INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

JUNE 1996

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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INSERT STUDENT I.D. NUMBER (PEN)

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CHEMISTRY 12 JUNE 1996 PROVINCIAL

Course Code = CH Examination Type = P

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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:

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$$

If the rate of formation of NH_3 is 9.0×10^{-4} mol/s, then the rate of consumption of N_2 is

A. 4.5×10^{-4} mol/s.
B. 6.0×10^{-4} mol/s.
C. 9.0×10^{-4} mol/s.
D. 1.4×10^{-3} mol/s.

2. Consider the following reaction:

$$2H_2O_{2(aq)} \rightarrow 2H_2O_{(\ell)} + O_{2(g)}$$

When 1.0 g of KI is added to the H_2O_2, bubbles of O_2 are produced at an increased rate. When the reaction is complete, the mass of KI is 1.0 g. The KI is a

A. product.
B. catalyst.
C. reactant.
D. reaction intermediate.

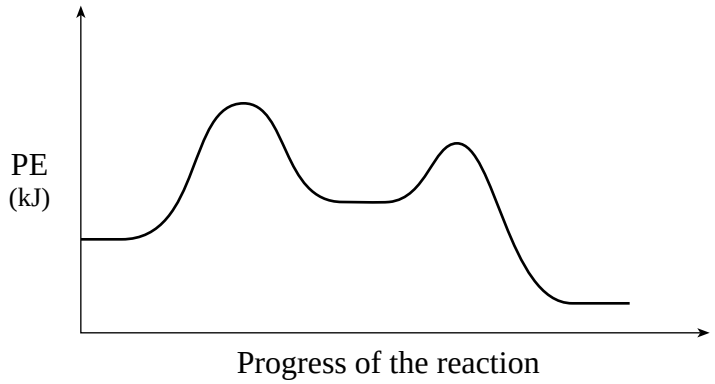
3. Which of the following are necessary for successful collisions to occur?

I. Favourable collision geometry.
II. Sufficient kinetic energy.
III. Large ΔH.

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

OVER

4. Consider the following potential energy diagram:



The above potential energy diagram represents an

A. exothermic reaction involving one step.
B. exothermic reaction involving two steps.
C. endothermic reaction involving one step.
D. endothermic reaction involving two steps.

5. Consider the following reaction mechanism:

Step 1: $V^{3+} + Cu^{2+} \rightarrow V^{4+} + Cu^{+}$ (slow)
Step 2: $Cu^{+} + Fe^{3+} \rightarrow Cu^{2+} + Fe^{2+}$ (fast)

The reaction intermediate is

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

6. Consider the following equilibrium:

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

Nitrogen gas and oxygen gas react when placed in a closed container. As the reaction proceeds towards equilibrium, the rate of the reverse reaction

A. increases as the concentration of products decreases.
B. decreases as the concentration of products decreases.
C. increases as the concentration of products increases.
D. decreases as the concentration of products increases.

7. Consider the following equilibrium:

$$2NO_{2(g)} \rightleftarrows N_2O_{4(g)} + 59 \text{ kJ}$$

For the above reaction,

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

8. Consider the following equilibrium:

$$2HI_{(g)} \rightleftarrows H_{2(g)} + I_{2(g)}$$

At constant temperature and volume, more I_2 is added to the above equilibrium. A new state of equilibrium results from a shift to the

A. left with a net decrease in $[H_2]$.
B. left with a net increase in $[H_2]$.
C. right with a net increase in $[H_2]$.
D. right with a net decrease in $[H_2]$.

9. Consider the following equilibrium:

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

In a 1.0 L container at equilibrium there are 1.0 mol $NOCl$, 0.70 mol NO and 0.40 mol Cl_2. At constant temperature and volume, 0.10 mol NOCl is added. The concentrations in the "new" equilibrium in comparison to the concentrations in the "old" equilibrium are

	$[NOCl]$	$[NO]$	$[Cl_2]$
A.	new = old	new = old	new = old
B.	new > old	new > old	new > old
C.	new < old	new < old	new > old
D.	new < old	new > old	new > old

OVER

10. Consider the following equilibrium:

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

When 0.1010 mol H_2O is placed in a 1.000 L container, equilibrium is established. The equilibrium concentration of O_2 is 0.0010 mol/L. The equilibrium concentrations of H_2O and H_2 are

	$[H_2O]$	$[H_2]$
A.	0.0990	0.0020
B.	0.1000	0.0010
C.	0.1005	0.0005
D.	0.1010	0.0020

11. Consider the following equilibrium:

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

The ratio used to calculate the equilibrium constant is

A. $\dfrac{[2CO]^2[O_2]}{[2CO_2]^2}$

B. $\dfrac{[2CO_2]^2}{[2CO]^2[O_2]}$

C. $\dfrac{[CO]^2[O_2]}{[CO_2]^2}$

D. $\dfrac{[CO_2]^2}{[CO]^2[O_2]}$

12. Consider the following equilibrium:

$$CO_{(g)} + 2H_{2(g)} \rightleftarrows CH_3OH_{(g)} + 91 \text{ kJ}$$

A change in temperature of the above system increases the value of the equilibrium constant. The new state of equilibrium was established by a shift

A. left as a result of a decrease in temperature.
B. right as a result of a decrease in temperature.
C. left as a result of an increase in temperature.
D. right as a result of an increase in temperature.

13. Consider the following equilibrium:

$$H_{2(g)} + S_{(s)} \rightleftarrows H_2S_{(g)}$$

In a 1.0 L container at equilibrium there are 0.050 mol H_2, 0.050 mol S and 1.0 mol H_2S. The value of K_{eq} is

A. 2.5×10^{-3}
B. 5.0×10^{-2}
C. 2.0×10^{1}
D. 4.0×10^{2}

14. When 250 mL of 0.36 M $Sr(OH)_2$ are added to 750 mL of water, the resulting ion concentrations are

A. $[Sr^{2+}] = 0.12\,M$ and $[OH^-] = 0.12\,M$
B. $[Sr^{2+}] = 0.12\,M$ and $[OH^-] = 0.24\,M$
C. $[Sr^{2+}] = 0.090\,M$ and $[OH^-] = 0.090\,M$
D. $[Sr^{2+}] = 0.090\,M$ and $[OH^-] = 0.180\,M$

15. Which of the following compounds could be used to prepare a 0.20 M solution of hydroxide ion?

A. KOH
B. $Fe(OH)_3$
C. $Mg(OH)_2$
D. $Zn(OH)_2$

16. When equal volumes of 0.20 M K_2CrO_4 and 0.20 M $AgNO_3$ are mixed, a red precipitate is formed. The net ionic equation for this reaction is

A. $K^+_{(aq)} + {NO_3}^-_{(aq)} \rightarrow KNO_{3(s)}$
B. $2Ag^+_{(aq)} + {CrO_4}^{2-}_{(aq)} \rightarrow Ag_2CrO_{4(s)}$
C. $K_2CrO_{4(aq)} + 2AgNO_{3(aq)} \rightarrow Ag_2CrO_{4(s)} + 2KNO_{3(s)}$
D. $2Ag^+_{(aq)} + {CrO_4}^{2-}_{(aq)} + 2K^+_{(aq)} + 2{NO_3}^-_{(aq)} \rightarrow Ag_2CrO_{4(s)} + 2KNO_{3(s)}$

OVER

17. Which of the following could be used to separate Pb^{2+} from Ba^{2+} by precipitation?

A. Na_2S
B. NaOH
C. Na_2CO_3
D. Na_2SO_4

18. The molar solubility of iron(II) sulphide is

A. 3.6×10^{-37} M
B. 3.0×10^{-19} M
C. 6.0×10^{-19} M
D. 7.7×10^{-10} M

19. When equal volumes of 2.0 M $Pb(NO_3)_2$ and 2.0 M KCl are mixed,

A. a precipitate forms because trial ion product $< K_{sp}$
B. a precipitate forms because trial ion product $> K_{sp}$
C. a precipitate does not form because trial ion product $< K_{sp}$
D. a precipitate does not form because trial ion product $> K_{sp}$

20. Consider the following equilibrium:

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

When $Br^{-}_{(aq)}$ is added to a saturated solution of AgCl,

A. more AgCl dissolves and its solubility product increases.
B. more AgCl precipitates and its solubility product decreases.
C. more AgCl dissolves and its solubility product remains constant.
D. more AgCl precipitates and its solubility product remains constant.

21. Which of the following properties are common to **both** strong acids and bases?

I. Taste bitter.
II. Conduct an electric current.
III. Cause neutral litmus to change colour.

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

22. Consider the following equilibrium:

$$H_2SO_3 + NO_2^- \rightleftarrows HSO_3^- + HNO_2$$

The Brönsted-Lowry acids and bases are, respectively,

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

23. The 0.10 M solution with the **greatest** electrical conductivity is

A. H_2S
B. H_2SO_4
C. H_2SO_3
D. H_2CO_3

24. Which of the following favours products?

A. $C_6H_5OH + CH_3COO^- \rightleftarrows C_6H_5O^- + CH_3COOH$
B. $H_2C_2O_4 + H_2C_6H_5O_7^- \rightleftarrows HC_2O_4^- + H_3C_6H_5O_7$
C. $C_6H_5COOH + HCOO^- \rightleftarrows C_6H_5COO^- + HCOOH$
D. $CH_3COOH + C_6H_5COO^- \rightleftarrows CH_3COO^- + C_6H_5COOH$

OVER

25. Consider the following equilibrium:

$$\mathrm{HInd} \rightleftarrows \mathrm{H^+ + Ind^-}$$

In a basic solution, the indicator bromcresol green will be

A. blue and $[\mathrm{HInd}]$ is less than $\left[\mathrm{Ind^-}\right]$
B. yellow and $[\mathrm{HInd}]$ is less than $\left[\mathrm{Ind^-}\right]$
C. blue and $[\mathrm{HInd}]$ is greater than $\left[\mathrm{Ind^-}\right]$
D. yellow and $[\mathrm{HInd}]$ is greater than $\left[\mathrm{Ind^-}\right]$

26. Consider the following equilibrium:

$$\mathrm{H_2O + H_2O} \rightleftarrows \mathrm{H_3O^+ + OH^-}$$

When a solution of $\mathrm{Sr(OH)_2}$ is added, the equilibrium shifts

A. left and $\left[\mathrm{H_3O^+}\right]$ increases.
B. left and $\left[\mathrm{H_3O^+}\right]$ decreases.
C. right and $\left[\mathrm{H_3O^+}\right]$ increases.
D. right and $\left[\mathrm{H_3O^+}\right]$ decreases.

27. An aqueous solution that contains more hydronium ions than hydroxide ions is a(n)

A. basic solution.
B. acidic solution.
C. neutral solution.
D. standardized solution.

28. Consider the following equilibrium:

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

The value of the base ionization constant is

A. 2.2×10^{-13}
B. 6.2×10^{-8}
C. 1.6×10^{-7}
D. 4.5×10^{-2}

29. The net ionic equation for the hydrolysis reaction occurring in a solution of NaF is

A. $F^-_{(aq)} + H_2O_{(\ell)} \rightleftarrows HF_{(aq)} + OH^-_{(aq)}$

B. $NaF_{(s)} + H_2O_{(\ell)} \rightleftarrows NaOH_{(aq)} + HF_{(aq)}$

C. $NaF_{(s)} + 2H_2O_{(\ell)} \rightleftarrows H_3O^+_{(aq)} + OH^-_{(aq)} + Na^+_{(aq)} + F^-_{(aq)}$

D. $Na(H_2O)_6{}^+_{(aq)} + H_2O_{(\ell)} \rightleftarrows H_3O^+_{(aq)} + Na(H_2O)_5(OH)^+_{(aq)}$

30. Arrange the following 0.10 M solutions in order of increasing $[H_3O^+]$.

NaBr NH_4Cl LiCN

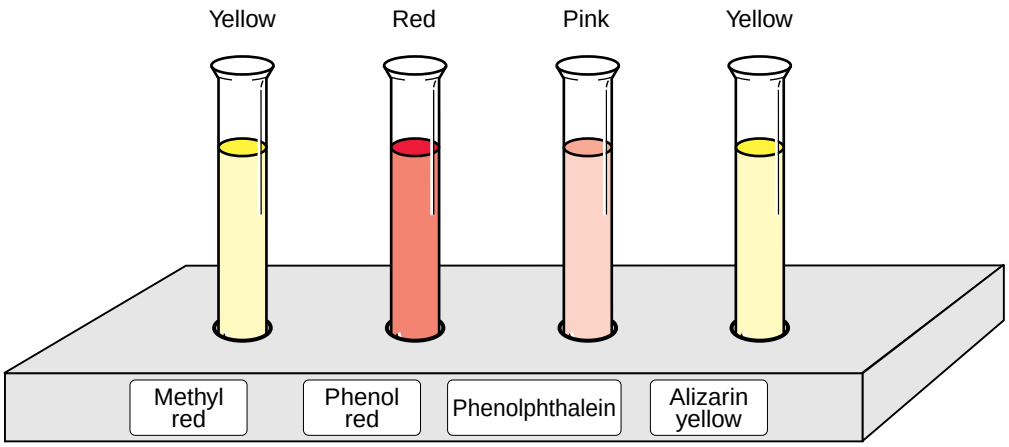
A. LiCN, NaBr, NH_4Cl
B. NH_4Cl, NaBr, LiCN
C. NH_4Cl, LiCN, NaBr
D. NaBr, LiCN, NH_4Cl

31. Calculate the pH of 4.0×10^{-4} M KOH.

A. 3.40
B. 4.60
C. 9.40
D. 10.60

OVER

32. A 0.10 M solution was tested with **four** indicators and the following was observed.



The $\left[OH^-\right]$ in this solution is

A. 1×10^{-10} M
B. 1×10^{-8} M
C. 1×10^{-6} M
D. 1×10^{-4} M

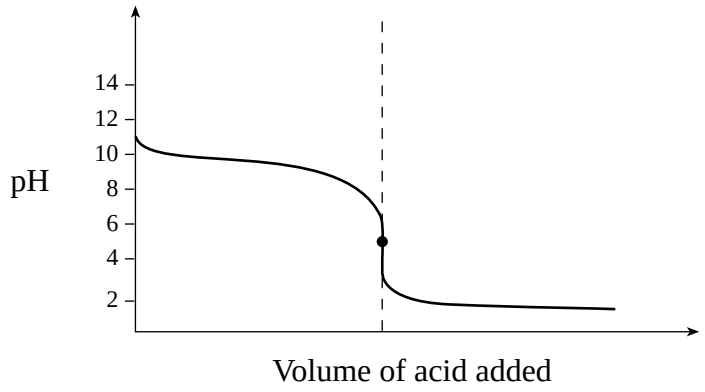
33. Consider the following equilibrium:

$$HInd \rightleftarrows H^+ + Ind^-$$

Which of the following relationships is true for an indicator at the transition point?

A. $\left[H^+\right] = K_w$
B. $\left[H^+\right] = pH$
C. $\left[H^+\right] = K_a$
D. $\left[H^+\right] = \left[OH^-\right]$

Use the following diagram to answer questions 34 and 35.



34. Which pair of 0.10 M solutions would result in the above titration curve?

A. HF and KOH
B. HCl and NH_3
C. H_2S and NaOH
D. HNO_3 and KOH

35. A suitable indicator for the above titration is

A. methyl violet.
B. alizarin yellow.
C. thymolphthalein.
D. bromcresol green.

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36. Which of the following is primarily responsible for acid rain?

A. HCl
B. H_2SO_4
C. $HClO_4$
D. CH_3COOH

OVER

37. In a redox reaction, the species which loses electrons

A. is oxidized.
B. is called the cathode.
C. gains mass at the electrode.
D. decreases in oxidation number.

38. Consider the following redox equation:

$$12\,H^{+}_{(aq)} + 2\,IO_3{}^{-}_{(aq)} + 10\,Fe^{2+}_{(aq)} \rightarrow 10\,Fe^{3+}_{(aq)} + I_{2(s)} + 6\,H_2O_{(\ell)}$$

The reducing agent is

A. I_2
B. H^+
C. Fe^{2+}
D. $IO_3{}^-$

39. Which of the following is the strongest oxidizing agent?

A. Cu^{2+}
B. Pb^{2+}
C. Ni^{2+}
D. Sn^{2+}

40. Metallic platinum reacts spontaneously with $Au^{3+}_{(aq)}$ but does not react with $Ag^{+}_{(aq)}$. The metals, in order of increasing strength as reducing agents, are

A. Ag, Pt, Au
B. Pt, Au, Ag
C. Au, Ag, Pt
D. Au, Pt, Ag

41. Which of the following pairs of ions will react spontaneously in solution?

A. Cu^{2+} and Fe^{2+}
B. Pb^{2+} and Sn^{2+}
C. Co^{2+} and Cr^{2+}
D. Mn^{2+} and Cr^{2+}

42. When NO_2 reacts to form N_2O_4 the oxidation number of nitrogen

A. increases by 2.
B. increases by 4.
C. increases by 8.
D. does not change.

43. Consider the following overall reaction:

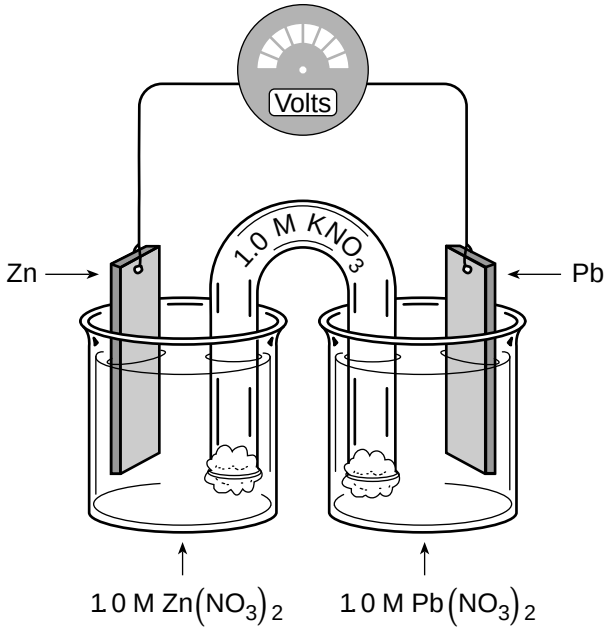
$$2Rh^{+}_{(aq)} + Pb_{(s)} \rightarrow 2Rh_{(s)} + Pb^{2+}_{(aq)} \qquad E^\circ = +0.73 \text{ V}$$

The E° for the half-reaction $Rh^{+}_{(aq)} + e^- \rightleftarrows Rh$ is

A. -0.86 V
B. -0.60 V
C. $+0.60$ V
D. $+0.86$ V

OVER

Use the following diagram to answer questions 44 and 45.



44. In the electrochemical cell above, the electrons flow from

A. zinc to lead and the mass of zinc increases.
B. zinc to lead and the mass of lead increases.
C. lead to zinc and the mass of zinc increases.
D. lead to zinc and the mass of lead increases.

45. The initial cell voltage is

A. -0.89 V
B. -0.63 V
C. $+0.63$ V
D. $+0.89$ V

46. Hydrogen and oxygen react to provide energy in a(n)

A. dry cell.
B. fuel cell.
C. alkaline cell.
D. lead-acid storage cell.

47. The corrosion of iron can be prevented by attaching a piece of zinc to the iron because

A. iron acts as an anode.
B. zinc reduces more readily than iron.
C. electrons flow from the zinc to the iron.
D. iron ions form more readily than zinc ions.

48. An iron spoon is electroplated with copper. The equation representing the reduction reaction is

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

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. Consider the following reaction mechanism:

Step 1: $ClO_{2(g)} + F_{2(g)} \rightarrow FClO_{2(g)} + F_{(g)}$ (slow)

Step 2: $F_{(g)} + ClO_{2(g)} \rightarrow FClO_{2(g)}$ (fast)

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

b) Identify a reaction intermediate. **(1 mark)**

Score for Question 1:

1. _____ (2)

2. Consider the decomposition of ammonia:

$$2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$$

When 1.0 mol NH_3 reacts, 46 kJ of energy is absorbed. Rewrite the equation for this reaction, including the value of the heat term. **(1 mark)**

Score for Question 2:

2. _____ (1)

3. Consider the following equilibrium:

$$\underset{\text{yellow}}{2CrO_4^{2-}{}_{(aq)}} + H_2O_{(\ell)} \rightleftarrows \underset{\text{orange}}{Cr_2O_7^{2-}{}_{(aq)}} + 2OH^-_{(aq)}$$

When HCl is added drop-by-drop to the yellow solution above, the solution turns orange. Explain why this colour change occurs. **(2 marks)**

Score for Question 3:

3. _____ (2)

4. Consider the following equilibrium:

$$2NO_{(g)} + O_{2(g)} \rightleftarrows 2NO_{2(g)}$$

At $227°C$ in a 2.00 L container there are 0.044 mol NO, 0.100 mol O_2 and 7.88 mol NO_2 at equilibrium. Calculate the equilibrium constant. **(3 marks)**

Score for Question 4:

4. _____ (3)

OVER

5. A 25.00 mL sample of a saturated ZnF_2 solution was evaporated to dryness. The mass of the residue was 0.508 g. Calculate the solubility product constant of ZnF_2. **(4 marks)**

Score for Question 5:
5. _____ (4)

6. The following data were collected when a 25.00 mL sample of water containing chloride ion was titrated using 0.100 M $AgNO_3$ to completely precipitate the chloride ion.

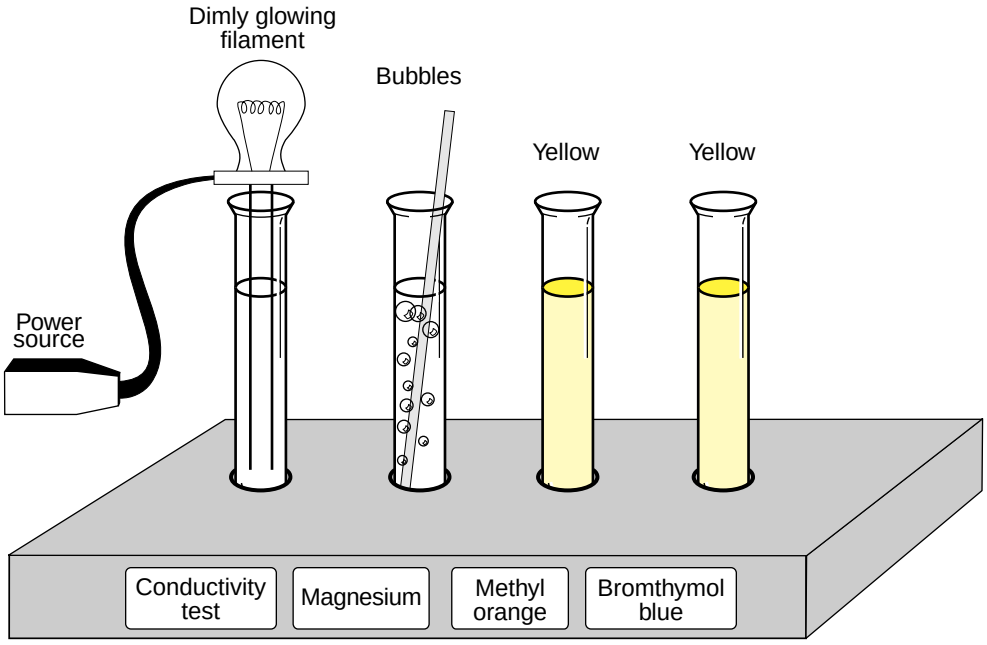
Initial volume of $AgNO_3$	18.20 mL
Final volume of $AgNO_3$	27.22 mL

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

b) Calculate the $\left[Cl^-\right]$. **(3 marks)**

Score for Question 6:
6. _____ (4)

7. A 1.0 M unknown solution was analyzed and the following was observed:



Classify the unknown as an acid or base indicating whether it is weak or strong. Justify your answer using the data provided. **(2 marks)**

Score for Question 7:

7. _____ (2)

OVER

8. Calculate the pH of 2.0 M nitrous acid. **(4 marks)**

Score for Question 8:

8. _____ (4)

9. A 2.0 L solution contains one mole of the weak acid, H_3PO_4, in equilibrium with one mole of the salt, NaH_2PO_4.

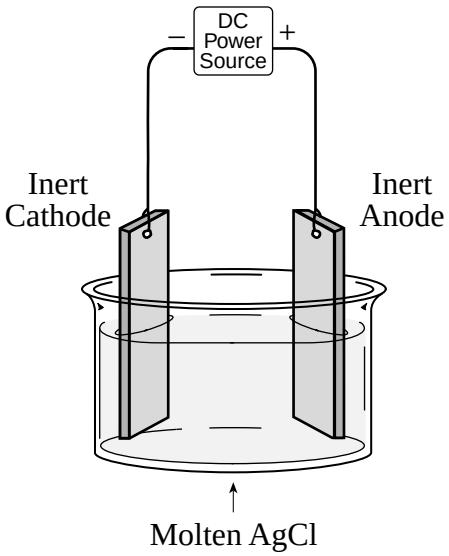
   a) Write an equation that represents this equilibrium. **(2 marks)**

   b) Explain why the pH of this solution does not change significantly when 10.0 mL of 1.0 M KOH is added. **(1 mark)**

Score for Question 9:

9. _____ (3)

10. Consider the following electrolytic cell used for the electrolysis of molten AgCl.



a) Clearly indicate on the diagram above, the direction of the electron flow through the wire. **(1 mark)**

b) Write the equation for the half-reaction taking place at the anode. **(1 mark)**

c) Write the equation for the half-reaction taking place at the cathode. **(1 mark)**

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

Score for Question 10:
10. _____ (4)

OVER

11. Write the balanced equation for the half-reaction:

$Cu(OH)_2 \rightarrow Cu_2O$ (basic) **(3 marks)**

Score for Question 11:
11. _____ (3)

END OF EXAMINATION