INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

APRIL 1997

PROVINCIAL EXAMINATION

MINISTRY OF EDUCATION, SKILLS AND TRAINING

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 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

   ENDOFEXAMINATION .

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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INSERT STUDENT I.D. NUMBER (PEN)

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CHEMISTRY 12 APRIL 1997 PROVINCIAL

Course Code = CH Examination Type = P

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2. _____ (2)

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11. _____ (4)

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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. 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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PART A: MULTIPLE CHOICE

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. At $30°C$, a 25.0 mL sample of bleach decomposes producing 50.0 mL of oxygen gas in 80 seconds. The rate of oxygen formation can be determined by the expression

   A. $50.0\ \text{mL}/80\,\text{s}$
   B. $50.0\ \text{mL}/30°\text{C}$
   C. $25.0\ \text{mL}/80\,\text{s}$
   D. $25.0\ \text{mL}/30°\text{C}$

2. As reactant particles approach one another, their

   A. kinetic energy increases and their potential energy increases.
   B. kinetic energy increases and their potential energy decreases.
   C. kinetic energy decreases and their potential energy increases.
   D. kinetic energy decreases and their potential energy decreases.

3. An activated complex has

   A. low potential energy and is stable.
   B. high potential energy and is stable.
   C. low potential energy and is unstable.
   D. high potential energy and is unstable.

4. Consider the following reaction:

$$\tfrac{1}{2}\text{H}_{2(g)} + \tfrac{1}{2}\text{I}_{2(g)} \rightarrow \text{HI}_{(g)}$$

   The activation energy for the formation of HI is 167 kJ and for the decomposition of HI is 139 kJ. The reaction for the formation of HI is

   A. exothermic and the $\Delta H = -28$ kJ
   B. exothermic and the $\Delta H = +28$ kJ
   C. endothermic and the $\Delta H = -28$ kJ
   D. endothermic and the $\Delta H = +28$ kJ

OVER

5. Consider the following reaction mechanism:

$$\text{Step 1:} \quad N_2O_{(g)} \rightarrow N_{2(g)} + O_{(g)}$$
$$\text{Step 2:} \quad N_2O_{(g)} + O_{(g)} \rightarrow N_{2(g)} + O_{2(g)}$$

A reactant in the overall reaction is

A. O
B. O_2
C. N_2
D. N_2O

6. In **all** systems at equilibrium, the

A. concentration of reactants is less than the concentration of products.
B. concentration of reactants and the concentration of products are equal.
C. concentration of reactants is greater than the concentration of products.
D. concentration of reactants and the concentration of products are constant.

7. Chemical systems tend to move toward positions of

A. minimum enthalpy and maximum entropy.
B. maximum enthalpy and minimum entropy.
C. minimum enthalpy and minimum entropy.
D. maximum enthalpy and maximum entropy.

8. An equilibrium system shifts left when the

A. rate of the forward reaction is equal to the rate of the reverse reaction.
B. rate of the forward reaction is less than the rate of the reverse reaction.
C. rate of the forward reaction is greater than the rate of the reverse reaction.
D. rate of the forward reaction and the rate of the reverse reaction are constant.

9. A 1.00 L flask contains a gaseous equilibrium system. The addition of reactants to this flask results in a

A. shift left and a decrease in the concentration of products.
B. shift left and an increase in the concentration of products.
C. shift right and a decrease in the concentration of products.
D. shift right and an increase in the concentration of products.

10. Consider the following equilibrium:

$$4KO_{2(s)} + 2H_2O_{(g)} \rightleftarrows 4KOH_{(s)} + 3O_{2(g)}$$

The equilibrium constant expression is

A. $K_{eq} = \dfrac{[KOH]^4[O_2]^3}{[KO_2]^4[H_2O]^2}$ B. $K_{eq} = \dfrac{[O_2]^3}{[H_2O]^2}$

C. $K_{eq} = \dfrac{[KO_2]^4[H_2O]^2}{[KOH]^4[O_2]^3}$ D. $K_{eq} = \dfrac{[H_2O]^2}{[O_2]^3}$

11. Which of the following equilibrium systems most favours the products?

A. $Cl_{2(g)} \rightleftarrows 2Cl_{(g)}$ $K_{eq} = 6.4 \times 10^{-39}$

B. $Cl_{2(g)} + 2NO_{(g)} \rightleftarrows 2NOCl_{(g)}$ $K_{eq} = 3.7 \times 10^{8}$

C. $Cl_{2(g)} + 2NO_{2(g)} \rightleftarrows 2NO_2Cl_{(g)}$ $K_{eq} = 1.8$

D. $2HCl_{(g)} \rightleftarrows H_{2(g)} + Cl_{2(g)}$ $K_{eq} = 2.0 \times 10^{-7}$

12. Consider the following equilibrium:

$$N_{2(g)} + O_{2(g)} \rightleftarrows 2NO_{(g)} \qquad \Delta H = +181 \text{ kJ}$$

When the temperature is decreased, the equilibrium

A. shifts left and the K_{eq} value increases.

B. shifts left and the K_{eq} value decreases.

C. shifts right and the K_{eq} value increases.

D. shifts right and the K_{eq} value decreases.

OVER

13. Consider the following equilibrium:

$$N_2O_{4(g)} \rightleftarrows 2NO_{2(g)} \qquad K_{eq} = 4.61\times10^{-3}$$

A 1.00 L container at equilibrium was analyzed and found to contain 0.0200 mol NO_2. At equilibrium, the concentration of N_2O_4 is

A. 0.0868 mol/L
B. 0.230 mol/L
C. 4.34 mol/L
D. 11.5 mol/L

14. The greatest mass of solid SnS will dissolve in 1.0 L of

A. H_2O
B. 0.10 M MgS
C. 0.10 M $(NH_4)_2S$
D. 0.10 M $Sn(NO_3)_2$

15. The K_{sp} expression for $Ca_3(PO_4)_2$ is

A. $K_{sp} = \dfrac{\left[Ca^{2+}\right]^3\left[PO_4^{3-}\right]^2}{\left[Ca_3(PO_4)_2\right]}$

B. $K_{sp} = \dfrac{\left[2Ca^{2+}\right]\left[3PO_4^{3-}\right]}{\left[Ca_3(PO_4)_2\right]}$

C. $K_{sp} = \left[Ca^{2+}\right]^3\left[PO_4^{3-}\right]^2$

D. $K_{sp} = \left[2Ca^{2+}\right]\left[3PO_4^{3-}\right]$

16. A student evaporated 200.0 mL of a saturated solution of $SrCrO_4$ to dryness. The residue contained 1.2×10^{-3} mol $SrCrO_4$. The solubility of $SrCrO_4$ is

A. 1.4×10^{-6} M
B. 3.6×10^{-5} M
C. 2.4×10^{-4} M
D. 6.0×10^{-3} M

17. In 1.5 M $(NH_4)_2SO_4$, the ion concentrations are

A. $[NH_4^+] = 1.5\ M$ and $[SO_4^{2-}] = 1.5\ M$
B. $[NH_4^+] = 1.5\ M$ and $[SO_4^{2-}] = 3.0\ M$
C. $[NH_4^+] = 3.0\ M$ and $[SO_4^{2-}] = 1.5\ M$
D. $[NH_4^+] = 3.0\ M$ and $[SO_4^{2-}] = 3.0\ M$

18. Which of the following is the least soluble in water at $25°C$?

A. $CaSO_4$
B. $BaSO_4$
C. $CuSO_4$
D. $MgSO_4$

19. To remove Mg^{2+} from a solution by precipitation, a student should add

A. NaI
B. KOH
C. Li_2SO_4
D. $(NH_4)_2S$

20. Which of the following represents the equilibrium in a saturated solution of $Cr_2(SO_4)_3$?

A. $Cr_2(SO_4)_{3(s)} \rightleftarrows Cr^{2+}_{(aq)} + SO_4^{3-}{}_{(aq)}$
B. $Cr_2(SO_4)_{3(s)} \rightleftarrows Cr^{3+}_{(aq)} + SO_4^{2-}{}_{(aq)}$
C. $Cr_2(SO_4)_{3(s)} \rightleftarrows 2Cr^{2+}_{(aq)} + 3SO_4^{3-}{}_{(aq)}$
D. $Cr_2(SO_4)_{3(s)} \rightleftarrows 2Cr^{3+}_{(aq)} + 3SO_4^{2-}{}_{(aq)}$

OVER

21. The conjugate acid of $C_6H_5O^-$ is

A. $C_6H_4O^-$
B. C_6H_5OH
C. $C_6H_4O^{2-}$
D. $C_6H_5OH^+$

22. Which of the following solutions will have the greatest electrical conductivity?

A. 1.0 M HCl
B. 1.0 M HNO_2
C. 1.0 M H_3BO_3
D. 1.0 M HCOOH

23. A solution of 1.0 M HF has

A. a lower pH than a solution of 1.0 M HCl
B. a higher pOH than a solution of 1.0 M HCl
C. a higher $\left[OH^-\right]$ than a solution of 1.0 M HCl
D. a higher $\left[H_3O^+\right]$ than a solution of 1.0 M HCl

24. Which of the following is the weakest acid?

A. HIO_3
B. HCN
C. HNO_2
D. C_6H_5COOH

25. Consider the following:

$$H_2O_{(l)} \rightleftarrows H^+_{(aq)} + OH^-_{(aq)}$$

When a small amount of 1.0 M KOH is added to the above system, the equilibrium

A. shifts left and $\left[H^+\right]$ decreases.
B. shifts left and $\left[H^+\right]$ increases.
C. shifts right and $\left[H^+\right]$ decreases.
D. shifts right and $\left[H^+\right]$ increases.

26. Which of the following solutions has the highest pH?

A. 1.0 M $NaIO_3$
B. 1.0 M Na_2CO_3
C. 1.0 M Na_3PO_4
D. 1.0 M Na_2SO_4

27. In a 100.0 mL sample of 0.0800 M NaOH the $\left[H_3O^+\right]$ is

A. 1.25×10^{-13} M
B. 1.25×10^{-12} M
C. 8.00×10^{-3} M
D. 8.00×10^{-2} M

28. Consider the following:

I	ammonium nitrate
II	calcium nitrate
III	iron(III) nitrate

When dissolved in water, which of these salts would form a neutral solution?

A. II only
B. III only
C. I and III only
D. I, II and III

OVER

29. A 1.0 M solution of sodium dihydrogen phosphate is

A. acidic and the pH < 7.00
B. acidic and the pH > 7.00
C. basic and the pH < 7.00
D. basic and the pH > 7.00

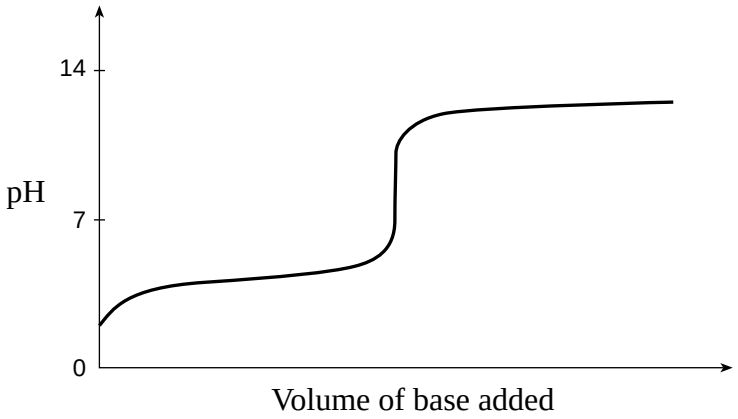
30. Consider the following equilibrium for an indicator:

$$HInd + H_2O \rightleftarrows Ind^- + H_3O^+$$

When a few drops of the indicator chlorophenol red are added to a colourless solution of pH 4.0, the resulting solution is

A. red as $[HInd] < [Ind^-]$
B. red as $[HInd] > [Ind^-]$
C. yellow as $[HInd] < [Ind^-]$
D. yellow as $[HInd] > [Ind^-]$

31. Consider the following titration curve:



Which pair of solutions would result in the above curve?

A. HCl and NH_3
B. HCl and NaOH
C. CH_3COOH and NH_3
D. CH_3COOH and NaOH

32. The volume of 0.200 M $Sr(OH)_2$ needed to neutralize 50.0 mL of 0.200 M HI is

A. 10.0 mL
B. 25.0 mL
C. 50.0 mL
D. 100.0 mL

33. The pOH of 0.050 M HCl is

A. 0.30
B. 1.30
C. 12.70
D. 13.70

34. A buffer solution can be prepared from

A. nitric acid and sodium nitrate.
B. sulphuric acid and sodium hydroxide.
C. hydrocyanic acid and sodium cyanide.
D. sodium hydroxide and sodium chloride.

35. Consider the following equilibrium for a buffer solution:

$$NH_{4\,(aq)}^{+} + H_2O_{(l)} \rightleftarrows H_3O^{+}_{(aq)} + NH_{3(aq)}$$

When a few drops of HCl are added,

A. both the $[NH_3]$ and the $[NH_4^+]$ increase.
B. both the $[NH_3]$ and the $[NH_4^+]$ decrease.
C. the $[NH_3]$ decreases and the $[NH_4^+]$ increases.
D. the $[NH_3]$ increases and the $[NH_4^+]$ decreases.

36. Normal rainwater has a pH of approximately 6 as a result of dissolved

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

OVER

37. Consider the following:

$$2NO_3^- + 4H^+ + 2e^- \rightarrow N_2O_4 + 2H_2O$$

This equation represents

A. reduction.
B. oxidation.
C. neutralization.
D. decomposition.

38. A strong oxidizing agent has a

A. weak attraction for electrons.
B. strong attraction for electrons.
C. weak ability to become reduced.
D. strong ability to become oxidized.

39. A solution of 1.0 M $Co(NO_3)_2$ should be stored in a container made of

A. tin.
B. zinc.
C. aluminum.
D. magnesium.

40. Hydrogen has an oxidation number of -1 in

A. H_2
B. NaH
C. H_2O
D. KOH

41. Consider the following redox reaction:

$$Al + MnO_4^- + 2H_2O \rightarrow Al(OH)_4^- + MnO_2$$

The chemical species being oxidized is

A. Al
B. MnO_4^-
C. $Al(OH)_4^-$
D. MnO_2

42. Which of the following half-reactions is balanced?

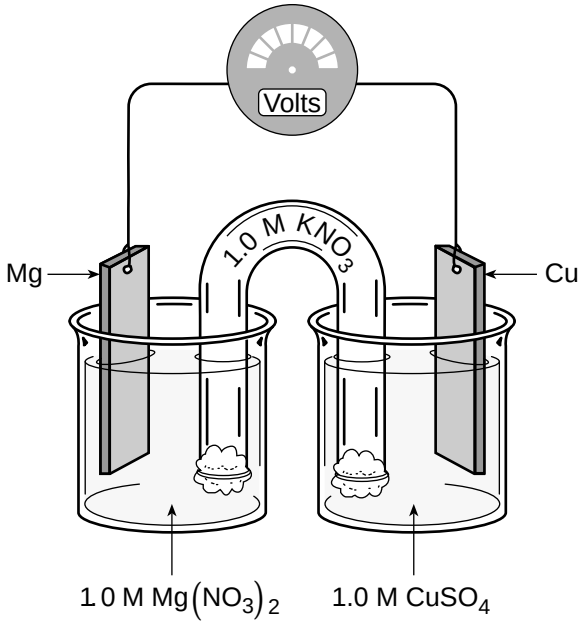
A. $IO_3^- + 6H^+ + 5e^- \rightarrow I_2 + 3H_2O$
B. $IO_3^- + 6H^+ + 4e^- \rightarrow \frac{1}{2} I_2 + 3H_2O$
C. $IO_3^- + 6H^+ \rightarrow \frac{1}{2} I_2 + 3H_2O + 5e^-$
D. $IO_3^- + 6H^+ + 5e^- \rightarrow \frac{1}{2} I_2 + 3H_2O$

43. To determine the $\left[Fe^{2+}\right]$ in a solution of $FeSO_4$ by a redox titration, a suitable reagent would be an acidified solution of

A. Cr^{3+}
B. Mn^{2+}
C. SO_4^{2-}
D. $Cr_2O_7^{2-}$

OVER

Use the following cell diagram to answer questions 44, 45 and 46.



44. In the above electrochemical cell, the reaction at the anode is

A. $Cu \rightarrow Cu^{2+} + 2e^-$
B. $Cu^{2+} + 2e^- \rightarrow Cu$
C. $Mg \rightarrow Mg^{2+} + 2e^-$
D. $Mg^{2+} + 2e^- \rightarrow Mg$

45. As the above electrochemical cell operates,

A. nitrate ions migrate into the copper half-cell.
B. copper(II) ions migrate through the salt bridge.
C. magnesium ions migrate through the salt bridge.
D. potassium ions migrate into the magnesium half-cell.

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

A. 2.03 V
B. 2.52 V
C. 2.71 V
D. 2.89 V

47. As a metal corrodes,

A. it gains electrons.
B. it becomes reduced.
C. it acts as a reducing agent.
D. its oxidation number decreases.

48. In the electrolysis of **molten** $PbBr_2$, the products at the anode and cathode are

	ANODE (INERT)	CATHODE (INERT)
A.	Br_2	H_2
B.	O_2	Pb
C.	Pb	Br_2
D.	Br_2	Pb

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

OVER

PART B: WRITTEN RESPONSE

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. One of the reactions in the production of smog involves the oxidation of nitrogen monoxide. A possible mechanism for this reaction is:

Step 1: $CO + OH \rightarrow CO_2 + H$

Step 2: $H + O_2 \rightarrow HOO$

Step 3: $HOO + NO \rightarrow OH + NO_2$

a) Write the balanced equation for the overall reaction. **(2 marks)**

b) Identify all reaction intermediates. **(1 mark)**

c) Identify the catalyst. **(1 mark)**

Score for Question 1:
1. _____ (4)

2. Consider the following equilibrium:

$$2H_2O_{(g)} \rightleftarrows 2H_{2(g)} + O_{2(g)}$$

Identify two ways to increase the rate of the forward reaction. **(2marks)**

i) _____

ii) _____

Score for Question 2:

2. _____ (2)

3. Consider the following:

$$H_{2(g)} + F_{2(g)} \rightleftarrows 2HF_{(g)} \qquad K_{eq} = 1.00 \times 10^2$$

A 1.00 L flask is initially filled with 2.00 mol H_2 and 2.00 mol F_2.
Calculate the $[H_2]$ at equilibrium. **(4 marks)**

Score for Question 3:

3. _____ (4)

OVER

4. A solution contains 0.20 M Cl^- and 0.20 M SO_4^{2-}.

   a) Identify a cation that could be added to the solution to give a precipitate with only one of these anions. **(1 mark)**

   b) Write the net ionic equation for the precipitation reaction in part a). **(1 mark)**

Score for Question 4:
4. _____ (2)

5. Will a precipitate form when 25.0 mL of 0.15 M $AgNO_3$ is added to 15.0 mL of 0.20 M NaCl? Support your answer with appropriate calculations. **(3 marks)**

Score for Question 5:
5. _____ (3)

6. a) Write the balanced equation representing the reaction of HF with H_2O. **(1 mark)**

b) Identify the Brönsted-Lowry bases in the above equation. **(1 mark)**

Score for Question 6:

6. _____ (2)

7. Consider the following data:

CHEMICAL SPECIES	FORMULA	IONIZATION CONSTANT
barbituric acid	$HC_4H_3N_2O_3$	$K_a = 9.8 \times 10^{-5}$
sodium propanoate	$NaC_3H_5O_2$	$K_b = 7.5 \times 10^{-10}$
propanoic acid	$HC_3H_5O_2$	?

Which is the stronger acid, propanoic acid or barbituric acid? Explain, using appropriate calculations. **(2 marks)**

Score for Question 7:

7. _____ (2)

OVER

8. A solution of 0.100 M HOCN has a pH of 2.24. Calculate the K_a value for this acid.
(4 marks)

Score for Question 8:
8. _____ (4)

9. Calculate the pH of a 25.0 mL solution formed by mixing 0.0300 mol HNO_3 and 0.0280 mol NaOH. **(2 marks)**

Score for Question 9:
9. _____ (2)

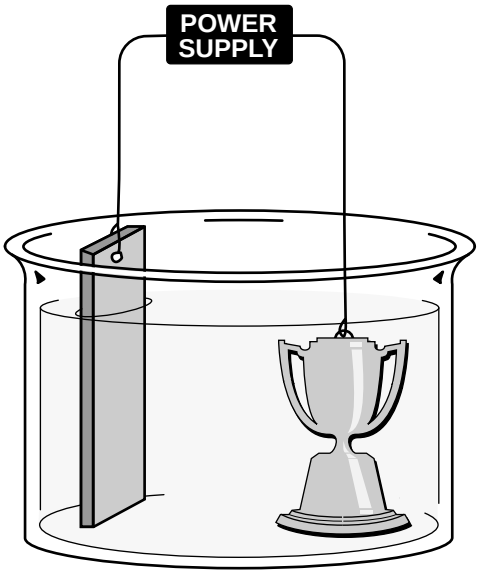
10. Balance the following half-reaction: **(3 marks)**

$$CrO_4^{2-} \rightarrow Cr(OH)_3 \qquad \text{(basic)}$$

Score for Question 10:
10. _____ (3)

OVER

11. A trophy manufacturer electroplates an iron trophy with gold.



a) Write the equation for the half-reaction that occurs at the iron trophy. **(1 mark)**

b) Identify an appropriate electrolyte. **(1 mark)**

c) Identify the cathode. **(1 mark)**

d) Explain how to maintain a constant metal ion concentration in the electrolyte. **(1 mark)**

_____

Score for Question 11:

11. _____ (4)

END OF EXAMINATION