INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

JUNE 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

   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 JUNE 1997 PROVINCIAL

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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. Consider the following reaction:

$$2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$$

At a certain temperature the rate of decomposition of N_2O_5 is 2.5×10^{-6} mol/s. The rate of formation of NO_2 is

A. 1.0×10^{-5} mol/s
B. 1.3×10^{-6} mol/s
C. 2.5×10^{-6} mol/s
D. 5.0×10^{-6} mol/s

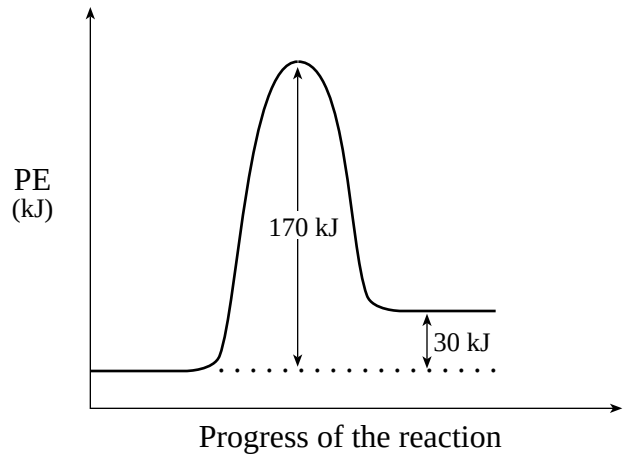
2. Which of the following factors affect the rates of both homogeneous and heterogeneous reactions?

I.	nature of reactants
II.	presence of a catalyst
III.	temperature of system
IV.	concentrations of reactants

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

OVER

3. Consider the following potential energy diagram:



The activation energy for the reverse reaction is

A. 30 kJ
B. 140 kJ
C. 170 kJ
D. 200 kJ

4. Consider the following reaction mechanism:

Step 1: $Cl_{(g)} + O_{3(g)} \rightarrow ClO_{(g)} + O_{2(g)}$

Step 2: $O_{(g)} + ClO_{(g)} \rightarrow Cl_{(g)} + O_{2(g)}$

The reaction intermediate is

A. Cl
B. O_2
C. O_3
D. ClO

5. In a reaction mechanism, the rate determining step is the

A. fastest and has the lowest activation energy.
B. fastest and has the highest activation energy.
C. slowest and has the lowest activation energy.
D. slowest and has the highest activation energy.

6. Consider the following equilibrium:

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

At high temperature, H_2O and CO are placed in a closed container. As the system approaches equilibrium, the

A. rate of the forward and reverse reactions both increase.
B. rate of the forward and reverse reactions both decrease.
C. rate of the forward reaction decreases and the rate of the reverse reaction increases.
D. rate of the forward reaction increases and the rate of the reverse reaction decreases.

7. Consider the following equilibrium:

$$N_2O_{4(g)} + 58 \text{ kJ} \rightleftarrows 2NO_{2(g)}$$

The equilibrium shifts right when

A. NO_2 is added.
B. N_2O_4 is removed.
C. the temperature is decreased.
D. the volume of the system is increased.

8. In an endothermic equilibrium system, the

A. minimum enthalpy and the maximum entropy both favour products.
B. minimum enthalpy and the maximum entropy both favour reactants.
C. minimum enthalpy favours products and the maximum entropy favours reactants.
D. minimum enthalpy favours reactants and the maximum entropy favours products.

9. An equilibrium system shifts left when the temperature is increased. The forward reaction is

A. exothermic and ΔH is positive.
B. exothermic and ΔH is negative.
C. endothermic and ΔH is positive.
D. endothermic and ΔH is negative.

OVER

10. Given the following equilibrium system:

$$Br_{2(g)} \rightleftarrows Br_{2(l)}$$

The equilibrium constant expression for the above system is

A. $K_{eq} = \dfrac{\left[Br_{2(l)}\right]}{\left[Br_{2(g)}\right]}$

B. $K_{eq} = \left[Br_{2(g)}\right]$

C. $K_{eq} = \dfrac{1}{\left[Br_{2(g)}\right]}$

D. $K_{eq} = \left[Br_{2(g)}\right]\left[Br_{2(g)}\right]$

11. Consider the following equilibrium:

$$PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)} \qquad \Delta H = +92.5 \text{ kJ}$$

When the temperature decreases, the equilibrium

A. shifts left and K_{eq} value increases.
B. shifts left and K_{eq} value decreases.
C. shifts right and K_{eq} value increases.
D. shifts right and K_{eq} value decreases.

12. Consider the following equilibrium:

$$CH_{4(g)} + H_2O_{(g)} \rightleftarrows CO_{(g)} + 3H_{2(g)} \qquad K_{eq} = 5.7$$

At equilibrium, the $\left[CH_4\right] = 0.40$ mol/L, $\left[CO\right] = 0.30$ mol/L and $\left[H_2\right] = 0.80$ mol/L. The $\left[H_2O\right]$ is

A. 0.067 mol/L
B. 0.11 mol/L
C. 2.2 mol/L
D. 5.3 mol/L

OVER

13. Consider the following equilibrium:

$$2O_{3(g)} \rightleftarrows 3O_{2(g)} \qquad K_{eq} = 55$$

If 0.060 mol of O_3 and 0.70 mol of O_2 are introduced into a 1.0 L vessel, the

A. $K_{trial} > K_{eq}$ and the $[O_2]$ increases.
B. $K_{trial} < K_{eq}$ and the $[O_2]$ increases.
C. $K_{trial} > K_{eq}$ and the $[O_2]$ decreases.
D. $K_{trial} < K_{eq}$ and the $[O_2]$ decreases.

14. When dissolved in water, which of the following forms a molecular solution?

A. $HCl_{(g)}$
B. $NaNO_{3(s)}$
C. $CH_3OH_{(l)}$
D. $K_2SO_{4(s)}$

15. Which of the following will be most soluble in water at $25°C$?

A. AgI
B. PbS
C. $MgSO_4$
D. $Ba(OH)_2$

OVER

16. A solution containing an unknown cation was added to three solutions and the following observations were recorded:

SOLUTION	OBSERVATION
NaI	no precipitate
Na_2SO_4	precipitate
NaOH	no precipitate

The unknown cation is

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

17. If the solubility of $Pb(OH)_2$ is $0.155\ g/L$, then the concentration of each ion in a saturated solution of a $Pb(OH)_2$ is

A. $\left[Pb^{2+}\right] = 0.155\ g/L$ and $\left[OH^{-}\right] = 0.155\ g/L$
B. $\left[Pb^{2+}\right] = 0.052\ g/L$ and $\left[OH^{-}\right] = 0.103\ g/L$
C. $\left[Pb^{2+}\right] = 6.43\times10^{-4}\ M$ and $\left[OH^{-}\right] = 1.29\times10^{-3}\ M$
D. $\left[Pb^{2+}\right] = 6.43\times10^{-4}\ M$ and $\left[OH^{-}\right] = 6.43\times10^{-4}\ M$

18. The K_{sp} expression for a saturated solution of $Ca_3(PO_4)_2$ is

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

19. At $25°C$, the solubility of an unknown compound is $7.1\times10^{-5}\ M$. The compound is

A. CuI
B. AgI
C. $CaCO_3$
D. $CaSO_4$

20. At $25°C$, the solubility of $Mg(OH)_2$ is

A. $1.1\times10^{-32}\ M$
B. $5.6\times10^{-12}\ M$
C. $2.4\times10^{-6}\ M$
D. $1.1\times10^{-4}\ M$

21. A Brönsted-Lowry base is defined as a chemical species that

A. accepts protons.
B. neutralizes acids.
C. donates electrons.
D. produces hydroxide ions in solution.

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

A. 1.0 M HCN
B. 1.0 M H_2SO_4
C. 1.0 M H_3PO_4
D. 1.0 M CH_3COOH

23. Consider the following equilibrium:

$$HC_6H_5O_7^{2-} + HIO_3 \rightleftarrows H_2C_6H_5O_7^{-} + IO_3^{-}$$

The order of Brönsted-Lowry acids and bases is

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

OVER

D. base, acid, base, acid

24. Consider the following:

$$SO_4^{2-} + HNO_2 \rightleftarrows HSO_4^- + NO_2^-$$

Equilibrium would favour

A. the products since HSO_4^- is a weaker acid than HNO_2.
B. the reactants since HSO_4^- is a weaker acid than HNO_2.
C. the products since HSO_4^- is a stronger acid than HNO_2.
D. the reactants since HSO_4^- is a stronger acid than HNO_2.

25. The net ionic equation for the hydrolysis of Na_2CO_3 is

A. $H_2O + Na^+ \rightleftarrows NaOH + H^+$
B. $H_2O + 2Na^+ \rightleftarrows Na_2O + 2H^+$
C. $H_2O + CO_3^{2-} \rightleftarrows H_2CO_3 + O^{2-}$
D. $H_2O + CO_3^{2-} \rightleftarrows HCO_3^- + OH^-$

26. Consider the following equilibrium:

$$2H_2O_{(l)} \rightleftarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

A few drops of 1.0 M HCl are added to the above system. When equilibrium is reestablished, the

A. $[H_3O^+]$ has increased and the $[OH^-]$ has decreased.
B. $[H_3O^+]$ has increased and the $[OH^-]$ has increased.
C. $[H_3O^+]$ has decreased and the $[OH^-]$ has increased.
D. $[H_3O^+]$ has decreased and the $[OH^-]$ has decreased.

27. In a solution with a $[OH^-]$ of 1.5×10^{-4} M, the $[H_3O^+]$ is

A. 6.7×10^{-11} M
B. 1.0×10^{-7} M

C. 1.5×10^{-4} M

D. 1.2×10^{-2} M

OVER

28. The pH of pure water is 6.52 at $60°\,C$. The $\left[OH^-\right]$ is

A. 3.3×10^{-8} M
B. 1.0×10^{-7} M
C. 3.0×10^{-7} M
D. 8.1×10^{-1} M

29. Consider the following data:

CHEMICAL SPECIES	K_a VALUE
H_3AsO_4	5.0×10^{-5}
$H_2AsO_4^-$	8.0×10^{-8}
$HAsO_4^{2-}$	6.0×10^{-10}

The K_b value for $H_2AsO_4^-$ is

A. 2.0×10^{-10}
B. 8.0×10^{-8}
C. 1.2×10^{-7}
D. 1.7×10^{-5}

30. A 1.0 M NH_4NO_2 is

A. acidic because $K_a > K_b$
B. basic because $K_a > K_b$
C. acidic because $K_a < K_b$
D. basic because $K_a < K_b$

31. Consider the following equilibrium for an indicator:

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

When a few drops of phenol red are added to 1.0 M NaOH, the equilibrium

A. shifts left and the colour of the solution turns red.
B. shifts right and the colour of the solution turns red.
C. shifts left and the colour of the solution turns yellow.
D. shifts right and the colour of the solution turns yellow.

32. When 1.0 M NH_3 is titrated with 1.0 M HCl, the most suitable indicator is

A. methyl violet.
B. indigo carmine.
C. phenolphthalein.
D. bromcresol green.

33. A net ionic equation representing the reaction between 1.0 M HNO_2 and 1.0 M NaOH is

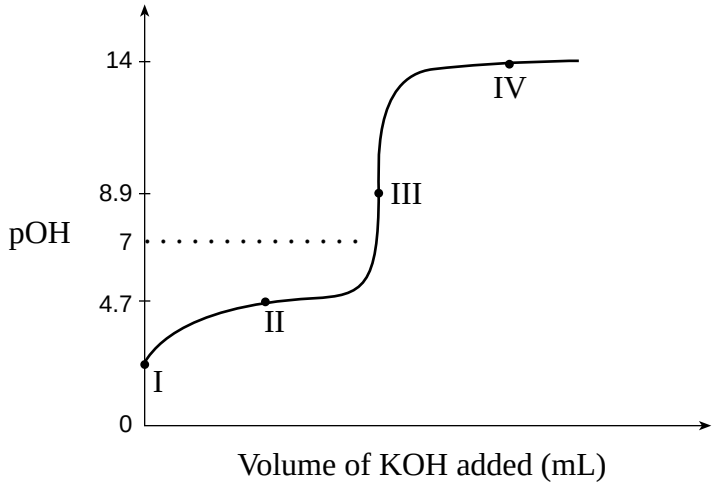
A. $Na^+ + NO_2^- \rightarrow NaNO_2$
B. $H^+ + NaOH \rightarrow Na^+ + H_2O$
C. $HNO_2 + OH^- \rightarrow NO_2^- + H_2O$
D. $HNO_2 + NaOH \rightarrow NaNO_2 + H_2O$

34. If 0.1 M HNO_2 is titrated with 0.1 M NaOH, the equivalence point will have a pH

A. equal to 7 since HNO_2 is a weak acid and NaOH is a weak base.
B. less than 7 since HNO_2 is a weak acid and NaOH is a strong base.
C. equal to 7 since HNO_2 is a strong acid and NaOH is a strong base.
D. greater than 7 since HNO_2 is a weak acid and NaOH is a strong base.

OVER

35. Consider the following titration curve for the neutralization of CH_3COOH by KOH:



On the graph above, the solution is buffered at point

A. I
B. II
C. III
D. IV

36. Which of the following oxides, when dissolved in water, will produce the most basic solution?

A. SO_2
B. CO_2
C. BaO
D. ClO

37. An oxidizing agent is a substance which

A. accepts protons.
B. donates protons.
C. accepts electrons.
D. donates electrons.

38. Consider the following oxidation-reduction reaction:

$$Mn^{2+} + IO_3^- + H_2O \rightarrow MnO_4^- + \tfrac{1}{2} I_2 + 2H^+$$

The reducing agent is

A. I_2
B. IO_3^-
C. H_2O

D. Mn^{2+}

39. A substance that is most likely to gain electrons during a spontaneous redox reaction is

A. I_2
B. Li
C. Au
D. Hg

40. The equation for the spontaneous reaction between Sn and 1.0 M HCl is

A. $Sn + H_2 \rightarrow Sn^{2+} + 2H^+$
B. $Sn + 2H^+ \rightarrow Sn^{2+} + H_2$
C. $Sn + Cl_2 \rightarrow Sn^{2+} + 2Cl^-$
D. $Sn + 2Cl^- \rightarrow Sn^{2+} + Cl_2$

41. Consider this redox equation:

$$C_2O_4^{2-} + MnO_2 \rightarrow Mn^{2+} + 2CO_2$$

As a result of this reaction the oxidation number of each C atom has

A. increased by 1.
B. increased by 2.
C. decreased by 2.
D. decreased by 4.

42. A solution of lead(II) nitrate could be safely stored in a container made of

A. Cu
B. Ni
C. Fe
D. Zn

43. Consider the following half-reaction:

$$HO_2^- \rightarrow O_2 \quad (\text{basic})$$

The balanced equation is

A. $HO_2^- \rightarrow O_2 + H^+ + 2e^-$

OVER

B. $2HO_2^- + 2e^- \rightarrow O_2 + 2OH^-$

C. $2HO_2^- + 2H^+ \rightarrow 2H_2O_2 + O_2$

D. $HO_2^- + OH^- \rightarrow O_2 + H_2O + 2e^-$

44. To determine the $\left[Fe^{2+}\right]$ in a redox titration, a suitable oxidizing agent is

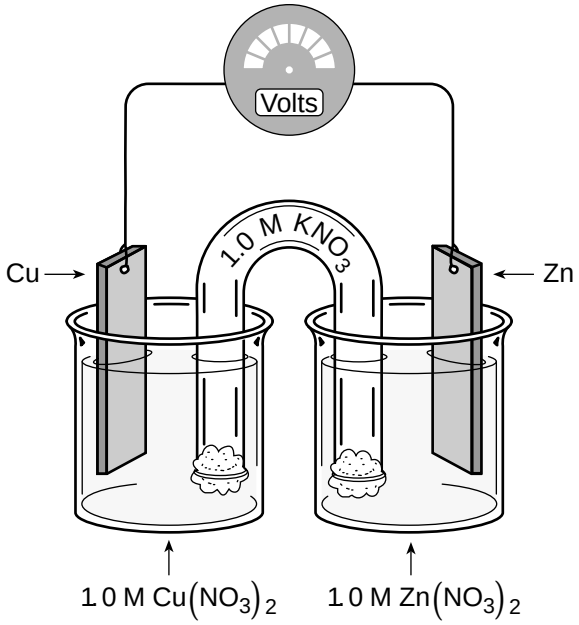
A. SO_4^{2-} in acid.

B. H_3PO_4 in acid.

C. MnO_4^- in acid.

D. MnO_4^- in base.

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



45. As the above cell operates,

A. copper ions migrate into the salt bridge.
B. cations migrate towards the zinc electrode.
C. the mass of the copper electrode increases.
D. anions migrate towards the copper electrode.

46. The initial cell voltage is

A. 0.42 V
B. 0.91 V

C. 1.10 V
D. 1.28 V

47. The electrolysis of a molten salt involves the migration of

A. anions only.
B. cations only.
C. electrons only.
D. both cations and anions.

48. When electroplating an iron spoon with silver, the half-reaction taking place on the spoon is

A. $Ag^{+}_{(aq)} + e^{-} \rightarrow Ag_{(s)}$
B. $Ag_{(s)} \rightarrow Ag^{+}_{(aq)} + e^{-}$
C. $Fe^{2+}_{(aq)} + 2e^{-} \rightarrow Fe_{(s)}$
D. $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^{-}$

OVER

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. The combustion of coal, C, produces carbon dioxide gas according to the following equation:

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + 394 \text{ kJ}$$

a) What is the value of ΔH for this reaction? **(1 mark)**

b) Using collision theory, explain why a lump of coal does not react with oxygen at room temperature and pressure. **(1 mark)**

_____

_____

c) Many coal mine disasters have resulted when a spark ignites coal dust in the air. Explain, using collision theory. **(2 marks)**

_____

_____

_____

_____

Score for Question 1:

1. _____ (4)

OVER

2. Consider the following equilibrium:

$$CO_{(g)} + 2H_{2(g)} \rightleftarrows CH_3OH_{(g)} \qquad \Delta H = -18 \text{ kJ}$$

Explain, using Le Chatelier's principle, how the following changes will affect the number of moles of CH_3OH present at equilibrium.

a) Adding a catalyst. **(1 mark)**

_____

_____

b) Decreasing the volume of the system. **(1 mark)**

_____

_____

Score for Question 2:

2. **OVER** (2)

3. Consider the following equilibrium:

$$H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)} \qquad K_{eq} = 64$$

Equal moles of H_2 and I_2 are placed in a 1.00 L container. At equilibrium, the $[HI] = 0.160$ mol/L. Calculate the initial $[H_2]$. **(3 marks)**

Score for Question 3:

3. **OVER** (3)

4. a) Write the net ionic equation for the precipitation reaction that occurs when solutions of $NaIO_3$ and $AgNO_3$ are mixed. **(1 mark)**

b) Using appropriate calculations, explain why a precipitate forms when 15.0 mL of 0.50 M $NaIO_3$ are added to 35.0 mL of 0.50 M $AgNO_3$. **(3 marks)**

Score for Question 4:

4. **OVER** (4)

5. What is the maximum $\left[CO_3^{2-}\right]$ that can exist in a 1.3×10^{-4} M $AgNO_3$ solution?

(2 marks)

Score for Question 5:
5. _____ (2)

6. a) Write the net ionic equation for the predominant reaction between $NaHSO_3$ and $NaHC_2O_4$. **(2 marks)**

b) Explain why the reactants are favoured in the above reaction. **(1 mark)**

_____

_____

Score for Question 6:
6. _____ (3)

OVER

7. What is the $\left[H_3O^+\right]$ in a solution formed by adding 60.0 mL of water to 40.0 mL of 0.040 M KOH? **(2 marks)**

Score for Question 7:
7. _____ (2)

8. Calculate the pH in 100.0 mL of 0.400 M H_3BO_3. **(4 marks)**

Score for Question 8:
8. _____ (4)

OVER

9. Balance the following redox reaction: **(3 marks)**

$$ClO_4^- + Al \rightarrow Cl^- + Al^{3+} \qquad \text{(acidic)}$$

Score for Question 9:
9. _____ (3)

10. An impure sample of iron was dissolved in acid. The Fe^{2+} in this solution was titrated with 0.0210 M $KMnO_4$. Use the following data table and redox equation to determine the moles of Fe^{2+} in the sample. **(3 marks)**

$$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

TRIAL	VOLUME $KMnO_4$
1	37.26 mL
2	35.18 mL
3	35.22 mL

Score for Question 10:

10. _____ (3)

OVER

11. The overall reaction in a fuel cell is:

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

a) Write the equation for the half-reaction at the anode. **(1 mark)**

b) Is the overall reaction spontaneous? Explain. **(1 mark)**

_____

_____

_____

_____

Score for Question 11:
11. _____ (2)

END OF EXAMINATION