INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

APRIL 1996

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 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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FOR OFFICE USE ONLY

INSERT STUDENT I.D. NUMBER (PEN)

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CHEMISTRY 12 APRIL 1996 PROVINCIAL

Course Code = CH Examination Type = P

1. _____ (2)

2. _____ (1)

3. _____ (2)

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12. _____ (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: 12 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. Collision theory states that

   A. all collisions lead to chemical reactions.
   B. most collisions lead to chemical reactions.
   C. very few reactions involve particle collisions.
   D. effective collisions lead to chemical reactions.

2. Consider the following factors:

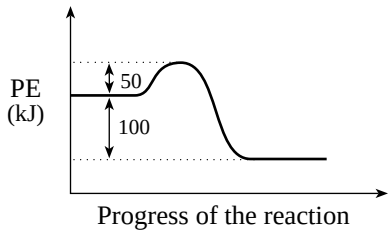
   I. Concentration of reactants.
   II. Temperature of reactants.
   III. Surface area of reactants.

   The factors that affect the rate of a chemical reaction between two gases are

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

3. A forward reaction has an activation energy of 50 kJ and a ΔH of -100 kJ. The PE diagram which describes this reaction is

A.



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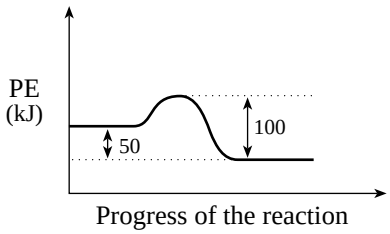

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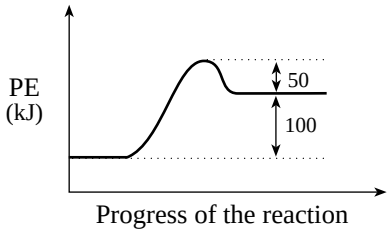
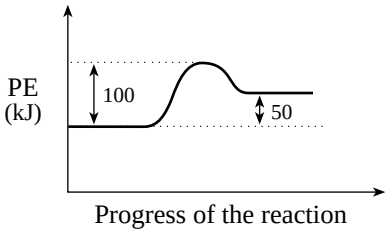


D.



OVER

4. Consider the following:

$$\tfrac{1}{2}N_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow NO_{(g)} \qquad \Delta H = +90 \text{ kJ/mol NO}$$

The correct equation including the heat term is

A. $N_{2(g)} + O_{2(g)} + 90 \text{ kJ} \rightarrow 2NO_{(g)}$
B. $N_{2(g)} + O_{2(g)} + 180 \text{ kJ} \rightarrow 2NO_{(g)}$
C. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)} + 90 \text{ kJ}$
D. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)} + 180 \text{ kJ}$

5. Consider the following reaction mechanism:

Step 1: $H_2O_2 + I^- \rightarrow H_2O + IO^-$

Step 2: $H_2O_2 + IO^- \rightarrow H_2O + O_2 + I^-$

The reaction intermediate is

A. I^-
B. IO^-
C. H_2O
D. H_2O_2

6. Consider the following equilibrium:

$$SO_2Cl_{2(g)} \rightleftarrows SO_{2(g)} + Cl_{2(g)}$$

A 1.0 L container is initially filled with 2.0 mol of SO_2Cl_2. As the reaction proceeds towards equilibrium, the rate of the forward reaction

A. increases and the $[SO_2]$ increases.
B. increases and the $[SO_2]$ decreases.
C. decreases and the $[SO_2]$ increases.
D. decreases and the $[SO_2]$ decreases.

7. Which of the following is true for all equilibrium systems?

A. The mass of reactants is equal to the mass of products.
B. Addition of a catalyst changes the equilibrium concentrations.
C. The concentration of reactants is equal to the concentration of products.
D. The rate of the forward reaction is equal to the rate of the reverse reaction.

8. When the temperature of an equilibrium system is increased, the equilibrium always shifts to favour the

   A. exothermic reaction.
   B. endothermic reaction.
   C. formation of products.
   D. formation of reactants.

9. Consider the following equilibrium:

$$2NO_{(g)} + Cl_{2(g)} \rightleftarrows 2NOCl_{(g)}$$

   At constant temperature and volume, Cl_2 is added to the above equilibrium system. As equilibrium reestablishes, the

   A. K_{eq} will increase.
   B. K_{eq} will decrease.
   C. $[NO]$ will increase.
   D. $[NOCl]$ will increase.

10. Consider the following equilibrium:

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)} + 92 \text{ kJ}$$

   In which of the following will both changes shift the equilibrium right?

   A. An increase in volume and a decrease in temperature.
   B. An increase in volume and an increase in temperature.
   C. A decrease in volume and a decrease in temperature.
   D. A decrease in volume and an increase in temperature.

11. Consider the following equilibrium:

$$COCl_{2(g)} \rightleftarrows CO_{(g)} + Cl_{2(g)} \qquad K_{eq} = 8.1 \times 10^{-4}$$

   For the above system,

   A. $[COCl_2] < [CO][Cl_2]$
   B. $[COCl_2] = [CO][Cl_2]$
   C. $[COCl_2] > [CO][Cl_2]$
   D. $[COCl_2] = \dfrac{1}{[CO][Cl_2]}$

OVER

12. Consider the following:

$$2C_{(s)} + O_{2(g)} \rightleftarrows 2CO_{(g)}$$

A 1.00 L flask is initially filled with 2.00 mol C and 0.500 mol O_2. At equilibrium, the $[O_2]$ is 0.250 mol/L. The K_{eq} value is

A. 0.444
B. 1.00
C. 2.00
D. 2.25

13. Consider the following:

$$2NO_{2(g)} \rightleftarrows N_2O_{4(g)} \qquad K_{eq} = 1.20$$

A 1.0 L flask is filled with 1.4 mol NO_2 and 2.0 mol N_2O_4. To reach equilibrium, the reaction proceeds to the

A. left as Trial $K_{eq} > K_{eq}$
B. left as Trial $K_{eq} < K_{eq}$
C. right as Trial $K_{eq} > K_{eq}$
D. right as Trial $K_{eq} < K_{eq}$

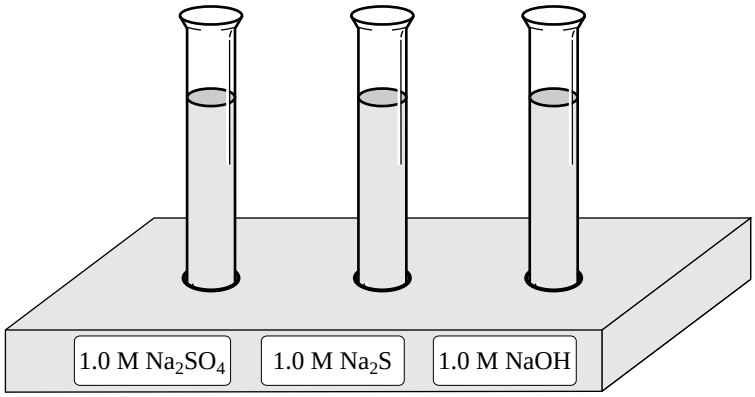
14. In a saturated solution, the rate of dissolving is

A. equal to zero.
B. equal to the rate of crystallization.
C. less than the rate of crystallization.
D. greater than the rate of crystallization.

15. Which of the following occurs when equal volumes of 0.20 M MgS and 0.20 M $ZnSO_4$ are mixed?

A. A precipitate does not form.
B. A precipitate of ZnS forms.
C. A precipitate of $MgSO_4$ forms.
D. Precipitates of $MgSO_4$ and ZnS form.

16. A nitrate solution containing an unknown cation is added to each of the following three test tubes.



A precipitate forms in one test tube only. The unknown cation is

A. Ag^+
B. Ca^{2+}
C. Sr^{2+}
D. NH_4^+

17. The solubility product expression for a saturated solution of $Fe_2(SO_4)_3$ is

A. $K_{sp} = \left[Fe^{3+}\right]^2 \left[SO_4^{2-}\right]^3$

B. $K_{sp} = \left[2Fe^{3+}\right]\left[3SO_4^{2-}\right]$

C. $K_{sp} = \dfrac{\left[Fe^{3+}\right]^2 \left[SO_4^{2-}\right]^3}{\left[Fe_2(SO_4)_3\right]}$

D. $K_{sp} = \dfrac{\left[2Fe^{3+}\right]\left[3SO_4^{2-}\right]}{\left[Fe_2(SO_4)_3\right]}$

18. The solubility of magnesium carbonate is

A. 4.6×10^{-11} M
B. 3.4×10^{-6} M
C. 6.8×10^{-6} M
D. 2.6×10^{-3} M

OVER

19. At $25°\,C$, the maximum $\left[Zn^{2+}\right]$ that can exist in 0.250 M Na_2S is

A. $5.0\times10^{-26}\,M$
B. $2.0\times10^{-25}\,M$
C. $8.0\times10^{-25}\,M$
D. $4.5\times10^{-13}\,M$

20. Consider the following equilibrium:

$$AgCl_{(s)} \rightleftarrows Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$$

Sodium chloride is added to a saturated solution of $AgCl$. The amount of solid $AgCl$ will

A. increase as the equilibrium shifts to the left.
B. decrease as the equilibrium shifts to the left.
C. increase as the equilibrium shifts to the right.
D. decrease as the equilibrium shifts to the right.

21. An **Arrhenius** acid is a substance that

A. accepts a proton.
B. donates a proton.
C. produces H^+ in solution.
D. produces OH^- in solution.

22. Consider the following equilibrium:

$$CH_3COOH_{(aq)} + NH_{3(aq)} \rightleftarrows CH_3COO^{-}_{(aq)} + NH_4{}^{+}{}_{(aq)}$$

The sequence of Brönsted-Lowry acids and bases in the above equilibrium is

A. acid, base, base, acid.
B. acid, base, acid, base.
C. base, acid, base, acid.
D. base, acid, acid, base.

23. Which of the following is a conjugate acid-base pair?

A. H_3PO_4 and PO_4^{3-}
B. $H_2PO_4^-$ and PO_4^{3-}
C. H_3PO_4 and HPO_4^{2-}
D. $H_2PO_4^-$ and HPO_4^{2-}

24. The 1.0 M acid solution with the largest $\left[H_3O^+\right]$ is

A. HNO_2
B. H_2SO_3
C. H_2CO_3
D. H_3BO_3

25. Water will act as a Brönsted-Lowry acid with

A. NH_3
B. H_2S
C. HCN
D. HNO_3

26. Consider the following equilibrium:

$$2H_2O_{(\ell)} \rightleftarrows H_3O^+_{(aq)} + OH^-_{(aq)} \qquad \Delta H = +114 \text{ kJ}$$

At $10°C$ the value of K_w is

A. equal to 1.00×10^{-7}
B. equal to 1.00×10^{-14}
C. less than 1.00×10^{-14}
D. greater than 1.00×10^{-14}

OVER

27. Consider the following data table:

	HCO_3^-	HSO_3^-
K_a	5.6×10^{-11}	1.0×10^{-7}
K_b	2.3×10^{-8}	6.7×10^{-13}

Which of the following statements is correct?

A. HCO_3^- is a stronger acid than HSO_3^-
B. HCO_3^- is a stronger base than HSO_3^-
C. HCO_3^- is stronger as an acid than as a base
D. HSO_3^- is stronger as a base than as an acid

28. Which of the following has a pH greater than 7.0 ?

A. 0.10 M H_2S
B. 0.10 M NH_4Cl
C. 0.10 M $Cr(NO_3)_3$
D. 0.10 M KCH_3COO

29. Calculate the pOH of 3.50 M NaOH.

A. -14.54
B. -0.54
C. 0.54
D. 13.46

30. Which of the following indicators should be used when 1.0 M HNO_2 is titrated with $NaOH_{(aq)}$?

A. methyl red
B. thymol blue
C. methyl orange
D. indigo carmine

31. Consider the following data table:

BEAKER	VOLUME	CONTENTS
1	15 mL	0.1 M $Sr(OH)_2$
2	20 mL	0.2 M NH_4OH
3	25 mL	0.1 M KOH
4	50 mL	0.2 M NaOH

Identify the beaker that requires the smallest volume of 0.1 M HCl for complete neutralization.

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

32. The net ionic equation for the titration of $HClO_{4(aq)}$ with $LiOH_{(aq)}$ is

A. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(\ell)}$
B. $HClO_{4(aq)} + OH^-_{(aq)} \rightarrow ClO_4{}^-_{(aq)} + H_2O_{(\ell)}$
C. $HClO_{4(aq)} + LiOH_{(aq)} \rightarrow LiClO_{4(aq)} + H_2O_{(\ell)}$
D. $H^+_{(aq)} + ClO_4{}^-_{(aq)} + Li^+_{(aq)} + OH^-_{(aq)} \rightarrow LiClO_{4(aq)} + H_2O_{(\ell)}$

33. Calculate the pH of a solution formed when 50.0 mL of 4.0 M HCl is added to 50.0 mL of 2.0 M NaOH.

A. 0.00
B. 1.00
C. 2.00
D. 7.00

34. A few drops of strong acid are added to 1.0 L of a pH 8.0 buffer solution. The resulting solution will have an approximate pH of

A. 5.6
B. 7.0
C. 7.9
D. 8.1

OVER

35. Which of the following would produce a buffer solution when added to 1.0 M NH_3?

A. HNO_3
B. KNH_2
C. NaOH
D. NH_4Cl

36. Sulphur dioxide gas forms an acidic solution. The equation representing this reaction is

A. $SO_{2(g)} + H_2O_{(\ell)} \rightarrow H_2SO_{3(aq)}$
B. $SO_{2(g)} + 2H_2O_{(\ell)} \rightarrow H_2SO_{4(aq)} + H_{2(g)}$
C. $SO_{2(g)} + H_2O_{(\ell)} \rightarrow {SO_3}^{2-}{}_{(aq)} + 2{H^+}_{(aq)}$
D. $SO_{2(g)} + H_2O_{(\ell)} \rightarrow {HSO_2}^{+}{}_{(aq)} + {OH^-}_{(aq)}$

37. In an oxidation half-reaction there is a

A. gain of protons.
B. gain of electrons.
C. loss of protons.
D. loss of electrons.

38. An oxidizing agent

A. loses electrons.
B. decreases in oxidation number.
C. loses mass in an operating electrochemical cell.
D. acts as an anode in an operating electrochemical cell.

39. Which of the following substances is the strongest reducing agent?

A. Hg
B. Zn
C. Sn
D. Ag

40. Three beakers contain 1.0 M $CuCl_2$. A piece of metal is placed in each of the beakers.

BEAKER	SOLUTION	METAL
1	$CuCl_2$	Zn
2	$CuCl_2$	Ag
3	$CuCl_2$	Ni

Reactions occur in

A. beaker 2 only.
B. beakers 1, 2 and 3.
C. beakers 1 and 2 only.
D. beakers 1 and 3 only.

41. What two substances are produced when Cr and 1.0 M MnO_4^- react in **basic** solution?

A. Mn^{2+} and Cr^{3+}
B. MnO_2 and Cr^{3+}
C. Mn^{2+} and Cr^{2+}
D. MnO_2 and CrO_4^{2-}

42. The oxidation number of nitrogen increases in

A. $NO_3^- \rightarrow NO$
B. $N_2O_4 \rightarrow NI_3$
C. $NH_3 \rightarrow NH_4^+$
D. $NO_2 \rightarrow N_2O_5$

43. Which of the following represents a balanced reduction half-reaction?

A. $VO_2^+ + H^+ + 2e^- \rightarrow VO^{2+} + H_2O$
B. $VO_2^+ + H_2 \rightarrow VO^{2+} + H_2O + 1e^-$
C. $VO_2^+ + 2H^+ + 1e^- \rightarrow VO^{2+} + H_2O$
D. $VO_2^+ + 4H^+ + 3e^- \rightarrow VO^{2+} + 2H_2O$

OVER

44. In an operating zinc-copper electrochemical cell, the oxidizing agent

A. loses electrons at the anode.
B. loses electrons to the cations.
C. gains electrons at the cathode.
D. gains electrons from the anions.

45. Which of the following statements would be correct if the zinc half-cell had been chosen as the standard instead of the hydrogen half-cell?

A. The reduction potentials of all half-cells would remain unchanged.
B. The reduction potentials of all half-cells would increase by 0.76 V.
C. The reduction potentials of all-half-cells would have positive values.
D. The reduction potential of the hydrogen half-cell would decrease by 0.76 V.

46. Which of the following metals could be used to cathodically protect a sample of lead?

A. iron
B. gold
C. silver
D. copper

47. Which of the following is formed at the anode during the electrolysis of 1.0 M NaI ?

A. I_2
B. O_2
C. H_2
D. Na

48. An example of electrorefining is the

A. extraction of aluminum from bauxite.
B. purification of lead from an impure anode.
C. recovery of zinc from a zinc sulphate solution.
D. production of chlorine from a sodium chloride solution.

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

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. a) Define the term *heterogeneous reaction.* **(1 mark)**

_____

_____

b) Give one example of a heterogeneous reaction. **(1 mark)**

_____

_____

Score for Question 1:

1. _____ (2)

2. Consider the following reaction:

$$4HBr_{(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)} + 2Br_{2(g)}$$

Explain why the mechanism for the above reaction involves more than one step. **(1 mark)**

_____

_____

_____

Score for Question 2:

2. _____ (1)

OVER

3. Consider the following equilibrium:

$$2NO_{(g)} + O_{2(g)} \rightleftarrows 2NO_{2(g)} \qquad K_{eq} = 6.45 \times 10^{5}$$

a) Write the K_{eq} expression. **(1 mark)**

b) Explain why the $[NO_2]$ is greater than the $[NO]$ at equilibrium when the $[O_2]$ is 1.0 mol/L. **(1 mark)**

Score for Question 3:

3. _____ (2)

4. Consider the following equilibrium:

$$2HI_{(g)} \rightleftarrows H_{2(g)} + I_{2(g)} \qquad K_{eq} = 81.0$$

A 1.00 L container is initially filled with 4.00 mol HI. Calculate the [HI] at equilibrium. **(4 marks)**

Score for Question 4:

4. _____ (4)

5. Write a balanced chemical equation for the equilibrium in a saturated solution of an ionic compound with low solubility. **(2 marks)**

Score for Question 5:
5. _____ (2)

6. A saturated solution of $AgCH_3COO$ was evaporated to dryness. The 250.0 mL sample was found to contain 1.84 g $AgCH_3COO$. Calculate the solubility product constant for $AgCH_3COO$. **(4 marks)**

Score for Question 6:
6. _____ (4)

OVER

7. Sodium phosphate, Na_3PO_4, is commonly used as a cleaning agent. Write the net ionic equation for the hydrolysis reaction between Na_3PO_4 and water. **(2 marks)**

Score for Question 7:
7. _____ (2)

8. Calculate the pH of 0.30 M CH_3COOH. **(3 marks)**

Score for Question 8:
8. _____ (3)

9. A new indicator "B.C. red" is red when $\left[H_3O^+\right] > 6.3\times10^{-3}$ and blue when $\left[H_3O^+\right] < 2.5\times10^{-4}$. Calculate the pH value at the transition point for this indicator.

(2 marks)

Score for Question 9:
9. _____ (2)

10. Calculate the mass of NaOH which is required to neutralize 25.00 mL of 0.500 M H_2SO_4. **(3 marks)**

Score for Question 10:
10. _____ (3)

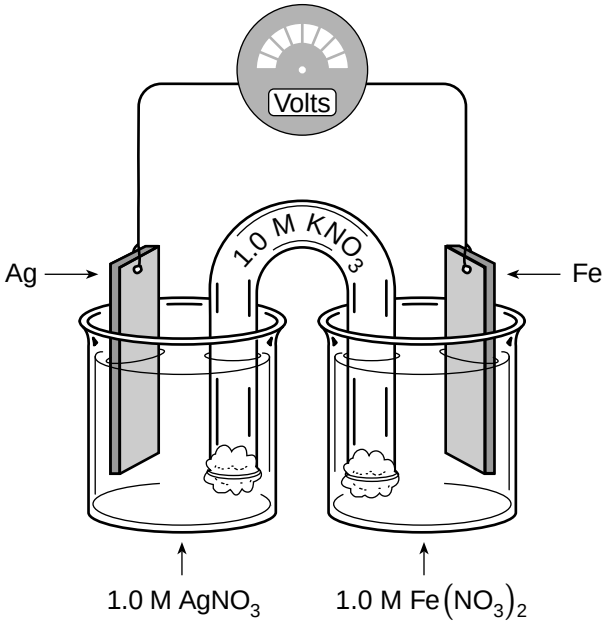
11. Balance the following half-reaction: **(3 marks)**

$$Sb_2O_5 \rightleftarrows Sb_2O_3 \qquad \text{(basic)}$$

Score for Question 11:
11. _____ (3)

OVER

12. Consider the electrochemical cell:



a) Towards which half-cell do the $NO_3^-{}_{(aq)}$ in the salt bridge initially move?

(1 mark)

b) Write the equation for the half-reaction occurring at the silver electrode. **(1 mark)**

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

d) What is the initial cell voltage? **(1 mark)**

Score for Question 12:
12. _____ (4)

END OF EXAMINATION