سلطنة عمان
وزارة التربية والتعليم

امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)
للعام الدراسي ١٤٤٠/١٤٣٩ هـ - ٢٠١٨ / ٢٠١٩ م
الدور الثاني - الفصل الدراسي الثاني

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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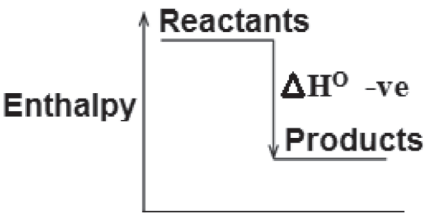
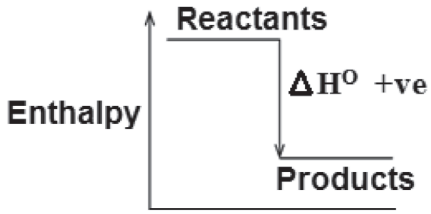
Use the following if necessary:
Faraday constant = 96500 $Cmol^{-1}$
Avogadro constant = 6.022×10^{23} mol^{-1}
Specific heat capacity (H_2O) = 4.18 J g^{-1} K^{-1}
Attachments: periodic table and table of standard electrode potentials

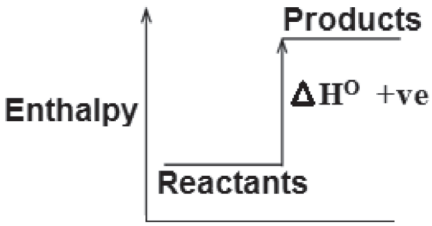
Question 1: Multiple Choice Items (14 marks)

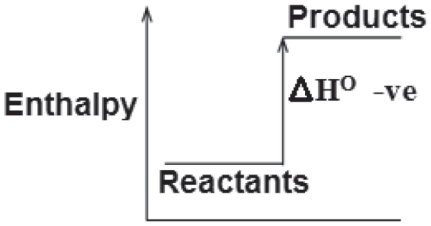
There are 14 multiple-choice items worth one marks each.
Shade in the bubble (⬭) next to the **correct** answer for each of the following items.

1) Which of these diagrams represents an endothermic reaction?

⬭ 

⬭ 

⬭ 

⬭ 

2) What is the standard enthalpy change of reaction for the following reaction?

$Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$

(ΔH^0_f for Cu^{2+} = +64.4 kJ mol^{-1} , ΔH^0_f for Zn^{2+} = –152.4 kJ mol^{-1})

⬭ 216.8 kJ released per mol
⬭ 88 kJ released per mol
⬭ 88 kJ absorded per mol
⬭ 216.8 kJ absorbed per mol

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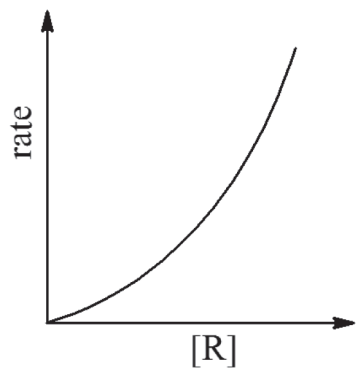
Question 1 continued

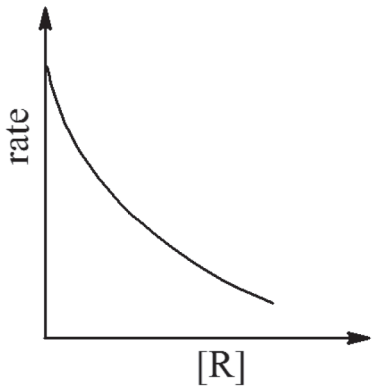
3) The table below shows results of heating two pieces of the same metal (A) and (B). They gained the same amount of heat. Use the information to calculate the mass of metal (B) in grams.

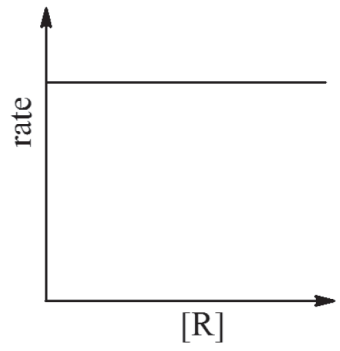
Metal	A	B
Temperature before heating (°C)	22.5	16.5
Temperature after heating (°C)	35	44.2
Mass (g)	54.6	?

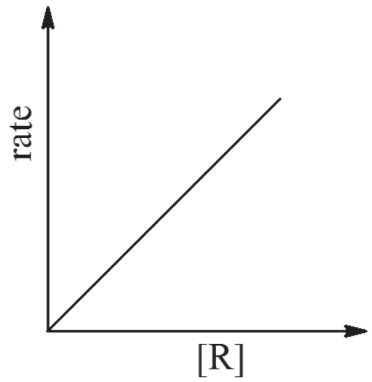
- ▢ 15.6
- ▢ 24.6
- ▢ 27.7
- ▢ 69.8

4) Which of the following rate-concentration graphs represents the first order reaction?

- ▢ 

- ▢ 

- ▢ 

- ▢ 

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Question 1 continued

5) Given the following data for this reaction:

$2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$

Experiment number	[NO] / mol dm^{-3}	[O2] / mol dm^{-3}	Rate / mol dm^{-3} s^{-1}
1	1.0	1.0	4
2	2.0	1.0	16.0
3	2.0	3.0	48.0

What is the rate equation for the reaction?

- ☐ Rate = $k[NO]\,[O_2]$
- ☐ Rate = $k[NO]^2[O_2]$
- ☐ Rate = $k[NO]^2[O_2]^2$
- ☐ Rate = $k[NO]\,[O_2]^2$

6) The decomposition of carbon disulfide (CS_2) to carbon monosulfide (CS) and sulfur, is a first order reaction with $k = 2.8 \times 10^{-7}\ s^{-1}$ at 1000°C.

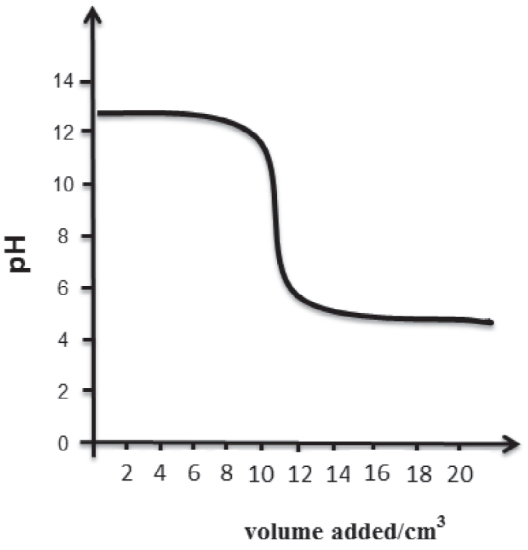
$$CS_{2(s)} \longrightarrow CS_{(s)} + S_{(s)}$$

What is the half-life (in seconds) of this reaction at 1000°C?

- ☐ 2.5×10^{6}
- ☐ 4.7×10^{-6}
- ☐ 3.8×10^{5}
- ☐ 6.1×10^{4}

7) What is the type of titration represented by the pH curve opposite?

- ☐ Strong acid added to strong alkali
- ☐ Strong acid added to weak alkali
- ☐ Weak acid added to strong alkali
- ☐ Weak acid added to weak alkali



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Question 1 continued

8) Which of the following mixture can act as a buffer solution?

- ☐ $HCl_{(aq)} + KCl_{(aq)}$
- ☐ $HF_{(aq)} + KF_{(aq)}$
- ☐ $NH_4Br_{(aq)} + NaI_{(aq)}$
- ☐ $NaOH_{(aq)} + NaBr_{(aq)}$

Use the following information to answer question (9):

Acids (all acids are at the same concentrations 0.1 mol dm^{-3})	K_a at 25°C (mol dm^{-3})
C_6H_5COOH	6.3×10^{-5}
HCN	4.9×10^{-10}
HF	7.2×10^{-4}
HCOOH	1.6×10^{-4}

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

- ☐ $HCN < C_6H_5COOH < HCOOH < HF$
- ☐ $HCN < C_6H_5COOH < HF < HCOOH$
- ☐ $HF < HCOOH < C_6H_5COOH < HCN$
- ☐ $HCOOH < HF < C_6H_5COOH < HCN$

10) Which of the following cells contains very reactive chemicals and must be treated carefully?

- ☐ Fuel cell
- ☐ Lithium cell
- ☐ Nickel-hydride cell
- ☐ Lead-acid cell

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Question 1 continued

11) Consider the following metals:

$K_{(s)}$, $Mg_{(s)}$, $Zn_{(s)}$

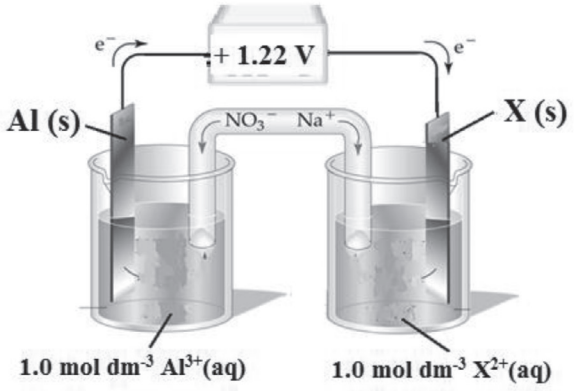
Which of the following oxidising agents can oxidise only one of the above metals?

- ☐ $Li^{+}_{(aq)}$
- ☐ $Na^{+}_{(aq)}$
- ☐ $Al^{3+}_{(aq)}$
- ☐ $Fe^{2+}_{(aq)}$

12) In an electrolysis cell, if a mixture of $MgBr_{2(aq)}$ and $CuBr_{2(aq)}$ is electrolysed. Which of the following substances is deposited at the cathode?

- ☐ $Mg_{(s)}$
- ☐ $Mg^{2+}_{(aq)}$
- ☐ $Cu_{(s)}$
- ☐ $Cu^{2+}_{(aq)}$

Study the electrochemical cell represented below to answer questions (13 and 14)



13) Which of the following metals represents the electrode (X)?

- ☐ $Mg_{(s)}$
- ☐ $Zn_{(s)}$
- ☐ $Cu_{(s)}$
- ☐ $Fe_{(s)}$

14) If the electrode (X) is replaced by copper electrode. Which of the following changes will occur?

- ☐ The value of $E^{\ominus}$ cell will decrease.
- ☐ The mass of the copper electrode will increase.
- ☐ The Na^{+} ions will migrate to the aluminum half-cell.
- ☐ The flow of electrons will reverse to the aluminum electrode.

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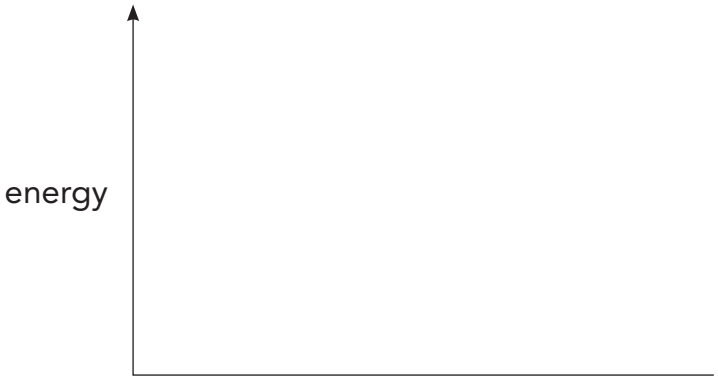
Question 2: Extended Questions (56 marks)

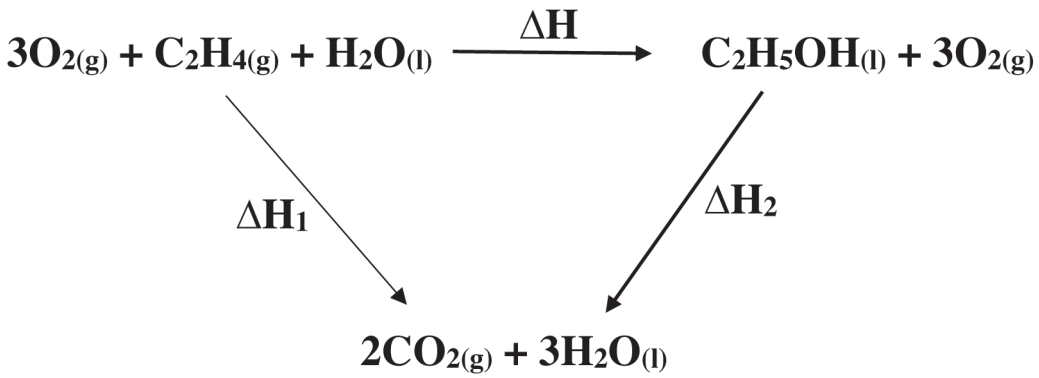
Write your answer for each of the following questions in the space provided.
Be sure to show all your work, including the correct units where applicable.

15) a. Draw a labeled energy level diagram for the reaction below

$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$ $\Delta H^{\ominus} = -297$ kJ mol^{-1}



b. Ethanol, C_2H_5OH, is used for example as a solvent and as a fuel by combustion. Study the standard energy cycle below then answer the following questions:



(i) Define the term standard enthalpy change of combustion.

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Question 2 continued

(ii) Calculate the standard enthalpy change (ΔH) in the energy cycle above.
[Given: $\Delta H_c^{\ominus}$ ($C_2H_{4(g)}$) = –1411 kJ mol^{-1} , $\Delta H_c^{\ominus}$ ($C_2H_5OH_{(l)}$) = –1367 kJ mol^{-1}]

16) a. Explain what is meant by the average O-H bond enthalpy?

b. Write a balanced equation to show the breakdown of water vapour ($H_2O_{(g)}$) into atoms (show the states and ΔH in the equation).

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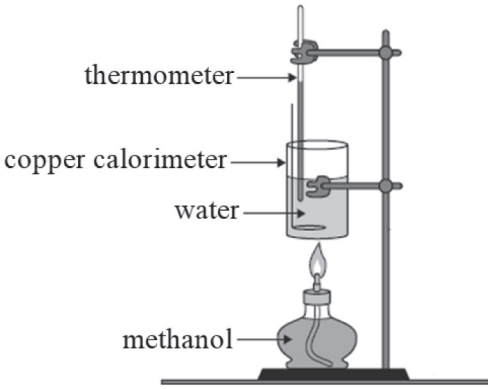
Question 2 continued

c. A student carried out an experiment to determine $\Delta H_c^{\ominus}$ for methanol, CH_3OH, using the apparatus below and obtained the following results.

Mass of water in calorimeter	150 g
Mass of methanol and burner at start	520.48 g
Mass of methanol and burner at end	519.53 g
Temperature of water at start	22°C
Temperature of water at end	37°C



(i) Is the combustion of methanol an endothermic or exothermic process? Explain your answer.

(ii) Calculate the standard enthalpy change of combustion of methanol, $\Delta H_c^{\ominus}$, in kJ mol^{-1}.

M_r (CH_3OH) = 32 g mol^{-1}.

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Question 2 continued

(iii) What will happen to the value of enthalpy change of combustion if the student burns two moles of methanol?

☐ Increases ☐ Decreases (choose the correct answer)

17) a. What it meant by half-life?

_____

_____

b. Explain why the half- life of first order reaction is independent of the initial concentration of reactant?

_____

_____

18) An investigation of decomposition of compound C at a fixed temperature was carried out. The following results were obtained.

Experiment number	Initial concentration of C ($mol.dm^{-3}$)	Initial rate ($mol.dm^{-3}s^{-1}$)
1	0.0194	1.01×10^{-3}
2	0.0404	1.99×10^{-3}
3	0.0590	3.04×10^{-3}
4	0.0806	3.95×10^{-3}
5	0.1178	6.04×10^{-3}

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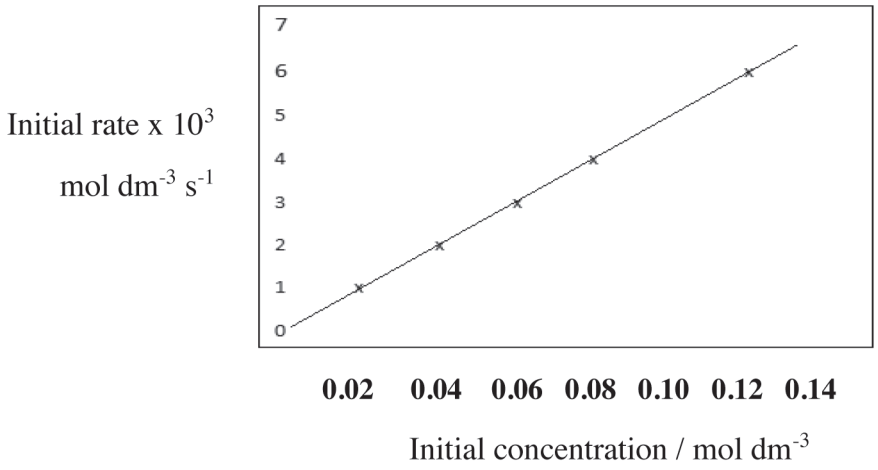
Question 2 continued

The graph of initial rate against concentration is plotted as shown below.



a. Use the graph to find the order of reaction with respect to C.

b. Write the equation of the rate constant.

c. Calculate the rate constant, giving its unit.

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Question 2 continued

19) a. A sample of tomatoes has a pH of 4.35 at 25 °C. Calculate the concentration of $H_3O^+_{(aq)}$.

b. One buffer in the blood is the hydrogen carbonate/carbonic acid system.

$$H_2CO_{3(aq)} \rightleftharpoons HCO^-_3$$

Explain how the pH of the blood is maintained at pH 7.4 when H^+ ion is added or removed and how this system work as buffer solution in your body.

Write equations to explain your answer.

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Question 2 continued

c. **(i)** The solubility product of zinc sulphide (ZnS) is 1.0×10^{-24} mol^2 dm^{-6} at 25 °C. Calculate the solubility of ZnS in mol dm^{-3} at 25 °C.

(ii) Explain why the units quoted for K_{sp} are mol^2 dm^{-6}.

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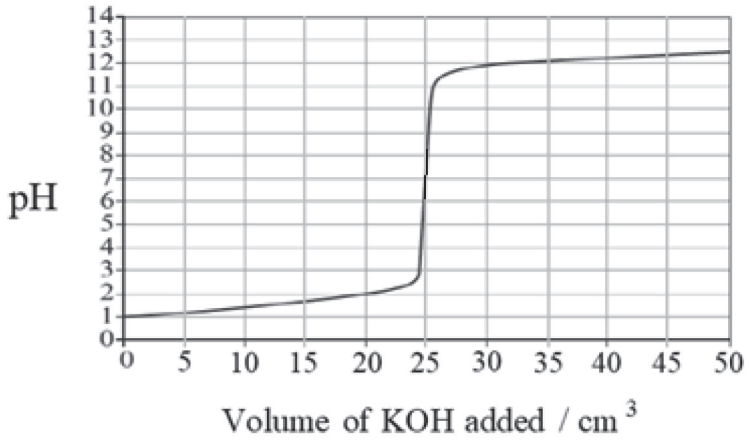
Question 2 continued

20) The following graph shows the pH curve for the titration of hydrochloric acid (HCl) solution with 25 cm^3 of potassium hydroxide (KOH) solution. Study the graph to answer the questions below.



a. What is the value of pH at equivalence point for this titration?

b. What is the volume of potassium hydroxide, KOH, required to neutralise the acid?

c. Calculate $[OH^-]$ at pH = 12.

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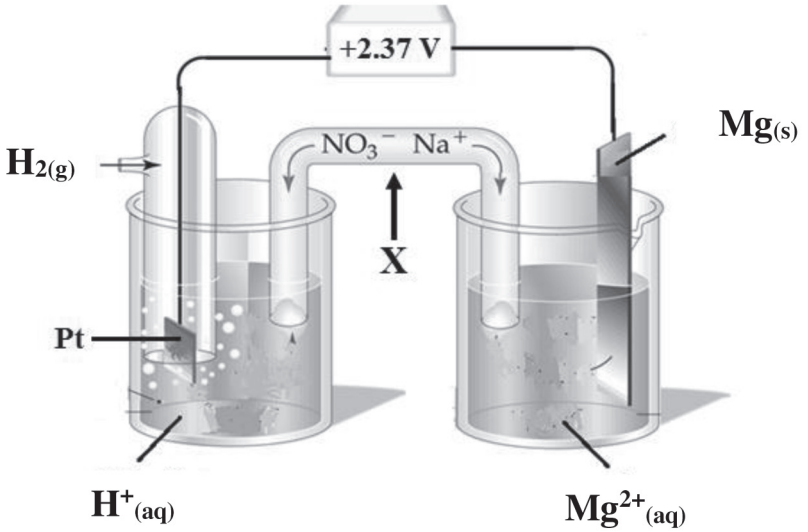
Question 2 continued

d. Explain why the phenolphthalein is a suitable indicator for this titration.

21) The electrochemical cell below consists of a hydrogen half-cell and a magnesium half-cell at standard conditions. The reading on the voltmeter is +2.37 V.



a. What are the three conditions needed for the hydrogen half-cell to function at standard conditions?

b. What is the name of the apparatus labelled (X).

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Question 2 continued

c. Is magnesium the anode or cathode in the cell above? Explain your answer.

d. Write the balanced net overall cell reaction that takes place in this cell.

e. Calculate the standard reduction potential of the magnesium half-cell. Show all your calculations.

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Question 2 continued

22) The table below shows six half cells, study it then answer the following questions.

Half cell
$Fe^{2+}_{(aq)} + 2e^- \rightleftharpoons Fe_{(s)}$
$H^+_{(aq)} + e^- \rightleftharpoons \frac{1}{2} H_{2(g)}$
$Ni^{2+}_{(aq)} + 2e^- \rightleftharpoons Ni_{(s)}$
$Cu^{2+}_{(aq)} + 2e^- \rightleftharpoons Cu_{(s)}$
$Mg^{2+}_{(aq)} + 2e^- \rightleftharpoons Mg_{(s)}$
$Ag^+_{(aq)} + e^- \rightleftharpoons Ag_{(s)}$

a. Write the balanced overall equation when ($Ag^+_{(aq)} \mid Ag_{(s)}$) half-cell is connected with ($Ni^{2+}_{(aq)} \mid Ni_{(s)}$) half-cell?

b. What will happen to the mass of (Cu) electrode when ($Cu^{2+}_{(aq)} \mid Cu_{(s)}$) half-cell is connected with ($Mg^{2+}_{(aq)} \mid Mg_{(s)}$) half-cell?

c. Calculate (E^{θ}_{cell}) for the following reaction:

$$Mg^{2+}_{(aq)} + Ni_{(s)} \longrightarrow Mg_{(s)} + Ni^{2+}_{(aq)}$$

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Question 2 continued

23) a. Write the half equation for the reaction occurring at each electrode during electrolysis of molten sodium iodide.

Anode half equation	Cathode half equation

b. An electric current of 0.50A was passed through concentrated aqueous solution of sulphuric acid $H_2SO_{4(aq)}$ and electrolysed for 30.0min.

How many coulombs of charge were passed during the experiment?

[End of the Examination]

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Standard electrode potentials in aqueous solutions at 25 °C

Half cell	$E^{\ominus}$ /V
$Li^{+}_{(aq)} / Li_{(s)}$	-3.03
$K^{+}_{(aq)} / K_{(s)}$	-2.92
$Na^{+}_{(aq)} / Na_{(s)}$	-2.71
$Mg^{2+}_{(aq)} / Mg_{(s)}$	-2.37
$Al^{3+}_{(aq)} / Al_{(s)}$	-1.66
$Zn^{2+}_{(aq)} / Zn_{(s)}$	-0.76
$Fe^{2+}_{(aq)} / Fe_{(s)}$	-0.44
$Ni^{2+}_{(aq)} / Ni_{(s)}$	-0.26
$H^{+}_{(aq)} / \frac{1}{2} H_{2(g)}$, Pt	0.00
$Cu^{2+}_{(aq)} / Cu_{(s)}$	+0.34
$\frac{1}{2} I_{2(aq)} / I^{-}_{(aq)}$, Pt	+0.54
$Fe^{3+}_{(aq)} / Fe^{2+}_{(aq)}$, Pt	+0.77
$Ag^{+}_{(aq)} / Ag_{(s)}$	+0.80
$\frac{1}{2} Br_{2(aq)} / Br^{-}_{(aq)}$, Pt	+1.09
$\frac{1}{2} O_{2(g)}$, Pt + $2H^{+}_{(aq)} / H_2O_{(l)}$	+1.23
$\frac{1}{2} Cl_{2(aq)} / Cl^{-}_{(aq)}$, Pt	+1.36
$Au^{3+}_{(aq)} / Au_{(s)}$	+1.50
$MnO_4^{-}{}_{(aq)} + 8H^{+}_{(aq)} / Mn^{2+}_{(aq)}$, Pt	+1.51
$\frac{1}{2} F_{2(aq)} / F^{-}_{(aq)}$, Pt	+2.87

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PERIODIC TABLE OF THE ELEMENTS

Key: Atomic Number → 1; Symbol → H; 1.008 ← Atomic Mass; Hydrogen ← Name

1 H 1.008 Hydrogen																	2 He 4.002602 Helium
3 Li 6.94 Lithium	4 Be 9.0121831 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.999 Oxygen	9 F 18.998403163 Fluorine	10 Ne 20.1797 Neon
11 Na 22.98976928 Sodium	12 Mg 24.305 Magnesium											13 Al 26.9815385 Aluminium	14 Si 28.085 Silicon	15 P 30.973761998 Phosphorus	16 S 32.06 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.948 Argon
19 K 39.0983 Potassium	20 Ca 40.078 Calcium	21 Sc 44.955908 Scandium	22 Ti 47.867 Titanium	23 V 50.9415 Vanadium	24 Cr 51.9961 Chromium	25 Mn 54.938044 Manganese	26 Fe 55.845 Iron	27 Co 58.933194 Cobalt	28 Ni 58.6934 Nickel	29 Cu 63.546 Copper	30 Zn 65.38 Zinc	31 Ga 69.723 Gallium	32 Ge 72.630 Germanium	33 As 74.921595 Arsenic	34 Se 78.971 Selenium	35 Br 79.904 Bromine	36 Kr 83.798 Krypton
37 Rb 85.4678 Rubidium	38 Sr 87.62 Strontium	39 Y 88.90584 Yttrium	40 Zr 91.224 Zirconium	41 Nb 92.90637 Niobium	42 Mo 95.95 Molybdenum	43 Tc 98 Technetium	44 Ru 101.07 Ruthenium	45 Rh 102.90550 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.8682 Silver	48 Cd 112.414 Cadmium	49 In 114.818 Indium	50 Sn 118.710 Tin	51 Sb 121.760 Antimony	52 Te 127.60 Tellurium	53 I 126.90447 Iodine	54 Xe 131.293 Xenon
55 Cs 132.90545196 Caesium	56 Ba 137.327 Barium	57/71	72 Hf 178.49 Hafnium	73 Ta 180.94788 Tantalum	74 W 183.84 Tungsten	75 Re 186.207 Rhenium	76 Os 190.23 Osmium	77 Ir 192.217 Iridium	78 Pt 195.084 Platinum	79 Au 196.966569 Gold	80 Hg 200.592 Mercury	81 Tl 204.38 Thallium	82 Pb 207.2 Lead	83 Bi 208.98040 Bismuth	84 Po 209 Polonium	85 At 210 Astatine	86 Rn 222 Radon
87 Fr 223 Francium	88 Ra 226 Radium	89/103	104 Rf 267 Rutherfordium	105 Db 268 Dubnium	106 Sg 269 Seaborgium	107 Bh 270 Bohrium	108 Hs 269 Hassium	109 Mt 278 Meitnerium	110 Ds 281 Darmstadtium	111 Rg 281 Roentgenium	112 Cn 285 Copernicium	113 Uut 286 Ununtrium	114 Fl 289 Flerovium	115 Uup 289 Ununpentium	116 Lv 293 Livermorium	117 Uus 294 Ununseptium	118 Uuo 294 Ununoctium

Lanthanide Series	57 La 138.90547 Lanthanum	58 Ce 140.116 Cerium	59 Pr 140.90766 Praseodymium	60 Nd 144.242 Neodymium	61 Pm 145 Promethium	62 Sm 150.36 Samarium	63 Eu 151.964 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92535 Terbium	66 Dy 162.500 Dysprosium	67 Ho 164.93033 Holmium	68 Er 167.259 Erbium	69 Tm 168.93422 Thulium	70 Yb 173.054 Ytterbium	71 Lu 174.9668 Lutetium
Actinide Series	89 Ac 227 Actinium	90 Th 232.0377 Thorium	91 Pa 231.03588 Protactinium	92 U 238.02891 Uranium	93 Np 237 Neptunium	94 Pu 244 Plutonium	95 Am 243 Americium	96 Cm 247 Curium	97 Bk 247 Berkelium	98 Cf 251 Californium	99 Es 252 Einsteinium	100 Fm 257 Fermium	101 Md 258 Mendelevium	102 No 259 Nobelium	103 Lr 266 Lawrencium

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MARKING GUIDE

GENERAL EDUCATION DIPLOMA

BILINGUAL PRIVATE SCHOOLS

SEMESTER TWO - SECOND SESSION

CHEMISTRY

2018 / 2019

Detailed Exam: Specifications for Semester Two:

Topics of the units	Weighting %	Multiple choice (20%)		Extended response (80%)		Cognitive levels			Total
		No. of Items	Marks	No. of questions	Marks	Knowing (30%)	Applying (50%)	Reasoning (20%)	
Chemical Energetic	23%	3	3	10	13	5	8	3	16
Quantitative Kinetics	18%	3	3		10	4	7	2	13
Quantitative Equilibrium	23%	3	3		13	5	8	3	16
Electrochemistry	36%	5	5		20	8	12	5	25
Total	100%	14	14		56	22	35	13	70

General Education Diploma, Bilingual Private Schools,
Semester Two, Second Session, Chemistry, 2018/2019.

Distribution of cognitive domains and marks.

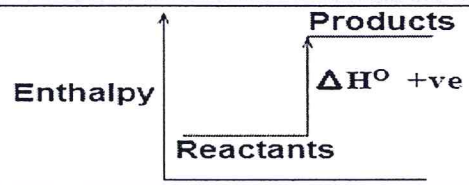
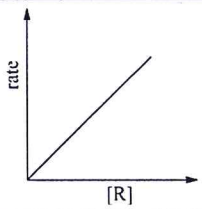
Serial. No	Question Number	Item	Mark	Unit	Page	Cognitive domain	Out-comes
1	1	1	1	Chemical Energetic	98	Knowing	6.1a
2	1	2	1	Chemical Energetic	104	Applying	6.1c
3	1	3	1	Chemical Energetic	104	Reasoning	6.1c
4	1	4	1	Quantitative Kinetics	353-354	Knowing	7.1b
5	1	5	1	Quantitative Kinetics	356	Applying	7.1b
6	1	6	1	Quantitative Kinetics	357	Applying	7.1cii
7	1	7	1	Quantitative Equilibrium	373	Knowing	8.1d
8	1	8	1	Quantitative Equilibrium	371	Applying	8.1eii
9	1	9	1	Quantitative Equilibrium	367	Reasoning	8.1a
10	1	10	1	Electrochemistry	394	Knowing	9.3a
11	1	11	1	Electrochemistry	386	Applying	9.2e
12	1	12	1	Electrochemistry	391-392	Applying	9.1b
13	1	13	1	Electrochemistry	381-385	Applying	9.2d
14	1	14	1	Electrochemistry	381-385	Reasoning	9.2e

Serial no.	Question no.	item	mark	Unit	Page	Cognitive domain	Outcome
	2	15.a	2	Chemical Energetic	98	K	6.1a
	2	15.b(i)	2	Chemical Energetic	104	K	6.1bi
	2	15.b(ii)	2	Chemical Energetic	102-113	A	6.2a
	2	16.a	1	Chemical Energetic	111	A	6.2aii
	2	16.b	1	Chemical Energetic	111-113	A	6.1bii, 6.2aii
	2	16.c(i)	2	Chemical Energetic	99	R	6.1a
	2	16.c(ii)	2	Chemical Energetic	106	A	6.1c
	2	16.c(iii)	1	Chemical Energetic	104	R	6.1c,b
	2	17.a	2	Quantitative Kinetics	353	K	7.1ci
	2	17.b	2	Quantitative Kinetics	353	R	7.1ci
	2	18.a	2	Quantitative Kinetics	357	A	7.1bii
	2	18.b	3	Quantitative Kinetics	357	A	7.1bii
	2	19.a	2	Quantitative Equilibrium	376	A	8.1b
	2	19.b	2	Quantitative Equilibrium	372	K	8.1eii
	2	19.c(i)	2	Quantitative Equilibrium	375	A	8.1i
	2	19.c(ii)	2	Quantitative Equilibrium	375	R	8.1i
	2	20.a	1	Quantitative Equilibrium	374	K	8.1d
	2	20.b	1	Quantitative Equilibrium	369-370	A	8.1d
	2	20.c	2	Quantitative Equilibrium	374	A	8.1b
	2	20.d	1	Quantitative Equilibrium	374	R	8.1c

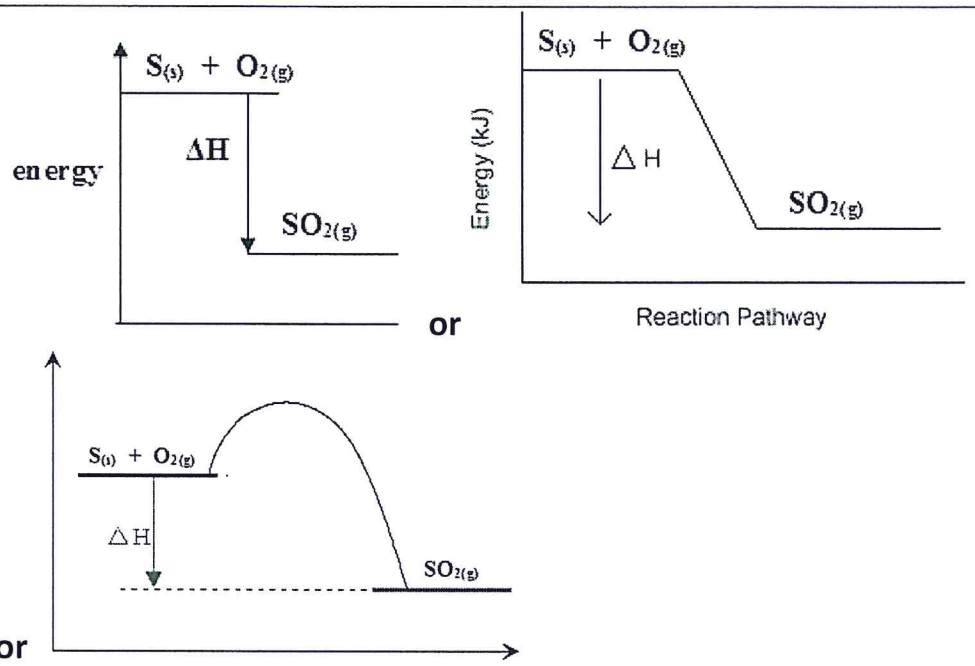
	2	21.a	3	Electrochemistry	381-385	K	9.2b
	2	21.b	2	Electrochemistry	382	K	9.2c
	2	21.c	2	Electrochemistry	381-385	R	9.2e
	2	21.d	2	Electrochemistry	381-384	A	9.2g
	2	21.e	2	Electrochemistry	385	A	9.2d
	2	22.a	2	Electrochemistry	387	A	9.2g
	2	22.b	1	Electrochemistry	382	R	9.2e,h
	2	22.c	2	Electrochemistry	386-387	A	9.2d
	2	23.a	2	Electrochemistry	392	K	9.1b
	2	23.b	2	Electrochemistry	391	A	9.1ci

Question ONE TOTAL MARKS: 14

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

Item No.	Correct option
1	
2	216.8 kJ released per mol
3	24.6
4	
5	Rate = $k[NO]^2[O_2]$
6	2.5×10^6
7	Weak acid added to strong alkali
8	$HF_{(aq)} + KF_{(aq)}$
9	$HCN < C_6H_5COOH < HCOOH < HF$
10	Lithium cell
11	$Na^+(aq)$
12	Cu (s)
13	Fe (s)
14	The mass of the copper electrode will increase.

Question TWO: TOTAL MARKS: 56

Item 15 Total marks 6			
item		**answer**	**marks**
15	**a**	 ½ mark for writing the enthalpy of the reactants. - ½ mark for writing the enthalpy of the products. - ½ mark for writing the enthalpy change(ΔH) of the reaction. - ½ mark for writing the arrow. Physical states are not necessary	**2**
	b(i)	The standard enthalpy change of combustion, $\Delta H_c^{\ominus}$, is the enthalpy change when one mole of the substance is completely burnt in excess oxygen **(1 mark),** at 1 bar or 1 atm or 10^5 Pa pressure and at a specified temperature (usually 25 °C) **(1 mark)**.	**2**
	b(ii)	$\Delta H_1 = \Delta H_c^{\ominus}(C_2H_4(g)) = -1411 kJmol^{-1}$, $\Delta H_2 = \Delta H_c^{\ominus}(C_2H_5OH(l)) = -1367 kJmol^{-1}$ $\Delta H_1 = \Delta H + \Delta H_2$ **(½ mark)** $-1411 = \Delta H + (-1367)$ **(½ mark)** $\Delta H = -44$ kJ mol^{-1} **(1 mark)** **OR:** $\Delta H = \Delta H_1 + (-\Delta H_2)$ **(½ mark)** $= -1411 + (1367)$ **(½ mark)** $= -44$ kJ mol^{-1} **(1 mark)**	**2**

Item 16 Total marks 7			
item		**answer**	**marks**
16	**a**	It is the enthalpy change when one mole of bonds between oxygen atoms and hydrogen atoms are broken in the gas phase.	**1**
	b	$H_2O_{(g)} \longrightarrow 2H_{(g)} + O_{(g)}$ ($\frac{1}{2}$ **mark**) $\quad \Delta H = E(O\text{-}H)$. ($\frac{1}{2}$ **mark**)	**1**
	c(i)	The process is exothermic. (1 mark) Because of the increase in temperature of water. Or Because the temperature of the surroundings increased. (1 mark)	**2**
	c(ii)	$q = m\,c\,\Delta T$ $q = 150 \times 4.18 \times (37 - 22)$] ($\frac{1}{2}$ mark) $q = 9405\ J$ ($\frac{1}{2}$ mark) Mass of methanol burnt = $520.48 - 519.53 = 0.95$ g moles of methanol burnt = $\frac{0.95}{32} = 0.03$ mol ($\frac{1}{2}$ mark) Because heat is evolved, we know that the reaction is exothermic and ΔH_c^θ is negative. $\Delta H_c^\theta = \frac{-9405}{0.03} = -313.5 \times 10^3\ J\ mol^{-1}$ $= -313.5\ kJ\ mol^{-1}$ ($\frac{1}{2}$ mark)	**2**
	c(iii)	**Increases**	**1**

Item 17 Total marks 4			
item		**answer**	**marks**
17	**a**	Half- life $t_{½}$ is the time taken for the concentration of a reactant to fall to half of its original value. **Each underline worth 1 mark**	**2**
	b	-Whatever the starting concentration of the reactant the half- life will always be constant **Each underline worth 1 mark**	**2**

Item 18 Total marks 6			
item		**answer**	**marks**
18	**a**	The reaction is <u>first order</u> with respect to C.	**2**
	b	Rate = k[C]	**1**
	c	Rate constant: Take one set of data from the experiment. (from experiment 3) Rate = k[C] $3.04 \times 10^{-3} = k \times (0.590)$ **(1+1 mark)** $k = 5.1 \times 10^{-3}\ s^{-1}$ **(1 mark)** from experiment 1: $k = 5.2 \times 10^{-3}\ s^{-1}$ from experiment 2 & 4: $k = 4.9 \times 10^{-3}\ s^{-1}$ from experiment 5: $k = 5.1 \times 10^{-3}\ s^{-1}$ **If the final answer is given without calculations full mark is given**	**3**

Item 19 Total marks 8			
item		**answer**	**marks**
19	a	H_3O^+: pH = -log $[H^+_{(aq)}]$ (½ mark) (½ mark) 4.35= -log$[H^+_{(aq)}]$ $[H^+_{(aq)}] = \underline{4.47 \times 10^{-5}}$ mol dm^{-3} **(1 mark)** **If the final answer is given without calculations full mark is given**	**2**
	b	The acid $H_2CO_{3(aq)}$ is derived from dissolved carbon dioxide is buffered by hydrogen carbonate ions and the pH will alter only slightly. **(½ mark)**: $H^+_{(aq)} + HCO_3^-{}_{(aq)} \longrightarrow H_2O_{(l)} + CO_{2(aq)}$ **(½ mark)**: If $H^+_{(aq)}$ ions are removed they are replaced by the reaction of carbon dioxide with water. the pH will alter only slightly. **(½ mark)** $CO_{2(aq)} + H_2O_{(l)} \longrightarrow H^+_{(aq)} + HCO_3^-{}_{(aq)}$ **(½ mark)**	**2**
	c(i)	$ZnS_{(s)} \rightleftharpoons Zn^{2+}{}_{(aq)} + S^{2-}{}_{(aq)}$ $K_{sp} = [Zn^{2+}][S^{2-}] = 1.0 \times 10^{-24}$ mol^2 dm^{-6} In a saturated solution $Zn^{2+} = S^{2-} = 1.0 \times 10^{-24}$ $= \sqrt{1.0 \times 10^{-24}}$ mol^2 dm^{-6} **(1 mark)** $= 1.0 \times 10^{-12}$ mol dm^{-3} **(1 mark)** Therefore the solubility of ZnS in water is 1.0×10^{-12} mol dm^{-3}.	**2**
	c(ii)	The unit of K_{sp} always relate to the total number of moles of ions in the compound. In ZnS there are 2 moles of ions. **(1 mark)** Units = 2 x (mol dm^{-3}) = mol^2 dm^{-6} **(1 mark)**	**2**

Item 20 Total marks 5

item		answer	marks
20	a	7	1
	b	$25\ cm^3$ or 25 mL or 0.025 L	1
	c	$pH = -\log_{10}[H^+]$ ($\frac{1}{2}$ mark) $12 = -\log_{10}[H^+]$ So $[H^+] = 1.0 \times 10^{-12}\ mol\ dm^{-3}$ ($\frac{1}{2}$ mark) $K_w = [H^+][OH^-]$ ($\frac{1}{2}$ mark) $1 \times 10^{-14} = 1 \times 10^{-12} \times [OH^-]$ $[OH^-] = 1 \times 10^{-2}\ mol\ dm^{-3}$ ($\frac{1}{2}$ mark)	2
	d	Because the pH range of this indicator lies on the vertical section of pH curve (or within the sudden change in pH) of this titration. Or: Because it changes its colour near the end point of this titration or near equivalence point. *(Any answer from above mark is given.)*	1

Item 21 Total marks 11			
item		**answer**	**marks**
21	**a**	Standard conditions are: Pressure: 1.00atm, Temperature: 298 K (25 °C) and $[H^+] = 1.00$ mol dm^{-3}. **Each answer 1 mark**	**3**
	b	Salt bridge.	**2**
	c	Anode , **(1 mark)** Mg is a stronger reducing agent than H_2 and therefore (Mg) will be oxidised. **or** Mg is more reactive than H_2 , $E^\ominus (Mg^{2+} / Mg)$ is negative, that (Mg) is oxidised. **(1 mark)**	**2**
	d	$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ **1 mark** **1 mark**	**2**
	e	$E^\ominus_{cell} = E^\ominus (2H^+ / H_2 , Pt) - E^\ominus (Mg^{2+} / Mg)$ $+2.37 = 0.00 - E^\ominus (Mg^{2+} / Mg)$ **(1 mark)** $E^\ominus (Mg^{2+} / Mg) = -2.37$ V **(1 mark)**	**2**

Item 22 Total marks 5			
item		**answer**	**marks**
22	a	$2\,Ag^{+}_{(aq)} + Ni_{(s)} \longrightarrow 2\,Ag_{(s)} + Ni^{2+}_{(aq)}$ 1 mark 1 mark	2
	b	It will increase Or it will be more. (1 mark)	1
	c	$E^{\theta}_{cell} = E^{\theta}\left(Mg^{2+}_{(aq)} \middle| Mg_{(s)}\right) - E^{\theta}\left(Ni_{(s)} \middle| Ni^{2+}_{(aq)}\right)$ ($\frac{1}{2}$ mark) $E^{\theta}_{cell} = (-2.37) - (-0.26)$ ($\frac{1}{2}$ mark) $= -2.11$ V (1 mark)	2

<table>
<tr><th colspan="3">Item 23 Total marks 4</th></tr>
<tr><th colspan="2">item</th><th>answer</th><th>marks</th></tr>
<tr><td>23</td><td>a</td><td><table><tr><td></td><td>anode</td><td>cathode</td></tr><tr><td></td><td>$2I^- \longrightarrow I_{2(s)} + 2e^-$</td><td>$Na^+ + e^- \longrightarrow Na_{(s)}$</td></tr></table>1 mark 1 mark</td><td>2</td></tr>
<tr><td></td><td>b</td><td>Charge transferred during the electrolysis.
$Q = Ixt$ $\frac{1}{2}$ mark
$= 0.50 \times 30 \times 60$ $\frac{1}{2}$ mark
$= 900C$ 1 mark</td><td>2</td></tr>
</table>

This is the end of the Marking Guide