INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

JUNE 1995

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.

THIS PAGE INTENTIONALLY BLANK

FOR OFFICE USE ONLY

INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

_____ – _____

CHEMISTRY 12 JUNE 1995 PROVINCIAL

Course Code = CH Examination Type = P

1. _____ (4)

2. _____ (2)

3. _____ (3)

4. _____ (2)

5. _____ (4)

6. _____ (2)

7. _____ (2)

8. _____ (2)

9. _____ (4)

10. _____ (4)

11. _____ (3)

THIS PAGE INTENTIONALLY BLANK

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.

THIS PAGE INTENTIONALLY BLANK

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. The rate of a chemical reaction can be expressed in

   A. grams per mole.
   B. energy consumed per mole.
   C. volume of gas per unit time.
   D. moles formed per litre of solution.

2. Consider the following:

I	frequency of successful collisions
II	volume of the reaction vessel
III	pressure of the system
IV	mass of the system

   To increase the rate of a reaction there **must** be an increase in

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

3. In general, a chemical reaction requiring a large activation energy will proceed

   A. at a fast rate.
   B. at a slow rate.
   C. only at low temperatures.
   D. only at low concentrations.

OVER

4. Which of the following equations represents an endothermic reaction?

   A. $N_2O_{4(g)} + 59\ kJ \rightarrow 2NO_{2(g)}$

   B. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)} + 572\ kJ$

   C. $2BrCl_{(g)} - 29.3\ kJ \rightarrow Br_{2(g)} + Cl_{2(g)}$

   D. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -394\ kJ$

5. Consider the following reaction mechanism:

   Step 1: $M + X \rightarrow MX$

   Step 2: $MX + A \rightarrow D + X$

   The chemical species MX is a(n)

   A. catalyst.
   B. inhibitor.
   C. final product.
   D. reaction intermediate.

6. Consider the following:

I	constant temperature
II	equal concentrations of reactants and products
III	equal rates of forward and reverse reactions

   A system at equilibrium **must** have

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

7. Consider the following equilibrium:

$$Cl_2O_{7(g)} + 8H_{2(g)} \rightleftarrows 2HCl_{(g)} + 7H_2O_{(g)}$$

Which of the following would increase the number of moles of HCl?

A. increase $[H_2O]$
B. increase $[Cl_2O_7]$
C. increase total pressure
D. increase volume of the system

8. Consider the following equilibrium:

$$C_{(s)} + 2H_{2(g)} \rightleftarrows CH_{4(g)} + 74 \text{ kJ}$$

When a small amount of solid C is added to the system,

A. $[H_2]$ decreases.
B. $[CH_4]$ increases.
C. the temperature increases.
D. all concentrations remain constant.

9. For which of the following equilibria does $K_{eq} = [O_2]$?

A. $O_{2(l)} \rightleftarrows O_{2(g)}$
B. $2O_{3(g)} \rightleftarrows 3O_{2(g)}$
C. $2H_2O_{(l)} \rightleftarrows 2H_{2(g)} + O_{2(g)}$
D. $2Hg_{(s)} + O_{2(g)} \rightleftarrows 2HgO_{(s)}$

10. Which of the following statements is correct?

A. K_{eq} is the ratio of [products] to [reactants].
B. K_{eq} determines how fast a reaction is completed.
C. A large K_{eq} value indicates that reactants are favoured.
D. A small K_{eq} value indicates that products are favoured.

OVER

11. Consider the following equilibrium:

$$2O_{2(g)} + N_{2(g)} \rightleftarrows N_2O_{4(g)}$$

When 2.0 mol of O_2 and 3.0 mol of N_2 were placed in a 10.0 L container at $25°C$, the value of $K_{eq} = 0.90$. If the same number of moles of reactant were placed in a 5.0 L container at $25°C$, the equilibrium constant would be

A. 0.011
B. 0.45
C. 0.90
D. 1.80

12. Consider the following equilibrium:

$$PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)} \qquad K_{eq} = 33.3$$

Predict what will occur when 2.0 mol of PCl_5, 3.0 mol of PCl_3 and 4.0 mol of Cl_2 are placed in a 1.0 L container and allowed to establish equilibrium.

A. $[PCl_5]$ will increase.
B. $[PCl_3]$ and $[Cl_2]$ will both increase.
C. $[PCl_5]$ and $[Cl_2]$ will both increase.
D. $[PCl_5]$ and $[PCl_3]$ will both decrease.

13. The temperature of an exothermic reaction at equilibrium is increased by $10°C$. The value of K_{eq}

A. doubles.
B. increases.
C. decreases.
D. remains constant.

14. In a saturated solution of KNO_3, the rate of crystallization is

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

15. In an experiment, 0.500 mol of $Fe(NO_3)_3$ is dissolved in water to produce a 2.00 L solution. The $[NO_3^-]$ in this solution is

A. 0.250 M
B. 0.500 M
C. 0.750 M
D. 1.50 M

16. A precipitation reaction occurs when equal volumes of 0.2 M $Pb(NO_3)_2$ and 0.2 M KI are mixed. The net ionic equation for this reaction is

A. $Pb^{2+}_{(aq)} + 2I^-_{(aq)} \rightarrow PbI_{2(s)}$
B. $PbI_{2(s)} \rightarrow Pb^{2+}_{(aq)} + 2I^-_{(aq)}$
C. $K^+_{(aq)} + NO_{3(aq)}^- \rightarrow KNO_{3(s)}$
D. $KNO_{3(s)} \rightarrow K^+_{(aq)} + NO_{3(aq)}^-$

17. A reagent that may be used to separate Cl^- from S^{2-} by precipitation is

A. KNO_3
B. $AgNO_3$
C. $Pb(NO_3)_2$
D. $Al(NO_3)_3$

18. At a certain temperature, the solubility of BaF_2 is 7.4×10^{-3} moles per litre. The K_{sp} of BaF_2 is

A. 1.6×10^{-6}
B. 5.5×10^{-5}
C. 1.1×10^{-4}
D. 7.4×10^{-3}

OVER

19. What is the maximum $\left[Sr^{2+}\right]$ that can exist in a solution of 0.10 M Na_2SO_4 ?

A. 3.4×10^{-7} M

B. 3.4×10^{-6} M

C. 1.7×10^{-6} M

D. 5.8×10^{-4} M

20. A student could precipitate silver chloride from a saturated solution of silver chloride by adding

A. water.
B. sodium iodide.
C. sodium nitrate.
D. sodium chloride.

21. A net ionic equation for the reaction between CH_3COOH and KOH is

A. $CH_3COO^-_{(aq)} + K^+_{(aq)} \rightleftarrows CH_3COOK_{(aq)}$

B. $CH_3COOH_{(aq)} + OH^-_{(aq)} \rightleftarrows H_2O_{(l)} + CH_3COO^-_{(aq)}$

C. $CH_3COOH_{(aq)} + KOH_{(aq)} \rightleftarrows H_2O_{(l)} + CH_3COOK_{(aq)}$

D. $CH_3COOH_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightleftarrows H_2O_{(l)} + KCH_3COO_{(aq)}$

22. **Drano®,** a commercial product used to clean drains, contains small bits of aluminum metal and

A. ammonia.
B. acetic acid.
C. hydrochloric acid.
D. sodium hydroxide.

23. Consider the following equilibrium:

$$HS^- + H_2C_2O_4 \rightleftarrows HC_2O_4{}^- + H_2S$$

The stronger acid is

A. HS^-

B. $H_2C_2O_4$

C. $HC_2O_4{}^-$

D. H_2S

24. Consider the following equilibria:

I	$HCO_3^- + H_2O \rightleftarrows H_2CO_3 + OH^-$
II	$NH_4^+ + H_2O \rightleftarrows H_3O^+ + NH_3$
III	$HSO_3^- + H_3O^+ \rightleftarrows H_2O + H_2SO_3$

Water acts as a Brönsted-Lowry base in

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

25. Consider the following equilibrium for phenolphthalein:

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

When phenolphthalein is added to 1.0 M NaOH, the colour of the resulting solution is

A. pink as $[HInd]$ is less than $[Ind^-]$
B. pink as $[HInd]$ is greater than $[Ind^-]$
C. colourless as $[HInd]$ is less than $[Ind^-]$
D. colourless as $[HInd]$ is greater than $[Ind^-]$

26. The $[OH^-]$ is greater than the $[H_3O^+]$ in

A. $HCl_{(aq)}$
B. $NH_{3(aq)}$
C. $H_2O_{(aq)}$
D. $CH_3COOH_{(aq)}$

OVER

27. Which of the following is represented by a K_b expression?

A. $Al(OH)_{3(s)} \rightleftarrows Al^{3+}_{(aq)} + 3OH^{-}_{(aq)}$

B. $HF_{(aq)} + H_2O_{(l)} \rightleftarrows H_3O^{+}_{(aq)} + F^{-}_{(aq)}$

C. $Cr_2O_{7(aq)}^{2-} + 2OH^{-}_{(aq)} \rightleftarrows 2CrO_{4(aq)}^{2-} + H_2O_{(l)}$

D. $CH_3NH_{2(aq)} + H_2O_{(l)} \rightleftarrows CH_3NH_{3(aq)}^{+} + OH^{-}_{(aq)}$

28. The concentration, K_a and pH values of four acids are given in the following table:

Acid	Concentration	K_a	pH
HA	3.0 M	2.0×10^{-5}	2.1
HB	0.7 M	4.0×10^{-5}	2.3
HC	4.0 M	1.0×10^{-5}	2.2
HD	1.5 M	1.3×10^{-5}	2.4

Based on this data, the **strongest** acid is

A. HA
B. HB
C. HC
D. HD

29. Which of the following, when dissolved in water, produces a basic solution?

A. KCl

B. $NaClO_4$

C. Na_2CO_3

D. NH_4NO_3

30. Which of the following equations correctly relates pH and $\left[H_3O^+\right]$?

A. $pH = \log \left[H_3O^+\right]$

B. $pH = 14 - \left[H_3O^+\right]$

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

D. $pH = pK_w - \left[H_3O^+\right]$

31. The pH of 0.15 M HCl is

A. 0.15
B. 0.71
C. 0.82
D. 13.18

32. Which of the following indicators would be yellow at pH 7 and blue at pH 10 ?

A. thymol blue
B. methyl violet
C. bromthymol blue
D. bromcresol green

33. Which of the following standardized solutions should a chemist select when titrating a 25.00 mL sample of 0.1 M NH_3, using methyl red as an indicator?

A. 0.114 M HCl

B. 6.00 M HNO_3

C. 0.105 M NaOH

D. 0.100 M CH_3COOH

34. A student combines 0.25 mol of NaOH and 0.20 mol of HCl in water to make 2.0 litres of solution. The pH of this solution is

A. 1.3
B. 1.6
C. 12.4
D. 12.7

OVER

35. Consider the following equilibrium:

$$HF_{(aq)} + H_2O_{(l)} \rightleftarrows H_3O^+_{(aq)} + F^-_{(aq)}$$

The above system will behave as a buffer when the $\left[F^-\right]$ is approximately equal to

A. K_a
B. $[HF]$
C. $\left[H_2O\right]$
D. $\left[H_3O^+\right]$

36. Which of the following gases results in the formation of acid rain?

A. H_2
B. O_3
C. SO_2
D. NH_3

37. Electrons are lost by the

A. reducing agent as it undergoes oxidation.
B. reducing agent as it undergoes reduction.
C. oxidizing agent as it undergoes oxidation.
D. oxidizing agent as it undergoes reduction.

38. Consider the following:

$$2MnO_4^- + 5H_2SO_3 \rightarrow 2Mn^{2+} + 3H_2O + 5SO_4^{2-} + 4H^+$$

The species that undergoes reduction is

A. S in H_2SO_3
B. H in H_2SO_3
C. O in MnO_4^-
D. Mn in MnO_4^-

39. Samples of Uranium, Vanadium and Yttrium (U, V, Y) were placed in solutions containing one of the metallic ions U^{3+}, V^{2+}, Y^{3+}. The following observations were recorded.

Trial	Ion	Metal	Observation
1	U^{3+}	Y	reaction
2	V^{2+}	U	reaction
3	V^{2+}	Y	reaction
4	Y^{3+}	V	no reaction

The oxidizing agents from the strongest to the weakest are

A. V^{2+}, U^{3+}, Y^{3+}
B. U^{3+}, V^{2+}, Y^{3+}
C. Y^{3+}, U^{3+}, V^{2+}
D. V^{2+}, Y^{3+}, U^{3+}

40. Which of the following reactions is spontaneous?

A. $Fe^{2+} + Sn \rightarrow Fe + Sn^{2+}$
B. $Fe^{3+} + Sn \rightarrow Fe^{2+} + Sn^{2+}$
C. $Fe^{2+} + Sn^{2+} \rightarrow Fe + Sn^{4+}$
D. $Fe^{2+} + Sn^{4+} \rightarrow Fe^{3+} + Sn^{2+}$

41. Which of the following is a balanced half-reaction in base?

A. $Cl_2 + 3H_2O \rightarrow ClO_3^- + 6H^+ + 5e^-$
B. $Cl_2 + 6OH^- \rightarrow ClO_3^- + 5e^- + 3H_2O$
C. $Cl_2 + 6H_2O \rightarrow 2ClO_3^- + 12H^+ + 10e^-$
D. $Cl_2 + 12OH^- \rightarrow 2ClO_3^- + 6H_2O + 10e^-$

42. In which of the following unbalanced equations does chromium undergo oxidation?

A. $Cr^{3+} \rightarrow Cr$
B. $Cr^{3+} \rightarrow Cr^{2+}$
C. $Cr^{3+} \rightarrow Cr_2O_7^{2-}$
D. $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$

OVER

43. Consider the following reaction:

$$Zn_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)}$$

What volume of 0.500 M $AgNO_3$ is required to react completely with 6.54 g of zinc?

A. 0.0131 L
B. 0.0262 L
C. 0.200 L
D. 0.400 L

44. In an electrochemical cell, the cathode

A. is reduced.
B. loses mass.
C. is the reducing agent.
D. is the site of reduction.

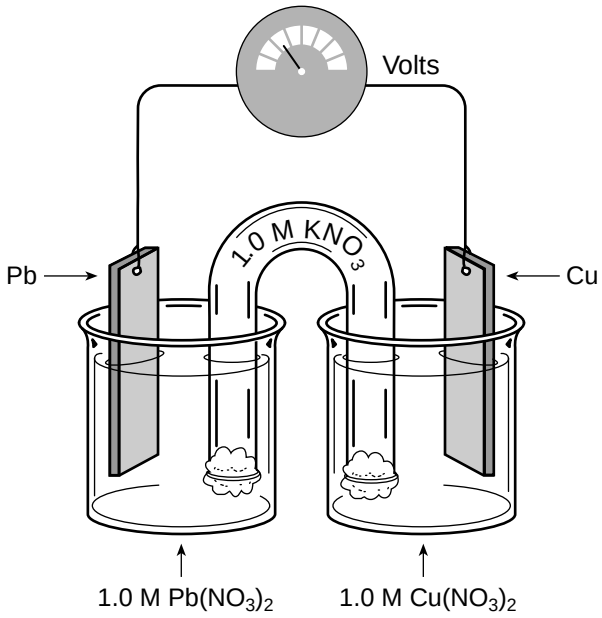
45. A reaction that occurs during the corrosion of iron is

A. $Fe + 3e^{-} \rightarrow Fe^{3+}$
B. $Fe \rightarrow Fe^{2+} + 2e^{-}$
C. $Fe^{2+} + 2e^{-} \rightarrow Fe$
D. $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$

46. When 1.0 M NaI is electrolyzed, bubbles of gas form on one electrode and a reddish-brown substance forms on the other. The half-reaction at the cathode is

A. $2I^{-} \rightarrow I_2 + 2e^{-}$
B. $Na^{+} + e^{-} \rightarrow Na$
C. $H_2O \rightarrow \frac{1}{2}O_2 + 2H^{+} + 2e^{-}$
D. $2H_2O + 2e^{-} \rightarrow H_2 + 2OH^{-}$

Use the following cell diagram to answer questions 47 and 48.



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

A. copper to lead through the wire.
B. lead to copper through the wire.
C. copper to lead through the salt bridge.
D. lead to copper through the salt bridge.

48. In the electrochemical cell above, the initial $E°$ value is

A. 0.03 V
B. 0.21 V
C. 0.29 V
D. 0.47 V

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

OVER

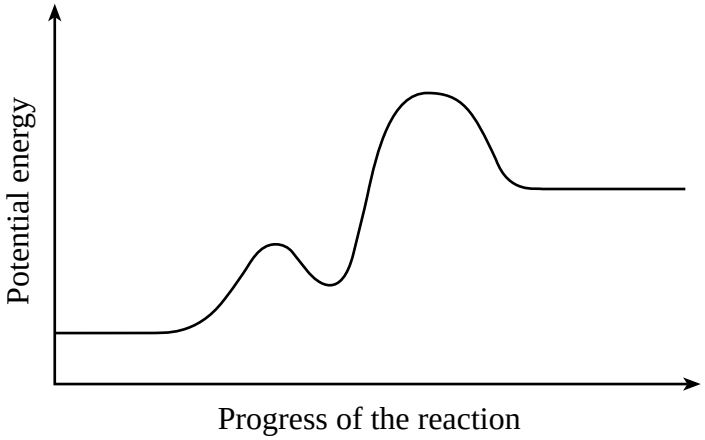
THIS PAGE INTENTIONALLY BLANK

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.**

Use the following diagram to answer question 1.



1. a) On the potential energy diagram above, **clearly** label the

   i) activation energy for the forward reaction. **(1 mark)**

   ii) heat of reaction, ΔH. **(1 mark)**

   iii) energy of the activated complex in the rate determining step. **(1 mark)**

   b) Is the reaction endothermic or exothermic in the forward direction? **(1 mark)**

   _____

Score for Question 1:
1. _____ (4)

OVER

2. Consider the following equilibrium:

$$N_2H_{4(g)} + 2O_{2(g)} \rightleftarrows 2NO_{(g)} + 2H_2O_{(g)}$$

More oxygen is added to the above equilibrium. After the system re-establishes equilibrium, identify the substance(s), if any, that have a net **(2 marks)**

a) increase in concentration. _____

b) decrease in concentration. _____

Score for Question 2:

2. _____ (2)

3. Given the following equilibrium:

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

Initially, 0.200 mol H_2 and 0.200 mol I_2 were placed into a 1.0 L container. At equilibrium, the $[I_2]$ is 0.040 mol/L. Calculate the K_{eq}. **(3 marks)**

Score for Question 3:

3. _____ (3)

4. Define *solubility*. **(2 marks)**

_____

_____

_____

Score for Question 4:

4. _____ (2)

5. Will a precipitate form if 30.0 mL of 0.054 M $Ca(NO_3)_2$ is mixed with 60.0 mL of 8.1×10^{-4} M Na_2SO_4 ? **(4 marks)**

Score for Question 5:
5. _____ (4)

6. A weak acid, $H_2C_6H_6O_6$, is dissolved in water. Write a chemical equation to represent this system. **(2 marks)**

Score for Question 6:
6. _____ (2)

OVER

7. A chemist pipettes 25.00 mL of 0.15 M HCl into a 100.0 mL volumetric flask. Then she adds water to the mark. Calculate the pH of this solution. **(2 marks)**

Score for Question 7:
7. _____ (2)

8. a) Write a chemical equation representing the hydrolysis of sodium acetate. **(1 mark)**

   b) Calculate the K_b value for the hydrolysis in part (a) above. **(1 mark)**

Score for Question 8:
8. _____ (2)

9. An acid is known to be either iodic, nitrous, ethanoic (acetic) or benzoic. A 0.200 M solution of this acid is found to have a pH of 2.44. Using this data and appropriate calculations, identify this acid. **(4 marks)**

Score for Question 9:
9. _____ (4)

10. Balance the following equation. **(4 marks)**

$$ClO_3^- + N_2H_4 \rightarrow NO + Cl^-$$

Score for Question 10:
10. _____ (4)

11. A student wishes to electroplate a coin with copper.

a) Identify a suitable anode. **(1 mark)**

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

c) To which battery terminal (positive or negative) should the coin be connected? **(1 mark)**

Score for Question 11:
11. _____ (3)

END OF EXAMINATION