐	Sn	+1.04
☐	Mn	–1.32
☐	Mn	+1.32

8) Which of the following reactions is feasible?

- ☐ $Cu(s) + Zn^{2+}(aq) \longrightarrow Cu^{2+}(aq) + Zn(s)$
- ☐ $Pb(s) + Sn^{2+}(aq) \longrightarrow Pb^{2+}(aq) + Sn(s)$
- ☐ $Sn(s) + Mg^{2+}(aq) \longrightarrow Sn^{2+}(aq) + Mg(s)$
- ☐ $Fe(s) + Cu^{2+}(aq) \longrightarrow Fe^{2+}(aq) + Cu(s)$

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Question 1 continued

9) Which of the following statements is not correct about the first electron affinity (EA_1)?

- ☐ It is generally exothermic.
- ☐ It will be more exothermic by increasing the nuclear charge.
- ☐ It will be more exothermic going from chlorine to bromine to iodine.
- ☐ It will be less exothermic by increasing the number of electron shells.

10) Which of the following equations below represents the atomization for potassium?

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

11) Using the data in the table below . What is the enthalpy change of solution of calcium bromide ($CaBr_2$) in kJ mol^{-1}?

Enthalpy change (ΔH)	Value/ kJ mol^{-1}
Lattice energy of $CaBr_2$	– 2176
Enthalpy change of hydration of Ca^{2+}	– 1577
Enthalpy change of hydration of Br^-	– 336

- ☐ – 73
- ☐ – 263
- ☐ – 4089
- ☐ – 4425

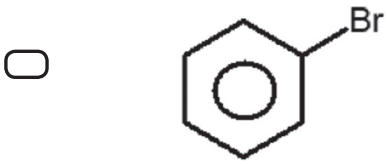
12) Which of the following statements is not correct about benzene?

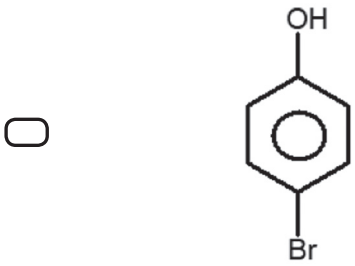
- ☐ It has a planar shape.
- ☐ It has a delocalized π system.
- ☐ The bond angles in benzene are 120°.
- ☐ The carbon atoms in benzene are sp^3 hybridized.

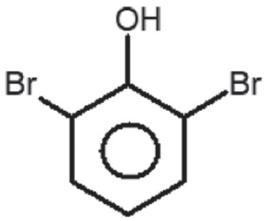
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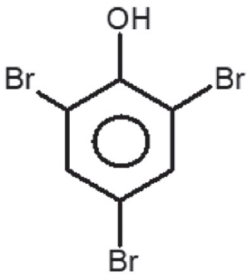
Question 1 continued

13) Which product is formed when phenol reacts with excess bromine water ($Br_2(aq)$)?









14) Which of the following is the correct order of increasing acidity?

- $CH_3CH_2OH < H_2O < C_6H_5OH$
- $H_2O < CH_3CH_2OH < C_6H_5OH$
- $C_6H_5OH < H_2O < CH_3CH_2OH$
- $CH_3CH_2OH < C_6H_5OH < H_2O$

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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 selection of solutions for buffer mixtures and K_a for the acid are listed below. Use them to answer the following questions.

Buffer mixture		K_a for acid / mol dm^{-3}
0.0100 mol dm^{-3} acid	**0.0200 mol dm^{-3} conjugate base**	
HCOOH	$HCOO^-$	1.6×10^{-4}
NH_4^+	NH_3	5.6×10^{-10}
HNO_2	NO_2^-	4.7×10^{-4}
C_6H_5COOH	$C_6H_5COO^-$	6.3×10^{-5}
H_2SO_3	HSO_3^-	1.5×10^{-2}
$H_2PO_4^-$	HPO_4^{2-}	6.3×10^{-8}

a. Define the following terms:

(i) Conjugate acid-base pair.

_____

_____ [1]

(ii) Buffer solution.

_____

_____ [1]

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Question 2 continued

b. Which one of the above acids has the highest value of pK_a?

[1]

c. Justify by calculating the pH, that C_6H_5COOH, $C_6H_5COO^-$ mixture is an acidic buffer solution.

[2]

d. Why can a mixture of methanoic acid HCOOH and sodium methanoate HCOONa act as a buffer solution whereas a solution of sodium methanoate HCOONa alone will not act as a buffer solution.

[1]

e. The carbon dioxide-hydrogencarbonate ion system is an important buffer in the human body.

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

State to which direction the position of the equilibrium will shift when the H^+ ion concentration increases. Explain your answer.

[2]

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Question 2 continued

16) A beaker contains a saturated solution of lead (II) chloride and a solid lead (II) chloride both are in an equilibrium. (K_{sp} for $PbCl_2 = 1.6 \times 10^{-5}$ mol^3 dm^{-9}).

a. Write equilibrium expressions for the solubility products for ($PbCl_2$).

_____[1]

b. Calculate the solubility in mol dm^{-3} of ($PbCl_2$).

_____[1]

c. Calculate the solubility in mol dm^{-3} of ($PbCl_2$) when 0.0500 mol dm^{-3} of sodium chloride (NaCl) is added.

_____

_____

_____[1]

d. Explain the effect of adding (NaCl) to the solubility of ($PbCl_2$).

_____

_____

_____

_____[1]

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Question 2 continued

17) The following table shows values of $E^{\ominus}$ for half cells represented by virtual symbols. Use them to answer the following questions:

Half cells	$E^{\ominus}$ / V
$X^{2+}(aq) / X(s)$	+ 0.35
$Y^{2+}(aq) / Y(s)$	– 0.26
$Z^{2+}(aq) / Z(s)$	+ 0.79
$M^{2+}(aq) / M(s)$	– 0.80
$L^{2+}(aq) / L(s)$	– 0.18

a. Define the term standard electrode potential.

[1]

b. State two conditions used to measure the standard electrode potential.

[2]

c. Which metal ion is the strongest oxidizing agent?

[1]

d. Which metal has the highest tendency to lose its electrons?

[1]

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Question 2 continued

e. What is the direction of electrons flow for the two half cells $Y^{2+}(aq)$ /Y(s) and X^{2+} (aq) /X(s). Write the final reaction equation.

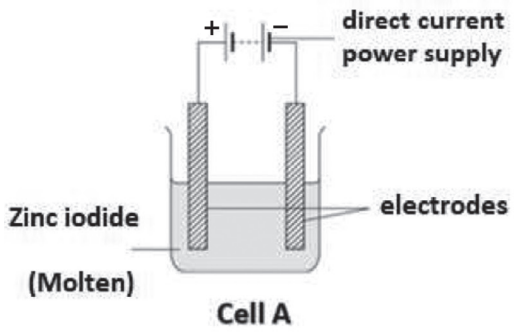
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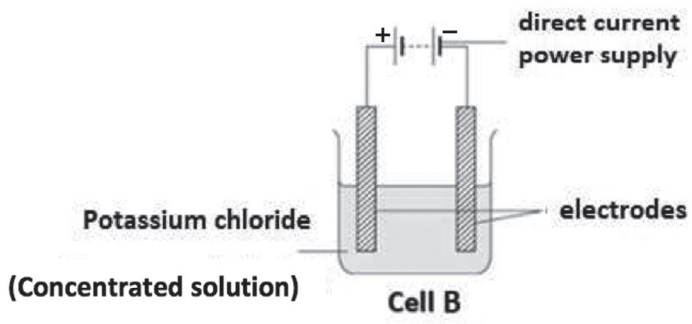
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_____[2]

18) Study the following cells that show the electrolysis of some electrolytes under standard conditions, to answer the questions below.





a. For **cell A**:

(i) What substance is formed at the anode?

_____[1]

(**ii**) Write a half-equation for the reaction occurring at the cathode.

_____[1]

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Question 2 continued

b. For **cell B**:

(i) Write a half-equation for the reaction occurring at the cathode?

_____[1]

(ii) If we use diluted aqueous solution of potassium chloride, what substance(s) are formed at the anode during the electrolysis?

_____[1]

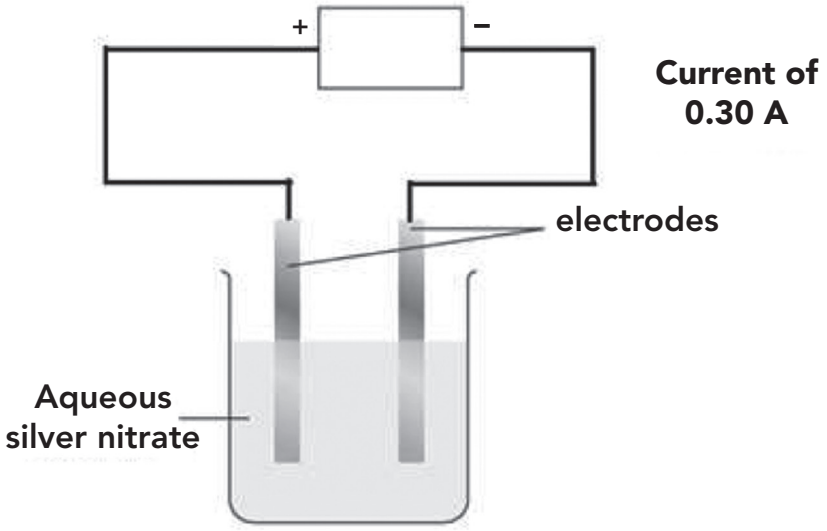
Explain your answer.

_____

_____

_____[1]

19) Study the following electrolysis cell under standard conditions. Then answer the questions:



a. Write the equation that describe the relationship between the Faraday constant and the Avogadro constant.

_____[1]

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Question 2 continued

b. What is the type of reaction that occurs at the anode?

_____[1]

c. In which electrode will the silver be formed?

_____[1]

d. Calculate the quantity of charge that passed during 75 minutes of electrolysis

_____

_____[1]

e. Calculate the mass of the silver formed.

(F = 96500 C mol^{-})

_____

_____

_____

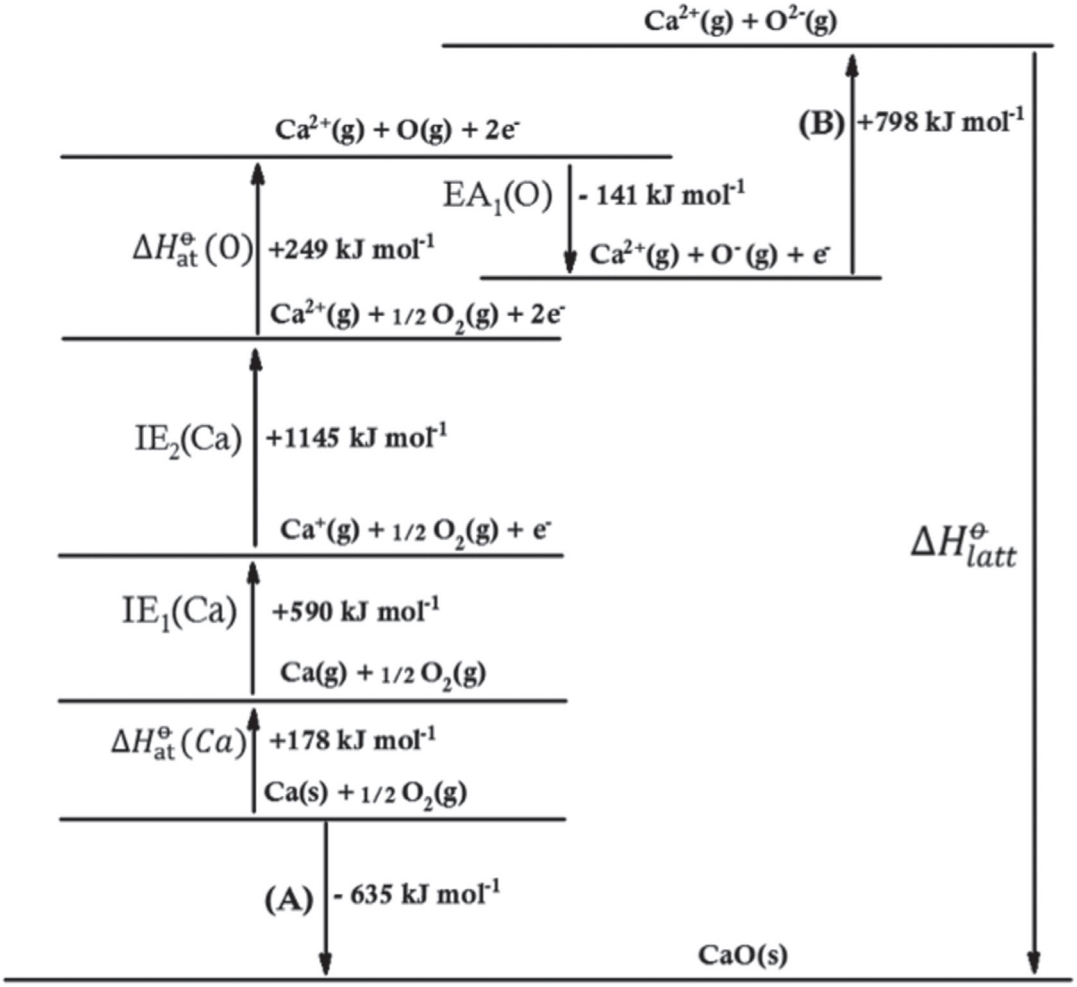
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_____[3]

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Question 2 continued

20) The Born–Haber cycle below can be used to determine the lattice energy of calcium oxide, CaO.



a. Define the term lattice energy.

_____

_____ [1]

b. What are the two properties of ions that affect the numerical magnitude of lattice energy?

_____

_____ [2]

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c. Identify the enthalpy changes labelled (A) and (B) in the cycle:

(A): _____ [1]

(B): _____ [1]

d. Calculate the lattice energy for calcium oxide.

_____

_____

_____ [1]

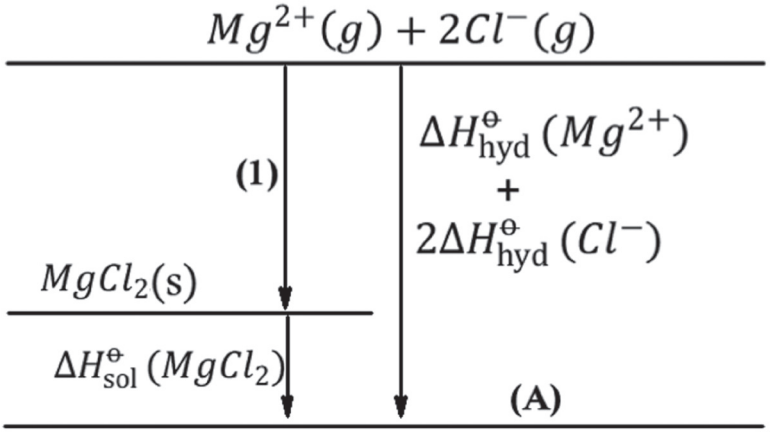
e. Explain why the lattice energy of calcium oxide is greater than the lattice energy of lithium fluoride.

_____

_____

_____ [1]

21) The energy cycle below shows the enthalpy changes when magnesium chloride is dissolved in water:



a. Define the term standard enthalpy change of hydration.

_____

_____ [1]

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Question 2 continued

b. From the energy cycle for magnesium chloride:

(i) Identify species (**A**) in the cycle, including its physical state.

_____ [1]

(ii) Identify the enthalpy change labelled by the number (**1**) in the cycle.

_____ [1]

(iii) Calculate the enthalpy of hydration for the chloride ion given that:

Enthalpy change	Value/ kJ mol^{-1}
$\Delta H^{\theta}_{latt}[MgCl_2]$	–2592
$\Delta H^{\theta}_{sol}[MgCl_2]$	–55
$\Delta H^{\theta}_{hyd}[Mg^{2+}]$	–1920

_____

_____

_____ [1]

c. Explain why the enthalpy change of hydration of Mg^{2+} is more exothermic than the enthalpy change of hydration of Ba^{2+}.

_____

_____

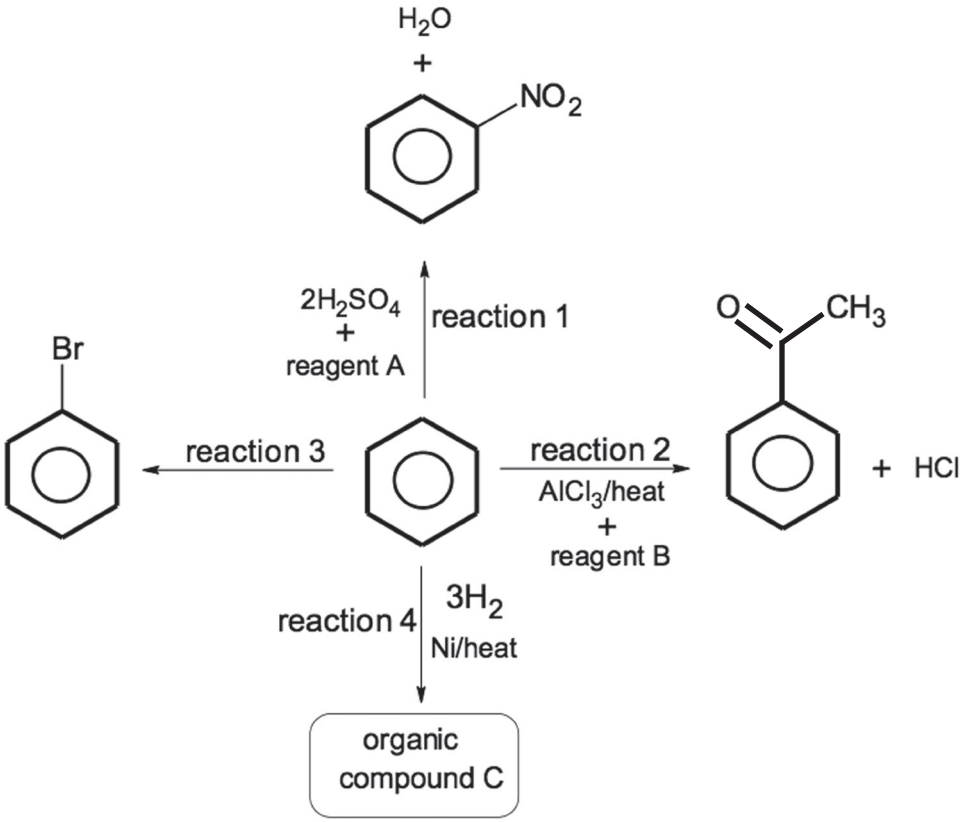
_____ [1]

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22) Study the reactions scheme below, to answer the following questions:



a. **For reaction 1:**

(i) State the reagent (A).

_____ [1]

(ii) Name the compound produced.

_____ [1]

b. **For reaction 2:**

(i) State the reagent (B).

_____ [1]

(ii) Name the compound produced.

_____ [1]

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c. **For reaction 3:**
Bromobenzene is produced. Which is more reactive?
○ Bromoethane ○ Bromobenzene **(Shade your answer)**
Explain your answer:

_____

_____[2]

d. **For reaction 4:**
Draw the structural formula of organic compound (C).

[1]

23) Study the reactions sequence below, to answer the following questions:



a. State the reagents required for reaction 1.

_____[2]

b. Name compound 1.

_____[1]

c. **Draw** and **name** the organic compound 3 produced in reaction 3.

_____

_____[2]

d. Explain the acidity of compound 2.

_____

_____[1]

[End of the Examination]

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Standard electrde potentals

Electrde reaction	$E^{\ominus}$/V
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+ 2.87
$S_2O_8^{2-}(aq) + 2e^- \rightleftharpoons 2SO_4^{2-}(aq)$	+ 2.01
$H_2O_2(l) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	+ 1.77
$Pb^{4+}(aq) + 2e^- \rightleftharpoons Pb^{2+}(aq)$	+ 1.69
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$	+ 1.52
$PbO_2(s) + 4H^+(aq) + 2e^- \rightleftharpoons Pb^{2+}(aq) + 2H_2O(l)$	+ 1.47
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+ 1.36
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l)$	+ 1.33
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	+ 1.23
$Br_2(aq) + 2e^- \rightleftharpoons 2Br^-(aq)$	+ 1.07
$VO_2^+(aq) + 2H^+(aq) + e^- \rightleftharpoons VO^{2+}(aq) + H_2O(l)$	+ 1.00
$VO_3^-(aq) + 4H^+(aq) + e^- \rightleftharpoons VO^{2+}(aq) + 2H_2O(l)$	+ 1.00
$ClO^-(aq) + H_2O(l) + 2e^- \rightleftharpoons Cl^-(aq) + 2OH^-(aq)$	+ 0.89
$NO_3^-(aq) + 10H^+(aq) + 8e^- \rightleftharpoons NH_4^+(aq) + 3H_2O(l)$	+ 0.87
$NO_3^-(aq) + 2H^+(aq) + e^- \rightleftharpoons NO_2(g) + H_2O(l)$	+ 0.81
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+ 0.80
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+ 0.77
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+ 0.54
$Cu^+(aq) + e^- \rightleftharpoons Cu(s)$	+ 0.52
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+ 0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+ 0.34
$VO^{2+}(aq) + 2H^+(aq) + e^- \rightleftharpoons V^{3+}(aq) + H_2O(l)$	+ 0.34

Electrde reaction	$E^{\ominus}$/V
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons SO_2(g) + 2H_2O(l)$	+ 0.17
$Cu^{2+}(aq) + e^- \rightleftharpoons Cu^+(aq)$	+ 0.15
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+ 0.15
$S_4O_6^{2-}(aq) + 2e^- \rightleftharpoons 2S_2O_3^{2-}(aq)$	+ 0.09
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Fe^{3+}(aq) + 3e^- \rightleftharpoons Fe(s)$	− 0.04
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	− 0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	− 0.14
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	− 0.25
$V^{3+}(aq) + e^- \rightleftharpoons V^{2+}(aq)$	− 0.26
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	− 0.28
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	− 0.44
$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s)$	− 0.74
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	− 0.76
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	− 0.83
$Cr^{2+}(aq) + 2e^- \rightleftharpoons Cr(s)$	− 0.91
$Mn^{2+}(aq) + 2e^- \rightleftharpoons Mn(s)$	− 1.18
$V^{2+}(aq) + 2e^- \rightleftharpoons V(s)$	− 1.20
$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	− 2.38
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	− 2.71
$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(s)$	− 2.87
$K^+(aq) + e^- \rightleftharpoons K(s)$	− 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*	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226	89 Ac (227)															

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

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MARKING GUIDE

GENERAL EDUCATION DIPLOMA
BILINGUAL PRIVATE SCHOOLS
SEMESTER ONE - FIRST SESSION

CHEMISTRY
2024 / 2025

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

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

Topic of the Units	Weighting %	Multiple Choice (20%)					Extended Response (80%)					Total Mark
		No. of Questions	Marks	Cognitive Levels			No. of Questions	Marks	Cognitive Levels			
				Knowing (30%)	Applying (50%)	Reasoning (20%)			Knowing (30%)	Applying (50%)	Reasoning (20%)	
Quantitative Equilibria	23%	14	4	1	2	1	10	12	4	6	2	16
Electrochemistry	33%		4	1	2	1		19	5	10	4	23
Lattice energy	21%		3	1	2	-		12	4	6	2	15
Arenes , Phenols	23%		3	1	1	1		13	4	6	3	16
Total	100 %		14	4	7	3		56	17	28	11	70

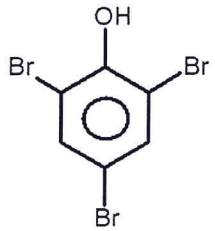
Distribution of cognitive domains and marks.

Item	Mark	Unit	Cognitive domain	Output
1	1	Quantitative Equilibria	Knowing	1.1.g
2	1	Quantitative Equilibria	Application	1.1.b
3	1	Quantitative Equilibria	Application	1.1.n
4	1	Quantitative Equilibria	Reasoning	1.1.o
5	1	Electrochemistry	Knowing	2.1. c
6	1	Electrochemistry	Application	2.1. m
7	1	Electrochemistry	Application	2.1. g 2.1.a .ii
8	1	Electrochemistry	Reasoning	2.1.h.ii
9	1	Lattice energy	Knowing	3.1.d, c
10	1	Lattice energy	Application	3.1.a
11	1	Lattice energy	Application	3.2.c
12	1	Arenes and Phenols	Knowing	4.1.b
13	1	Arenes and Phenols	Application	4.2.b.ii
14	1	Arenes and Phenols	Reasoning	4.2.d
15.a	2	Quantitative Equilibria	Knowing	1.1.b, f
15.b	1	Quantitative Equilibria	Application	1.1.e
15.c	2	Quantitative Equilibria	Application	1.1.j
15.d	1	Quantitative Equilibria	Reasoning	1.1.h
15.e	2	Quantitative Equilibria	Knowing	1.1.i
16.a	1	Quantitative Equilibria	Application	1.1.m
16.b	1	Quantitative Equilibria	Application	1.1.n
16.c	1	Quantitative Equilibria	Application	1.1. p
16.d	1	Quantitative Equilibria	Reasoning	1.1.o
17.a	1	Electrochemistry	Knowing	2.1.a.i
17.b	2	Electrochemistry	Knowing	2.1.e
17.c	1	Electrochemistry	Application	2.1.j
17.d	1	Electrochemistry	Application	2.1.j
17.e	2	Electrochemistry	Reasoning	2.1.h.i
18.a.i	1	Electrochemistry	Applying	2.2.a
18.a.ii	1	Electrochemistry	Application	2.2.a
18.b.i	1	Electrochemistry	Application	2.2.a
18.b.ii	2	Electrochemistry	Reasoning	2.2.a
19.a	1	Electrochemistry	Knowing	2.2.b
19.b	1	Electrochemistry	Knowing	2.2.a
19.c	1	Electrochemistry	Application	2.1.c.v
19.d	1	Electrochemistry	Application	2.2.c.i
19.e	3	Electrochemistry	Application	2.2.c.ii
20.a	1	Lattice energy	Knowing	3.1.a

20.b	2	Lattice energy	Knowing	3.1.g
20.c	2	Lattice energy	Application	3.1.e
20.d	1	Lattice energy	Application	3.1.f
20.e	1	Lattice energy	Reasoning	3.1.g
21.a	1	Lattice energy	Knowing	3.2.a
21.b	3	Lattice energy	Application	3.2.b, c
21.c	1	Lattice energy	Reasoning	3.2.d
22.a.i	1	Arenes and Phenols	Knowing	4.1.d
22.a.ii	1	Arenes and Phenols	Application	4.1.d
22.b.i	1	Arenes and Phenols	Knowing	4.1.c.i
22.b.ii	1	Arenes and Phenols	Application	4.1.c.i
22.c	2	Arenes and Phenols	Reasoning	4.1.e
22.d	1	Arenes and Phenols	Application	4.1.c.iv
23.a	2	Arenes and Phenols	Knowing	4.2.a.i
23.b	1	Arenes and Phenols	Application	4.1.b
23.c	2	Arenes and Phenols	Application	4.2.b.i
23.d	1	Arenes and Phenols	Reasoning	4.2.c

TOTAL PAGES: 6
MARKS: 70
Question One (14 Marks)

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

Item	Correct option	
1	C	It is a mixture of a weak acid and its conjugate base.
2	C	II and III
3	C	4.46×10^{-5} mol^3 dm^{-9}
4	B	NaCl(aq)
5	D	Voltage cell
6	B	0.72 V
7	B	Sn +1.04
8	D	$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$
9	C	It will be more exothermic going from chlorine to bromine to iodine.
10	A	$K(s) \longrightarrow K(g)$
11	A	−73
12	D	The carbon atoms in benzene are sp^3 hybridized.
13	D	
14	A	$CH_3CH_2OH < H_2O < C_6H_5OH$

Question Two (56 Marks)

Part	Section	The answer	The mark
15	a. (i)	An acid-base pair on each side of an acid–base equilibrium equation that are related to each other by the difference of a hydrogen ion (proton).	1
	a. (ii)	A solution that minimizes changes in the pH when moderate amounts of acid or base are added.	1
	b	NH_4^+	1
	c	$K_a = \frac{[H^+][C_6H_5COO^-]}{[C_6H_5COOH]}$, $6.3 \times 10^{-5} = \frac{[H^+](0.0200)}{(0.0100)}$ $[H^+] = 3.15 \times 10^{-5}$ mol dm^{-3} [1 mark] pH = $-\log_{10}[H^+] = -\log_{10}[3.15 \times 10^{-5}] = 4.5$ [1 mark] **Or** $pH = pK_a + \log\frac{(0.0200)}{(0.0100)}$ [1 mark] pH = 4.5 [1 mark]	2
	d	Because in the mixture of HCOOH and HCOONa the large reserve supply of HCOOH and $HCOO^-$ ensures that the concentration of HCOOH and $HCOO^-$ molecules in solution does not change significantly to remove the added H^+ or OH^-, so the pH changes very little. **Or** Because there is no a large reserve supply of HCOOH and $HCOO^-$ in a solution of sodium methanoate HCOONa alone.	1
	e	When the H^+ ion concentration increases: • the position of the equilibrium shifts to the left [1 mark] • H^+ ions combine with HCO_3^- ions to form carbon dioxide and water until equilibrium is restored, keeping the pH constant. [1 mark]	2
16	a	$K_{sp}=[Pb^{2+}][Cl^-]^2$	1
	b	Let solubility be "s" $[Pb^{2+}]$= s, $[Cl^-]$=2s , $K_{sp}=4s^3$ s = 1.59×10^{-2} mol dm^{-3} (1mark for the correct value)	1
	c	Ignore $[Cl^-]$ in $PbCl_2$ $K_{sp}=[Pb^{2+}][Cl^-]^2$ $1.6 \times 10^{-5}= [Pb^{2+}][0.0500]^2$ $[Pb^{2+}]= 6.4 \times 10^{-3}$ mol dm^{-3} (1mark for the correct value)	1
	d	The chloride ion is common to both sodium chloride and lead(II) chloride. The addition of the common ion, Cl^-, will reduce the solubility of the lead(II) chloride because the added chloride ions shift the position of equilibrium to the left, and the lead(II) chloride is precipitated.	1

Part	Section	The answer	The mark
17	a	The voltage produced when a standard half – cell is connected to standard hydrogen electrode under standard conditions. **Or:** The potential of a cell composed of two electrodes as measured under standard conditions.	1
	b	1- Ion concentration 1.00mol dm^{-3} 2- Temperature: 298 K Or 25 C° 3 - The pressure 1 atm or 101 k pa or 1.0 bar (any two correct answers get the marks)	2
	c	Z^{2+}	1
	d	M	1
	e	Electrons flow from Y^{2+} /Y half-cell to X^{2+} / X half cell **Or** from more negative value of $E^{\ominus}$ to more positive value. **Or** Y metal will lose electrons to X^{2+} / X half-cell. **Or** X^{2+} ions will accept electrons from Y^{2+} / Y half-cell. **Or** The more positive pole attracts the negative electrons. **Or** Move from the strong reducing agent Y(s) to strong oxidizing agent X^{2+}. [1 mark] $X^{2+}(aq) + Y(s) \rightleftharpoons X(s) + Y^{2+}(aq)$ [1 mark]	2
18	a.i	I_2 (Iodine)	1
	a.ii	$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$ (The full equation must be correct)	1
	b.i	$2H^+(aq) + 2e^- \longrightarrow H_2(g)$ **Or** $H^+(aq) + e^- \longrightarrow 1/2H_2(g)$ (The full equation must be correct)	1
	b.ii	mixture of oxygen and chlorine gases. **Or** oxygen gas. [1 mark] Because the relatively lower concentration of Cl^- ions allows OH^- ions to fall below Cl^- ions in the discharge series. **Or** Because the discharge potential of OH^- is less than Cl^- in the electrochemical series (discharge series). [1 mark]	2

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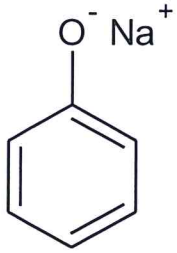
Part	Section	The answer	The mark
19	a	$F=L.e$	1
	b	Oxidation	1
	c	The cathode	1
	d	Q= It = 0.30 X 75 X 60 = 1350 C [1 mark]	1
	e	$Ag^+ (aq) + e^- \rightleftharpoons Ag (s)$ The number of coulombs required to deposit 1mole of product at the electrode : = F1 [1 mark] $m = \frac{1350 \times 108}{1 \times 96500}$ [1 mark] = 1.51 g [1 mark]	3

Part	Section	The answer	The mark
20	a	The energy change when 1 mole of an ionic compound is formed from its gaseous ions under standard conditions.	1
	b	- Ionic charge. [1 mark] - Ionic radius. [1 mark]	2
	c	(A): $\Delta H_f^{\ominus}$ **Or** enthalpy change of formation [1 mark] (B): $EA_2(O)$ **Or** Second electron affinity [1 mark]	2
	d	$\Delta H_{latt}^{\ominus} = \Delta H_f^{\ominus}[CaO] - (\Delta H_{at}^{\ominus}[Ca] + IE_1[Ca] + IE_2[Ca] + \Delta H_{at}^{\ominus}[O] + EA_1[O] + EA_2[O])$ $= -3454\ kJ\ mol^{-1}$ [1 mark]	1
	e	Calcium oxide has a greater lattice energy than lithium fluoride. The doubly charged Ca^{2+} and O^{2-} ions in calcium oxide attract each other more strongly than the singly charged Li^+ and F^- ions in lithium fluoride.	1

10

Part	Section	The answer	The mark
21	a	The enthalpy change when 1 mole of a specified gaseous ion dissolves in sufficient water to form a very dilute solution under standard conditions.	1
	b (i)	$MgCl_2(aq)$	1
	b (ii)	$\Delta H^{\ominus}_{latt}[MgCl_2]$ **Or** lattice enthalpy	1
	b (iii)	$2\Delta H^{\ominus}_{hyd}[Cl^-] = \Delta H^{\ominus}_{latt}[MgCl_2] + \Delta H^{\ominus}_{sol}[MgCl_2] - \Delta H^{\ominus}_{hyd}[Mg^{2+}]$ $\Delta H^{\ominus}_{hyd}[Cl^-] = -364$ kJ mol^{-1} **Or** 363.5kJ mol^{-1} [1 mark]	1
	c	Because the ionic radius of Mg^{2+} is smaller and there is less shielding than for Ba^{2+}. **Or** because the value of $\Delta H^{\ominus}_{hyd}$ is more exothermic for ions with the same charge but smaller ionic radii. **Or** $\Delta H^{\ominus}_{hyd}$ is more exothermic for Mg^{2+} than for Ba^{2+} because the charge density is greater for magnesium than for barium.	1

Part	Section	The answer	The mark
22	a(i)	HNO_3 or nitric acid	1
	a(ii)	Nitrobenzene	1
	b(i)	CH_3COCl or ethanoyl chloride	1
	b(ii)	Phenylethanone	1
	c	Bromoethane [1 mark] Bromoethane is more reactive than bromobenzene because the bond between carbon and bromine in bromoethane is weaker and easier to break. In bromobenzene, the bond is stronger due to the influence of the benzene ring, making it less reactive. [1 mark]	2
	d		1

Part	Section	The answer	The mark
23	a	$HNO_2 + HCl$ **Or** $NaNO_2 + HCl$ (1 mark for each)	2
	b	Phenylamine **Or** aniline	1
	c	 (1 mark) Sodium phenoxide (1 mark)	2
	d	The acidity of phenol is due to the delocalisation of the negative charge on the phenoxide ion into the π bonding electron system on the benzene ring. because it can lose a proton (H^+), to form phenoxide ion ($C_6H_5O^-$)	1

This is the end of the Marking Guide







امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)

الفصل الدراسي الأول - الدور الثاني

للعام الدراسي ١٤٤٦ - ١٤٤٧ هـ - ٢٠٢٤ / ٢٠٢٥ م

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** ▭ ◉ ◥ ☒ ☑

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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 mixtures is an acidic buffer solution?

⬭ Strong base and weak acid.

⬭ Strong acid and weak base.

⬭ Weak base and its conjugate acid.

⬭ Weak acid and its conjugate base.

2) Which of the following is not a reaction of a Brønsted - Lowry acid and base?

⬭ $CH_3Cl(aq) + OH^-(aq) \rightleftharpoons CH_3OH(aq) + Cl^-(aq)$

⬭ $NH_3(aq) + HCl(aq) \rightleftharpoons NH_4^+(aq) + Cl^-(aq)$

⬭ $H_2O(l) + HSO_4^-(aq) \rightleftharpoons H_2SO_4(aq) + OH^-(aq)$

⬭ $HCO_3^-(aq) + H_2O(l) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$

3) Which expression describes the relationship between solubility product, K_{sp}, and the solubility, s, of $Ca(OH)_2$?

⬭ $K_{sp} = 2S^2$

⬭ $K_{sp} = 4S^2$

⬭ $K_{sp} = 2S^3$

⬭ $K_{sp} = 4S^3$

4) A buffer solution is made of 0.20 mol dm^{-3} $NaNO_2$ and 0.20 mol dm^{-3} HNO_2. Which of the following statements is correct?

⬭ If NaOH is added, the OH^- ions react with the $NaNO_2$.

⬭ If HCl is added, the H^+ ions react with the NO_2^- ions.

⬭ If a small amount of HCl is added, the pH increases very slightly.

⬭ If a small amount of NaOH is added, the pH decreases very slightly.

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Question 1 continued

5) Which of the following terms describes the voltage produced when a standard half-cell is connected to a standard hydrogen electrode under standard conditions?

- ☐ Electrolysis.
- ☐ Half cell.
- ☐ Voltage cell.
- ☐ Standard electrode potential.

6) Which one of the following describes the standard hydrogen electrode?

	Hydrogen gas pressure (atm)	**H^+ ions concentration** (mol dm^{-3})	**The half – equation for the hydrogen electrode**
☐	1.00	1.00	$\frac{1}{2} H_2(g) + e^- \rightleftharpoons H^+(aq)$
☐	101	0.50	$\frac{1}{2} H_2(g) + e^- \rightleftharpoons H^+(aq)$
☐	1 .00	1.00	$H^+(aq) + e^- \rightleftharpoons \frac{1}{2} H_2(g)$
☐	101	0.50	$H^+(aq) + e^- \rightleftharpoons \frac{1}{2} H_2(g)$

7) Which of the following options is correct about the following reaction?

$$Cr(s) + Ca^{2+}(aq) \longrightarrow Cr^{2+}(aq) + Ca(s)$$

	The feasibility of the reaction	E^{Θ}/ V
☐	Feasible	+ 1.96
☐	Not feasible	- 1.96
☐	Feasible	+ 3.78
☐	Not feasible	- 3.78

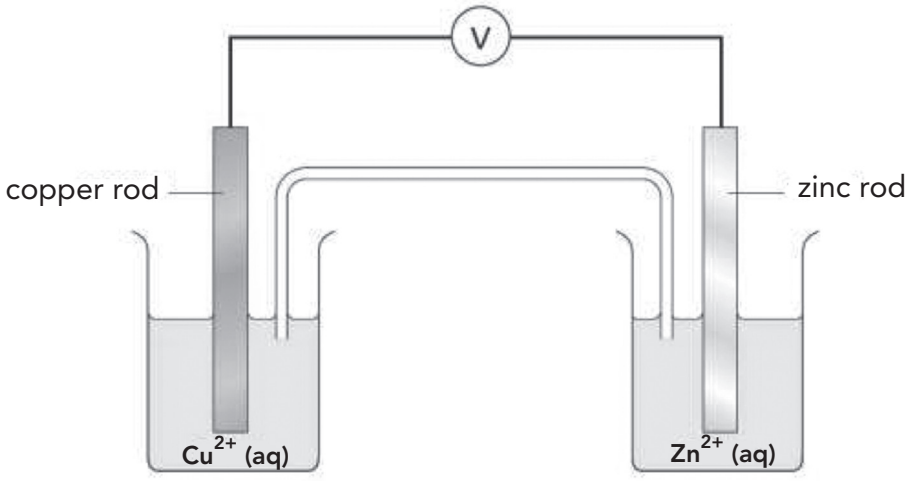
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Question 1 continued

8) Which of the following options is not correct about the following cell?



- ☐ The Zinc rod is reduced.
- ☐ The voltage generated by this cell is +1.10 V.
- ☐ The Zn metal will lose electrons to the Cu^{2+} / Cu half-cell.
- ☐ The electron flow is from the Zn^{2+} / Zn half-cell to the Cu^{2+} / Cu half-cell.

9) Which of the following statements is correct about electron affinity?

- ☐ It is the energy required to add an electron to a cation.
- ☐ It is the energy released when an electron is removed from a cation.
- ☐ It is the energy released when an electron is added to a gaseous atom.
- ☐ It is the energy required to remove an electron from a gaseous atom.

10) Which of the following equations represents the enthalpy of hydration of sodium chloride (NaCl)?

- ☐ $Na(s) + \frac{1}{2}Cl_2(g) \longrightarrow NaCl(s)$.
- ☐ $Na^+(g) + Cl^-(g) \longrightarrow NaCl(s)$.
- ☐ $NaCl(s) \longrightarrow Na^+(aq) + Cl^-(aq)$.
- ☐ $Na^+(g) + Cl^-(g) \longrightarrow Na^+(aq) + Cl^-(aq)$.

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Question 1 continued

11) Using the data in the table below. What is the enthalpy change of hydration of Ba^{2+} ion in kJ mol^{-1}?

Type of enthalpy change	Value of enthalpy change ($kJ\,mol^{-1}$)
Enthalpy change of hydration of OH^- ion	– 460
Lattice energy of $Ba(OH)_2$ (s)	– 2230
Enthalpy of solution of $Ba(OH)_2$ (s)	– 50

- ▢ –1260
- ▢ –1360
- ▢ –1820
- ▢ –3200

12) Which of the following options is correct about benzene?

	Bonds angle	Hybridization
▢	108°	sp^2
▢	108°	sp
▢	120°	sp^2
▢	120°	sp

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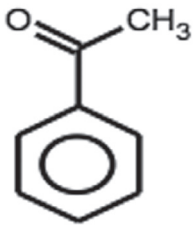
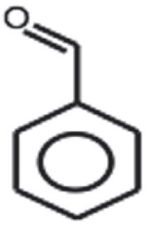
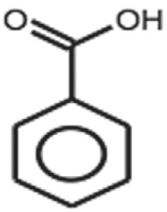
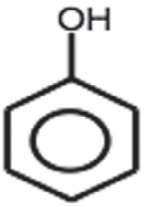
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13) Which of the following is the electrophile in the nitration of benzene?

- ▢ NO_2^+
- ▢ NO_2^-
- ▢ NO_3^-
- ▢ NO^+

14) Which product is formed in the Friedel-Crafts acylation of benzene with ethanoyl chloride, CH_3COCl ?

- ▢ 
- ▢ 
- ▢ 
- ▢ 

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Question 2: Extended responses (56 marks)

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

15) The following table shows equilibrium reactions and acid dissociation constants (Ka) in aqueous solutions. Use them to answer the following questions.

No.	Equilibrium in aqueous solutions	Ka / mol dm^{-3}
1	$CO_2 + H_2O \rightleftharpoons H^+ + HCO_3^-$	4.5×10^{-7}
2	$HSiO_3^- \rightleftharpoons H^+ + SiO_3^{2-}$	1.3×10^{-12}
3	$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$	1.7×10^{-5}
4	$HF \rightleftharpoons H^+ + F^-$	5.6×10^{-4}

a. For equilibrium **No.1**: (2 marks)

The hydrogencarbonate ion (HCO_3^-) is a conjugate base:

(i) Define the term conjugate base.

_____

(ii) What is the role of (HCO_3^-) in the blood?

_____

b. For equilibrium **No.2**: (2 marks)

(i) What are the acid and its conjugate base for the forward reaction?

The acid: _____

Its conjugate base: _____

(ii) Calculate the pK_a value?

_____

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c. What other component should be added to CH_3COOH to make a buffer solution? (1 mark)

d. A buffer solution consists of (0.0100 mol dm^{-3}) HF and (0.0200 mol dm^{-3}) NaF

(3 marks)

(i) Define the term buffer solution.

(ii) Calculate the pH of this buffer solution.

16) The solubility of lead(II) bromide, $PbBr_2$ is 2.17 x 10^{-3} mol dm^{-3} at a certain temperature.

a. Write equilibrium expressions for the solubility products for ($PbBr_2$). (1 mark)

b. Calculate the solubility product, K_{sp} of ($PbBr_2$) in mol^3 dm^{-9}. (1 mark)

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Question 2 continued

c. If sodium bromide is added to the lead(II) bromide solution, the solubility of lead(II) bromide will. (2 marks)

☐ Increase ☐ Decrease ☐ No change **(shade your answer)**

Explain your answer.

17) The following table shows values of E^{Θ} for some half cells. Use them to answer the following questions:

Half cells	E^{Θ}/ V
$Fe^{3+}(aq) / Fe(s)$	+ 0.77
$Mg^{2+}(aq) / Mg(s)$	– 2.38
$Cr^{3+}(aq) / Cr(s)$	– 0.74
$Ag^{+}(aq) / Ag(s)$	+ 0.80

a. Name the reference electrode used to measure the above standard electrode potential? (1 mark)

b. Define the term standard cell potential. (1 mark)

c. Which metal in the table is the strongest reducing agent? (1 mark)

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Question 2 continued

d. Which metal ion in the table is the easiest to reduce? (1 mark)

_____

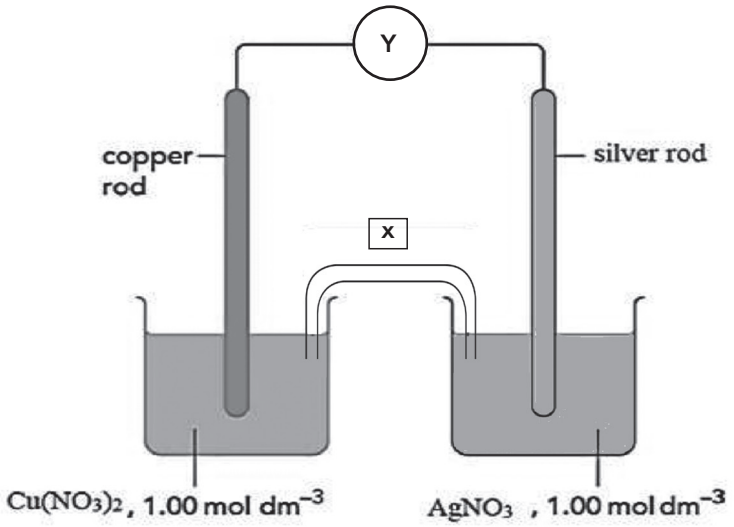
e. What is the direction of electron flow in the external circuit represented by the following pairs of half-equations $Mg^{2+}(aq)$ / Mg (s) and $Ag^{+}(aq)$ / Ag (s)? (1 mark)

_____

f. Write the whole equation that takes place in an electrochemical cell consisting of $Fe^{3+}(aq)$ /Fe(s) half-cell and Cr^{3+} (aq)/Cr(s) half-cell? (1 mark)

_____

18) Study the following figure which is about an electrochemical cell under standard conditions, to answer the questions below.



a. What type is this cell? (1 mark)

_____

b. Name the following labelled: (2 marks)

(X): _____

(Y): _____

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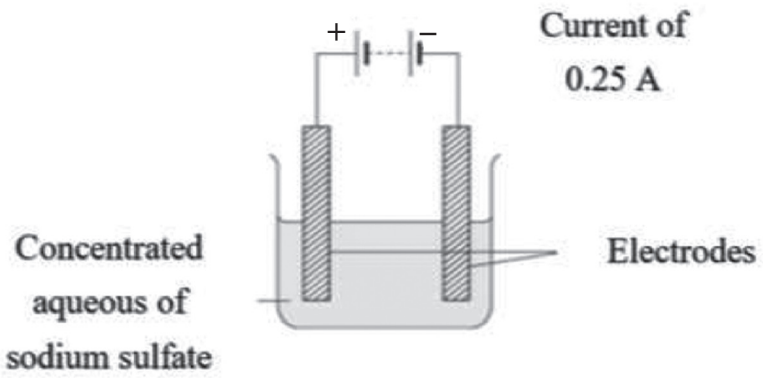
Question 2 continued

c. Calculate the cell voltage for this cell. (1 mark)

d. Calculate the value of the electrode potential at 298 K of Ag(s) /Ag^+(aq)electrode if the concentration of Ag^+ (aq) ions increases to (2.00) mol dm^{-3}
(E^{Θ} = + 0.80 V) (3 marks)

19) Study the following cell that shows the electrolysis of a concentrated aqueous solution of sodium sulfate, Na_2SO_4 for 15.0 min.

(F = 96500 C mol^{-1}, 1mole of gas occupies 24.0 dm^3 at r.t.p)



a. What substance will form at the cathode? (1 mark)

b. Write a half-equation for the reaction occurring at the anode. (1 mark)

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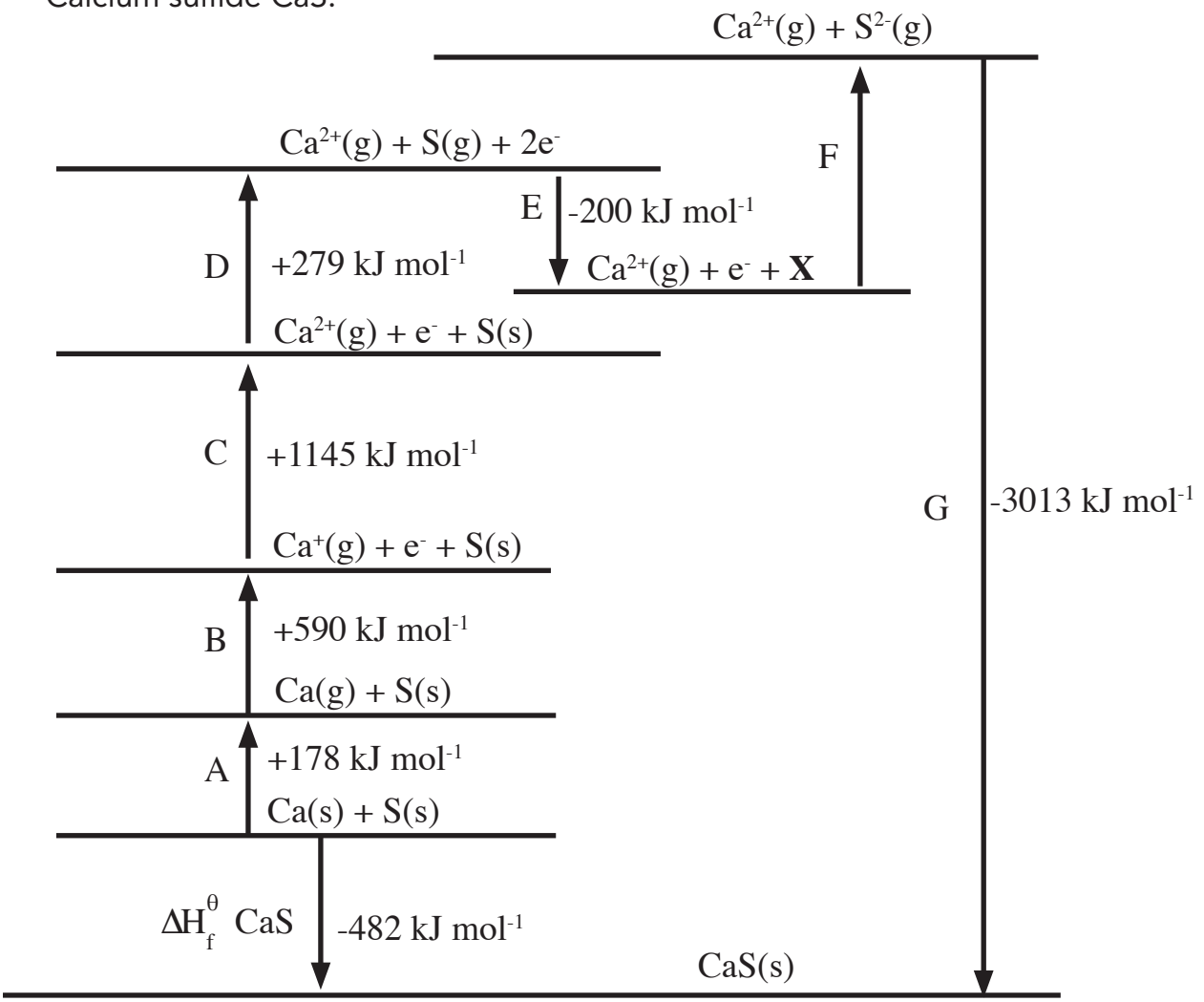
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Question 2 continued

c. Calculate the charge transferred during the electrolysis. (1 mark)

d. Calculate the volume of the substance that is produced at the anode at r.t.p . (3 marks)

20) The Born–Haber cycle below can be used to determine the lattice energy of Calcium sulfide CaS.



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Question 2 continued

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

b. Identify the substance (X) with state produced in step E. (1 mark)

c. Identify the enthalpy change in step (B) in the cycle. (1 mark)

d. Calculate the enthalpy change labelled by (F). (2 marks)

e. Explain why the enthalpy change (C) is greater than the enthalpy change (B). (1 mark)

21) Use the data in the table to answer the questions below:

Reactions	Enthalpy change ($kJmol^{-1}$)
$K^+(g) + I^-(g) \longrightarrow KI(s)$	−629
$K^+(g) \longrightarrow K^+(aq)$	−322
$I^-(g) \longrightarrow I^-(aq)$	−293

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

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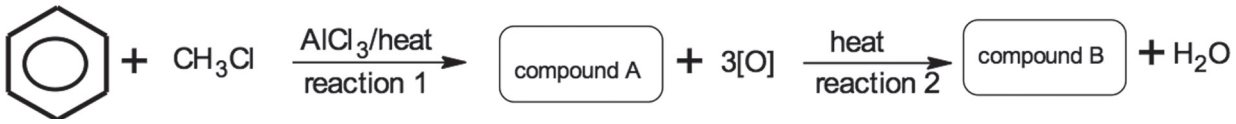
Question 2 continued

b. Calculate the enthalpy of solution for potassium iodide. (2 marks)

c. State two factors that affect lattice energy. (2 marks)

d. What is the order of the lattice energies of group 1 iodides (LiI, NaI, KI) from the greatest to the smallest? (1 mark)

22) Study the reactions sequence below, to answer the following questions:



a. For reaction 1: (4 marks)

(i) Draw compound A.

(ii) Name of the reaction.

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Question 2 continued

(iii) The reaction is:

○ Elimination reaction ○ Substitution reaction ○ redox reaction

(shade your answer)

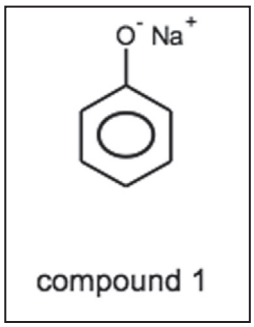
Explain your answer.

b. For reaction 2: (2 marks)

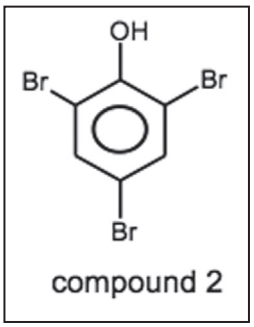
(i) Draw compound B.

(ii) Name the oxidizing agent used?

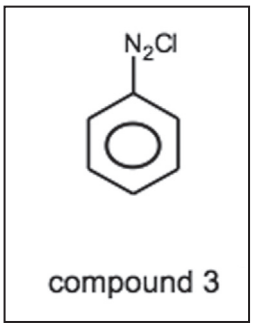
23) Study the compounds given below to answer the following questions:



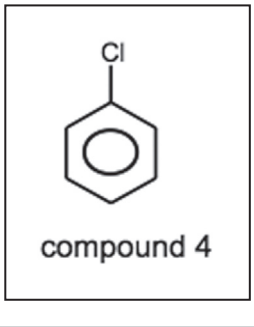
compound 1



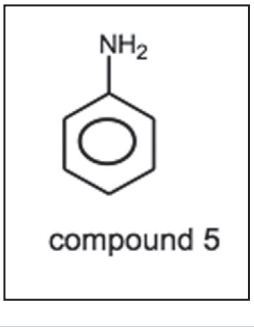
compound 2



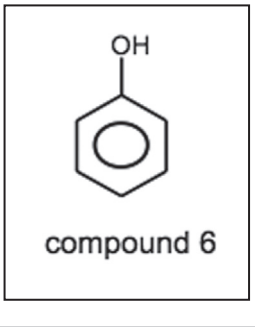
compound 3



compound 4



compound 5



compound 6

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Question 2 continued

a. Name the following compounds: (2 marks)

Compound 1: _____

Compound 2: _____

b. Which organic compound from the above is produced for the following reactions: (2 marks)

(i) Compound 6 reacts with Na.

_____

(ii) Compound 5 reacts with HNO_2 and HCl.

_____

c. Draw the chemical equation for producing compound 2, showing all the reagents used. (2 marks)

d. Why is chloroethane more reactive than compound 4. (1 mark)

_____

_____

[End of the Examination]

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Standard electrde potentals

Electrde reaction	$E^{\ominus}$/V
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+ 2.87
$S_2O_8^{2-}(aq) + 2e^- \rightleftharpoons 2SO_4^{2-}(aq)$	+ 2.01
$H_2O_2(l) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	+ 1.77
$Pb^{4+}(aq) + 2e^- \rightleftharpoons Pb^{2+}(aq)$	+ 1.69
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$	+ 1.52
$PbO_2(s) + 4H^+(aq) + 2e^- \rightleftharpoons Pb^{2+}(aq) + 2H_2O(l)$	+ 1.47
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+ 1.36
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l)$	+ 1.33
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	+ 1.23
$Br_2(aq) + 2e^- \rightleftharpoons 2Br^-(aq)$	+ 1.07
$VO_2^+(aq) + 2H^+(aq) + e^- \rightleftharpoons VO^{2+}(aq) + H_2O(l)$	+ 1.00
$VO_3^-(aq) + 4H^+(aq) + e^- \rightleftharpoons VO^{2+}(aq) + 2H_2O(l)$	+ 1.00
$ClO^-(aq) + H_2O(l) + 2e^- \rightleftharpoons Cl^-(aq) + 2OH^-(aq)$	+ 0.89
$NO_3^-(aq) + 10H^+(aq) + 8e^- \rightleftharpoons NH_4^+(aq) + 3H_2O(l)$	+ 0.87
$NO_3^-(aq) + 2H^+(aq) + e^- \rightleftharpoons NO_2(g) + H_2O(l)$	+ 0.81
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+ 0.80
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+ 0.77
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+ 0.54
$Cu^+(aq) + e^- \rightleftharpoons Cu(s)$	+ 0.52
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+ 0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+ 0.34
$VO^{2+}(aq) + 2H^+(aq) + e^- \rightleftharpoons V^{3+}(aq) + H_2O(l)$	+ 0.34

Electrde reaction	$E^{\ominus}$/V
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons SO_2(g) + 2H_2O(l)$	+ 0.17
$Cu^{2+}(aq) + e^- \rightleftharpoons Cu^+(aq)$	+ 0.15
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+ 0.15
$S_4O_6^{2-}(aq) + 2e^- \rightleftharpoons 2S_2O_3^{2-}(aq)$	+ 0.09
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Fe^{3+}(aq) + 3e^- \rightleftharpoons Fe(s)$	− 0.04
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	− 0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	− 0.14
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	− 0.25
$V^{3+}(aq) + e^- \rightleftharpoons V^{2+}(aq)$	− 0.26
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	− 0.28
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	− 0.44
$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s)$	− 0.74
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	− 0.76
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	− 0.83
$Cr^{2+}(aq) + 2e^- \rightleftharpoons Cr(s)$	− 0.91
$Mn^{2+}(aq) + 2e^- \rightleftharpoons Mn(s)$	− 1.18
$V^{2+}(aq) + 2e^- \rightleftharpoons V(s)$	− 1.20
$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	− 2.38
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	− 2.71
$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(s)$	− 2.87
$K^+(aq) + e^- \rightleftharpoons K(s)$	− 2.92

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Periodic Table

Atomic number — 11
Element symbol — Na
Mass number — 22.99

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

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

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MARKING GUIDE

GENERAL EDUCATION DIPLOMA

BILINGUAL PRIVATE SCHOOLS

SEMESTER ONE - SECOND SESSION

CHEMISTRY

2024 / 2025

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

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

Topic of the Units	Weighting %	Multiple Choice (20%)					Extended Response (80%)					Total Mark
		No. of Questions	Marks	Cognitive Levels			No. of Questions	Marks	Cognitive Levels			
				Knowing (30%)	Applying (50%)	Reasoning (20%)			Knowing (30%)	Applying (50%)	Reasoning (20%)	
Quantitative Equilibria	23%	14	4	1	2	1	10	12	4	6	2	16
Electrochemistry	33%		4	1	2	1		19	5	10	4	23
Lattice energy	21%		3	1	2	-		12	4	6	2	15
Arenes , Phenols	23%		3	1	1	1		13	4	6	3	16
Total	100 %		14	4	7	3		56	17	28	11	70

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

Distribution of cognitive domains and marks.

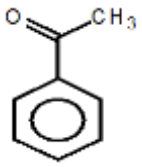
Item	Mark	Unit	Cognitive domain	Output
1	1	Quantitative Equilibria	Knowing	1.1.g
2	1	Quantitative Equilibria	Application	1.1.a
3	1	Quantitative Equilibria	Application	1.1.n
4	1	Quantitative Equilibria	Reasoning	1.1.h
5	1	Electrochemistry	Knowing	2.1. c
6	1	Electrochemistry	Application	2.1. e
7	1	Electrochemistry	Application	2.1 h i
8	1	Electrochemistry	Reasoning	2.1.i
9	1	Lattice energy	Knowing	3.1.b
10	1	Lattice energy	Application	3.1.b
11	1	Lattice energy	Application	3.2.a
12	1	Arenes and Phenols	Knowing	4.1.a
13	1	Arenes and Phenols	Application	4.1.d
14	1	Arenes and Phenols	Reasoning	4.1.c.iii
15.a.i	1	Quantitative Equilibria	Knowing	1.1.a
15.a.ii	1	Quantitative Equilibria	Knowing	1.1.i
15.b.i	1	Quantitative Equilibria	Application	1.1.b
15.b.ii	1	Quantitative Equilibria	Application	1.1.c
15.c	1	Quantitative Equilibria	Knowing	1.1.g
15.d.i	1	Quantitative Equilibria	Knowing	1.1.f
15.d.ii	2	Quantitative Equilibria	Application	1.1.j
16.a	1	Quantitative Equilibria	Application	1.1.m
16.b	1	Quantitative Equilibria	Application	1.1.n
16.c	2	Quantitative Equilibria	Reasoning	1.1.o
17.a	1	Electrochemistry	Knowing	2.1 d
17.b	1	Electrochemistry	Knowing	2.1 a ii
17.c	1	Electrochemistry	Application	2.1 j
17.d	1	Electrochemistry	Application	2.1 j
17.e	1	Electrochemistry	Application	2.1
17.f	1	Electrochemistry	Reasoning	2.1 hii + k
18.a	1	Electrochemistry	Knowing	2.1
18.b	2	Electrochemistry	Knowing	2.1 c iv. 2.1 c vii.
18.c	1	Electrochemistry	Application	2.1 g
18.d	3	Electrochemistry	Application	2.1 m
19.a	1	Electrochemistry	Application	2.2 a
19.b	1	Electrochemistry	Application	2.2 a
19.c	1	Electrochemistry	Application	2.2 c i
19 .d	3	Electrochemistry	Reasoning	2.2 cii

20.a	1	Lattice energy	Knowing	3.1.a
20.b	1	Lattice energy	Application	3.1.b
20.c	1	Lattice energy	Application	3.1.e
20.d	2	Lattice energy	Application	3.1.f
20.e	1	Lattice energy	Reasoning	3.1.b
21.a	1	Lattice energy	Knowing	3.2.a
21.b	2	Lattice energy	Application	3.2.c
21.c	2	Lattice energy	Knowing	3.1.g
21.d	1	Lattice energy	Application	3.1.g
22.a.i	1	Arenes and Phenols	Knowing	4.1.c.ii
22.a.ii	1	Arenes and Phenols	Knowing	4.1.c.ii
22.a.iii	2	Arenes and Phenols	Reasoning	4.1.c
22.b.i	1	Arenes and Phenols	Knowing	4.1.c.iii
22.b.ii	1	Arenes and Phenols	Knowing	4.1.c.iii
23.a	2	Arenes and Phenols	Application	4.1.b
23.b	2	Arenes and Phenols	Application	4.2.b
23.c	2	Arenes and Phenols	Application	4.1.c.i
23.d	1	Arenes and Phenols	Reasoning	4.1.e

TOTAL MARKS: 70 **PAGES: 5**

Question One (14 Marks)

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

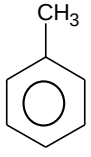
Item	Correct option	
1	D	Weak acid and its conjugate base.
2	A	$CH_3Cl(aq) + OH^-(aq) \rightleftharpoons CH_3OH(aq) + Cl^-(aq)$
3	D	$K_{sp} = 4S^3$
4	B	If HCl is added, the H^+ ions react with the NO_2^- ions.
5	D	Standard electrode potential
6	C	1 .00 1.00 $H^+(aq) + e^- \rightleftharpoons \frac{1}{2} H_2(g)$
7	B	Not feasible −1.96
8	A	The Zinc rod is reduced.
9	C	It is the energy released when an electron is added to a gaseous atom
10	D	$Na^+(g) + Cl^-(g) \rightarrow Na^+(aq) + Cl^-(aq)$
11	B	-1360
12	C	120^o sp^2
13	A	NO_2^+
14	A	

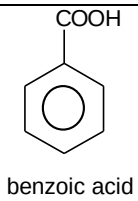
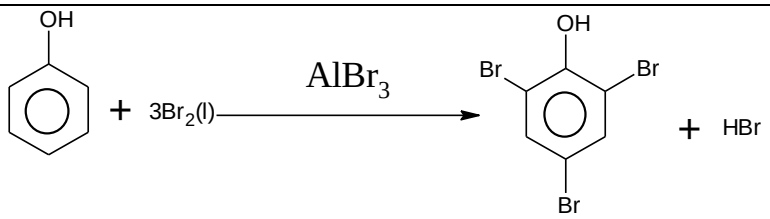
Question Two (56 Marks)

Part	Section	The answer	The mark
15	a. (i)	A conjugate base is an acid that lost its hydrogen ion (proton). **OR** A conjugate base contains one less H atom than the acid that formed it.	1
	a. (ii)	Controlling pH in blood.	1
	b. (i)	The acid: $HSiO_3^-$ Its conjugate base: SiO_3^{2-} (the student should write the acid and Its conjugate base to get the mark)	1
	b. (ii)	$pk_a = -\log(1.3\times10^{-12}) = \underline{11.89}$	1
	c	The large reserve supply of <u>its conjugate base CH_3COO^-</u> **Or** <u>the salt of CH_3COOH</u>	1
	d. (i)	A solution that minimizes changes in pH when moderate amounts of acid or base are added.	1
	d. (ii)	$K_a = \frac{[H^+][F^-]}{[HF]}$, $5.6 \times 10^{-4} = \frac{[H^+](0.0200)}{(0.0100)}$ $[H^+] = 2.8 \times 10^{-4}$ mol dm^{-3} [1 mark] $pH = -\log_{10}[H^+] = -\log_{10}[2.8 \times 10^{-4}] = 3.55$ [1 mark] **Or** $pH = pK_a + \log\frac{(0.02)}{(0.01)}$ [1 mark] pH = 3.55 [1 mark]	2
16	a	$K_{sp}=[Pb^{2+}][Br^-]^2$	1
	b	Let solubility be "s" $[Pb^{2+}]$= s, $[Br^-]$=2s , $K_{sp}=4s^3$ Substituting s = 2.17×10^{-3} $K_{sp} = 4s^3 = 4(2.17 \times 10^{-3})^3$ $= 4.10 \times 10^{-8}$ mol^3 dm^{-9} [1 mark]	1
	c	Decrease [1 mark] The bromide ion is common to both sodium bromide and lead(II) bromide. The addition of the common ion, Br^-, will reduce the solubility of the lead(II) bromide because <u>the added bromide ions shift the position of equilibrium to the left, and the lead(II) bromide is precipitated.</u> [1 mark]	2

Part	Section	The answer	The mark
17		The standard hydrogen electrode	1
	b	The difference in standard electrode potential between two specified half cells	1
	c	Mg	1
	d	Ag^+	1
	e	From $Mg^{2+}(aq)$ / Mg (s) to Ag^+ (aq) / Ag (s) **Or** From Mg to Ag	1
	f	$Cr(s) + Fe^{3+}(aq) \longrightarrow Cr^{3+}(aq) + Fe(s)$	1
18	a	Voltage cell	1
	b	(X): The salt bridge (Y): The voltmeter	1 1
	c	$E^{\ominus} = +0.80 - (+0.34)$ $= 0.46$ V	1
	d	$E = E^{\ominus} + 0.059/z \log_{10} [Ag^+(aq)]$ [1mark for z =1] $= 0.80 + 0.059/1 \log_{10} [2.00]$ [1mark] $= 0.98$ V [1 mark]	3

Part	Section	The answer	The mark
19	a	Hydrogen (H_2)	1
	b	$4OH^-(aq) \longrightarrow O_2(g) + 2H_2O(l) + 4e^-$	1
	c	Q= It = 0.25X 15 X 60 = 225 C	1
	d	Find the number of coulombs required to produce 1 mole of gas. 4 moles of electrons are released per mole of O_2 formed = 4F [1 mark] $=4 \times 96500$ $= 386000$ C mol^{-1} 225 C produces $225/386000 \times 24.0$ [1 mark] $= 0.0140$ dm^3 O_2 at r.t.p. [1 mark]	3

Part	Section	The answer	The mark
20	a	The enthalpy changes when one mole of gaseous atoms is formed from the element in its standard state under standard conditions	1
	b	$S^-(g)$	1
	c	$IE_1(Ca)$ **Or** First ionization energy.	1
	d	$\Delta H^{\ominus}_{latt} = \Delta H^{\ominus}_f[CaS] - (\Delta H^{\ominus}_{at}[Ca] + IE_1[Ca] + IE_2[Ca] + \Delta H^{\ominus}_{at}[S] + EA_1[S] + EA_2[S])$ [1 mark] $-3013 = -482 - (178 + 590 + 1145 + 279 - 200 + F)$ $F = +539\ kJ\ mol^{-1}$ [1 mark]	2
	e	After the first electron is removed, the atom becomes a positively charged ion. This increases the effective nuclear charge experienced by the remaining electrons, making them more tightly bound to the nucleus	1
21	a	The standard enthalpy change of solution: the enthalpy changes when one mole of a substance dissolves in a solvent to form an infinitely dilute solution under standard conditions	1
	b	$\Delta H^0_{latt} + \Delta H^0_{sol} = \Delta H^0_{hyd}(K^+) + \Delta H^0_{hyd}(I^-)$ $-629 + \Delta H^0_{sol} = (-322) + (-293)$ [1 mark] $\Delta H^0_{sol} = +14\ kJmol^{-1}$ [1 mark]	2
	c	Ionic radius. Ionic charge.	1 1
	d	$LiI > NaI > KI$	1
22	a.i	 methylbenzene	1
	a.ii	Friedel-Crafts Alkylation	1
	a.iii	Substitution reaction	1

		The alkyl group is introduced into the benzene ring by replacing one of the hydrogen atoms. This reaction involves the use of an alkyl halide and a Lewis acid catalyst, $AlCl_3$, to generate the electrophile that reacts with the benzene ring.	1
	b.i	 benzoic acid	1
	b.ii	Hot alkaline potassium manganate(VII) **Or** $KMnO_4$	1
23	**a**	sodium phenoxide 2,4,6-Tribromophenol	1 1
	b,i	compound 1 **Or** Sodium phenoxide	1
	b.ii	compound 3 **Or** Diazonium salt	1
	c		2
	d	Chloroethane is highly reactive in nucleophilic substitution due to a weaker, polar carbon-chlorine bond. **Or** Chlorobenzene is less reactive due to resonance stabilization and a stronger, less polar C-Cl bond.	1

This is the end of the Marking Guide