JANUARY 1995

PROVINCIAL EXAMINATION

MINISTRY OF EDUCATION

CHEMISTRY 12

GENERAL INSTRUCTIONS

1. Insert the stickers with your Student I.D. Number (PEN) 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 INK in the space provided.

5. 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 |.

6. 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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CHEMISTRY 12 JANUARY 1995 PROVINCIAL
(CHP)

1. _____ (2)

2. _____ (2)

3. _____ (2)

4. _____ (2)

5. _____ (3)

6. _____ (4)

7. _____ (2)

8. _____ (2)

9. _____ (2)

10. _____ (4)

11. _____ (2)

12. _____ (2)

13. _____ (3)

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CHEMISTRY 12 PROVINCIAL EXAMINATION

	Value	Suggested Time

1. This examination consists of **two** parts:

		Value	Suggested Time
PART A	48 multiple-choice questions	48	70
PART B	13 written-response questions	32	50
	Total:	**80 marks**	**120 minutes**

2. The following tables can be found in the separate **Data Booklet.**

    • Periodic Table of the Elements
    • Atomic Masses of the Elements
    • Names, Formulae, and Charges of Some Common Ions
    • Solubility of Common Compounds in Water
    • Solubility Product Constants at $25°C$
    • Relative Strengths of Brönsted-Lowry Acids and Bases
    • Acid-Base Indicators
    • Standard Reduction Potentials of Half-cells

    No other reference materials or tables are allowed.

3. An approved scientific calculator is essential for the examination. The calculator must be a hand-held device designed **only** for mathematical computations such as logarithmic and trigonometric functions. It **can be** programmable, but **must not** contain any graphing capabilities. You **must not** bring into the examination room any devices to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, or keyboards.

4. You have **two hours** to complete this examination.

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Value: 48 marks   **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 at constant temperature in an **open** system:

$$MgCO_{3(s)} + 2HCl_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + MgCl_{2(aq)}$$

Which of the following properties could be used to determine reaction rate?

A.   mass of the system
B.   pressure of the gas
C.   concentration of H_2O
D.   concentration of $MgCO_3$

2.   Which combination of factors will affect the rate of the following reaction?

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$
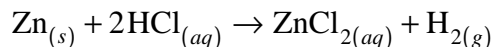
A.   temperature and surface area only
B.   temperature and concentration only
C.   concentration and surface area only
D.   temperature, concentration and surface area

3.   As reactant molecules approach each other

A.   heat is released.
B.   a reaction intermediate forms.
C.   kinetic energy changes to potential energy.
D.   potential energy changes to kinetic energy.

4. Consider the following potential energy diagram.
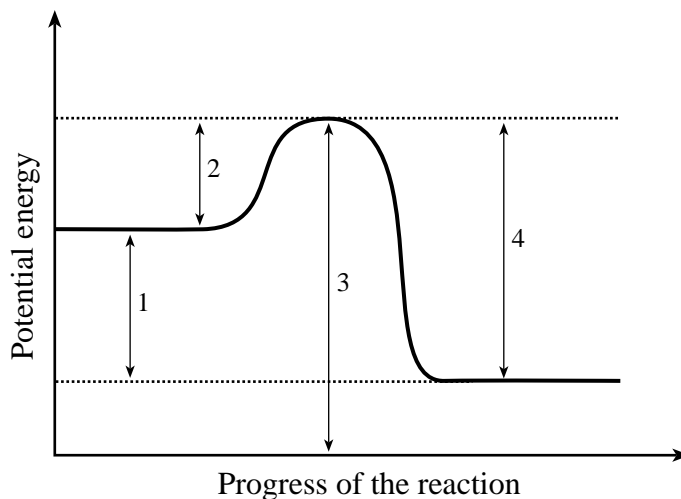
The interval representing ΔH for the reverse reaction is

A.   1
B.   2
C.   3
D.   4

5. When a catalyst is added to a reaction, ΔH will

A.   increase slowly.
B.   remain constant.
C.   decrease slowly.
D.   increase rapidly due to the alternate pathway.

6. Equilibrium is said to be **dynamic** because the

A.   forward and reverse reactions stop.
B.   reverse reaction goes to completion.
C.   forward reaction goes to completion.
D.   forward and reverse reactions continue.

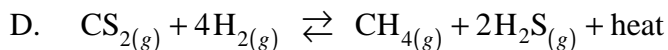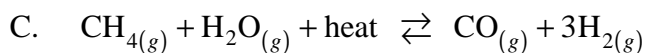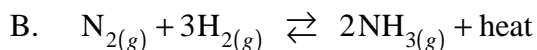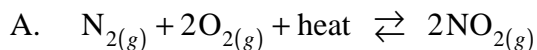7. The equilibrium constant expression for the following reaction is

$$2Hg_{(l)} + O_{2(g)} \rightleftarrows 2HgO_{(s)}$$
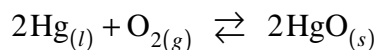
A. $K_{eq} = \dfrac{1}{[O_2]}$

B. $K_{eq} = [O_2]$

C. $K_{eq} = \dfrac{[2HgO]}{[O_2][2Hg]}$

D. $K_{eq} = \dfrac{[HgO]^2}{[Hg]^2[O_2]}$

8. Which of the following reactions will shift left when pressure is increased **and** when temperature is decreased?

A. $N_{2(g)} + 2O_{2(g)} + heat \rightleftarrows 2NO_{2(g)}$

B. $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)} + heat$

C. $CH_{4(g)} + H_2O_{(g)} + heat \rightleftarrows CO_{(g)} + 3H_{2(g)}$

D. $CS_{2(g)} + 4H_{2(g)} \rightleftarrows CH_{4(g)} + 2H_2S_{(g)} + heat$

9. The value of the equilibrium constant will change when

A. a catalyst is used.
B. temperature changes.
C. product concentrations change.
D. the volume of a gaseous system changes.

10. Products are favoured in an equilibrium reaction when the
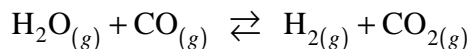
A. reaction is endothermic.
B. equilibrium constant is large.
C. macroscopic properties are constant.
D. activation energy of the forward reaction is high.

11. Consider the following equilibrium system at $900°C$:

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

Initially 5.0 moles of H_2O and 4.0 moles of CO were reacted. At equilibrium, it is found that 2.0 moles of H_2 are present. How many moles of H_2O remain in the mixture?

A. 1.0 moles
B. 2.0 moles
C. 3.0 moles
D. 4.0 moles

12. In which of the following reactions does the tendency towards minimum enthalpy and maximum entropy oppose each other?

A. $3O_{2(g)} \rightarrow 2O_{3(g)}$ $\qquad\qquad$ $\Delta H = +285$ kJ

B. $\frac{1}{2}N_{2(g)} + O_{2(g)} \rightarrow NO_{2(g)}$ $\qquad\qquad$ $\Delta H = +34$ kJ

C. $2H_2O_{(g)} \rightarrow 2H_{2(g)} + O_{2(g)}$ $\qquad\qquad$ $\Delta H = +484$ kJ

D. $P_{4(s)} + 6H_{2(g)} \rightarrow 4PH_{3(g)}$ $\qquad\qquad$ $\Delta H = +37$ kJ

13. Consider the following equilibrium system at $25°C$:

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$
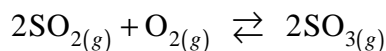
At equilibrium, $[SO_2]$ is 4.00×10^{-3} mol/L, $[O_2]$ is 4.00×10^{-3} mol/L and $[SO_3]$ is 2.33×10^{-3} mol/L. From this data, the K_{eq} value for the above system is

A. 6.85×10^{-3}
B. 1.18×10^{-2}
C. 84.8
D. 146

14. The $\left[OH^-\right]$ is measured to be $3.3\times10^{-3}\,mol/L$ in a 100 mL sample of a saturated solution of $Al(OH)_3$. The solubility of $Al(OH)_3$ is

   A. 1.1×10^{-4} mol/L

   B. 3.3×10^{-4} mol/L

   C. 1.1×10^{-3} mol/L

   D. 3.3×10^{-3} mol/L

15. Consider the following equilibrium:

$$NH_4Cl_{(s)} + energy \rightleftarrows NH_{4(aq)}^+ + Cl_{(aq)}^-$$
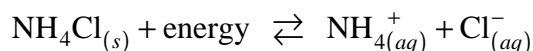
   Which of the following will increase the solubility of ammonium chloride?

   A.   stirring the solution

   B.   adding more water

   C.   adding more $NH_4Cl_{(s)}$

   D.   increasing the temperature

16. Which of the following salts has the **lowest** solubility?

   A.   copper(I) chloride
   B.   ammonium sulphide
   C.   potassium hydroxide
   D.   mercury(II) sulphate

17. The mixture that could produce a precipitate of **two** compounds is

   A. $0.2\,M\ HgSO_4$ and $0.2\,M\ FeCl_2$

   B. $0.2\,M\ AgNO_3$ and $0.2\,M\ MgCl_2$

   C. $0.2\,M\ K_2CO_3$ and $0.2\,M\ CuSO_4$

   D. $0.2\,M\ ZnSO_4$ and $0.2\,M\ Ba(OH)_2$

18. In a saturated solution of zinc hydroxide, at **40°C**, the $\left[Zn^{2+}\right] = 1.8 \times 10^{-5}$ M.
    The K_{sp} of $Zn(OH)_2$ is

    A. 5.8×10^{-15}
    B. 2.3×10^{-14}
    C. 1.8×10^{-14}
    D. 6.5×10^{-10}

19. When **equal volumes** of 0.060 M $AgNO_3$ and 0.00090 M $NaBrO_3$ are mixed, the
    trial ion product (TIP) is

    A.   less than K_{sp} and a precipitate forms.
    B.   greater than K_{sp} and a precipitate forms.
    C.   less than K_{sp} and no precipitate forms.
    D.   greater than K_{sp} and no precipitate forms.

20. What is the maximum amount of sodium sulphate, Na_2SO_4, that will dissolve in 1.0 L
    of 0.10 M $Pb(NO_3)_2$ without forming a precipitate?

    A. 1.8×10^{-8} mol
    B. 1.8×10^{-7} mol
    C. 1.3×10^{-4} mol
    D. 1.0×10^{-1} mol

21. There are two beakers on a laboratory bench. One beaker contains 1.0 M HCl and the other
    contains tap water. To distinguish the acid solution from the tap water, one would use

    A.   a piece of copper.
    B.   a piece of magnesium.
    C.   phenolphthalein indicator.
    D.   a piece of red litmus paper.

22. Caustic soda, NaOH, is found in

    A.   fertilizers.
   B.   beverages.
    C.   toothpaste.
    D.   oven cleaners.

23. The indicator methyl red is red in a solution of NaH_2PO_4. Which of the following equations is consistent with this observation?

   A. $H_2PO_4^- + H_2O \rightleftarrows HPO_4^{2-} + H_3O^+$

   B. $H_2PO_4^- + H_2O \rightleftarrows H_3PO_4 + OH^-$

   C. $HPO_4^{2-} + H_2O \rightleftarrows PO_4^{3-} + H_3O^+$

   D. $HPO_4^{2-} + H_2O \rightleftarrows H_2PO_4^- + OH^-$

24. At the equivalence point in a titration involving 0.1 M solutions, which of the following combinations would have the **lowest** conductivity?

   A. nitric acid and barium hydroxide
   B. acetic acid and sodium hydroxide
   C. sulphuric acid and barium hydroxide
   D. hydrochloric acid and sodium hydroxide

25. An indicator, HInd, produces a yellow colour in 0.1 M HCl solution and a red colour in 0.1 M HCN solution. Therefore, in the following equilibrium

$$HCN + Ind^- \rightleftarrows HInd + CN^-$$
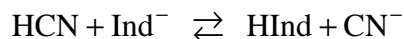
   A. products are favoured and the stronger acid is HInd.
   B. products are favoured and the stronger acid is HCN.
   C. reactants are favoured and the stronger acid is HInd.
   D. reactants are favoured and the stronger acid is HCN.

26. Consider the following equilibrium system:

$$H_2O_{(l)} + H_2O_{(l)} \rightleftarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$
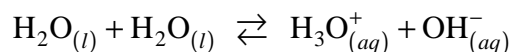
The equilibrium constant for this system is referred to as

   A. K_w
   B. K_a
   C. K_b
   D. K_{sp}

27. Which of the following is the **strongest** acid?

    A.   acetic acid
    B.   oxalic acid
    C.   benzoic acid
    D.   carbonic acid

28. Which of the following salt solutions would be acidic?

    A.   sodium acetate
    B.   iron(III) chloride
    C.   sodium carbonate
    D.   potassium chloride

29. A student records the pH of **0.1 M** solutions of two acids:

Acid	pH
X	4.0
Y	2.0

Which of the following statements can be concluded from the above data?

    A.   Acid X is stronger than acid Y.
    B.   Acid X and acid Y are both weak.
    C.   Acid X is diprotic while acid Y is monoprotic.
    D.   Acid X is 100 times more concentrated than acid Y.

30. The $\left[H_3O^+\right]$ in a solution of pH 0.60 is

    A. 4.0×10^{-14} M
    B. 2.2×10^{-1} M
    C. 2.5×10^{-1} M
    D. 6.0×10^{-1} M

31. Consider the following acid-base indicator equilibrium:

$$HInd_{(aq)} + H_2O_{(l)} \rightleftarrows H_3O^+_{(aq)} + Ind^-_{(aq)}$$
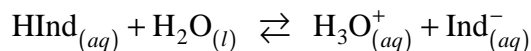
Which of the following statements describes the conditions that exist in an indicator equilibrium system at its transition point?

A. $[HInd] = [Ind^-]$

B. $[Ind^-] = [H_3O^+]$

C. $[HInd] = [H_3O^+]$

D. $[H_3O^+] = [H_2O]$

32. What volume of 0.100 M NaOH is required to neutralize a 10.0 mL sample of 0.200 M H_2SO_4 ?

A.   5.0 mL
B.   10.0 mL
C.   20.0 mL
D.   40.0 mL

33. Which of the following titrations would have an equivalence point less than pH 7 ?

A. NH_3 and HCl
B.   NaOH and HNO_3
C. $Ba(OH)_2$ and H_2SO_4
D.   KOH and CH_3COOH

34. Which of the following compounds, when added to a solution of ammonium nitrate, will result in the formation of a buffer solution?

A.   ammonia
B.   nitric acid
C.   sodium nitrate
D.   ammonium chloride

35. Which of the following oxides would hydrolyze to produce hydroxide ions?

   A. NO
   B. SO_2
   C. Cl_2O
   D. Na_2O

36. 'Normal' rain water is slightly acidic due to the presence of dissolved

   A. methane.
   B. carbon dioxide.
   C. sulphur dioxide.
   D. nitrogen dioxide.

37. Consider the following:

$$PbO_2 + Pb + 4H^+ + 2SO_4^{2-} \rightarrow 2PbSO_4 + 2H_2O$$

   The substance which loses electrons is

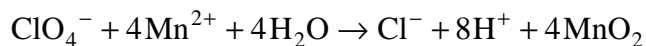   A. Pb
   B. PbO_2
   C. H^+
   D. SO_4^{2-}

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

   A. cobalt
   B. copper
   C. calcium
   D. chromium

39. Which of the following species will react with Cl_2 but not with Br_2 ?

   A. Mn
   B. acidified Mn^{2+}
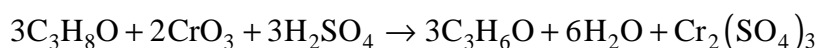   C. acidified MnO_2
   D. acidified MnO_4^-

40. Consider the following:

$$ClO_4^- + 4Mn^{2+} + 4H_2O \rightarrow Cl^- + 8H^+ + 4MnO_2$$

The forward reaction is

A. spontaneous and the E° is +0.16 V
B. spontaneous and the E° is −0.16 V
C. non-spontaneous and the E° is +0.16 V
D. non-spontaneous and the E° is −0.16 V

41. Consider the following:
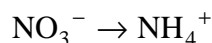
$$3C_3H_8O + 2CrO_3 + 3H_2SO_4 \rightarrow 3C_3H_6O + 6H_2O + Cr_2(SO_4)_3$$

The oxidation number of the chromium

A. increases as it undergoes reduction.
B. increases as it undergoes oxidation.
C. decreases as it undergoes oxidation.
D. decreases as it undergoes reduction.

42. Consider the following:

$$NO_3^- \rightarrow NH_4^+$$

The balanced half-reaction is

A. $NO_3^- + 10H^+ + 9e^- \rightarrow NH_4^+ + 3H_2O$
B. $NO_3^- + 7H^+ + 8e^- \rightarrow NH_4^+ + 3OH^-$
C. $NO_3^- + 6H^+ + 4e^- \rightarrow NH_4^+ + 3H_2O$
D. $NO_3^- + 10H^+ + 8e^- \rightarrow NH_4^+ + 3H_2O$

43. During a redox titration the purple permanganate ion undergoes reduction to become the colourless manganese(II) ion. Which of the following reagents could be titrated using acidified permanganate ion as the indicator?

A. I_2
B. Sn^{4+}
C. Fe^{2+}
D. SO_4^{2-}
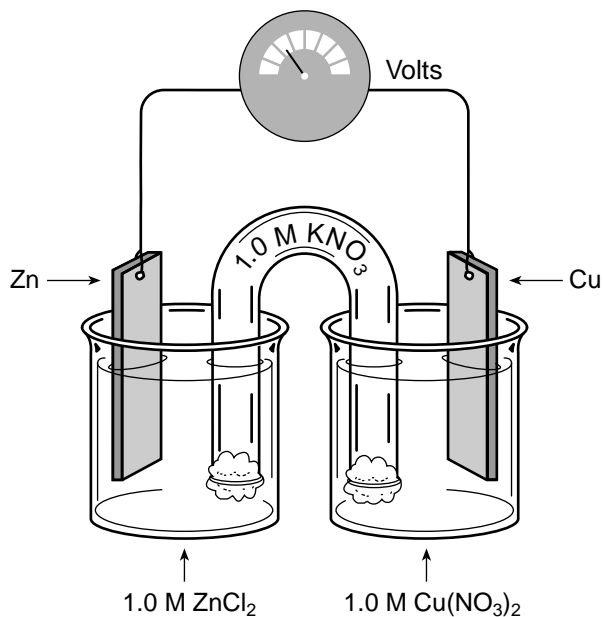
44. In the above electrochemical cell,

    A.   the mass of the anode increases and the mass of the cathode increases.
    B.   the mass of the anode decreases and the mass of the cathode decreases.
    C.   the mass of the anode decreases and the mass of the cathode increases.
    D.   the mass of the anode increases and the mass of the cathode decreases.

45. In the electrochemical cell above,

    A.   electrons migrate into the salt bridge.
    B.   the zinc ions migrate into the salt bridge.
    C.   the chloride ions migrate into the salt bridge.
    D.   the copper(II) ions migrate into the salt bridge.

46. In the operating electrochemical cell above, the initial voltage is

    A. -1.10 V
    B. -0.42 V
    C. 0.00 V
    D. $+1.10$ V

47. The substance formed at the anode during the electrolysis of 1.0 M NaI is

    A. iodine.
    B. oxygen.
    C. sodium.
    D. hydrogen.

48. When molten aluminum oxide is electrolyzed, the cathode reaction is

    A. $Al \rightarrow Al^{3+} + 3e^-$
    B. $Al^{3+} + 3e^- \rightarrow Al$
    C. $O_2 + 4e^- \rightarrow 2O^{2-}$
    D. $2O^{2-} \rightarrow O_2 + 4e^-$

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

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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.
	For questions involving calculation, full marks will NOT be given for providing only an answer.

1. State **two** reasons why some collisions may **not** result in a chemical reaction.
   (2 marks)

   Reason I: _____

   _____

   Reason II: _____

   _____

   Score for
   Question 1:

   1. _____
      (2)

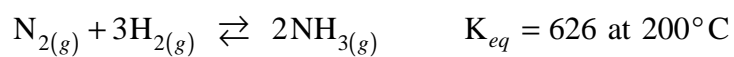2. Describe the relationship between activation energy and the rate of a chemical reaction. **(2 marks)**

   _____

   _____

   _____

   _____

   Score for
   Question 2:

   2. _____
      (2)

OVER

3. What is "equal" in a chemical reaction that has reached a state of equilibrium? **(2 marks)**

_____

_____

4. Consider the following equilibrium:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \qquad K_{eq} = 626 \text{ at } 200°C$$

At equilibrium, $[N_2]$ is 1.06 mol/L and $[H_2]$ is 0.456 mol/L.
Calculate $[NH_3]$ in the equilibrium mixture. **(2 marks)**

5. A 1.0 M solution of sodium sulphite is added to a 1.0 M solution of copper(II) chloride resulting in the formation of a precipitate.
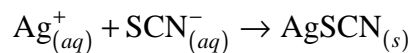
   a) Identify the precipitate. **(1 mark)**

   b) Write the complete ionic equation for the reaction. **(1 mark)**

   c) Identify all spectator ions. **(1 mark)**

6. In an experiment, 100.0 mL samples containing silver ions are titrated with 0.200 M KSCN. The equation for the reaction is

$$Ag^+_{(aq)} + SCN^-_{(aq)} \rightarrow AgSCN_{(s)}$$

The following data are recorded.

Trial	Volume KSCN (mL)
1	23.10
2	22.62
3	22.58

Calculate the concentration of the silver ion in the solution. **(4 marks)**

OVER

7. a) Write the Brönsted-Lowry acid-base equation for the reaction between $HCN_{(aq)}$ and $NH_{3(aq)}$. **(1 mark)**

    b) Write a conjugate acid-base pair from the equation above. **(1 mark)**

8. a) Write the formula of an amphiprotic anion that will act as an acid when added to water. **(1 mark)**

    b) Write a hydrolysis equation to represent the anion selected in part (a) above behaving as an acid. **(1 mark)**

9. Calculate the pH of a solution prepared by dissolving 0.050 mol of NaOH in enough water to make 500.0 mL of solution. **(2 marks)**

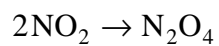10. Calculate the pH of 0.50 M H_2S. **(4 marks)**

11. Consider the following equation:

$$2NO_2 \rightarrow N_2O_4$$

a) Does the above represent a redox reaction? _____ $\left(\frac{1}{2} \textbf{ mark}\right)$

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

_____

_____

OVER

12. Balance the following half-reaction in acidic conditions. **(2 marks)**

$$Br_2 \rightarrow BrO_3^-$$
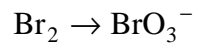
13. Consider the electrolysis of **molten** magnesium chloride.

   a) Identify the product formed at the anode. **(1 mark)**

   b) Write the equation for the reduction half-reaction. **(1 mark)**

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

END OF EXAMINATION