INSERT STUDENT I.D. NUMBER

STICKER IN THIS SPACE

JANUARY 1994

PROVINCIAL EXAMINATION

• MINISTRY OF EDUCATION •

CHEMISTRY 12

GENERAL INSTRUCTIONS

1. Insert the stickers with your Student I.D. Number in the allotted spaces above. **Under no circumstance is your name or identification, other than your Student I.D. Number, to appear on this paper.**

2. Take the separate Answer Sheet and follow the directions on its front page.

3. Be sure you have an HB pencil and an eraser for completing your Answer Sheet. Follow the directions on the Answer Sheet when answering multiple-choice questions.

4. For each of the written-response questions, write your answer in the space provided. When instructed to open this booklet, **check the numbering of the pages** to ensure that they are numbered in sequence from page one to the last page, which is identified by **END OF EXAMINATION**.

5. At the end of the examination, place your Answer Sheet inside the front cover of this booklet and return the booklet and your Answer Sheet to the supervisor.

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FOR OFFICE USE ONLY

INSERT STUDENT I.D. NUMBER

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CHEMISTRY 12 JANUARY 1994 PROVINCIAL (CHP)

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CHEMISTRY 12 PROVINCIAL EXAMINATION

		Value	Suggested Time
1.	This examination consists of two parts:		
	PART A: 48 multiple-choice questions	48	70
	PART B: 11 written-response questions	32	50
	Total:	80 marks	120 minutes

2. You have **TWO HOURS** to complete this examination.

3. The last **FOUR** pages, inside the back cover, contain the following tables that may be detached for convenient reference:

   i) Periodic Table of the Elements
   ii) Atomic Masses of the Elements
   iii) Names, Formulae, and Charges of some Common Ions
   iv) Solubility of Common Compounds in Water
   v) K_{sp} Values
   vi) Relative Strengths of Brönsted-Lowry Acids and Bases
   vii) Acid-base Indicators
   vii) Two-place Logarithms
   viii) Standard Reduction Potentials of Half-cells.

   No other reference materials or tables are allowed.

4. An approved scientific calculator is considered essential for the examination. The calculator **MUST NOT** be programmable to process alpha-numeric strings, nor should it be capable of processing user-defined functions. It **MUST NOT** have the capacity to accept coefficients from either an equation or a system of equations, thereby producing the roots of that equation or system. The calculator **MUST NOT** contain a plotter or printer.

5. **FOR WRITTEN RESPONSE QUESTIONS:**

   i) Organization and planning space has been incorporated into the space allowed for each question.

   ii) Answers must include units where appropriate and be given to the correct number of significant figures.

   iii) In questions involving calculation, full marks will not be given for providing only an answer.

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PART A: MULTIPLE–CHOICE QUESTIONS

Value: 48 marks (one mark per question) **Suggested Time: 70 minutes**

INSTRUCTIONS: For each question, select the **BEST** answer and record your choice on the answer sheet provided. Using an **HB** pencil, completely fill in the circle that has the letter corresponding to your answer.

1. Consider the following reaction:

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + ZnCl_{2(aq)}$$

Data collected for the above reaction are summarized in the table below:

Time (min)	Mass of Zn (g)	Volume H_2 (mL)	Temperature (°C)
0	4.65	0	20
2	4.50	50	21
4	4.35	100	22

The rate of this reaction can be measured in units of

A. g/min
B. g/mL
C. min/mL
D. g/(mL)(°C)

2. Consider the following reaction:

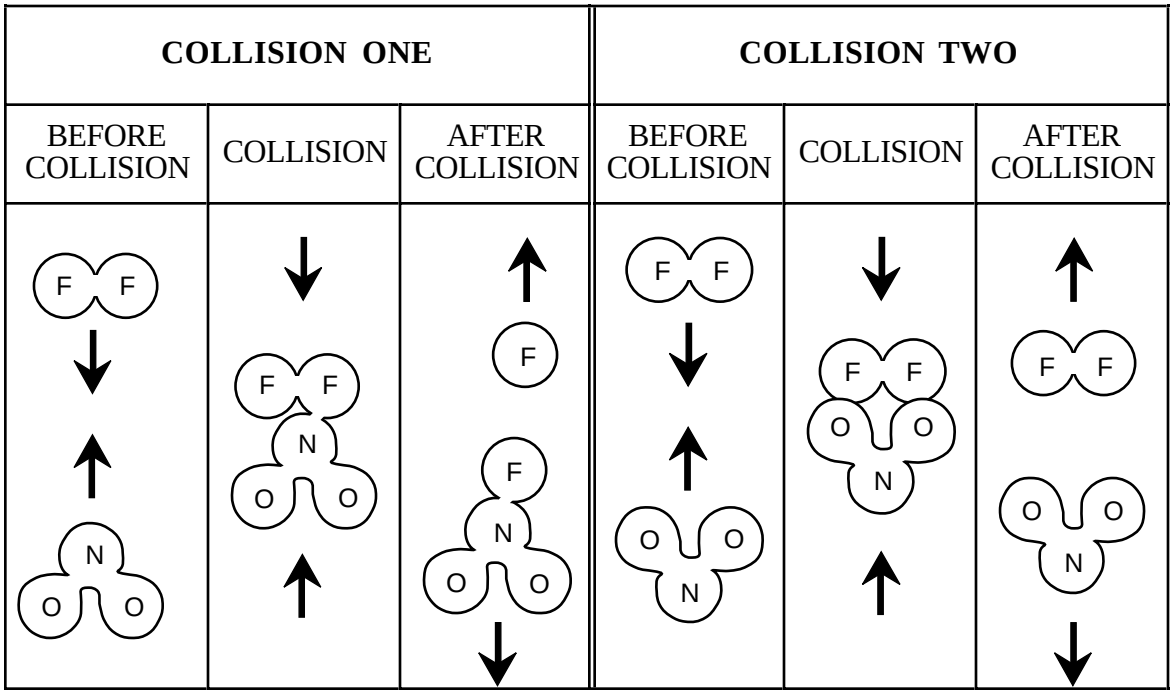
$$2S_{(s)} + 3O_{2(g)} \rightarrow 2SO_{3(g)} + \text{heat}$$

The rate of this reaction could be increased by

A. decreasing temperature.
B. adding a catalyst.
C. increasing the concentration of $S_{(s)}$.
D. increasing the concentration of $SO_{3(g)}$.

OVER

3. Consider the following collisions, each occurring at the same temperature:



Which one of the following factors explains why collision one is successful while collision two is not successful?

A. Catalyst.
B. Geometry.
C. Concentration.
D. Kinetic energy.

4. Consider the following reaction:

$$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)} + 112 \text{ kJ}$$

The ΔH for the above reaction is

A. positive and the reaction is exothermic.
B. negative and the reaction is exothermic.
C. positive and the reaction is endothermic.
D. negative and the reaction is endothermic.

5. When a lit match is touched to the wick of a candle, the candle begins to burn. When the match is removed, the candle continues to burn. In this reaction, the match

   A. behaves as a catalyst.
   B. supplies activation energy.
   C. is part of the rate determining step.
   D. lowers the activation energy barrier.

6. Consider the following reversible reaction:

$$Fe^{3+}_{(aq)} + SCN^{-}_{(aq)} \rightleftarrows FeSCN^{2+}_{(aq)}$$

   A solution of $Fe(NO_3)_3$ is added to a solution of KSCN. Which one of the following statements describes the changes in forward and reverse reaction rates as the reaction moves towards equilibrium?

   A. Forward and reverse rates increase.
   B. Forward and reverse rates decrease.
   C. Forward rate increases and reverse rate decreases.
   D. Forward rate decreases and reverse rate increases.

7. A system at equilibrium is said to be dynamic because at equilibrium the

   A. temperature does not change.
   B. macroscopic properties are constant.
   C. forward and reverse reactions continue to occur.
   D. concentrations of reactants and products are constant.

8. Consider the following equilibrium system:

$$CaCO_{3(s)} \rightleftarrows CaO_{(s)} + CO_{2(g)}$$

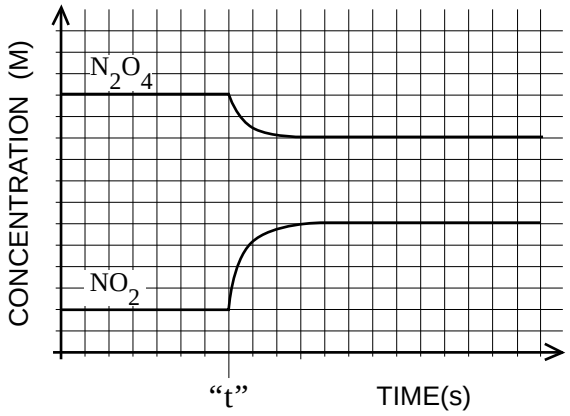
   Which one of the following changes would cause the above system to shift left?

   A. Add more CaO.
   B. Remove $CaCO_3$.
   C. Decrease volume.
   D. Increase surface area of CaO.

OVER

9. Consider the following concentration versus time graph for the equilibrium:

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



At time = " t ", which one of the following stresses occurred?

A. Catalyst was added.
B. Pressure was changed.
C. Temperature was changed.
D. Concentration of NO_2 was changed.

10. Consider the following equilibrium constant expression:

$$K_{eq} = [CO_2]$$

Which one of the following equilibrium systems does the above expression represent?

A. $CO_{2(g)} \rightleftarrows CO_{2(s)}$

B. $PbO_{(s)} + CO_{2(g)} \rightleftarrows PbCO_{3(s)}$

C. $CaCO_{3(s)} \rightleftarrows CaO_{(s)} + CO_{2(g)}$

D. $H_2CO_{3(aq)} \rightleftarrows H_2O_{(l)} + CO_{2(aq)}$

11. Hydrogen gas dissociates into atomic hydrogen as follows:

$$H_{2(g)} \rightleftarrows 2H_{(g)} \qquad K_{eq} = 1.2 \times 10^{-71}$$

The value of the equilibrium constant for the above system indicates that

A. the reaction rate is very slow.
B. the equilibrium is exothermic.
C. reactants are favoured at equilibrium.
D. a catalyst is necessary to establish equilibrium.

12. Consider the following equilibrium system:

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

At equilibrium, a 2.0 litre sample was found to contain 1.00 mol CO, 0.500 mol Cl_2 and 0.100 mol $COCl_2$. The K_{eq} value for the above system is

A. 0.40
B. 0.20
C. 2.5
D. 5.0

13. Consider the following equilibrium system:

$$2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)} \qquad K_{eq} = 4.0$$

In an experiment, 0.40 mol $SO_{2(g)}$, 0.20 mol $O_{2(g)}$ and 0.40 mol $SO_{3(g)}$ are placed into a 1.0 litre container. Which of the following statements relates the changes in $[SO_2]$ and $[O_2]$ as equilibrium becomes established?

A. The $[SO_2]$ and $[O_2]$ increase.
B. The $[SO_2]$ and $[O_2]$ decrease.
C. The $[SO_2]$ and $[O_2]$ do not change.
D. The $[SO_2]$ increases and the $[O_2]$ decreases.

OVER

14. Which one of the following would form an ionic solution when dissolved in water?

A. I_2

B. CH_3OH

C. $Ca(NO_3)_2$

D. $C_{12}H_{22}O_{11}$

15. In a saturated solution of $Zn(OH)_2$, the $\left[Zn^{2+}\right]$ is

A. less than 0.10 M
B. more than 10.0 M
C. more than 0.10 M, but less than 1.0 M
D. more than 1.0 M, but less than 10.0 M

16. The **complete** ionic equation for the reaction between $MgCl_{2(aq)}$ and $AgNO_{3(aq)}$ is

A. $Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \longrightarrow AgCl_{(s)}$

B. $2AgNO_{3(aq)} + MgCl_{2(aq)} \longrightarrow 2AgCl_{(s)} + Mg(NO_3)_{2(aq)}$

C. $2Ag^{+}_{(aq)} + Mg^{2+}_{(aq)} + 2NO^{-}_{3(aq)} + 2Cl^{-}_{(aq)} \longrightarrow MgCl_{2(s)} + 2Ag^{+}_{(aq)} + 2NO^{-}_{3(aq)}$

D. $2Ag^{+}_{(aq)} + 2NO^{-}_{3(aq)} + Mg^{2+}_{(aq)} + 2Cl^{-}_{(aq)} \longrightarrow 2AgCl_{(s)} + Mg^{2+}_{(aq)} + 2NO^{-}_{3(aq)}$

17. Which of the following would precipitate the Ca^{2+} and Mg^{2+} found in hard water?

A. S^{2-}

B. PO_4^{3-}

C. SO_4^{2-}

D. CH_3COO^{-}

18. The $\left[SO_4^{2-}\right]$ in a saturated solution of $PbSO_4$ is

$$\left(K_{sp} = 1.1 \times 10^{-8}\right)$$

A. 1.2×10^{-16} M
B. 5.5×10^{-9} M
C. 1.1×10^{-8} M
D. 1.0×10^{-4} M

19. Which one of the following salts is soluble?

A. $BaSO_4$
B. $CaCO_3$
C. K_3PO_4
D. $Fe(OH)_2$

20. The compound Ag_2S has a solubility of 1.3×10^{-4} moles per litre at 25°C. The K_{sp} for this compound is

A. 2.2×10^{-12}
B. 8.8×10^{-12}
C. 1.7×10^{-8}
D. 3.4×10^{-8}

21. The 1.0 M acidic solution with the highest pH value is

A. H_2S
B. HNO_2
C. HNO_3
D. H_3BO_3

22. A test that could be safely used to distinguish a strong base from a weak base is

A. taste.
B. touch.
C. litmus paper.
D. electrical conductivity.

OVER

23. The conjugate acid of $H_2C_6H_5O_7^-$ is

A. $C_6H_5O_7^{3-}$

B. $HC_6H_5O_7^{2-}$

C. $H_2C_6H_5O_7$

D. $H_3C_6H_5O_7$

24. Identify the two substances that act as Bronsted-Lowry bases in the equation

$$HS^- + SO_4^{2-} \rightleftarrows S^{2-} + HSO_4^-$$

A. HS^- and S^{2-}

B. SO_4^{2-} and S^{2-}

C. HS^- and HSO_4^-

D. SO_4^{2-} and HSO_4^-

25. Which one(s) of the following substances is/are amphiprotic?

(1) H_3PO_4 (2) $H_2PO_4^-$ (3) HPO_4^{2-}

A. 2 only
B. 3 only
C. 1 and 2
D. 2 and 3

26. At 25°C, the equation representing the ionization of water is

A. $H_2O + H_2O \rightleftarrows 2H_2 + O_2$

B. $H_2O + H_2O \rightleftarrows H_2O_2 + H_2$

C. $H_2O + H_2O \rightleftarrows 4H^+ + 2O^{2-}$

D. $H_2O + H_2O \rightleftarrows H_3O^+ + OH^-$

27. The equilibrium constant expression for sulphurous acid is

A. $K_a = \left[H^+\right]\left[HSO_3^-\right]$

B. $K_a = \dfrac{\left[H^+\right]\left[HSO_3^-\right]}{\left[H_2SO_3\right]}$

C. $K_a = \dfrac{\left[2H^+\right]\left[SO_3^{2-}\right]}{\left[H_2SO_3\right]}$

D. $K_a = \dfrac{\left[H^+\right]\left[SO_3^{2-}\right]}{\left[H_2SO_3\right]}$

28. The pH of a 0.3 M solution of NH_3 is approximately

A. 14.0
B. 11.0
C. 6.0
D. 3.0

29. Which one of the following salts will produce an acidic solution?

A. KBr
B. LiCN
C. NH_4Cl
D. $NaCH_3COO$

30. Which of the following oxides will form the most acidic solution?

A. SO_2
B. MgO
C. Na_2O
D. Al_2O_3

OVER

31. Which of the following pairs of gases are primarily responsible for producing “acid rain”?

A. O_2 and O_3
B. N_2 and O_2
C. CO and CO_2
D. NO_2 and SO_2

32. The approximate K_a for the indicator phenolphthalein is

A. 6×10^{-19}
B. 8×10^{-10}
C. 6×10^{-8}
D. 2×10^{-2}

33. How many moles of $Mg(OH)_2$ are required to neutralize 30.00 mL of 0.150 M HCl ?

A. 2.25×10^{-3} mol
B. 4.50×10^{-3} mol
C. 5.00×10^{-3} mol
D. 9.00×10^{-3} mol

34. The **net** ionic equation for the neutralization of HBr by $Ca(OH)_2$ is

A. $H^+_{(aq)} + OH^-_{(aq)} \rightleftarrows H_2O_{(l)}$
B. $Ca^{2+}_{(aq)} + 2Br^-_{(aq)} \rightleftarrows CaBr_{2(s)}$
C. $2HBr_{(aq)} + Ca(OH)_{2(aq)} \rightleftarrows 2H_2O_{(l)} + CaBr_{2(s)}$
D. $2H^+_{(aq)} + 2Br^-_{(aq)} + Ca^{2+}_{(aq)} + 2OH^-_{(aq)} \rightleftarrows 2H_2O_{(l)} + Ca^{2+}_{(aq)} + 2Br^-_{(aq)}$

35. Sodium potassium tartrate ($NaKC_4H_4O_6$) is used to raise the pH of fruit during processing. In this process, sodium potassium tartrate is being used as a/an

A. salt.
B. acid.
C. base.
D. buffer.

36. The pH of an aqueous solution is 4.32. The $[OH^-]$ is

A. 6.4×10^{-1} M
B. 4.8×10^{-5} M
C. 2.1×10^{-10} M
D. 1.6×10^{-14} M

37. Consider the following equation:

$$2\ Fe + 3Cu(NO_3)_2 \longrightarrow 2Fe(NO_3)_3 + 3Cu$$

Electrons are lost in the reaction by

A. Fe
B. Cu
C. Fe^{3+}
D. Cu^{2+}

38. Which one of the following is the strongest reducing agent?

A. I^-
B. F^-
C. Cl^-
D. Br^-

OVER

39. In the reaction below:

$$6H^+ + 6I^- + C1O_3^- \rightarrow 3I_2 + 3H_2O + Cl^-$$

the oxidizing agent is

A. I_2

B. I^-

C. H^+

D. ClO_3^-

40. Which of the following reactions is spontaneous at standard conditions?

A. $2H_2O \rightarrow 2H_2 + O_2$

B. $2Fe^{3+} + Fe \rightarrow 3Fe^{2+}$

C. $2Cl^- + Br_2 \rightarrow Cl_2 + 2Br^-$

D. $2Br^- + Sn^{4+} \rightarrow Sn^{2+} + Br_2$

41. The oxidation state of S in $S_2O_8^{2-}$ is

A. –2

B. +7

C. +8

D. +14

42. As SO_4^{2-} changes to SO_3^{2-}, it is said that sulphur is being reduced since its oxidation number

A. increases as electrons are lost.

B. decreases as electrons are lost.

C. increases as electrons are gained.

D. decreases as electrons are gained.

43. Which of the following chemicals could be used in a titration in which Br^- is changed to Br_2 ?

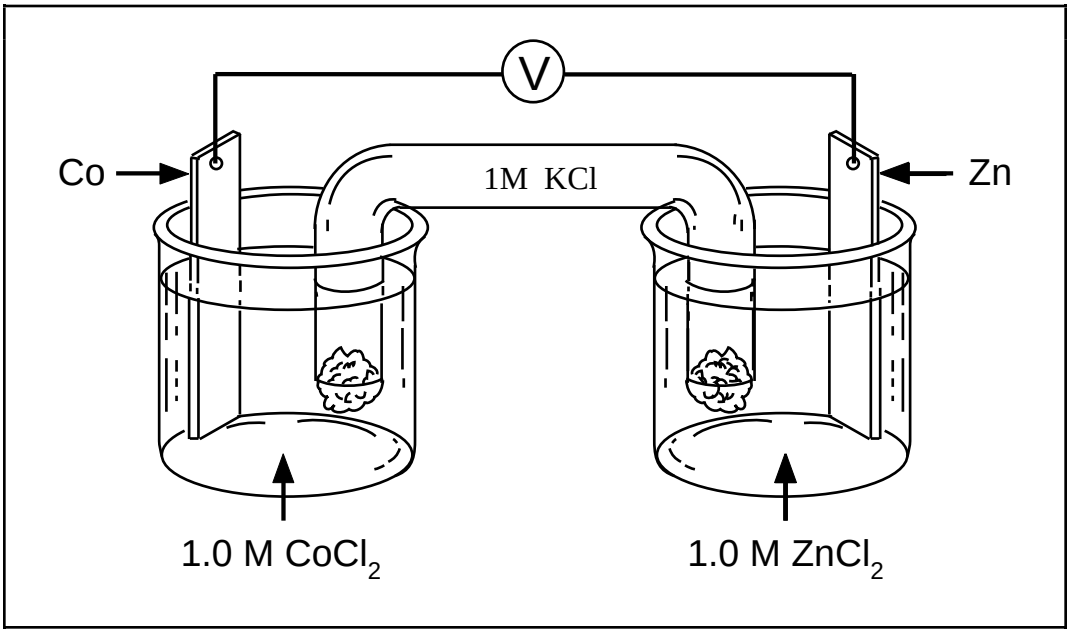
A. I_2

B. Cl^-

C. NO_3^- (acidified)

D. H_2O_2 (acidified)

Use the following cell diagram for question 44.



44. The initial voltage of the cell in the above diagram is

A. 0.48 V

B. –0.48 V

C. 0.00 V

D. 1.04 V

45. The E° of the hydrogen half-cell is

A. arbitrarily set.

B. determined by experiment.

C. independent of temperature.

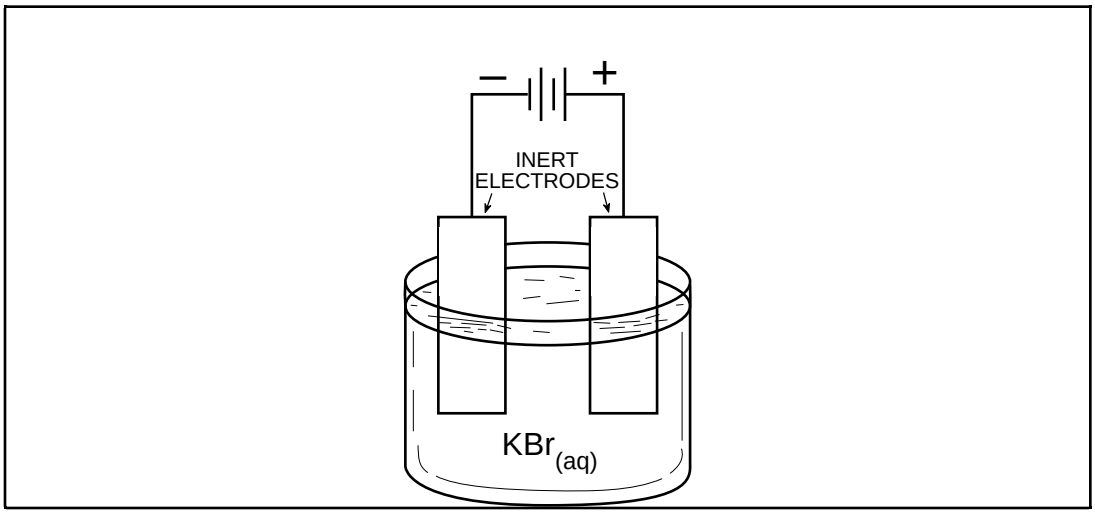
D. found by comparison with the oxygen half-cell.

OVER

46. Which of the following metals can be used to cathodically protect iron?

A. tin
B. zinc
C. nickel
D. copper

Use the following electrolytic cell diagram to answer question 47 and 48.



47. The product at the cathode is

A. K
B. O_2
C. H_2
D. Br_2

48. In the above cell,

A. K^+ ions move to cathode and Br^- ions move to anode.
B. Br^- ions move to cathode and K^+ ions move to anode.
C. Br^- ions move to cathode and H^+ ions move to anode.
D. OH^- ions move to cathode and Br^- ions move to anode.

This is the end of the multiple-choice section.
Answer the remaining questions directly in this examination booklet.

PART B: WRITTEN–RESPONSE QUESTIONS

Value: 32 marks **Suggested Time: 50 minutes**

INSTRUCTIONS: You will be expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner.

Your steps and assumptions leading to a solution must be written in the spaces below the questions.

Answers must include units where appropriate and be given to the correct number of significant figures.

In questions involving calculation, full marks will not be given for providing only an answer.

1. Consider the following reaction:

$$Cu_{(s)} + 2AgNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$$

In a rate experiment, a coil of copper wire is placed into a solution of silver nitrate. The following data are recorded.

Time (hours)	Mass of Copper (g)
0.0	3.45
4.0	2.12

Calculate the rate of this reaction. **(2 marks)**

Score for Question 1.

1. _____ (2)

2. Define "activated complex." **(2 marks)**

_____

_____

_____

Score for Question 2.

2. _____ (2)

OVER

3. Consider the following equilibrium system:

$$\underset{\text{yellow}}{Fe^{3+}_{(aq)}} + \underset{\text{colourless}}{SCN^{-}_{(aq)}} \rightleftarrows \underset{\text{red}}{FeSCN^{2+}_{(aq)}}$$

In an experiment, a student places the above equilibrium system into a cold water bath and notes that the intensity of the red colour increases. The student then concludes that the equilibrium is exothermic.

a) Do you agree or disagree? $\left(\frac{1}{2}\textbf{ mark}\right)$ _____

b) Explain: $\left(1\frac{1}{2}\textbf{ marks}\right)$_____

_____

_____

_____

Score for Question 3.

3. _____ (2)

4. Consider the following equilibrium system:

$$PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)}$$

At 250°C, 0.40 mol of PCl_3 and 0.60 mol of Cl_2 are placed into a 1.0 litre container. At equilibrium, the $[PCl_5]$ = 0.11 mol/L. Calculate the value of K_{eq}. **(3 marks)**

Score for Question 4.

4. _____ (3)

5. A 100 ml solution containing 0.2 M Al^{3+}, 0.2 M NH_4^+ and 0.2 M Mg^{2+} is added to a 100 ml solution containing 0.2 M S^{2-}, 0.2 M Cl^- and 0.2 M OH^-. Identify the ions that do **not** form a precipitate. **(2 marks)**

Score for Question 5.
5. _____ (2)

6. A science teacher needs 5.0 L of limewater for an experiment. Limewater is a saturated solution of $Ca(OH)_2$. Calculate the minimum mass of $Ca(OH)_2$ required to make this solution. $K_{sp} = 1.3 \times 10^{-6}$ **(5 marks)**

Score for Question 6.
6. _____ (5)

OVER

7. Write the equation for the hydrogen carbonate ion acting as a weak acid. **(1 mark)**

_____

Score for Question 7.
7. _____ (1)

8. a) A student prepares a buffer by dissolving solid sodium acetate, $NaCH_3COO$, in a solution of acetic acid, CH_3COOH. Write the **net** ionic equation for the buffer system. **(1 mark)**

_____

b) What happens to the concentrations of CH_3COOH and CH_3COO^- when a small amount of acid is added to this system? **(1 mark)** Explain the reason. **(1 mark)**

_____

_____

_____

_____

_____

c) What happens to the pH of the buffer when a small amount of acid is added? **(1 mark)**

_____

_____

_____

Score for Question 8.
8. _____ (4)

9. Determine the pH of a 0.10 M solution of hydrogen cyanide. **(4 marks)**

Score for Question 9.
9. _____ (4)

10. Balance the following redox equation in an acidic solution. **(4 marks)**

$$FeO_4^{2-} + NH_3 \longrightarrow N_2 + Fe^{3+}$$

Score for Question 10.
10. _____ (4)

OVER

11. In an electrolytic cell, current is passed through molten NaCl.

a) Suggest suitable electrodes for this process. **(1 mark)**

b) Write the equation for the reaction occurring at the cathode. **(1 mark)**

c) Write the **overall** equation. **(1 mark)**

Score for Question 11.
11. _____ (3)

END OF EXAMINATION