سلطنة عمان
وزارة التربية والتعليم

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

تنبيه:
- المادة: الكيمياء.
- الأسئلة في (١٥) 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

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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.

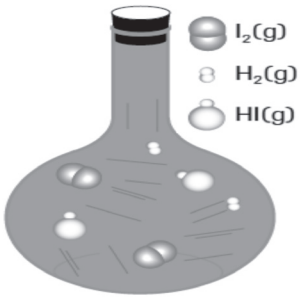
1) The opposite figure shows the amounts of reactants and products for a gaseous reaction at equilibrium.

Which of the following statements is correct about the figure?

- ○ Equilibrium position lies well over to the right.
- ○ Products predominate in the equilibrium mixture.
- ○ The amounts of reactants and products stay the same.
- ○ The partial pressures of reactants are less than of products.

2) A mixture of $H_{2(g)}$ and $I_{2(g)}$ is sealed in a flask , then allowed to reach equilibrium according to the equation below:

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)} \qquad \Delta H > 0$$



Which of the following actions to the reaction system would make the initial dark purple colour of iodine vapour fades gradually?

	$[H_{2(g)}]$	$[HI_{(g)}]$	Temperature
○	Removing	Adding	Decreasing
○	Adding	Removing	Increasing
○	Adding	Adding	Decreasing
○	Removing	Removing	Increasing

Question 1 continued

3) The following reaction is carried out in four different test tubes in water bath under different conditions. *(Note: the initial water bath Temperature is 25°C).*

$$[Co(H_2O)_{6(aq)}]^{2+} + 4Cl^-_{(aq)} \rightleftharpoons [CoCl_4]^{2-}_{(aq)} + 6H_2O_{(l)} \qquad \Delta H > 0$$

(Pink) (Blue)

Test tube	(1)	(2)	(3)	(4)
Water bath Temperature	60°C	10°C	60°C	10°C
Adding HCl	No	Yes	Yes	No
Removing H_2O	No	Yes	Yes	No

In which test tube(s) **all** the actions to the reaction system in the above table would make the solution of the mixture blue?

- ☐ Only 3
- ☐ 2 and 3
- ☐ 1 and 4
- ☐ 2 , 3 and 4

4) The following hypothetical endothermic reaction is at equilibrium, at a particular temperature:

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

What will happen when the pressure of the equilibrium mixture is decreased?

- ☐ The amount of reactants will increase.
- ☐ The amount of products will stay constant.
- ☐ The position of equilibrium will shift to the left.
- ☐ The position of equilibrium will shift to the right.

5) The reaction below is at equilibrium at a particular temperature.

$$NO_{2(g)} + NO_{(g)} \rightleftharpoons N_2O_{(g)} + O_{2(g)} \qquad Kc = 1$$

Which of the following conclusions is correct about this reaction?

- ☐ The rate of forward reaction is not equal to the rate of backward reaction.
- ☐ The value of $[N_2O_{(g)}] \times [O_{2(g)}]$ equals that of $[NO_{2(g)}] \times [NO_{(g)}]$.
- ☐ The position of equilibrium lies in favour of the reactants.
- ☐ The position of equilibrium lies in favour of the products.

Question 1 continued

6) The reaction below is at equilibrium at 100°C, and its Kp is 2.65

$$SO_2Cl_{2(g)} \rightleftharpoons SO_{2(g)} + Cl_{2(g)} \qquad \Delta H = +93.1 \text{ kJ/mol}$$

What is the expected Kp value at 200°C?

- ☐ Equals 2.65
- ☐ Less than 2.65
- ☐ More than 2.65
- ☐ Between 2 and 2.65

7) In which of the following balanced equations, the unit of Kc is $mol^2.dm^{-6}$?

- ☐ $C_2H_{4(g)} \rightleftharpoons 2C_{(s)} + 2H_{2(g)}$
- ☐ $CO_{2(g)} + H_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(g)}$
- ☐ $N_2H_{4(l)} + O_{2(g)} \rightleftharpoons N_{2(g)} + 2H_2O_{(l)}$
- ☐ $CH_{4(g)} + H_2O_{(g)} \rightleftharpoons CO_{(g} + 3H_{2(g)}$

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

Acid or Base solution	A	B	C	D	E	F
$[OH^-]$ mol.dm^{-3} at 25°C	1.6×10^{-13}	1.0×10^{-9}	1.6×10^{-8}	2.5×10^{-5}	3.1×10^{-2}	3.0×10^{-1}

8) Which of the following solutions are proton accepters in water?

- ☐ A and B.
- ☐ A and E.
- ☐ C and D.
- ☐ E and F.

9) In which solution, the concentration of hydrogen ions is 3.2×10^{-13} mol dm^{-3} ?

- ☐ A
- ☐ B
- ☐ E
- ☐ F

Question 1 continued

10) The table below shows K_w values at three different temperatures

Temperature (°C)	K_w (mol^2dm^{-6})
25	10^{-14}
40	3×10^{-14}
100	5.13×10^{-13}

What is the correct conclusion based on the values of the table?

- ☐ The pH of water is similar at all temperatures.
- ☐ $[H^+]$ at 40°C is greater than $[H^+]$ at 100°C.
- ☐ Water is neutral at all temperatures.
- ☐ $[OH^-]$ is the highest at 25 °C.

11) For the following reaction:

$$X + H_2O \rightleftharpoons Y + H_3O^+$$

Which option indicates the substances that could not correspond to X and Y?

	X	Y
☐	$C_{17}H_{19}NO_3$	$HC_{17}H_{19}NO_3^+$
☐	$Al(H_2O)_6^{3+}$	$Al[(H_2O)_5(OH)]^{2+}$
☐	HSO_4^-	SO_4^{2-}
☐	H_2CO_3	HCO_3^-

12) Which of the following statements is correct about the electron transfer in the redox reactions?

- ☐ Metal ions lose electrons as it undergoes reduction.
- ☐ Oxidizing agent gives electrons as it undergoes oxidation.
- ☐ Reducing agent gains electrons as it undergoes reduction.
- ☐ Electrons flow from the reducing agent to the oxidizing agent.

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Question 1 continued

13) If the order of three hypothetical oxidizing agents and hydrogen ion from the weakest to the strongest is ($B^{2+} < H^{+} < D^{+} < A^{2+}$), Which of the following results is correct about the four reactions below?

	B + HCl	B + A^{2+}	D + HCl	D + A^{2+}
☐	$H_{2(g)}$ given off	$A_{(s)}$ precipitated	$H_{2(g)}$ given off	$A_{(s)}$ precipitated
☐	No reaction	$A_{(s)}$ precipitated	No reaction	$A_{(s)}$ precipitated
☐	$H_{2(g)}$ given off	$A_{(s)}$ precipitated	No reaction	$A_{(s)}$ precipitated
☐	$H_{2(g)}$ given off	No reaction	$H_{2(g)}$ given off	No reaction

14) Consider the standard electrode potentials shown in the table below:

Half-cell	**E°/V**
$K^{+}_{(aq)}$, $K_{(s)}$	-2.92
$Mg^{2+}_{(aq)}$, $Mg_{(s)}$	-2.37
$Zn^{2+}_{(aq)}$, $Zn_{(s)}$	-0.76

Which of the following cations in the half-cells below can only oxidize one of the above metals?

☐ $Na^{+}_{(aq)}$, $Na_{(s)}$ E°/V= -2.71 V

☐ $Li^{+}_{(aq)}$, $Li_{(s)}$ E°/V= -3.03V

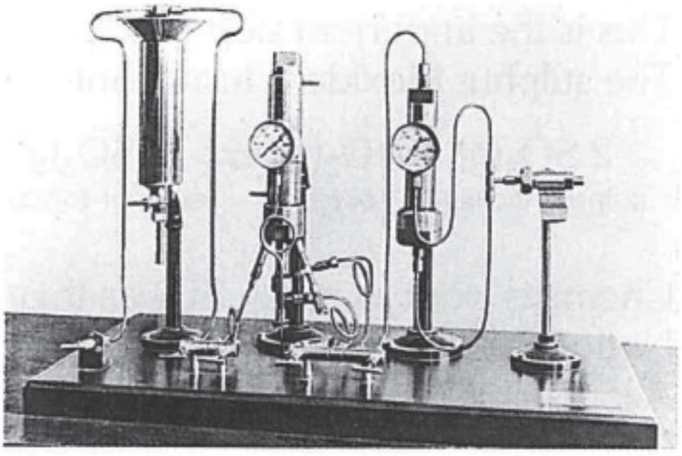
☐ $Al^{3+}_{(aq)}$, $Al_{(s)}$ E°/V= -1.66 V

☐ $Pb^{2+}_{(aq)}$, $Pb_{(s)}$ E°/V= -0.13 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 picture below shows the Haber's apparatus which was made by the scientist Fritz Haber to make ammonia.



a. Write the chemical equation of the equilibrium mixture made by Haber.

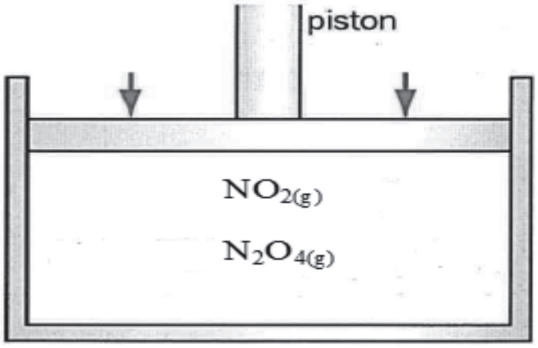
b. By using this apparatus, only very small quantities of ammonia could be produced. How did chemical companies and the scientist Carl Bosch solve this problem to make higher yields of ammonia?

Question 2 continued

16) In an experiment, gases of $NO_{2(g)}$ and $N_2O_{4(g)}$ are allowed to reach equilibrium in a sealed cylinder fitted with a movable piston at a particular temperature according to the following equation and diagram. Study them to answer the following questions.

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

(brown gas) (pale yellow gas)



a. What would be the colour of the equilibrium mixture when the piston is pressed downward? Explain your answer.

b. When the cylinder is heated, the brown colour gets deeper. Based on this information, answer the questions below:

(i) What happens to the concentration of $N_2O_{4(g)}$ in the equilibrium mixture?

(ii) What would happen to the equilibrium position (lies well to the right or to the left)? Explain your answer.

Question 2 continued

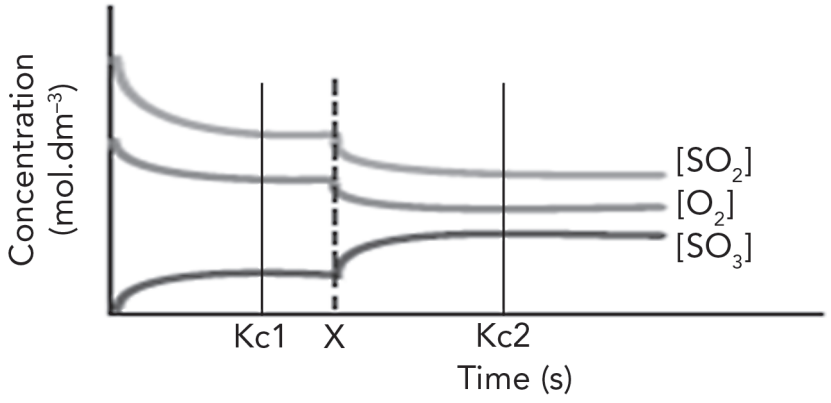
(iii) Is the backward reaction endothermic or exothermic? Explain your answer.

17) If the Kc of the reaction below at 100°C is 2.2×10^{-8} mol dm^{-3}.

$$COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$$

Which would be favoured (reactants, products or neither)? Explain your answer.

18) The graph below shows the change in the concentration of gases $SO_{3(g)}$,$SO_{2(g)}$ and $O_{2(g)}$ with time in a closed system until the mixture reached equilibrium. Then the temperature of the equilibrium mixture is decreased at time (X). Use the graph to answer the following questions:



a. Write the chemical equation for the forward reaction.

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Question 2 continued

b. Is the forward reaction endothermic or exothermic? Explain your answer according to Le Chatelier's principle.

c. Which will predominate in the equilibrium mixture (reactants, products or neither) after the time (X)?

d. Which one do you expect to have greater value, Kc1 or Kc2?

19) Citric acid ($C_5H_7O_5COOH_{(aq)}$) gives orange and lemon their sharp taste .

a. Write the chemical dissociation equation for citric acid.

b. What is the effect of orange juice on red litmus paper? Explain your answer.

c. Explain why pure citric acid does not show its acidic properties.

Question 2 continued

d. Which of the acids (citric or nitric acid) of same concentrations has higher concentration of $H^+(aq)$ ions? Explain your answer.

20) Use the information below to answer the following questions.

Name	Ascorbic acid
Formula	$C_5H_7O_4COOH$
Found as vitamin (C) in	Fruits and Vegetables
Ka (at 25°C)	7.9×10^{-5}

a. Calculate the pH value for ascorbic acid solution with a concentration of (0.2 mol dm^{-3}) at 25°C? Show all your calculations.

Question 2 continued

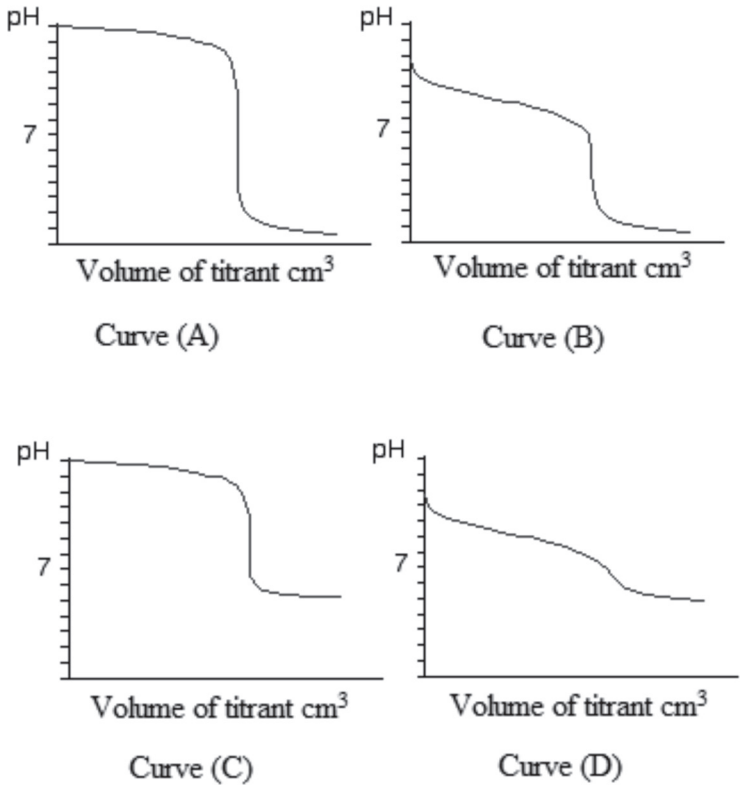
b. A buffer solution is prepared by mixing 200 cm^3 of ascorbic acid (0.20 $mol.dm^{-3}$) with 200 cm^3 of sodium ascorbate, $C_5H_7O_4COONa$ (0.20 $mol.dm^{-3}$)

(i) Calculate the pH of this buffer solution. Show all your calculations.

(ii) Explain how would this buffer solution work if few drops of (OH^-) ions are added?

Question 2 continued

21) The graphs below show the pH curves for four acid / base titrations.



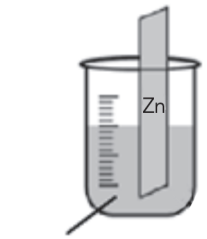
a. In which pH curves, strong acids were used? Explain your answer?

b. In which pH curve, we cannot get accurate end point? Explain your answer?

Question 2 continued

22) The diagram below shows a zinc metal bar added to magnesium nitrate and copper nitrate solutions. Study it, and then answer the following questions.

(Note: E°/V for $Zn^{2+}_{(aq)}$, $Zn_{(s)} = -0.76$, for $Mg^{2+}_{(aq)}$, $Mg_{(s)} = -2.37$, for $Cu^{2+}_{(aq)}$, $Cu_{(s)} = 0.34$)



$Cu(NO_3)_{2(aq)}$ **and** $Mg(NO_3)_{2(aq)}$

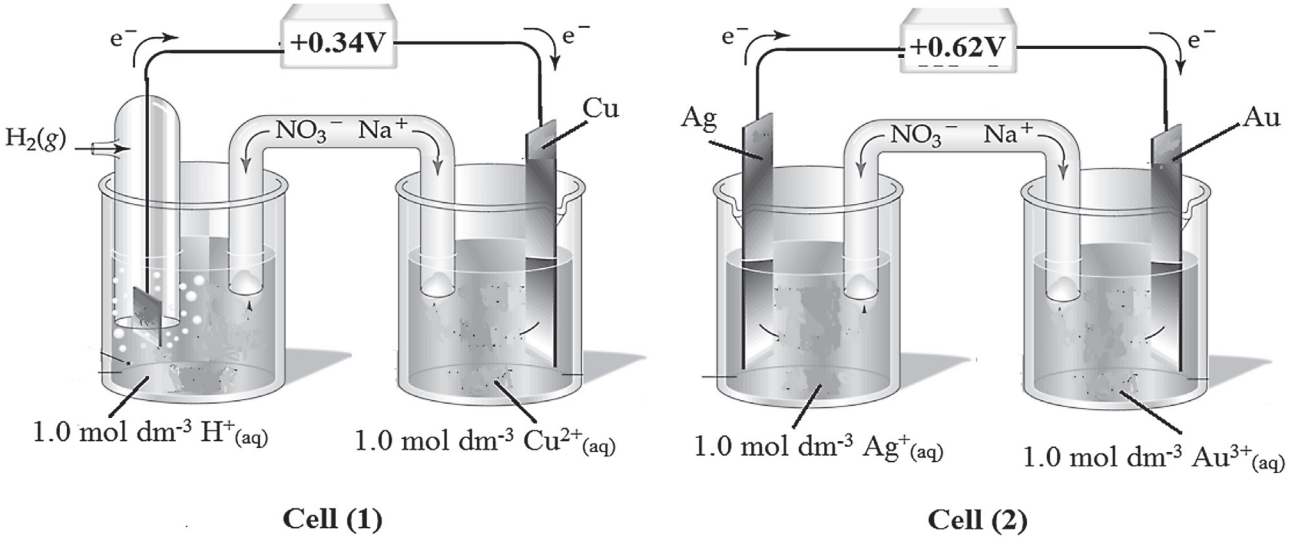
a. Identify the reducing agent(s) in this experiment?

b. Write the reduction - half reaction(s) that take(s) place in this beaker?

c. Explain why iron objects are protected from corrosion by dipping them into molten zinc?

Question 2 continued

23) The diagram below shows two electrochemical cells under standard conditions. Consider it to answer the following questions.



a. What is the name of the left half-cell in cell (1)?

b. Write the balanced equation for the overall redox reaction that occurs in cell (2).

c. Write the cell diagram as a short-hand way to represent the reaction that occurs in cell (1).

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Question 2 continued

d. If the standard electrode potential (E^{θ}/V) for ($Au^{3+}_{(aq)}$, $Au_{(s)}$) is +1.42 V,

(i) Calculate the standard electromotive force (E^{θ}_{cell}) for $Cu_{(s)} \mid Cu^{2+}_{(aq)} \vdots Ag^{+}_{(aq)} \mid Ag_{(s)}$ cell in volts. Show your calculations.

(ii) Can you keep a solution containing ($Au^{3+}_{(aq)}$ ions) in a bottle made of copper metal? Explain your answer.

[End of Examination]

مُسَوَّدَة

MARKING GUIDE

GENERAL EDUCATION DIPLOMA

BILINGUAL PRIVATE SCHOOLS

SEMESTER TWO - FIRST SESSION

CHEMISTRY

2016 / 2017

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

Exam Specifications:

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

General Education Diploma, Semester Two, First 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	358-360	Knowing	2,3
2	1	2	2	Equilibrium mixtures	358-360	Applying	2,3
3	1	3	2	Equilibrium mixtures	358-360	Reasoning	3
4	1	4	2	Equilibrium mixtures	360	Applying	3
5	1	5	2	Equilibrium constants	370-375	Knowing	3,4
6	1	6	2	Equilibrium constants	370-375	Applying	3,5
7	1	7	2	Equilibrium constants	373	Applying	1,2
8	1	8	2	Acid / base equilibria	382	Applying	2
9	1	9	2	Acid / base equilibria	387	Applying	6
10	1	10	2	Acid / base equilibria	387	Knowing	6
11	1	11	2	Acid / base equilibria	382	Reasoning	3
12	1	12	2	Electrode potentials	408	Knowing	1
13	1	13	2	Electrode potentials	409	Applying	5
14	1	14	2	Electrode potentials	410	Reasoning	6
15	2	15.a	1	Equilibrium mixtures	357,362, 362	Knowing	2,4
16	2	15.b.	2	Equilibrium mixtures	357,362, 362	Knowing	2,4
17	2	16.a	2	Equilibrium mixtures	359	Applying	1,2,3

18	2	16.b.i	1	Equilibrium mixtures	358-360	Applying	1,2,3
19	2	16.b.ii	2	Equilibrium mixtures	358-360	Applying	1,2,3
20	2	16.b.iii	2	Equilibrium mixtures	358-360	Reasoning	1,2,3
21	3	17	2	Equilibrium constants	370-375	Applying	3,4,5
22	3	18.a	1	Equilibrium constants	368,369	Applying	1,3,4,5
23	3	18.b	2	Equilibrium constants	375	Reasoning	3,4,5
24	3	18.c	1	Equilibrium constants	374	Applying	3,4,5
25	3	18.d	1	Equilibrium constants	370-375	Applying	2,3,4,5

Serial. No	Question Number	Item	Mark	Unit	Page	Cognitive domain	Out put
26	3	19.a	1	Acid / base equilibria	381	Knowing	2
27	3	19.b	1	Acid / base equilibria	381	Knowing	1
28	3	19.c	1	Acid / base equilibria	381	Knowing	1
29	3	19.d	2	Acid / base equilibria	380	Knowing	1
30	3	20.a	2	Acid / base equilibria	386	Applying	4
31	3	20.b.i	3	Acid / base equilibria	393	Applying	9
32	3	20.b.ii	2	Acid / base equilibria	393	Applying	9
33	4	21.a	2	Acid / base equilibria	390	Reasoning	7

34	4	21.b	1	Acid / base equilibria	390	Applying	7
35	4	22.a	1	Electrode potential	1	Knowing	408
36	4	22.b	1	Electrode potential	1	Knowing	409
37	4	22.c	1	Electrode potential	8	Knowing	413
38	4	23.a	1	Electrode potential	4	Applying	410
39	4	23.b	1	Electrode potential	2	Applying	409
40	4	23.c	2	Electrode potential	3	Applying	409
41	4	23.d.i	2	Electrode potential	5.ii	Reasoning	412
42	4	23.d.ii	2	Electrode potential	6	Applying	409

TOTAL MARKS: 70 **PAGES: 6**

Question One (28 Marks)

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

Item No.	Correct option
1	The amounts of reactants and products stay the same.
2	Adding Removing Increasing
3	Only 3
4	The amount of products will stay constant.
5	The value of $[N_2O_{(g)}]x[O_{2(g)}]$ equals that of $[NO_{2(g)}]x[NO_{(g)}]$.
6	More than 2.65
7	$CH_{4(g)} + H_2O_{(g)} \rightleftharpoons CO_{(g)} + 3H_{2(g)}$
8	E and F
9	E
10	Water is neural at all temperatures.
11	X: $C_{17}H_{19}NO_3$ Y: $HC_{17}H_{19}NO_3^+$
12	Electrons flow from the reducing agent to the oxidising agent.
13	$H_{2(g)}$ given off $A_{(s)}$ precipitated No reaction $A_{(s)}$ precipitated
14	$Na^+_{(aq)}$, $Na_{(s)}E^\ominus/V = -2.71$ V

15.	**a.**	$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ *-Balancing is unnecessary.* *- (To get the mark all components of the equation should be correct)*	1 mark
	b.	-They used double walled steel vessel to get high pressure. - They used an iron catalyst. - They used traces of other metal oxides. *(Any two correct answers from the above mark is given).*	2 marks
16.	**a.**	Pale yellow gas. *(½ mark)* -Because when the piston is pressed downward, the pressure is increased*(½ mark)* therefore the equilibrium position shifts to the right, to the product to the side with the lowest number of gas molecules*(½mark)*, therefore the equilibrium mixture will have more $N_2O_{4(g)}$ *(½ mark)* than before and so more pale yellow will be.	2 marks
	b.i	Decreases.	1mark
	b.ii	lies well to the left. *(1 mark)* -since the brown colour gets deeper, it means we have more of reactant $NO_{2(g}$ and less of product $N_2O_{4(g)}$. this means that equilibrium position lies well to the left. -Because increasing the temperature of exothermic reaction will shift the equilibrium position to the backward reaction (or to the reactant or to the left or to $NO_{2(g)}$where less $N_2O_{4(g)}$ and more $NO_2$is produced. -Because increasing the temperature favours the endothermic reaction which is the backward reaction that makes the equilibrium position shifts to the left (or to the reactant or to $NO_{2(g)}$ where less $N_2O_{4(g)}$ and more $NO_{2(g)}$is produced. *(Any correct answer from the above 1 mark is given).*	2marks
	b.iii	- endothermic *(1 mark)* - increasing the temperature favours the endothermic reaction and since the forward reaction is exothermic the backward reaction will be endothermic. - Since the brown colour gets deeper when the cylinder is heated, the forward reaction is exothermic, thus the backward reaction will be endothermic *(Any correct answer from the above 1 mark is given).*	2marks

17.		Reactants. *(1 mark)* - Because the value of Kc is less than 1 - Or for small value of Kc , the equilibrium position lies well over to the reactants, to the left, so the reactants predominate in the equilibrium mixture. - Or because the concentration of the reactant $COCl_{2\,(g)}$ is greater than of the products $CO_{(g)}$ and $Cl_{2\,(g)}$	2marks

18.	**a**	$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ *-Balancing is unnecessary.* - *(to get the mark , all components of the equation should be correct)*	1mark
	b	- Exothermic reaction *(1 mark)* -Because decreasing the temperature for the exothermic reaction will shift the reaction position to the forward reaction (or to the product or to the right or to $SO_{3(g)}$ where less $SO_{2(g)}$ and $O_{2(g)}$ is formed and more $SO_{3(g)}$ is produced. -Or decreasing the temperature favours the exothermic reaction which makes the equilibrium position to shift to the forward reaction (or to the product or to the right or to $SO_{3(g)}$ where less $SO_{2(g)}$ and $O_{2(g)}$ is formed and more $SO_{3(g)}$ is produced. -Or since the concentration of the products has increased as shown in the graph when the temperature of the mixture is decreased, this mean that forward reaction is exothermic *(Any correct answer from the above 1 mark is given),*	2marks
	c	Reactants.	1mark
	d	Kc2	1mark

19	**a**	$C_5H_7O_5COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons C_5H_7O_5COO^-_{(aq)} + H_3O^+_{(aq)}$ *(to get the mark , all components of equation should b correct)*	1 mark
	b	No effect (½ mark) Because it is an acid. (½ mark)	1 mark
	c	because it is in its molecular forms when it is pure, or it needs to be dissolved in water to ionize and show acidic properties	1 mark
	d	Nitric acid. (½ mark) because it is a strong acid Or it dissociates completely in water. (½ mark)	1 mark
20	**a**	We know $K_a = [H^+_{(aq)}][C_5H_7O_4COO^-_{(aq)}] / [C_5H_7O_4COOH_{(aq)}]$ (½ mark) $Ka = x^2 / 0.2$ $\mathbf{7.9 \times 10^{-5} = x^2 / 0.2}$ $\mathbf{X^2 = 1.58 \times 10^{-5}}$ $\mathbf{X = 3.97 \times 10^{-3}}$ (½ mark) $\mathbf{So\ [H^+] = 3.97 \times 10^{-3}}$ mol .dm^{-3} (½ mark) $\mathbf{pH = -\log [H^+]}$ $\mathbf{pH = -\log 3.97 \times 10^{-3}}$ $\mathbf{pH = 2.4}$ (½ mark)	2 marks

20	**b.i**	The original 0.2 mol.dm^{-3} solution has become 0.1 mol.dm^{-3} on adding the equal volumes together. We know that : $K_a = [H^+_{(aq)}] [C_5H_7O_4COO^-_{(aq)}] / [C_5H_7O_4COOH_{(aq)}]$ (½ mark) By substitution into the equilibrium expression we get : **7.9×10^{-5}** = $[H^+_{(aq)}]$ x [0.1] / 0.1 (1 mark) **So** $[H^+_{(aq)}]$ = **7.9×10^{-5}** (½ mark) We know pH = - log $[H^+_{(aq)}]$ (½ mark) pH = -log **7.9×10^{-5}** pH = 4.10 (½ mark) (If *student used the equation pH = pKa + log [salt / acid] in the calculations correctly, mark is given.*	3 marks
	b.ii	According to the equation below, adding OH^- ions will result in shifting the position of equilibrium to the right because OH^- ions will react with any H^+ ions in the solution. (1 mark) $OH^-_{(aq)} + H^+_{(aq)} \rightleftharpoons H_2O_{(l)}$ Then plenty **$C_5H_7O_4COOH$** molecules are ready to split up and replace the lost H^+ ions. (1 mark)	2 marks
21	**a**	Curves A and B (½ mark each) For curve A the equivalent points is 7 or there is large sudden change in pH at the end point of the titration (½ mark) for curve B the equivalent point is less than 7 or there is a smaller sudden change mainly on the acid side (½ mark)	2 marks
	b	Curve D. (½ mark) Because there is no sudden change in pH at the end point of Titration (½ mark)	1 mark

22	**a**	Zinc metal or Zn	1mark
	b	$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ *(if student added the equation of Mg^{2+}, no mark is given)*	1mark
	c	- Because zinc ($Zn_{(s)}$) is more reactive than iron ($Fe_{(s)}$). So it corrodes (oxidized) in preference to iron. - Because iron is less reactive than zinc. - Because the standard electrode reduction potential of zinc is lower than the standard electrode of iron. - Because zinc is a stronger reducing agent than iron. *(For any answer from above mark is given)*	1mark

23	a	The standard hydrogen half-cell or the standard hydrogen electrode	1mark
	b	$Au^{3+}_{(aq)} + 3Ag_{(s)} \longrightarrow Au_{(s)} + 3Ag^{+}_{(aq)}$ *(To get the mark all components of the reaction should be correct , physical states are unnecessary.)*	1mark
	c	$Pt \mid H_{2(g)}, 2H^{+}_{(aq)} \vdots Cu^{+2}_{(aq)} \mid Cu_{(s)}$ *(1 mark)* *(1 mark)*	2marks
	d.i	From cell (1): $E^{\theta}(Cu^{2+}_{(aq)}, Cu_{(s)}) = +0.34$ V *(½ mark)* From cell (2): E^{θ} cell(2) = $E^{\theta}(Ag_{(s)}, Ag^{+}_{(aq)}) + E^{\theta}(Au^{3+}_{(aq)}, Au_{(s)})$ +0.62 = $E^{\theta}(Ag_{(s)}, Ag^{+}_{(aq)}) + (+1.42)$ *(½ mark)* $E^{\theta}(Ag_{(s)}, Ag^{+}_{(aq)}) = -0.8$ V *(½ mark)* Therefore (E^{θ}_{cell}) for $Cu_{(s)} \mid Cu^{2+}_{(aq)} \vdots Ag^{+}_{(aq)} \mid Ag_{(s)} = -0.34 + (+0.8)$ $= +0.46$ V *(½ mark)*	2marks
	d.ii	**No** , a reaction between $(Au^{3+}_{(aq)})$ solution with copper metal (Cu) will occur. *(1 mark)* Explanation: *(1 mark)* - Because $(Cu_{(s)})$ is more reactive than $(Au_{(s)})$. So it corrodes (oxidized) in preference to Au. - Because the standard electrode reduction potential of $E^{\theta}(Cu^{2+}_{(aq)}, Cu_{(s)})$ is lower than the standard electrode of $E^{\theta}(Au^{3+}_{(aq)}, Au_{(s)})$. - Because $(Au^{3+}_{(aq)})$ is a stronger oxidising agent than $(Cu^{2+}_{(aq)})$. - Because $(Cu_{(s)})$ is a stronger reducing agent than $(Au_{(s)})$. *(For any answer from above mark is given)*	2marks

End of mark scheme