سلطنة عمان
وزارة التربية والتعليم

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

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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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 the following statements is correct about exothermic reactions?

⬭ The enthalpy change (ΔH) is positive.
⬭ The energy of the system is decreased.
⬭ The heat is taken in from the surrounding.
⬭ The reactants have less enthalpy than the products.

2) Which of the following equations represents the standard enthalpy of formation ($\Delta H_f^{\ominus}$) of ethyne $C_2H_{2(g)}$?

⬭ $2C_{(graphite)} + H_{2(g)} \longrightarrow C_2H_{2(g)}$
⬭ $C_2H_{2(g)} + Cl_{2(g)} \longrightarrow C_2H_2Cl_{2(g)}$
⬭ $C_2H_{2(g)} + \frac{5}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + H_2O_{(g)}$
⬭ $CaC_{2(s)} + 2H_2O_{2(l)} \longrightarrow C_2H_{2(g)} + Ca(OH)_{2(aq)}$

3) Red lead oxide, Pb_3O_4, is used in metal priming paints. It can be made by heating PbO in air.

$$6PbO_{(s)} + O_{2(g)} \longrightarrow 2Pb_3O_{4\,(s)}$$

Which two enthalpy changes are needed to calculate the enthalpy change for this reaction?

⬭ Enthalpy change of atomisation of Pb and enthalpy change of formation of Pb_3O_4.
⬭ Enthalpy change of combustion of PbO and enthalpy change of atomisation of Pb.
⬭ Enthalpy change of formation of PbO and enthalpy change of atomisation of O_2.
⬭ Enthalpy change of formation of PbO and enthalpy change of formation of Pb_3O_4.

Question 1 continued

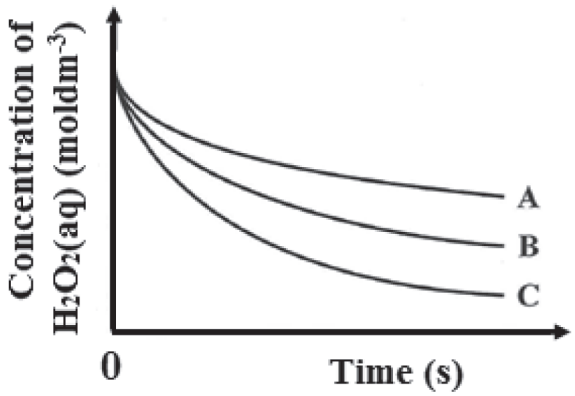
4) Which of the following statements is incorrect about the half – life of a first - order reaction?

- ☐ It is constant.
- ☐ It depends on the initial reactant concentration.
- ☐ It can be calculated from the reaction rate constant.
- ☐ It is the time necessary for the reactant concentration to drop to half its original value.

5) The initial concentration of a substance is 0.6 mol dm^{-3}, if 50% of it is reacted in 0.5 min, what is the rate of this reaction in mol dm^{-3} s^{-1}?

- ☐ 0.01
- ☐ 0.02
- ☐ 0.3
- ☐ 1.2

6) The diagram below shows the concentration change of (H_2O_2) with time in different experiments (A, B and C).

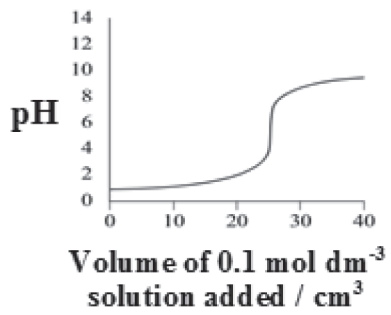


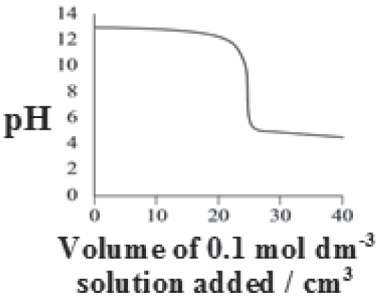
Which of the following statements is correct?

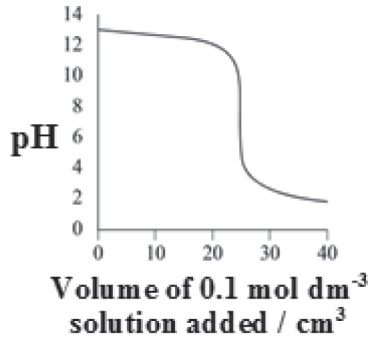
- ☐ The initial [H_2O_2] in A is higher than in B.
- ☐ The order of the reaction is zero order.
- ☐ Hydrogen peroxide H_2O_2 is a product.
- ☐ The reaction in C is faster than in A.

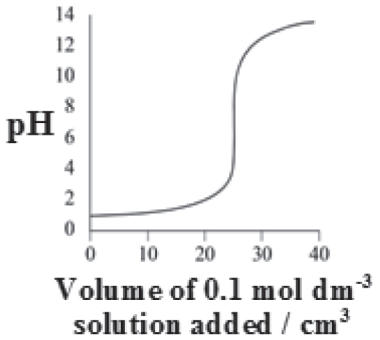
Question 1 continued

7) The titration curves below were obtained using different acids and bases, each with concentration of 0.1 mol dm^{-3}
Which curve is produced by adding ammonia to 25 cm^3 of hydrochloric acid?









8) Which of the following would form a buffer solution when equal moles are mixed together?

- ☐ HCl and NaCl.
- ☐ HCN and NaCN.
- ☐ KNO_3 and KOH.
- ☐ Na_2SO_4 and NaOH.

9) What is [NaOH] solution in mol dm^{-3} which has pH = 11.0 at 25 °C ?

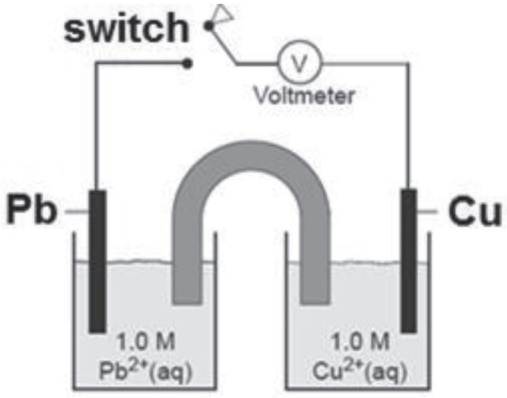
- ☐ 1.0×10^{-3}
- ☐ 1.0×10^{-11}
- ☐ 11.0×10^{-3}
- ☐ 11.0×10^{-11}

Question 1 continued

10) Which statement is correct about the electrochemical cell and electrolytic cell?

- ☐ The reduction occurs at the negative electrode in electrochemical cell.
- ☐ The anode is positive and the cathode is negative in both cells.
- ☐ The oxidation occurs at the cathode in the electrolytic cell.
- ☐ The reduction occurs at the cathode in both cells.

The diagram below shows an electrochemical cell at standard conditions. Study it to answer questions (11) and (12).



$$Pb^{2+}_{(aq)} + 2\acute{e} \rightleftharpoons Pb_{(s)} \qquad E^{\Theta} = -0.13\ V$$

$$Cu^{2+}_{(aq)} + 2\acute{e} \rightleftharpoons Cu_{(s)} \qquad E^{\Theta} = +0.34\ V$$

11) Which changes will occur when the switch is closed?

- ☐ Pb is oxidised, and electrons flow to the Cu electrode.
- ☐ Pb is reduced, and electrons flow to the Cu electrode.
- ☐ Cu is oxidised, and electrons flow to the Pb electrode.
- ☐ Cu is reduced, and electrons flow to the Pb electrode.

12) What is the standard electromotive force E^{Θ}_{cell} for this cell?

- ☐ −0.21 V
- ☐ +0.21 V
- ☐ −0.47 V
- ☐ +0.47 V

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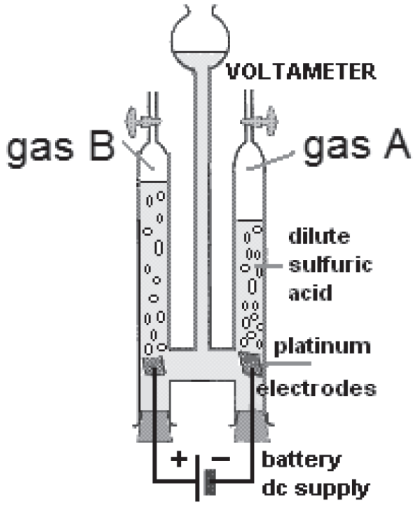
Question 1 continued

The shown apparatus is used for the electrolysis of water. Tubes are initially filled with an aqueous solution of H_2SO_4. Study it to answer questions (13) and (14).



13) What is the gas A produced from the electrolysis of water?

- ☐ SO_2
- ☐ SO_3
- ☐ O_2
- ☐ H_2

14) What is the mass ratio of gas A to gas B produced in the tubes?

	Gas A	Gas B
☐	1	2
☐	1	4
☐	1	8
☐	1	16

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. Some powdered NH_4NO_3 (2.5 g) was dissolved in 50.0g of water in a simple expanded polystyrene calorimeter. The temperature fell by 10.1°C.
(Mr: NH_4NO_3 = 80.0 g mol^{-1})

(i) Define the enthalpy change of solution ΔH_{sol}.

(ii) Calculate the enthalpy change of solution of ammonium nitrate in kJ mol^{-1} unit.

b. Explain why the standard enthalpy of neutralisation of equal volume of strong acid by strong base such as aqueous sodium hydroxide is always close to –57.6 kJ mol^{-1}

Question 2 continued

16) Consider the following reaction and information below:

$$H_{2(g)} + Br_{2(g)} \longrightarrow 2HBr_{(g)}$$

Bond	H—H	H—Br	Br—Br
energy (kJ mol^{-1})	+436	+366	+193

a. Explain what is meant by Br—Br bond enthalpy?

b. Write the symbol for the H—Br bond enthalpy.

c. Calculate ΔH for the formation of $HBr_{(g)}$.

d. Draw labelled energy level diagram for the reaction above.

Question 2 continued

17) a. Ethanal, CH_3CHO dimerises in dilute alkaline solution according to the equation.

$$2CH_3CHO_{(aq)} \xrightarrow{OH^-_{(aq)}} CH_3CH(OH)CH_2CHO_{(aq)}$$

The following data were obtained in series of experiments on the rate of reaction between ethanal and hydroxide ion at a constant temperature.

Experiment number	[OH]/mol dm^{-3}	[CH_3CHO]/mol dm^{-3}	Relative rate
1	0.01	0.147	1
2	0.02	0.15	2
3	0.01	0.30	2

(i) Show how the data in the table can be used to deduce that the reaction is first-order with respect to OH^-

(ii) Deduce the order with respect to CH_3CHO and the overall reaction order.

Question 2 continued

b. Ethyl chloride decomposes into ethylene and hydrochloric acid in a first-order reaction that has a half-life of 120 hours at 650°C.
Calculate the rate constant for the reaction under these conditions in s^{-1} unit.

18) The reaction between (X) and (Y) was studied:

$$X_{(g)} + Y_{(g)} \longrightarrow XY_{(g)}$$

By doing two experiments at the same temperature , it is found that rate = k[X] [Y]

Use the rate equation and the table below to answer the following questions:

Experiment	[X] / mol dm^{-3}	[Y] / mol dm^{-3}	Rate / mol dm^{-3} s^{-1}
1	0.100	0.005	1.35×10^{-7}
2	0.200	?	5.4×10^{-7}

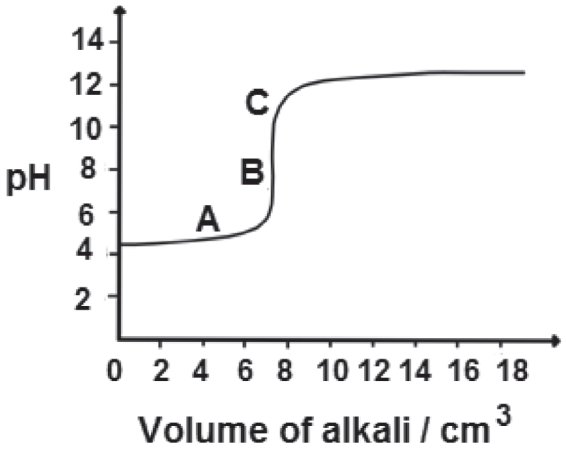
a. What is meant by half-life of a reaction?

b. State two factors, which can affect the rate of a reaction?

Question 2 continued

c. Calculate [Y] in experiment 2.

19 a. Study the following titration graph and answer the questions below:



(i) Choose the best indicator for this titration from the table below?

Indicator	Range
Methyl orange	3.2 – 4.4
Phenolphthalein	8.2 – 10.0

(ii) In which point the number of moles of the base is larger than number of moles of acid?

☐ A ☐ B ☐ C

(choose the correct answer)

Question 2 continued

b. The solubility product constant, K_{sp} , of Iron (III) hydroxide, $Fe(OH)_3$, at 25°C is 6.0×10^{-38} mol^4 dm^{-12}.

(i) Write the solubility product constant, K_{sp} , expression for $Fe(OH)_3$.

(ii) Calculate the solubility of $Fe(OH)_3$ at 25°C.

(iii) What happens to solubility of $Fe(OH)_3$ when adding a solution containing $OH^-_{(aq)}$?

☐ Increases ☐ Decreases ☐ Does not change

(choose the correct answer)

20) A buffer solution has a volume of 1.00 L and contains 0.20 mol of acetic acid (CH_3COOH) and 0.10 mol of sodium acetate (CH_3COONa).
(K_a for $CH_3COOH = 1.8 \times 10^{-5}$)

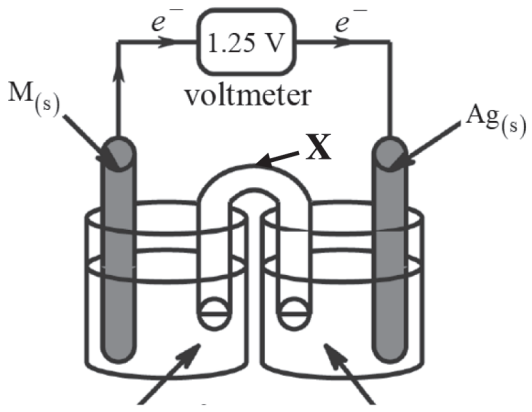
a. What is meant by a buffer solution?

Question 2 continued

b. Calculate the pH of this buffer solution.

c. Describe how this buffer solution minimises the effect of addition of a small amount of strong acid, $H^+_{(aq)}$.

21) The electrochemical cell below consists of (Ag) half-cell and unknown half-cell represented by (M) at standard conditions. The reading on the voltmeter is +1.25 V. Study the diagram and answer the following questions.



Question 2 continued

a. What is the name of the apparatus labelled (X)?

b. Write the half-cell oxidation and reduction reactions that occur in this cell.

The half-cell oxidation reaction:

The half-cell reduction reaction:

c. Write the cell diagram as a short hand way to represent the reactions that occur in this cell.

d. If the standard electrode potential ($E^{\ominus}$/V) in volts for ($Ag^{+}_{(aq)}/Ag_{(s)}$) is + 0.80 V, calculate the standard electrode potential ($E^{\ominus}$/V) of the unknown electrode represented by (M). Show your calculations.

e. **(i)** What would be the direction of electron flow through the wire when ($M^{2+}_{(aq)}$ / $M_{(s)}$) half-cell is replaced with standard hydrogen electrode?

(ii) What are the three conditions needed for the hydrogen half-cell to function at standard conditions?

Question 2 continued

22) a. A current is passed through $Ga(NO_3)_3$ solution for 1.5 hours, and after this time period the mass of metal produced was 6.5 g. What is the current in amperes that is required to produce this amount of gallium? [M_r(Ga) = 69.72 g mol^{-1}].

b. The following grid shows some types of common fuel cells and batteries. Study it to answer the questions below.

A	Fuel cell	B	NiMH cell	C	Nickle-Cadmium cell
D	Lead-acid cell	E	Lithium cell		

In the spaces provided, write the correct symbol for the following statements:

(i) It has lead plates dipping into moderated concentrated sulphuric acid. (____)

(ii) It converts hydrogen and oxygen into water. (____)

(iii) It is light and produces a large voltage. (____)

(iv) Its negative electrode made of a metal that can absorb hydrogen to make a hydride. (____)

c. A student said: You can keep a solution containing ($Ag^+_{(aq)}$ ions) in a container made of copper metal. Do you agree or disagree. Explain your answer using $E^\ominus$ values and equation.

[End of Examination]

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Values of E^{Θ} for some half reactions

Half cell	E^{Θ} /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
$H^{+}_{(aq)} / \frac{1}{2}H_{2(g)}$, 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

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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مُسَوَّدَة

مُسَوَّدَة

MARKING GUIDE

GENERAL EDUCATION DIPLOMA

BILINGUAL PRIVATE SCHOOLS

SEMESTER TWO - FIREST 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, First 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	97-99	Knowing	6.1a
2	1	2	1	Chemical Energetic	110	Applying	6.1b
3	1	3	1	Chemical Energetic	110	Reasoning	6.1b
4	1	4	1	Quantitative Kinetics	357	Knowing	7.1ci
5	1	5	1	Quantitative Kinetics	349-350	Applying	7.1a
6	1	6	1	Quantitative Kinetics	353-354	Applying	7.1b
7	1	7	1	Quantitative Equilibrium	373	Knowing	8.1d
8	1	8	1	Quantitative Equilibrium	371-372	Applying	8.1e
9	1	9	1	Quantitative Equilibrium	367-370	Reasoning	8.1a
10	1	10	1	Electrochemistry	384+391	Knowing	9.1b
11	1	11	1	Electrochemistry	384-386	Reasoning	9.2e,g
12	1	12	1	Electrochemistry	385-387	Applying	9.2d
13	1	13	1	Electrochemistry	391-392	Applying	9.1cii
14	1	14	1	Electrochemistry	391-392	Applying	9.1cii

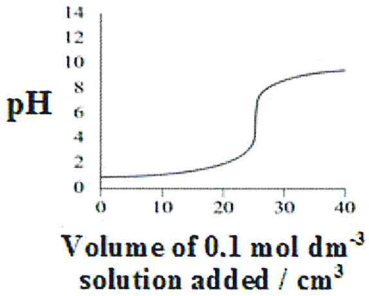
General Education Diploma, Bilingual Private Schools,
Semester Two, First Session, Chemistry, 2018/2019

Serial no.	Question no.	item	mark	Unit	Page	Cognitive domain	Outcome
	2	15.ai	2	Chemical Energetic	100	Knowing	6.1b
	2	15.aii	3	Chemical Energetic	100	Applying	6.1c
	2	15.b	1	Chemical Energetic	101	Reasoning	6,1b
	2	16.a	1	Chemical Energetic	111-113	Knowing	6.2aii
	2	16.b	1	Chemical Energetic	111-113	Knowing	6.2aii
	2	16.c	3	Chemical Energetic	111-113	Applying	6.2aii
	2	16.d	2	Chemical Energetic	111-113	Reasoning	6.2a
	2	17.ai	1	Quantitative Kinetics	355	Applying	7.1a
	2	17.aii	2	Quantitative Kinetics	355	Applying	7.1bi
	2	17.b	2	Quantitative Kinetics	356-357	Applying	7.1c
	2	18.a	1	Quantitative Kinetics	353	Knowing	7.1c
	2	18.b	2	Quantitative Kinetics	351	Knowing	7.1a
	2	18.c	2	Quantitative Kinetics	356	Reasoning	7.1d
	2	19.a(i)	1	Quantitative Equilibrium	373	Knowing	8.1d
	2	19.a(ii)	1	Quantitative Equilibrium	373	Knowing	8.1c
	2	19.b(i)	1	Quantitative Equilibrium	374	Reasoning	8.1d
	2	19.b(ii)	2	Quantitative Equilibrium	375-376	Applying	8.1g,h
	2	19.b(iii)	1	Quantitative Equilibrium	375	Applying	8.1i
	2	20.a(i)	2	Quantitative Equilibrium	376	Reasoning	8.1j
	2	20.a(ii)	2	Quantitative Equilibrium	371	Knowing	8.1e
	2	20.a(iii)	2	Quantitative Equilibrium	372	Applying	8.1f

	2	20.b	1	Quantitative Equilibrium	371	Reasoning	8.1e
	2	21.a	1	Electrochemistry	382	Knowing	9.2c
	2	21.b	2	Electrochemistry	385	Applying	9.2g
	2	21.c	1	Electrochemistry	384-386	Applying	9.2e
	2	21.d	2	Electrochemistry	386	Applying	9.2d
	2	21.e(i)	1	Electrochemistry	382-383	Reasoning	`9.2b,ei
	2	21.e(ii)	3	Electrochemistry	381-385	Knowing	9.2b
	2	22.a	2	Electrochemistry	390-391	Applying	9.1c
	2	22.b	3	Electrochemistry	393-394	Knowing	9.3a
	2	23.a	3	Electrochemistry	388-389	Applying	9.2i,h
	2	23.b	2	Electrochemistry	386-387	Reasoning	9.2e

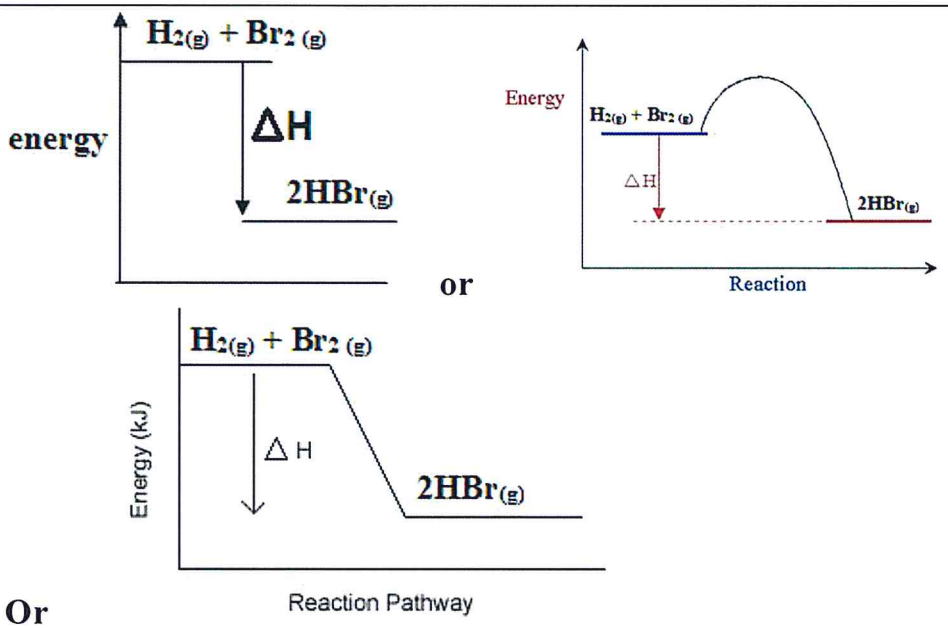
Question ONE TOTAL MARKS: 14

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

Item No.	Correct option
1	The energy of the system is decreased.
2	$2C_{(graphite)} + H_2(g) \longrightarrow C_2H_2(g)$
3	Enthalpy change of formation of PbO and enthalpy change of formation of Pb_3O_4.
4	It depends on the initial reactant concentration.
5	0.01
6	The reaction in C is faster than in A.
7	
8	HCN and NaCN.
9	1.0×10^{-3}
10	The reduction occurs at the cathode, in both cells.
11	Pb is oxidised, and electrons flow to the Cu electrode.
12	+0.47 V
13	H_2
14	<table><tr><th>Gas A</th><th>Gas B</th></tr><tr><td>1</td><td>8</td></tr></table>

Question TWO: TOTAL MARKS: 56

Item 15 Total marks 6			
item		**answer**	**marks**
15	**a(i)**	It is the enthalpy change when one mole of the substance is dissolved in water.	**1**
	a(ii)	$q = mc\Delta T$ $q = (50g) \times (4.18Jg^{-1}K^{-1}) \times (10.1K)$ $= 2.11 \times 10^3 J = 2.11kJ$ **(1 mark)** Amount in moles of NH_4NO_3 dissolved $= \frac{2.5g}{80.0gmol^{-1}} = 0.03mol$ **(1 mark)** Solution of 0.03mol of NH_4NO_3 required 2.11kJ Solution of 1.00mol of NH_4NO_3 would require $\frac{2.11}{0.03}$ kJ $= 70.3kJ$ The process is endothermic, so $\Delta H_{sol} = +70.3kJ\ mol^{-1}$ **(1 mark)** **(another answer: if the student might use the mass as (50 + 2.5 = 52.5 g):** **$q = 2.216$ kJ , $\Delta H_{sol} = +73.88\ kJ\ mol^{-1}$)**	**3**
	b	- All strong acids are completely ionised in solution **(1 mark)** and give 1 mole of water **(1 mark).** or - The ionic equation representing the enthalpy of neutralisation of any strong acid by a strong base is $H^+_{(aq)} + OH^- \longrightarrow H_2O_{(l)}\ \Delta H^\ominus = -57.6\ kJ\ mol^{-1}$ **(2 mark)**	**2**

Item 16 Total marks 7			
item		**answer**	**marks**
16	**a**	The energy required to break one mole of Br—Br bonds in gas phase.	**1**
	b	E(H—Br)	**1**
	c	ΔH = enthalpy of bonds broken – enthalpy of bonds formed **(1 mark)** ΔH = (E(H—H) + E(Br—Br)) –2E(H—Br) ΔH = (+436 + 193) – (2x366) **(1 mark)** ΔH = - 103 kJ **(1 mark)**	**3**
	d	 **or** **Or** **1 mark for drawing the diagram and 1 mark for writing labels**	**2**

Item 17 Total marks 5			
item		answer	marks
17	a(i)	In experiments, 1 and 2 $[OH^-]$ has doubled and the rate of reaction has doubled so the reaction is first order with respect to $[OH^-]$. **Another answer: The student can show mathematical expression and calculation**	1
	a(ii)	In experiments 1 and 3 the concentration of ethanal has doubled and the rate of reaction has doubled. so the reaction is first order for ethanal. In experiment 2 and 3 both concentration has changed **(1 mark)** Overall the reaction is second order and the rate equation is: Or: Rate $= k[CH_3CHO][OH^-]$ **(1 mark)**	2
	b	$k = \frac{0.693}{t_{1/2}}$ **(1 mark)** $k = \frac{0.693}{4.3 \times 10^5} = 1.6 \times 10^{-6}\ s^{-1}$ **(1 mark)**	2

Item 18 Total marks 5			
item		**answer**	**marks**
18	**a**	The half-life of a reaction is the time taken for the concentration of a reactant to decrease to half its initial value.	**1**
	b	The following factors affect the rate of a reaction: [**only two**] { concentration or pressure – temperature – catalysts – state of division – nature of the solvent – light }	**2**
	c	From experiment 1: $\because R = k [X] [Y]$ $\therefore K = \frac{rate}{[X][Y]} = \frac{1.35 \times 10^{-7}}{(0.1)(0.005)} = 0.27 \times 10^{-3}$ mol^{-1} dm^{-3} s^{-1} **1 mark** From experiment 2: $\because$ rate = k [X] [Y] $\therefore 5.4 \times 10^{-7} = (0.27 \times 10^{-3})(0.2)[Y]$ $\therefore [Y] = 0.01$ mol dm^{-3} **1 mark**	**2**

Item 19 Total marks 6			
item		answer	marks
19	a(i)	Phenolphthalein	1
	a(ii)	C	1
	b(i)	$K_{sp} = [Fe^{3+}][OH^-]^3$	1
	b(ii)	$K_{sp} = [Fe^{3+}][OH^-]^3$ ($\frac{1}{2}$ mark) $6 \times 10^{-38} = 27x^4$ $x = \sqrt[4]{\left(\frac{6 \times 10^{-38}}{27}\right)} = 2.17 \times 10^{-10}$ ($\frac{1}{2}$ mark) $\therefore [Fe^{3+}] = 2.17 \times 10^{-10}$ mol dm^{-3} One mole of $Fe(OH)_3$ dissolves to give one mole of Fe^{3+} ions, so the solubility of $Fe(OH)_3$ is 2.17×10^{-10} mol dm^{-3} (1 mark)	2
	b(iii)	Decreases	1

Item 20 Total marks 7			
item		answer	marks
20	a	One whose pH remains nearly constant on the addition of small quantities of acid or base. **Each underlined answer is worth 1 mark**	2
	b	$[CH_3COOH] = 0.20\ mol\ dm^{-3}$, $[CH_3COONa] = 0.10\ mol\ dm^{-3}$ $[H^+] = \frac{K_a \times [CH_3COOH]}{[CH_3COO^-]}$ (½ mark) $[H^+] = \frac{1.8 \times 10^{-5} \times 0.20}{0.10} = 3.6 \times 10^{-5}\ mol\ dm^{-3}$ **(1 mark)** $pH = -\log_{10}[H^+]$ (½ mark) $pH = -\log_{10}(3.6 \times 10^{-5}) = 4.44$ **(1 mark)** **Or** pH = pK$_a$ + log ([base or salt] / [acid]) (½ mark) pK$_a$ = -log (-1.8 × 10^{-5}) = 4.74 **(1 mark)** pH = 4.74 + log(0.1/0.2) **(1 mark)** pH = 4.43 (½ mark)	3
	c	- The extra $H^+_{(aq)}$ ions react with $CH_3COO^-_{(aq)}$ ions **(1 mark)** and the equilibrium moves to the left to remove the added $H^+_{(aq)}$ **(1 mark)**. - The $H^+_{(aq)}$ ions react with $CH_3COO^-_{(aq)}$ ions **(1 mark)** to form the weak acid $CH_3COOH_{(aq)}$.**(1 mark)** - The equilibrium moves to the left **(1 mark)** to prevent the effect of adding strong acid, $H^+_{(aq)}$.**(1 mark)** - The equilibrium moves to the left $H^+_{(aq)} + CH_3COO^-_{(aq)} \longrightarrow CH_3COOH_{(aq)}$ **Any answer from above mark is given. (2 marks)**	2

Item 21 Total marks 13			
item		answer	marks
21	a	Salt bridge.	1
	b	**Half-cell oxidation reaction :** $M_{(s)} \longrightarrow M^{2+}_{(aq)} + 2\,e^-$ (½ mark) (½ mark) (½ mark) **half-cell reduction reaction :** $Ag^+_{(aq)} + e^- \longrightarrow Ag_{(s)}$ (½ mark) (½ mark) (½ mark)	3
	c	$M_{(s)} \mid M^{2+}_{(aq)} \,\vdots\, Ag^+_{(aq)} \mid Ag_{(s)}$ (1 mark) (1 mark)	2
	d	$E^\theta_{cell} = E^\theta_{\text{right-hand half-cell}} - E^\theta_{\text{left-hand half-cell}}$ (1 mark) $E^\theta_{cell} = E^\theta_{(Ag)} - E^\theta_{(M)}$ $1.25 = 0.80 - E^\theta_{(M)}$ (1 mark) $E^\theta_{(M)} = -0.45\ V$ (1 mark) **Or** $E^\Theta_{cell} = E_{oxidation} - E_{reduction}$ (1 mark) $1.25 = 0.80 - E_{oxidation}$ (1 mark) $E_{reduction} = -0.45\ V$ (1 mark) **The following formulae could be used:** $E^\Theta_{cell} = E_{cathode} - E_{anode}$ (1 mark)	3
	ei	- From standard hydrogen electrode to Ag electrode. - From M to Ag - From left to right - The direction of elections will be the same (unchanged) **Any answer from above mark is given. (1 mark)**	1
	eii	Pressure: 1.00atm, Temperature: 298 K (25 °C) $[H^+] = 1.00\ mol\ dm^{-3}$. **Each condition is worth 1 mark**	3

Item 22 Total marks 7			
item		**answer**	**marks**
22	**a**	$\frac{m}{69.72} = \frac{I \times t}{zF}$ **or** n = (I.t) / (zF) **(1 mark)** $\frac{6.5}{69.72} = \frac{I \times 1.5 \times 60 \times 60}{3 \times 96500}$ **(1 mark)** $I = 5.0$ A **(1 mark)**	**3**
	b	i. D ii. A iii. E iv. B Each answer (½ **mark**)	**2**
	c	Disagree, **(1 mark)** - Because $Ag^+(aq)$ reacts with Cu(s). - Using $E^\ominus$ values: $E^{\ominus}_{cell} = E^\ominus (Ag^+ / Ag) - E^\ominus (Cu^{2+} / Cu)$ $= +0.80 - (+0.34) = +0.46$ V - The reaction is feasible between $Ag^+_{(aq)}$ and $Cu_{(s)}$: $Ag^+_{(aq)} + Cu_{(s)} \longrightarrow Ag_{(s)} + Cu^{2+}_{(aq)}$ - $Ag^+_{(aq)}$ is strong oxidising agent. - $Cu_{(s)}$ is more reactive (or strong reducing agent or displaces $Ag^+_{(aq)}$) **Any answer from above mark is given. (1 mark)**	**2**

This is the end of the Marking Guide