سلطنة عمان
وزارة التربية والتعليم

امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)
للعام الدراسي ١٤٣٨/١٤٣٧ هـ - ٢٠١٦ / ٢٠١٧ م
الدور الثاني - الفصل الدراسي الثاني

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٤) صفحة.
- زمن الإجابة: ثلاث ساعات.
- الإجابة في الورقة نفسها.

تعليمات وضوابط التقدم للامتحـان:

- الحضور إلى اللجنة قبل عشر دقائق من بدء الامتحان للأهمية.
- إبراز البطاقة الشخصية لمراقب اللجنـة.
- يمنع كتابة رقم الجلوس أو الاسم أو أي بيانات أخرى تدل على شخصية الممتحن في دفتر الامتحان، وإلا ألغي امتحانه.
- يحظر على الممتحنين أن يصطحبوا معهم بمركز الامتحان كتبا دراسية أو كراسات أو مذكرات أو هواتف محمولة أو أجهزة النداء الآلي أو أي شيء له علاقة بالامتحان كما لا يجوز إدخال آلات حادة أو أسلحة من أي نوع كانت أو حقائب يدوية أو آلات حاسبة ذات صفة تخزينية.
- يجب أن يتقيد المتقدمون بالزي الرسمي (الدشداشة البيضاء والمصر أو الكمة للطلاب والدارسين والزي المدرسي للطالبات واللباس العماني للدارسات) ويمنع النقاب داخل المركز ولجان الامتحان.
- لا يسمح للمتقدم المتأخر عن موعد بداية الامتحان بالدخول إلا إذا كان التأخير بعذر قاهر يقبله رئيس المركز وفي حدود عشر دقائق فقط.
- يتم الالتزام بالإجراءات الواردة في دليل الطالب لأداء امتحان دبلوم التعليم العام.
- 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 - عاصمـة سلطنة عمـــان 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

Do not write in this space

Question 1: Multiple Choice Items (28 marks)

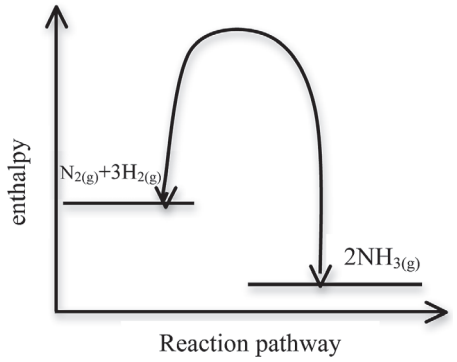
There are 14 multiple-choice items worth two marks each.
Shade in the bubble (○) next to the **correct** answer for each of the following items.

1) Which of the following statements is incorrect about the state of equilibrium?

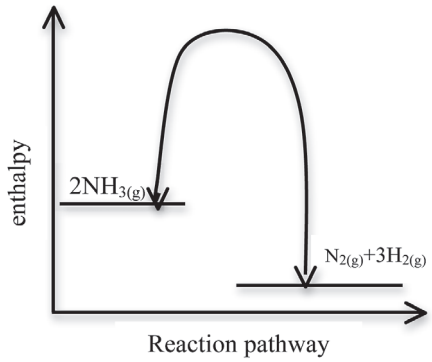
- ○ The amounts of reactants and products stay constant.
- ○ The rate of forward and backward reactions are the same.
- ○ The concentrations of reactants and products are always equal.
- ○ The position of the equilibrium can lie in favour of reactants or products.

2) What is the correct graph that represents the Haber process?

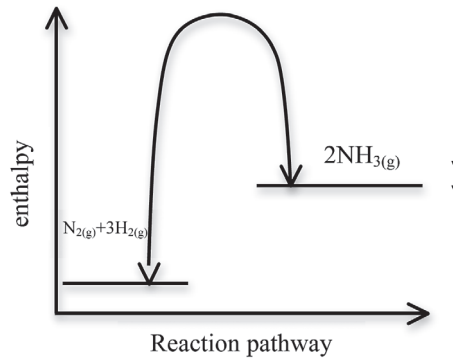
○



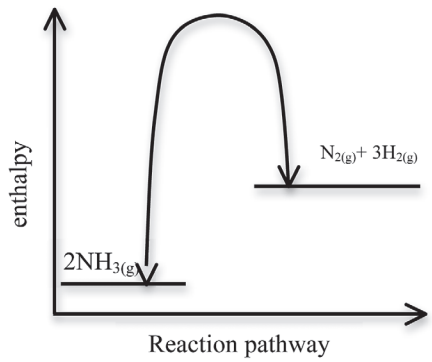
○



○



○



Question 1 continued

3) What is the effect of removing some amount of $H_{2(g)}$ from the reaction system of the following reaction on $[CO_{(g)}]$ and $[CH_{4(g)}]$?

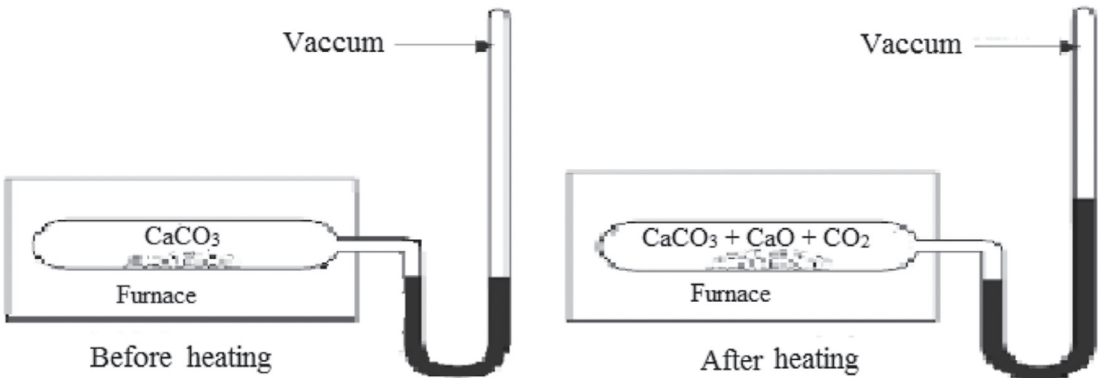
$$CO_{(g)} + 3H_{2(g)} \rightleftharpoons CH_{4(g)} + H_2O_{(g)}$$

	[CO]	$[CH_4]$
☐	Increases	Decreases
☐	Increases	Increases
☐	Decreases	Decreases
☐	Decreases	Increases

When calcium carbonate is heated to 800 °C in a closed evacuated vessel, it decomposes to yield $CaO_{(s)}$ and $CO_{2(g)}$ as shown below:

$$CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)} \qquad \Delta H > 0$$

CO_2 builds up pressure within the vessel as shown in the figure below. The pressure of the gas goes on increasing and finally becomes constant as long as the temperature remains constant. Study the diagram below to answer question 4.



4) Which of the following conclusions is correct about this reaction after heating?

- ☐ The reaction will stop although $CaCO_3$ is still present in the mixture.
- ☐ The reaction system has reached the equilibrium state.
- ☐ The reaction system is not at dynamic equilibrium.
- ☐ The backward reaction is favoured.

Question 1 continued

5) At 200 °C, nitrogen oxide reacts with oxygen to form nitrogen dioxide as follows:

$$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)} \qquad K_c = 3 \times 10^6\ mol^{-1}dm^3$$

What we can conclude from the three species at equilibrium?

- ☐ $[NO_{(g)}]^2 \times [O_{2(g)}]$ will be much larger than $[NO_{2(g)}]^2$.
- ☐ $[NO_{(g)}]^2 \times [O_{2(g)}]$ will be much smaller than $[NO_{2(g)}]^2$
- ☐ $[O_{2(g)}]$ will be exactly equal to $[NO_{(g)}]$
- ☐ $[O_{2(g)}]$ will be exactly twice $[NO_{(g)}]$

6) The following hypothetical reaction is at dynamic equilibrium. If some amounts of gases (A) and (B) are added to this reaction system, what will happen?

$$A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + D_{(g)}$$

- ☐ More reactants will be formed and the value of K_c will remain constant.
- ☐ More reactants will be formed and the value of K_c will be reduced.
- ☐ More products will be formed and the value of K_c will remain constant.
- ☐ More products will be formed and the value of K_c will be increase.

7) The equilibrium constant for the following reaction is 0.50 at 600 °C.

$$HCHO_{(g)} \rightleftharpoons H_{2(g)} + CO_{(g)}$$

A mixture of HCHO, H_2, and CO is introduced into a flask at 600°C. After a short time, analysis of some amount of the reaction mixture shows that the concentrations to be $[HCHO_{(g)}] = 1.5$ M, $[H_{2(g)}] = 0.5$ M, and $[CO_{(g)}] = 1.0$ M.

Which of the following conclusions is correct about this reaction mixture?

- ☐ More $HCHO_{(g)}$ needs to be formed to reach equilibrium.
- ☐ More $H_{2(g)} + CO_{(g)}$ needs to be formed to reach equilibrium.
- ☐ The reaction mixture has reached equilibrium and Kc equals 0.50
- ☐ The reaction mixture has reached equilibrium and Kc is less than 0.50

Question 1 continued

Use the following information in the table below to answer question 8, 9, 10 & 11

Acids	$C_5H_7O_5COOH$	CH_3COOH	$CH_2ClCOOH$	$CHCl_2COOH$
Ka (at 25°C)	8.4×10^{-4}	1.7×10^{-5}	1.3×10^{-3}	5.0×10^{-2}

8) Which property is correct about these acids?

- ☐ Their pH value is greater than 7.
- ☐ They dissociate completely in water.
- ☐ Their solutions turn red litmus paper blue.
- ☐ They only show their acidic properties when dissolved in water.

9) Which acid has the weakest conjugate base?

- ☐ $C_5H_7O_5COOH_{(aq)}$
- ☐ $CHCl_2COOH_{(aq)}$
- ☐ $CH_2ClCOOH_{(aq)}$
- ☐ $CH_3COOH_{(aq)}$

10) What is the pH for $CH_2ClCOOH$ solution with a concentration of 0.8 mol dm^{-3}?

- ☐ 1.0
- ☐ 1.5
- ☐ 2.0
- ☐ 2.9

11) Which acid can make a best buffer solution?

- ☐ $CH_3COOH_{(aq)}$
- ☐ $C_5H_7O_5COOH_{(aq)}$
- ☐ $CH_2ClCOOH_{(aq)}$
- ☐ $CHCl_2COOH_{(aq)}$

Question 1 continued

12) Which of the following statements is correct about the reaction of a copper bar $Cu_{(s)}$ with $AgNO_{3(aq)}$?

- ☐ Sliver ions gain electrons.
- ☐ Sliver ions act as reducing agent.
- ☐ Copper bar mass increases.
- ☐ Copper metal is being reduced.

13) Consider a voltaic cell which is made from the two half–cells below:

$$Ag^{+}_{(aq)} + e^{-} \longrightarrow Ag_{(s)} \qquad E°/V = +0.80\ V$$

$$Cd^{2+}_{(aq)} + 2e^{-} \longrightarrow Cd_{(s)} \qquad E°/V = -0.40\ V$$

Which of the following combinations is correct about this cell under standard conditions?

	The anode	E°_{cell}/V
☐	Ag	0.40
☐	Ag	1.20
☐	Cd	0.40
☐	Cd	1.20

14) According to the standard reduction potentials below:

$$Au^{3+}_{(aq)} + 3e^{-} \longrightarrow Au_{(s)} \qquad E^{\circ}/V = 1.50\ V$$

$$Ag^{+}_{(aq)} + e^{-} \longrightarrow Ag_{(s)} \qquad E^{\circ}/V = 0.80\ V$$

$$Cu^{2+}_{(aq)} + 2e^{-} \longrightarrow Cu_{(s)} \qquad E^{\circ}/V = 0.34\ V$$

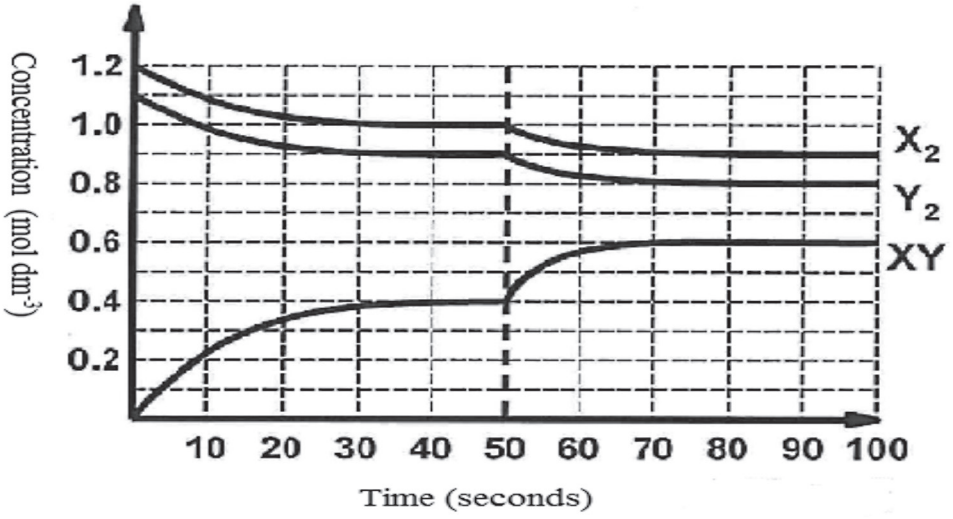
What is the (E°/V) value of a substance that can only oxidize copper metal?

- ☐ Less than 0.34 V.
- ☐ Between 0.34 and 0.80 V.
- ☐ Between 0.80 and 1.50 V.
- ☐ Greater than 1.50 V.

Question 2: Extended Answers (42 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 graph below shows the change in the concentration of gases $X_{2(g)}$, $Y_{2(g)}$ and $XY_{(g)}$ with time in a closed system until equilibrium has been reached. Then, the temperature of the equilibrium system is decreased at time (50 s). Use the graph to answer the following questions.



a. State the definition of the following:

(i) Le Chatelier's principle.

(ii) Reversible reaction.

b. Write the balanced chemical equation for this reaction.

Do not write in this space

Do not write in this space

Question 2 continued

c. State two factors that will not affect the position of equilibrium for this reaction.

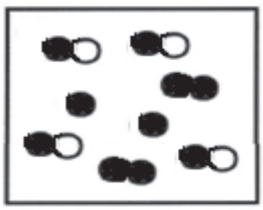
d. At which range(s) of time(s), the mixture is not at equilibrium?
(0-30) , (30-50) , (50-70) or (70-100) / [Choose the correct range(s)].

e. Which will predominate in the equilibrium mixture (reactants, products or neither) after time (50 s)?.

16) The following reaction is at equilibrium at 27 °C and its Kc = 2

$$A_{2(g)} + B_{(g)} \rightleftharpoons A_{(g)} + AB_{(g)}$$

The diagram below shows the equilibrium mixture of this reaction in a vessel containing (A) molecules, (A_2) molecules and (AB) molecules. (B) molecules are missing.



● = 1 mole of gas A
●○ = 1 mole of gas AB
●● = 1 mole of gas A_2

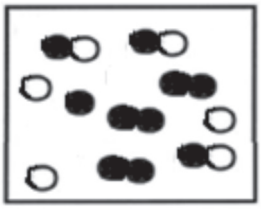
a. How many moles of (B) molecules should be shown in the diagram when the system is at equilibrium?

Question 2 continued

b. Which are favoured (reactants or products) at equilibrium? Explain your answer.

c. If a catalyst is added, what do you expect will happen to the amounts of reactants and products? Explain your answer.

d. When the temperature of the reaction system is increased to 227 °C a new equilibrium mixture is obtained as shown in the diagram below.



Is the forward reaction endothermic or exothermic? Explain your answer

Question 2 continued

17) Acids and bases are found in the human body and they have many functions.

a. What is the name of the acid that is found in our stomach?

_____

_____

b. Explain why $Al(OH)_3$ is a suitable treatment for the increase of the acidity of stomach ?

_____

_____

c. Complete the following reactions:

(i) $HNO_{3\,(aq)} + Ca_{(s)} \rightleftharpoons$ _____ + _____

(ii) $Na_2CO_{3\,(aq)} + H_2SO_{4(aq)} \rightleftharpoons$ _____ + _____ + _____

d. Explain why $H_2SO_{4(l)}$ cannot react with sodium carbonate powder?

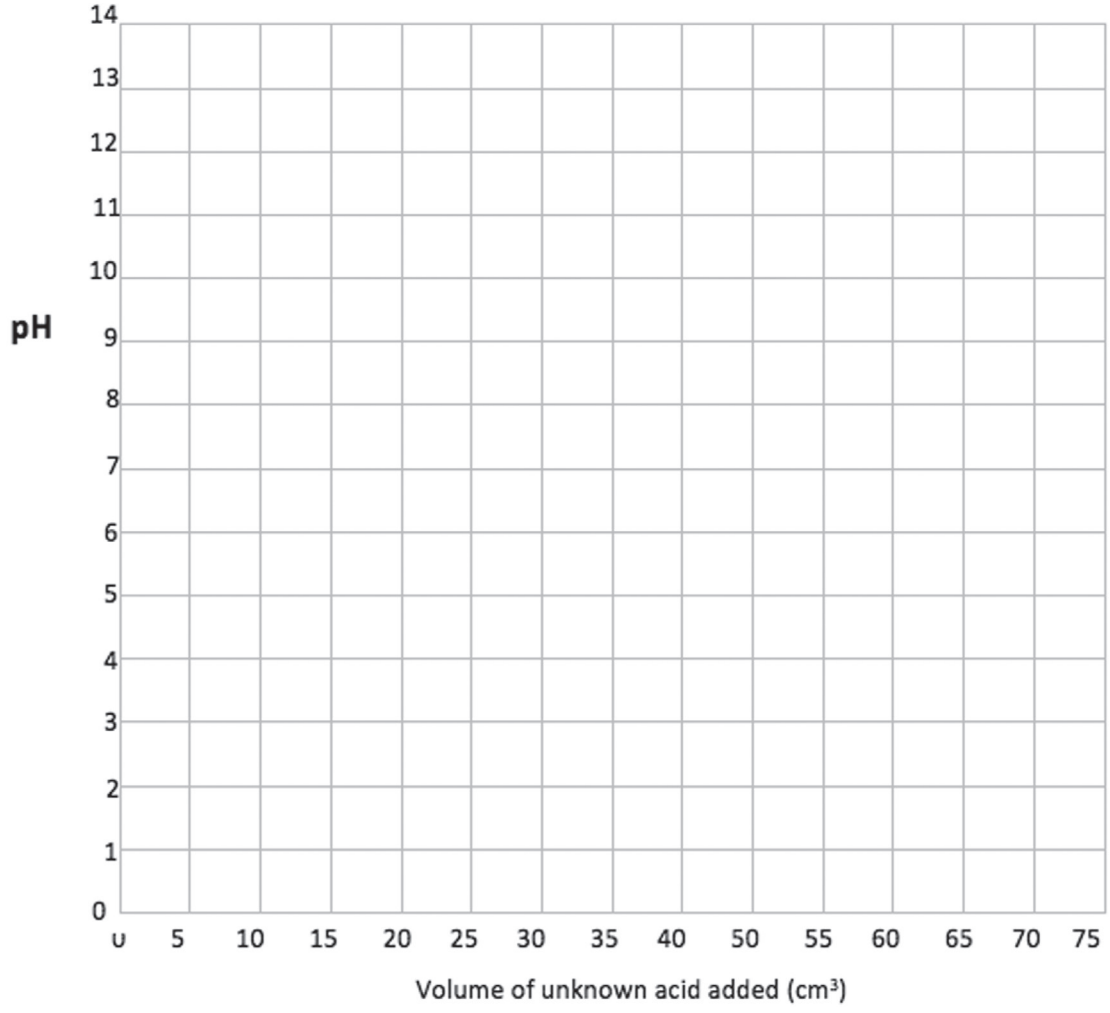
_____

Question 2 continued

18) The following table shows the change in pH for the titration of 0.15 mol dm^{-3} of unknown base (BOH) against 0.15 mol dm^{-3} of unknown acid (HA) .

Volume of the acid added/cm^3	0	10	20	30	40	48	50	51	60	70
pH	13	12.8	12.6	12.4	12.2	11	8.5	6.2	5	4.2

a. Draw the pH curve for this titration using the values from the above table by plotting the results on the following grid.



b. Predict the type of this titration in terms of acid /base strength.

_____

Question 2 continued

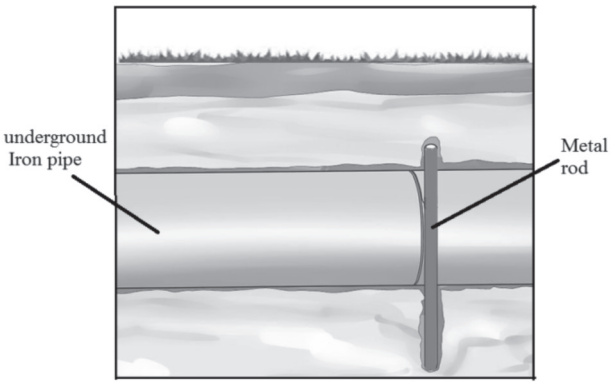
c. Calculate [OH^-] at pH= 12.6 at 25 °C. Show all your calculations.

d. Which indicator :(phenol red with range (6.8-8.4) or methyl orange with range (3.2-4.4) is suitable for this titration? Explain your answer.

19) Calculate the Ka value for Nitrous acid ($HNO_{2\,(aq)}$) solution with a concentration of 1.5×10^{-2} mol dm^{-3} , if the pH of the solution is 2.6 . Show all your calculations

Question 2 continued

20) The diagram below shows one method used for protecting iron objects from corrosion. Study it then answer the following questions.



a. What is the name of this method?

b. Why magnesium rod is used in this method?

c. Explain another method used for protecting iron objects from corrosion?

Question 2 continued

21) Table 1 below shows standard electrode potentials (E^{θ}/V) for six half cells. Use it to answer the following questions.

Half cell	E^{θ}/V
$Ni^{2+}_{(aq)} \mid Ni_{(s)}$	- 0.26
$Cu^{2+}_{(aq)} \mid Cu_{(s)}$	+ 0.34
$Cd^{2+}_{(aq)} \mid Cd_{(s)}$	- 0.40
$Ag^{+}_{(aq)} \mid Ag_{(s)}$	+ 0.80
$Mg^{2+}_{(aq)} \mid Mg_{(s)}$	- 2.37
$Al^{3+}_{(aq)} \mid Al_{(s)}$	- 1.66

a. In an experiment to determine the relative strengths of oxidizing agents, each metal (cadmium, aluminum and nickel) was separately placed into two solutions, each containing a cation of the other two metals. Table 2 below shows some results of two such combinations.

	$Cd^{2+}_{(aq)}$	$Al^{3+}_{(aq)}$	$Ni^{2+}_{(aq)}$
$Cd_{(s)}$		no reaction	**(iii)**
$Al_{(s)}$	**(i)**		reaction
$Ni_{(s)}$	no reaction	**(ii)**	

Complete table 2 by writing **reaction** or **no reaction**.

(i) _____

(ii) _____

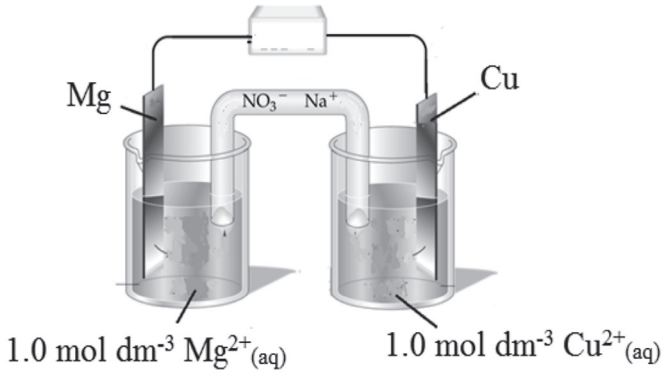
(iii) _____

Question 2 continued

b. Which metal(s) in table 1 will reduce Ag^{+} to Ag but will not reduce Ni^{2+} to Ni?

c. Which of the above metal(s) can be used to prevent oxidation of cadmium metal? Explain your answer.

d. The opposite diagram shows an electrochemical cell setup between (Cu) electrode and (Mg) electrode.
Study it then answer the following questions.



(i) Write the cell diagram as a short-hand way to represent the reaction that occurs in this cell?

(ii) If (Mg) half-cell is replaced with (Ni) half-cell, will the direction of electrons flow be changed? Explain your answer.

[End of Examination]

مُسَوَّدَة

مُسَوَّدَة

MARKING GUIDE

GENERAL EDUCATION DIPLOMA

BILINGUAL PRIVATE SCHOOLS

SEMESTER TWO - SECOND SESSION

CHEMISTRY

2016 / 2017

General Education Diploma, Semester Two, Second Session
Bilingual Private Schools, Chemistry, 2016/2017

Topics of the units	Weighting	Multiple choice (40%)		Extended response (60%)		Cognitive levels			Total
		Number of questions	Marks	Number of questions	Marks	Knowing (30%)	Applying (50%)	Reasoning (20%)	
Equilibrium mixture	26 %	4	8	3	10	5	9	4	18
Equilibrium constant	19 %	3	6		7	4	7	2	13
Acid/base equilibria	31 %	4	8		14	7	11	4	22
Electrode potential	15 %	3	6		11	5	8	4	17
Total	100 %	14	28	3	42	21	35	14	70

Exam Specifications:

General Education Diploma, Semester Two, Second Session
Bilingual Private Schools, Chemistry, 2016/2017

Distribution of cognitive domains and marks.

Serial No	Question number	Item	Mark	Unit	Page	Cognitive domain	Output
1	1	1	2	Equilibrium mixtures	356-359	Knowing	1,2,3
2	1	2	2	Equilibrium mixtures	360-363	Applying	1,2,3
3	1	3	2	Equilibrium mixtures	358-359	Applying	1, 3
4	1	4	2	Equilibrium mixtures	356-360	Reasoning	1,2,3
5	1	5	2	Equilibrium constants	370	Knowing	3,5
6	1	6	2	Equilibrium constants	368-374	Applying	2,3,5
7	1	7	2	Equilibrium constants	368-375	Applying	2,3,5
8	1	8	2	Acid / base equilibria	381	Knowing	1
9	1	9	2	Acid / base equilibria	382	Applying	3
10	1	10	2	Acid / base equilibria	386	Applying	4
11	1	11	2	Acid / base equilibria	392	Reasoning	9
12	1	12	2	Electrode potential	408	Knowing	1
13	1	13	2	Electrode potential	411-412	Applying	5
14	1	14	2	Electrode potential	411	Reasoning	6
15	2	15.a.i	1	Equilibrium mixtures	358	Knowing	1,3
16	2	15.a.ii	1	Equilibrium mixtures	356	Knowing	1,2
18	2	15.b.	2	Equilibrium mixtures	356-360	Applying	1,3
19	2	15.c.	2	Equilibrium mixtures	358-360	Reasoning	3
20	2	15.d.	2	Equilibrium mixtures	356-360	Applying	3
21	2	15.e.	1	Equilibrium mixtures	358-360	Applying	3
22	3	16.a	1	Equilibrium constants	368-370	Applying	1,2,3,4

General Education Diploma, Semester Two, Second Session
Bilingual Private Schools, Chemistry, 2016/2017

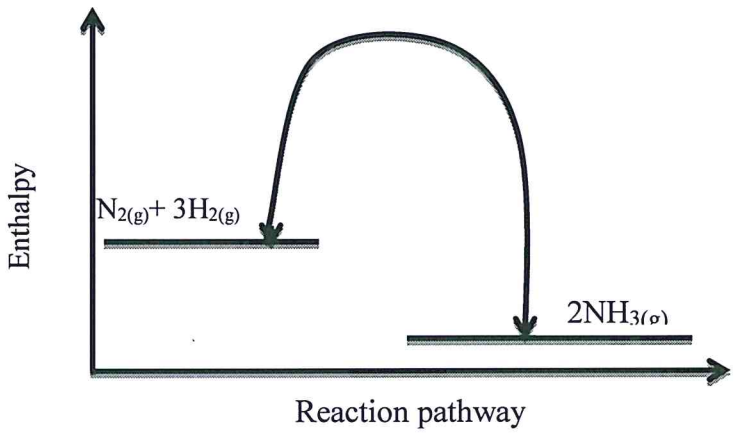
Serial No	Question number	Item	Mark	Unit	Page	Cognitive domain	Output
24	3	16.b	2	Equilibrium constants	368-375	Applying	3,5
25	3	16.c	2	Equilibrium constants	368-375	Knowing	3,5
26	3	16.d	2	Equilibrium constants	375	Reasoning	3,5
27	3	17.a	1	Acid / base equilibria	380	Knowing	2
28	3	17.b	1	Acid / base equilibria	381	Applying	1
29	3	17.c.i	1	Acid / base equilibria	380	Knowing	2

Serial No	Question number	Item	Mark	Unit	Page	Cognitive domain	Output
30	3	17.c.ii	1	Acid / base equilibria	380	Knowing	1
31	3	17.d	1	Acid / base equilibria	381	Applying	5
32	3	18.a	2	Acid / base equilibria	390	Applying	7
33	3	18.b	1	Acid / base equilibria	390	Applying	7
34	3	18.c	2	Acid / base equilibria	383	Applying	4
35	3	18.d	2	Acid / base equilibria	391	Reasoning	8
36	4	19	3	Acid / base equilibria	385-386	Applying	4
37	4	20.a	1	Electrode potential	414	Knowing	8
38		20.b	1	Electrode potential	413-414	Knowing	7,8
39	4	20.c	1	Electrode potential	414	Knowing	8
40	4	21.a.i	½	Electrode potential	411	Applying	6
41	4	21.a.ii	½	Electrode potential	411	Applying	6
42	4	21.a.iii	½	Electrode potential	411	Applying	6
42	4	21.b	1	Electrode potential	411	Applying	6
43	4	21.c	2	Electrode potential	411	Applying	6
44	4	21.d.i	1½	Electrode potential	409	Applying	4
45	4	21.d.ii	2	Electrode potential	408-409	Reasoning	6

TOTAL MARKS: 70 **PAGES: 6**

Question One (28 Marks)

There are 14 multiple-choice items. Each correct answer is worth TWO marks.

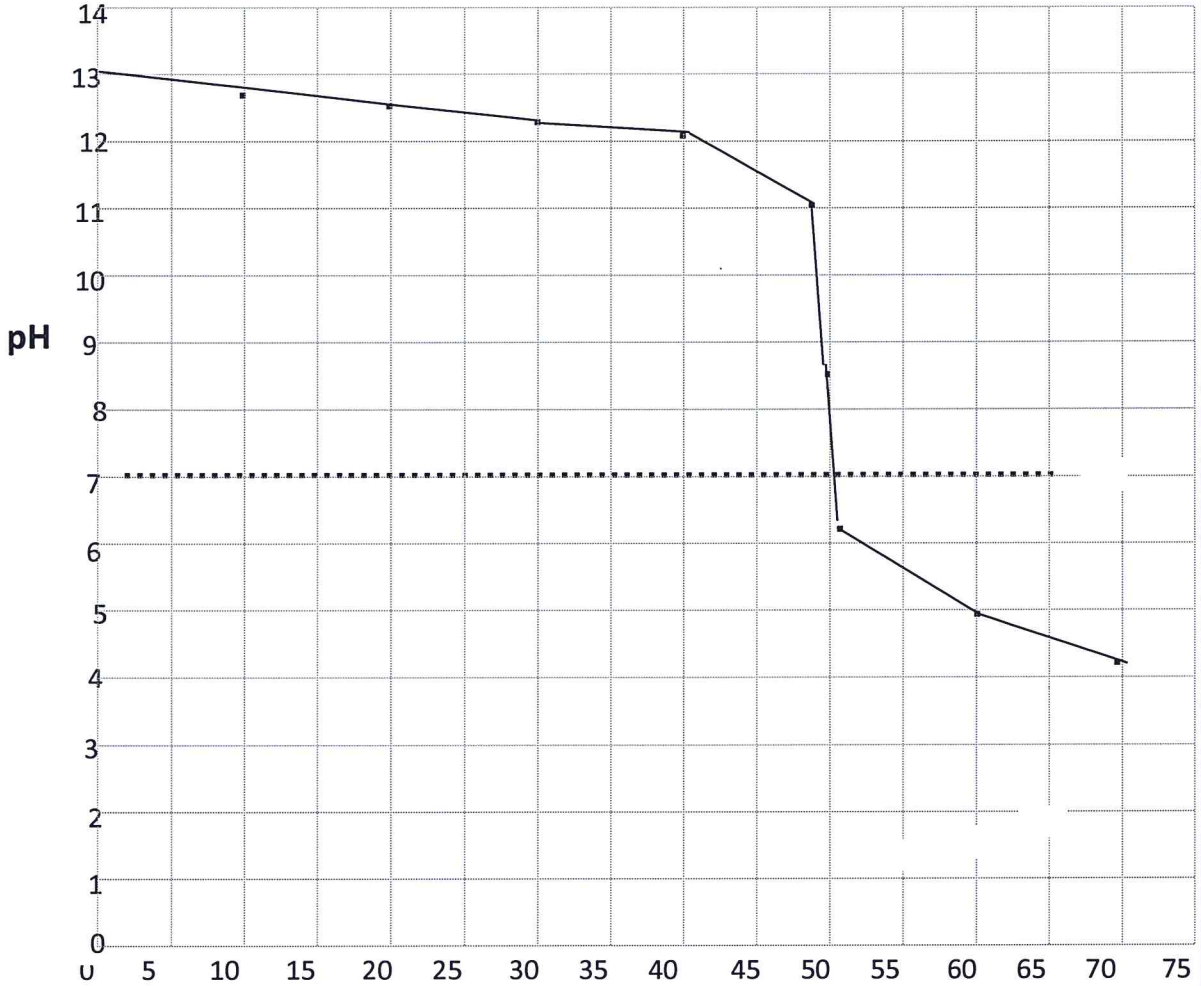
Item	Correct option
1	The concentrations of reactants and products are always equal.
2	
3	Increases Decreases
4	The reaction system has reached equilibrium state.
5	$[NO_{(g)}]^2$ x $[O_{2(g)}]$will be much smaller than $[NO_{2(g)}]^2$.
6	More products will be formed and the value of K_c will remain constant.
7	More $H_{2(g)}$ + $CO_{(g)}$ needs to be formed to reach equilibrium.
8	They only shows their acidic properties when dissolved in water .
9	$CHCl_2COOH$
10	1.5
11	$CH_3COOH_{(aq)}$.
12	Silver ions gain electrons.
13	Cd 1.20
14	between 0.34 and 0.80 V

Part	Section	Answer	Mark
15	a.	i. The position of equilibrium shifts to try to cancel out any changes introduced. *(1 mark)* ii. Change (reaction) which can go forward or backward *(1 mark)*	2marks
	b.	$X_{2(g)} + Y_{2(g)} \rightleftharpoons 2XY_{(g)}$ *-(½ mark for Balancing).* - (1 mark for *both reactants and products and they should be both correct to get the mark* *- (½ mark for showing the reversible arrows)*	2 marks
	c.	Catalyst *(1 mark)* Pressure *(1 mark)*	2marks
	d.	(0-30) (50-70) *(Each correct range from the above 1 mark is given).*	2marks
	e.	Reactants.	1mark

Part	Section	Answer	Mark
16	a.	2 moles	1 mark
	b.	Products *(1 mark)* Because the value of Kc > 1 Or because the value of Kc is more than or greater than 1 Or because the number of moles (or concentration or amount or number of molecules) of products are greater than of reactants. *(1 mark)*	2marks
	c.	The amounts of reactants and products would not change *(1mark)* - Because the catalyst does not affect the position of equilibrium - Because both forward and backward reactions are speeded up with the same rate. - Because with catalyst the time it takes for the state of equilibrium to be reached will be quicker , but the amounts of reactants and products presents would not change *For Any answer from above mark is given (1 mark)*	2 marks

	d.	Exothermic *(1 mark)* Because Kc value has decreased when temperature was increased (½ mark), this means that the position of equilibrium shifts to left, reverse direction, as temperature increases)the equilibrium mixture contains less of the products and more reactants compared to the original mixture. (½ mark)	2 marks

17	**a**	HCl or hydrochloric acid.	1 mark
	b	Because it is a weak base, so it reduces the acidity in the stomach. Or it gets rid of the excess acid.	1 mark
	c.i	$2HNO_{3\,(aq)} + Ca_{(s)} \rightleftharpoons Ca(NO_3)_{2(aq)} + H_{2(g)}$ *To get the mark all products should be correct.* *Balancing is unnecessary.*	1 mark
	c.ii	$Na_2CO_{3\,(aq)} + H_2SO_{4(aq)} \rightleftharpoons Na_2SO_{4\,(aq)} + CO_{2(g)} + H_2O_{(l)}$ *To get the mark all products should be correct.*	1 mark
	d	Because it only shows its acidic properties when dissolved in water **or** because it is present in its molecular form when it is a pure liquid.	1 mark

18	**a**	 *1 mark for the vertical section, ½ mark for the upper and½ mark lower part of the curve.*	2 marks

	b	Weak acid / strong base titration	1 mark
	c	pH= -log $[H^+_{(aq)}]$ 12.6= -log $[H^+_{(aq)}]$ (½ mark) $[H^+_{(aq)}] = 2.5 \times 10^{-13}$ mol dm^{-3} (½ mark) $K_w = [H^+_{(aq)}]\,[OH^-_{(aq)}]$ 10^{-14} mol^2 dm^{-6} = $[2.5 \times 10^{-13}]\,[OH^-_{(aq)}]$ (½ mark) $[OH^-_{(aq)}] = 0.040$ mol dm^{-3} (½ mark)	2 marks
	d	phenol red . (1 mark) - Because its range lies on the vertical section of the pH curve or near the sudden change of pH. **Or** - it changes color near the end point of titration or near equivalence point (1 mark)	2 marks

part **19**	**section**	We know $pH = -\log [H^+_{(aq)}]$ $2.6 = -\log [H^+_{(aq)}]$ (½ mark) $[H^+_{(aq)}] = 0.0025$ mol dm^{-3} or 2.5×10^{-3} mol dm^{-3} (½ mark) $HNO_{2\,(aq)} + H_2O \rightarrow NO_2^-{}_{(aq)} + H_3O^+$ $(1.5 \times 10^{-2} - x)$ x x $X = 2.5 \times 10^{-3}$ mol dm^{-3} (½ mark) $[HNO_{2(aq)}] = 1.5 \times 10^{-2} - 2.5 \times 10^{-3} = 1.25 \times 10^{-2}$ mol dm^{-3} $[HNO_{2(aq)}] = 1.25 \times 10^{-2}$ mol dm^{-3} (½ mark) $[H^+_{(aq)}] = x = 2.5 \times 10^{-3}$ mol dm^{-3} $[NO_2^-{}_{(aq)}] = x = 2.5 \times 10^{-3}$ mol dm^{-3} $Ka = [H^+_{(aq)}][NO_2^-{}_{(aq)}] / [HNO_{2(aq)}]$ $Ka = [2.5 \times 10^{-3}][2.5 \times 10^{-3}] / 1.25 \times 10^{-2}$ (½ mark) $Ka = 5.0 \times 10^{-4}$ (½ mark) If students neglects the amount of x for $[HNO_{2(aq)}]$, marks are given .	3 marks

		Answer	Mark
20	**a**	Sacrificial protection.	1 mark
	b	- Because magnesium ($Mg_{(s)}$) is more reactive than iron ($Fe_{(s)}$). So it corrodes (oxidized) in preference to iron. - Because magnesium ($Mg_{(s)}$) is higher up the iron ($Fe_{(s)}$) in the electrochemical series. - Because iron is less reactive than magnesium. - Because the standard electrode reduction potential of magnesium is lower than the standard electrode potential of iron. - Because magnesium is a stronger reducing agent than iron. *(For any answer from above mark is given or has the same meaning mark is given)*	1 mark
	c	Galvanisation: the iron or steel is dipped into molten metal that is more reactive than iron such as zinc, So it will corrodes (oxidized) in preference to the iron.	1 mark
21	**a.i**	Reaction	½ mark
	a.ii	No reaction	½ mark
	a.iii	Reaction	½ mark
	b	Copper (Cu)	1 mark

	c	Magnesium ($Mg_{(s)}$) and aluminium ($Al_{(s)}$) (½ mark each) *explaination* *(1 mark)* - Because magnesium ($Mg_{(s)}$) and aluminium ($Al_{(s)}$) are more reactive than cadmium ($Cd_{(s)}$). So they corrode (oxidized) in preference to cadmium. - Because magnesium and aluminium are higher up the cadmium in the electrochemical series. - Because cadmium is less reactive than magnesium and aluminium. - Because the standard electrode reduction potentials of magnesium and aluminium are lower than the standard electrode of cadmium. - Because magnesium and aluminium are a stronger reducing agent than cadmium. *(For any answer from above mark is given or has the same meaning mark is given)*	2 marks
	d.i	$Mg_{(s)} \mid Mg^{2+}_{(aq)} \vdots Cu^{2+}_{(aq)} \mid Cu_{(s)}$ *(½ mark)* *(½ mark)* *(½ mark)*	1½ marks
	d.ii	No change in the direction of electron flow. *(1 mark)* Explanation: *(1 mark)* - Because the standard electrode reduction potentials of magnesium and nickel are lower than the standard electrode of copper. - Because magnesium ($Mg_{(s)}$) and nickel ($Ni_{(s)}$) are more reactive than copper ($Cu_{(s)}$). So are corrodes (oxidized) in preference to copper. - Because magnesium and nickel are higher up the copper in the electrochemical series. - Because copper is less reactive than magnesium and nickel. - Because magnesium and nickel are a stronger reducing agent than copper. - Because ($Cu^{2+}_{(aq)}$) is a stronger oxidising agent than($Mg^{2+}_{(aq)}$) and (Ni^{2+}). *(For any answer from above mark is given or has the same meaning mark is given)*	2 marks

This is the end of the Marking Guide