INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

JUNE 1999

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 and on the **back** cover of this booklet. **Under no circumstance is your name or identification, other than your Student I.D. Number, to appear on this booklet.**

2. Ensure that in addition to this examination booklet, you have a **Data Booklet** and an **Examination Response Form**. Follow the directions on the front of the Response Form.

3. **Disqualification** from the examination will result if you bring books, paper, notes or unauthorized electronic devices into the examination room.

4. All multiple-choice answers must be entered on the Response Form using an **HB pencil**. Multiple-choice answers entered in this examination booklet will **not** be marked.

5. For each of the written-response questions, write your answer in the space provided in this booklet.

6. 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.

7. At the end of the examination, place your Response Form inside the front cover of this booklet and return the booklet and your Response Form to the supervisor.

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. Aside from an approved calculator, electronic devices, including dictionaries and pagers, are **not** permitted in the examination room.

3. 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.

4. **A calculator is essential for the Chemistry 12 Provincial Examination.** The calculator must be a hand-held device designed primarily for mathematical computations involving logarithmic and trigonometric functions and may also include graphing functions. Computers, calculators with a QWERTY keyboard, and electronic writing pads will not be allowed. Students must not bring any external support devices such as manuals, printed or electronic cards, printers, memory expansion chips, or external keyboards. Students may have more than one calculator available during the examination, but calculators may not be shared. Communication between calculators is prohibited and calculators must not have the ability to either transmit or receive electronic signals. In addition to an approved calculator, students will be allowed to use rulers, compasses, and protractors during the examination.

5. The time allotted for this examination is **two hours**.

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 Response Form provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. Which of the following can be used to represent the rate of a reaction?

   A. $\frac{g}{L}$

   B. $\frac{g}{mol}$

   C. $\frac{g \bullet min}{mol}$

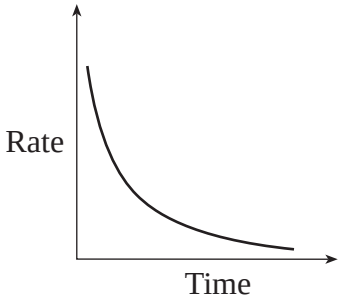
   D. $\frac{mol}{L \bullet min}$

2. Consider the following reaction:

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

Which graph shows the relationship between rate of consumption of H_2O_2 and time?

A.



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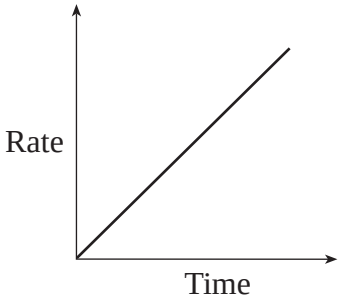

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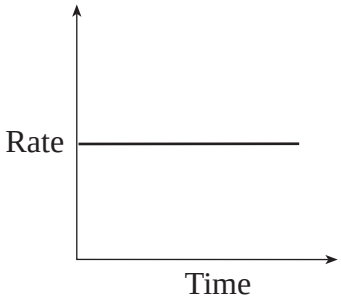

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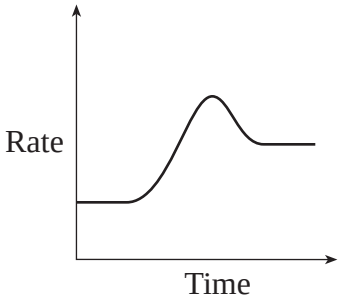


OVER

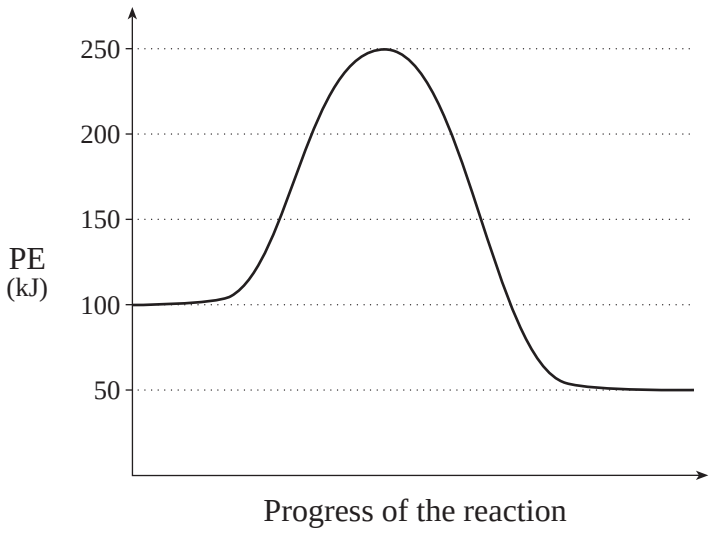
3. Consider the following reaction:

$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_{2(aq)}$$

The rate of this reaction increases when more magnesium is added. This change is caused by the

A. addition of a catalyst.
B. increase in surface area.
C. change in nature of the reactants.
D. increase in concentration of reactants.

4. Consider the following PE diagram:

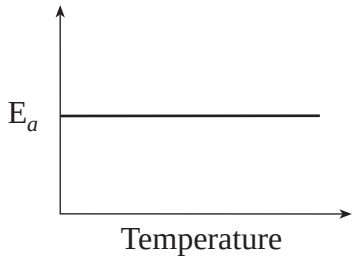


Which of the following describes the forward reaction?

	ΔH (kJ)	ACTIVATION ENERGY (kJ)
A.	+50	250
B.	–50	200
C.	–50	150
D.	+50	150

5. Which graph shows the relationship between activation energy (E_a) and temperature?

A.



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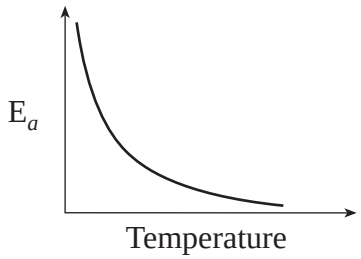

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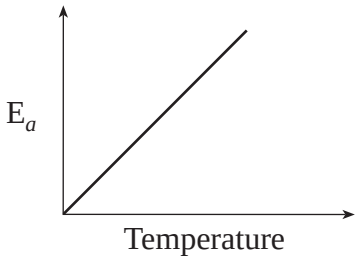

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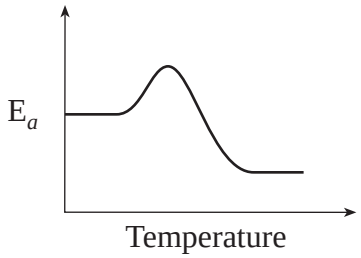


6. A catalyst changes the rate of a reaction by

A. changing ΔH.
B. increasing the temperature.
C. decreasing the energy of the products.
D. providing an alternate reaction mechanism.

7. Consider the following reaction:

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

Which of the following describes the changes in enthalpy and entropy as the reaction proceeds?

	ENTHALPY	ENTROPY
A.	increases	decreases
B.	increases	increases
C.	decreases	decreases
D.	decreases	increases

OVER

8. Consider the following equilibrium:

$$2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)} + \text{energy}$$

Which of the following will cause this equilibrium to shift to the left?

A. adding a catalyst
B. adding some SO_2
C. increasing the volume
D. decreasing the temperature

9. Methanol, CH_3OH, can be produced by the following:

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

The conditions that are necessary to maximize the equilibrium yield of CH_3OH are

A. low temperature and low pressure.
B. high temperature and low pressure.
C. low temperature and high pressure.
D. high temperature and high pressure.

10. A catalyst is added to a system already at equilibrium. How are the forward and reverse reaction rates affected by the addition of the catalyst?

	FORWARD RATE	REVERSE RATE
A.	increases	increases
B.	increases	remains constant
C.	remains constant	decreases
D.	remains constant	remains constant

11. Consider the following reaction:

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

What is the equilibrium constant expression for the reaction?

A. $K_{eq} = [H_2]^2[O_2]$

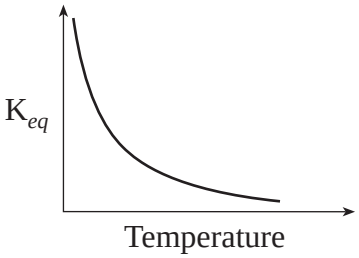
B. $K_{eq} = \dfrac{[H_2]^2[O_2]}{[H_2O]^2}$

C. $K_{eq} = \dfrac{[H_2O]^2}{[H_2]^2[O_2]}$

D. $K_{eq} = \dfrac{1}{[H_2]^2[O_2]}$

12. The relationship between K_{eq} and temperature for an exothermic reaction is represented by

A.



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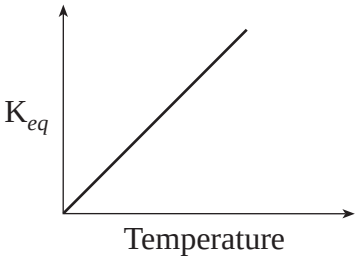

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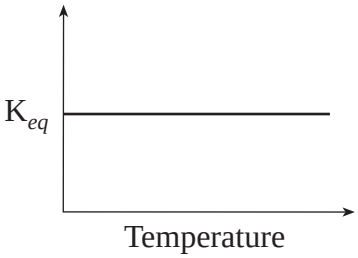

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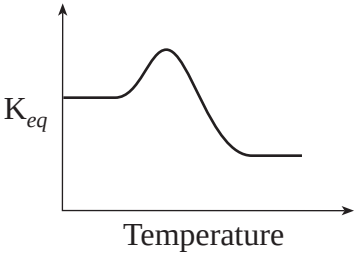


OVER

13. Consider the following equilibrium:

$$2\,NOBr_{(g)} \rightleftarrows 2\,NO_{(g)} + Br_{2(g)} \qquad K_{eq} = 6.4\times10^{-2}$$

At equilibrium, a $1.00\,L$ flask contains $0.030\,mol$ NOBr and $0.030\,mol$ NO. How many mol Br_2 are present?

A. 1.9×10^{-3} mol
B. 6.4×10^{-2} mol
C. 3.0×10^{-2} mol
D. 4.7×10^{-1} mol

14. The ion concentrations in $2.00\,L$ of $0.32\,M$ K_3PO_4 are

	$[K^+]$	$[PO_4^{3-}]$
A.	0.16 M	0.16 M
B.	0.32 M	0.32 M
C.	0.48 M	0.16 M
D.	0.96 M	0.32 M

15. Which of the following compounds is the least soluble in water?

A. CaS
B. $Fe(OH)_3$
C. $KMnO_4$
D. $NH_4HC_2O_4$

16. A solution contains two cations, each having a concentration of $0.20\,\text{M}$. When an equal volume of $0.20\,\text{M}$ OH^- is added, these cations are removed from the solution by precipitation. These ions are

A. Ba^{2+} and K^+
B. Sr^{2+} and Na^+
C. Mg^{2+} and Sr^{2+}
D. Mg^{2+} and Ca^{2+}

17. The solubility of $Mn(IO_3)_2$ is $4.8\times10^{-3}\,\text{M}$. What is the value of K_{sp} ?

A. 1.1×10^{-7}
B. 4.4×10^{-7}
C. 7.1×10^{-6}
D. 1.1×10^{-1}

18. The maximum $\left[SO_4^{2-}\right]$ that can exist in $1.0\times10^{-3}\,\text{M}$ $Ca(NO_3)_2$ without a precipitate forming is

A. 7.1×10^{-5} M
B. 1.0×10^{-3} M
C. 8.4×10^{-3} M
D. 7.1×10^{-2} M

19. A $1.0\times10^{-4}\,\text{M}$ solution has a pH of 10.00. The solute is a

A. weak acid.
B. weak base.
C. strong acid.
D. strong base.

OVER

20. Consider the following Brönsted-Lowry equilibrium system:

$$HSO_3^- + H_2PO_4^- \rightleftarrows SO_3^{2-} + H_3PO_4$$

What are the two Brönsted-Lowry bases in the equilibrium above?

A. HSO_3^- and SO_3^{2-}
B. $H_2PO_4^-$ and SO_3^{2-}
C. HSO_3^- and H_3PO_4
D. $H_2PO_4^-$ and H_3PO_4

21. The equation representing the predominant reaction of sodium ethanoate, $NaCH_3COO$, with water is

A. $CH_3COO^- + H_2O \rightleftarrows CH_3COOH + OH^-$
B. $CH_3COO^- + H_2O \rightleftarrows H_3O^+ + CH_2COO^{2-}$
C. $CH_3COOH + H_2O \rightleftarrows H_3O^+ + CH_3COO^-$
D. $CH_3COOH + H_2O \rightleftarrows CH_3COOH_2^+ + OH^-$

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

A. 0.1M HF
B. 0.1M NaF
C. 0.1M H_2SO_3
D. 0.1M $NaHSO_3$

23. Which of the following is the strongest Brönsted-Lowry base?

A. NH_3
B. CO_3^{2-}
C. HSO_3^-
D. $H_2BO_3^-$

24. Consider the following:

	ION
I.	HCO_3^-
II.	$H_2PO_4^-$
III.	CH_3COO^-

The amphiprotic ions are

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

25. The ionization of water at room temperature is represented by

A. $H_2O \rightleftarrows 2H^+ + O^{2-}$

B. $2H_2O \rightleftarrows 2H_2 + O_2$

C. $2H_2O \rightleftarrows H_2 + 2OH^-$

D. $2H_2O \rightleftarrows H_3O^+ + OH^-$

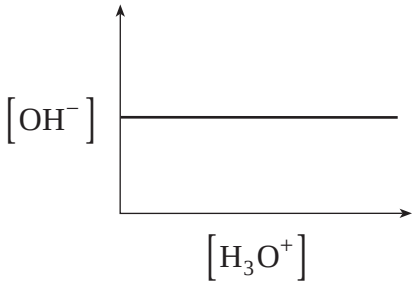
26. Addition of HCl to water causes

A. both $[H_3O^+]$ and $[OH^-]$ to increase.
B. both $[H_3O^+]$ and $[OH^-]$ to decrease.
C. $[H_3O^+]$ to increase and $[OH^-]$ to decrease.
D. $[H_3O^+]$ to decrease and $[OH^-]$ to increase.

OVER

27. Which of the following graphs describes the relationship between $[H_3O^+]$ and $[OH^-]$ in aqueous solutions at a constant temperature?

A.



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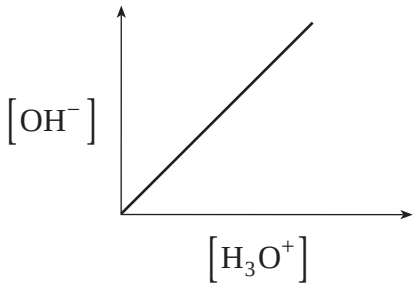

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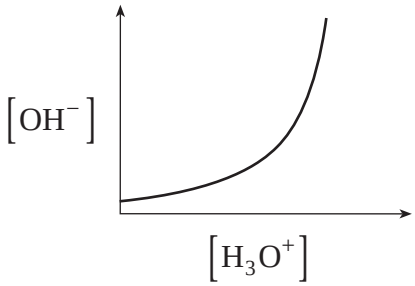

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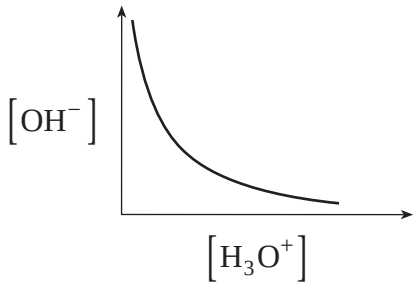


28. Consider the following:

I.	H_2SO_4
II.	HSO_4^-
III.	SO_4^{2-}

Which of the above is/are present in a reagent bottle labelled $1.0\,M$ H_2SO_4?

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

29. The pH of a $0.10\,M$ KOH solution is

A. 0.10
B. 1.00
C. 13.00
D. 14.10

30. The equilibrium expression for the predominant reaction between the hydrogen oxalate ion, $HC_2O_4^-$, and water is

A. $K_a = \frac{[C_2O_4^{2-}][H_3O^+]}{[HC_2O_4^-]}$

B. $K_b = \frac{[HC_2O_4^-]}{[C_2O_4^{2-}][OH^-]}$

C. $K_a = \frac{[HC_2O_4^-][H_3O^+]}{[C_2O_4^{2-}]}$

D. $K_b = \frac{[H_2C_2O_4][OH^-]}{[HC_2O_4^-]}$

31. Which of the following salts will dissolve in water to produce a neutral solution?

A. LiF

B. $CrCl_3$

C. KNO_3

D. NH_4Cl

32. An indicator changes colour in the pH range 9.0 to 11.0. What is the value of K_a for the indicator?

A. 1×10^{-13}

B. 1×10^{-10}

C. 1×10^{-7}

D. 1×10^{1}

OVER

33. Which of the following always applies at the transition point for the indicator $HInd$?

A. $\left[Ind^-\right] = \left[OH^-\right]$

B. $\left[HInd\right] = \left[Ind^-\right]$

C. $\left[Ind^-\right] = \left[H_3O^+\right]$

D. $\left[HInd\right] = \left[H_3O^+\right]$

34. Calculate the $\left[H_3O^+\right]$ of a solution prepared by adding 10.0 mL of $2.0\,M$ HCl to 10.0 mL of $1.0\,M$ NaOH.

A. 0.020 M
B. 0.50 M
C. 1.0 M
D. 2.0 M

35. Consider the following:

I.	H_3O^+
II.	CH_3COO^-
III.	CH_3COOH

The purpose of a buffer system consisting of CH_3COOH and CH_3COONa is to maintain a relatively constant concentration of

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

36. Which of the following, when dissolved in water, will produce an acidic solution?

A. SrO

B. NO_2

C. CaO

D. Na_2O

37. Which of the following is capable of acting both as an oxidizing agent and a reducing agent?

A. H^+

B. Na^+

C. Sn^{2+}

D. MnO_4^-

38. Consider the following redox reaction:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

The substance undergoing reduction is

A. O_2

B. CO_2

C. H_2O

D. $C_6H_{12}O_6$

39. The oxidation number of P in $H_4P_2O_7$ is

A. -10

B. -5

C. $+5$

D. $+10$

OVER

40. A solution containing an unknown cation reacts spontaneously with both zinc and copper. The unknown cation is

A. $1.0\,M\ H^+$
B. $1.0\,M\ Ag^+$
C. $1.0\,M\ Sr^{2+}$
D. $1.0\,M\ Mn^{2+}$

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

A. $ClO^- + H_2O + e^- \rightarrow Cl_2 + 2OH^-$
B. $2ClO^- + H_2O + 2e^- \rightarrow Cl_2 + 3OH^-$
C. $2ClO^- + 2H_2O + 2e^- \rightarrow Cl_2 + 4OH^-$
D. $2ClO^- + 2H_2O \rightarrow Cl_2 + 4OH^- + 2e^-$

42. Which of the following is a spontaneous redox reaction?

A. $Ag^+ + I^- \rightarrow AgI$
B. $Ag^+ + Fe^{2+} \rightarrow Ag + Fe^{3+}$
C. $3Ag^+ + Au \rightarrow 3Ag + Au^{3+}$
D. $2Ag^+ + Ni^{2+} \rightarrow 2Ag + Ni$

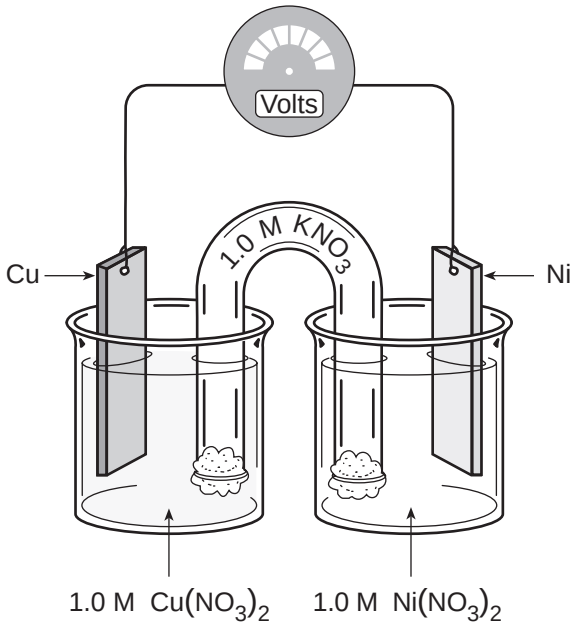
43. Salting of roads during the winter increases the corrosion of cars. This is because the salt

A. reacts with the iron.
B. provides an electrolyte.
C. acts as a reducing agent.
D. acts as an oxidizing agent.

44. Which of the following will **not** react spontaneously with $1.0\,M\ HCl$?

A. tin
B. lithium
C. mercury
D. aluminum

45. Consider the following electrochemical cell:



The half-reaction that occurs at the anode is

A. $Ni \rightarrow Ni^{2+} + 2e^-$

B. $Ni^{2+} + 2e^- \rightarrow Ni$

C. $Cu \rightarrow Cu^{2+} + 2e^-$

D. $Cu^{2+} + 2e^- \rightarrow Cu$

OVER

46. Which of the following can be produced by electrolysis from a $1.0\,\mathrm{M}$ aqueous solution containing its ion?

A. nickel
B. sodium
C. aluminum
D. magnesium

47. In the electrolysis of molten $ZnCl_2$ using carbon electrodes, the reaction that occurs at the anode is

A. $Zn \rightarrow Zn^{2+} + 2e^-$

B. $Zn^{2+} + 2e^- \rightarrow Zn$

C. $2Cl^- \rightarrow Cl_2 + 2e^-$

D. $Cl_2 + 2e^- \rightarrow 2Cl^-$

48. In order for an electrolytic cell to operate, it must have

A. a voltmeter.
B. a salt bridge.
C. a power supply.
D. an aqueous 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**

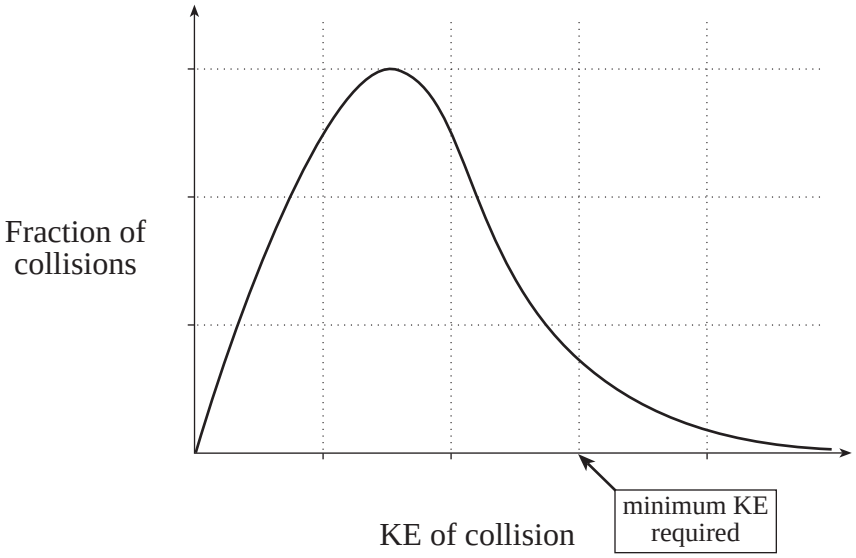
INSTRUCTIONS: You will be expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner.

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. Consider the following KE distribution curve for colliding particles:



a) On the diagram above, sketch a line for the distribution of collisions at a higher temperature. **(2 marks)**

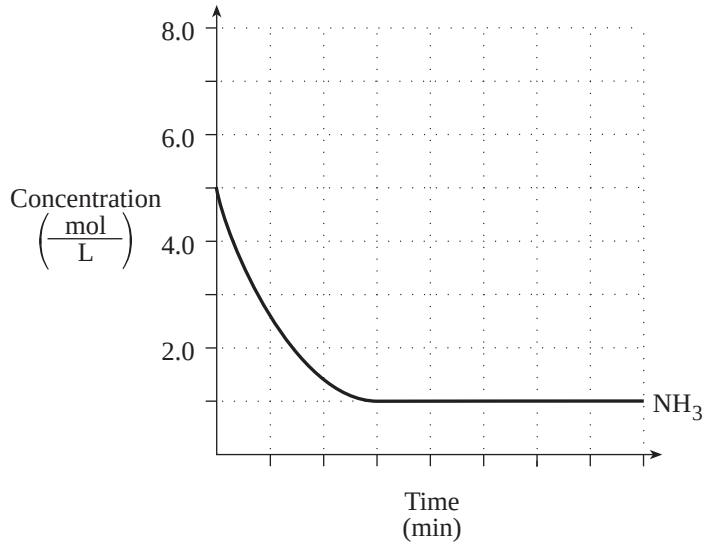
b) Shade in the area representing the collisions that could result in forming an activated complex at the lower temperature. **(1 mark)**

OVER

2. Consider the following equilibrium system:

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

A $1.00\ \text{L}$ container is filled with $5.0\ \text{mol}\ NH_3$ and the system proceeds to equilibrium as indicated by the graph.



a) Draw and label the graph for N_2 and H_2. **(2 marks)**

b) Calculate the K_{eq} for $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$. **(2 marks)**

3. State Le Chatelier's Principle. **(2 marks)**

4. Write the net ionic equation representing the reaction that occurs when $50.0\,\text{mL}$ of $0.20\,\text{M}$ $ZnSO_4$ and $50.0\,\text{mL}$ of $0.20\,\text{M}$ BaS are combined. **(2 marks)**

OVER

5. When $1.00\,\text{g}$ of $MgCO_3$ is added to $2.0\,\text{L}$ of water, some, but not all, will dissolve to form a saturated solution. Calculate the mass of solid that remains undissolved. **(4 marks)**

6. In aqueous solutions, H_3O^+ is the strongest acid present. This phenomenon is called the levelling effect. Explain why this occurs. **(2 marks)**

7. A $1.00\,\text{M}$ OCl^- solution has an $\left[OH^-\right]$ of $5.75\times10^{-4}\,\text{M}$.

a) Calculate K_b for OCl^-. **(3 marks)**

b) Calculate K_a for $HOCl$. **(1 mark)**

OVER

8. Calculate the mass of $NaOH$ needed to prepare $2.0\,L$ of a solution with a pH of 12.00.

(3 marks)

9. The data below were obtained in a redox titration of a $25.00\ \text{mL}$ sample containing Sn^{2+} ions using $0.125\ \text{M}\ KMnO_4$ according to the following reaction:

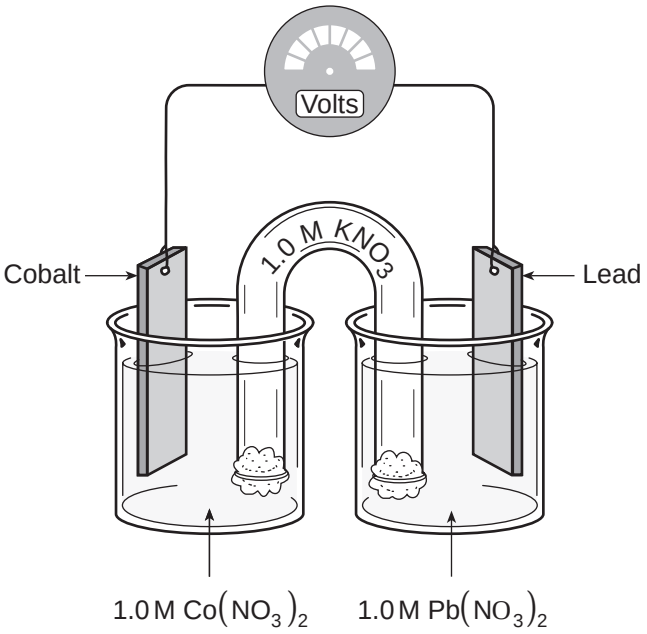
$$2MnO_4^- + 16H^+ + 5Sn^{2+} \rightarrow 2Mn^{2+} + 8H_2O + 5Sn^{4+}$$

	Volume of $KMnO_4$ used (mL)		
	Trial #1	Trial #2	Trial #3
Initial buret reading	2.00	13.80	24.55
Final buret reading	13.80	24.55	35.32

Calculate the $[Sn^{2+}]$ in the original sample. **(4 marks)**

OVER

10. Consider the following electrochemical cell:



a) Calculate the initial cell voltage. **(1 mark)**

b) What is the purpose of the salt bridge? **(1 mark)**

11. Consider the electrolysis of $1.0\,\mathrm{M}\ H_2SO_4$ using inert platinum electrodes.

a) Write the oxidation half-reaction. **(1 mark)**

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

END OF EXAMINATION