AUGUST 1995

PROVINCIAL EXAMINATION

MINISTRY OF EDUCATION
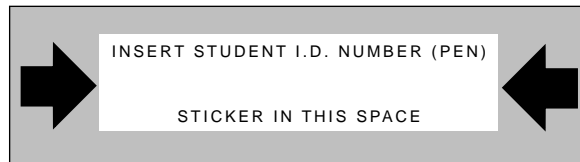
CHEMISTRY 12

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

_____ – _____

CHEMISTRY 12 AUGUST 1995 PROVINCIAL

Course Code = CH   Examination Type = P

1. _____
   (2)

2. _____
   (2)

3. _____
   (2)

4. _____
   (3)

5. _____
   (3)

6. _____
   (3)

7. _____
   (2)

8. _____
   (3)

9. _____
   (2)

10. _____
    (3)

11. _____
    (4)

12. _____
    (3)

THIS PAGE INTENTIONALLY BLANK

CHEMISTRY 12 PROVINCIAL EXAMINATION

	Value	Suggested Time

1. This examination consists of **two** parts:

		Value	Suggested Time
PART A	48 multiple-choice questions	48	70
PART B	12 written-response questions	32	50

		Value	Suggested Time
	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.
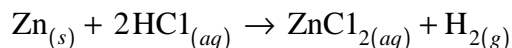
THIS PAGE INTENTIONALLY BLANK

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:

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$

Solid zinc was added to 1.0 M HCl. In 20.0 s, the temperature of the container increased by $0.5°C$ and 25.00 mL of H_2 was produced. The rate of this reaction was
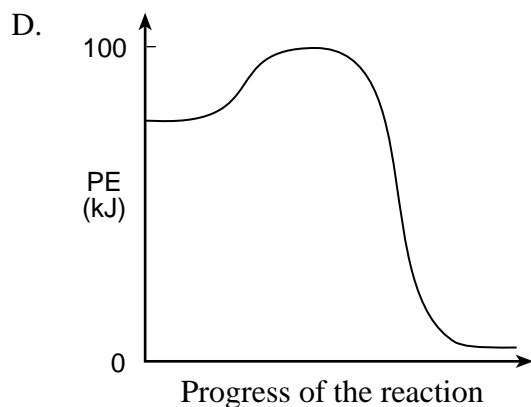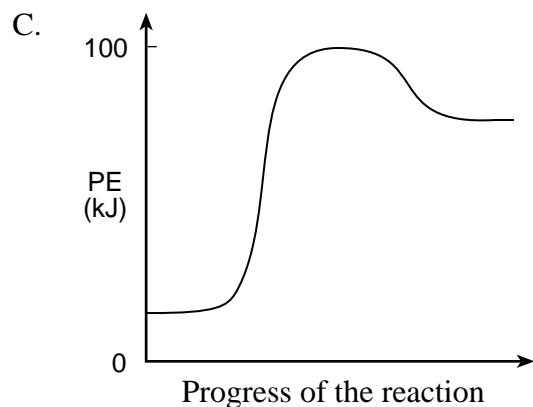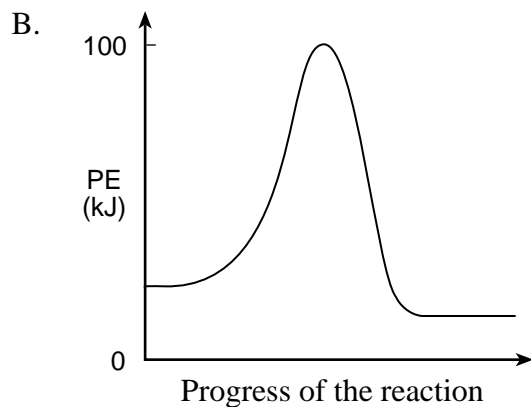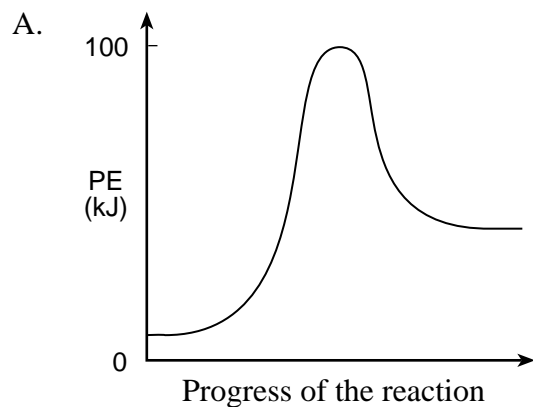
A. $0.5°C/s$
B. 1.0 M HCl/s
C. 1.25 mL H_2/s
D. 0.050 mol HCl/s

2. Which of the following reactions is **slowest** at room temperature?

A. $Zn_{(s)} + S_{(s)} \rightarrow ZnS_{(s)}$
B. $Ba^{2+}_{(aq)} + SO_4^{2-}_{(aq)} \rightarrow BaSO_{4(s)}$
C. $NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$
D. $2Ag^+_{(aq)} + CO_3^{2-}_{(aq)} \rightarrow Ag_2CO_{3(s)}$

3. Milk is refrigerated in order to slow the rate of decomposition by bacterial action. The decrease in reaction rate is due to

A.   a decrease in surface area.
B.   a decrease in ΔH for the reaction.
C.   a decrease in the fraction of particles possessing sufficient energy.
D.   the introduction of an alternate pathway with greater activation energy.

OVER

4. Which of the following corresponds to the fastest reaction at room temperature?

A.

PE
(kJ)

Progress of the reaction

B.

PE
(kJ)

Progress of the reaction

C.

PE
(kJ)

Progress of the reaction

D.

PE
(kJ)

Progress of the reaction

5. An untreated sugar cube does not burn when held over a lighted match. A sugar cube coated with cigarette ash readily ignites and burns. All of the cigarette ash remains after the reaction. The **factor** that caused this change in rate is the

A. nature of reactants.
B. presence of a catalyst.
C. increase in surface area.
D. increase in concentration.

Use the following diagram to answer questions 6 and 7.
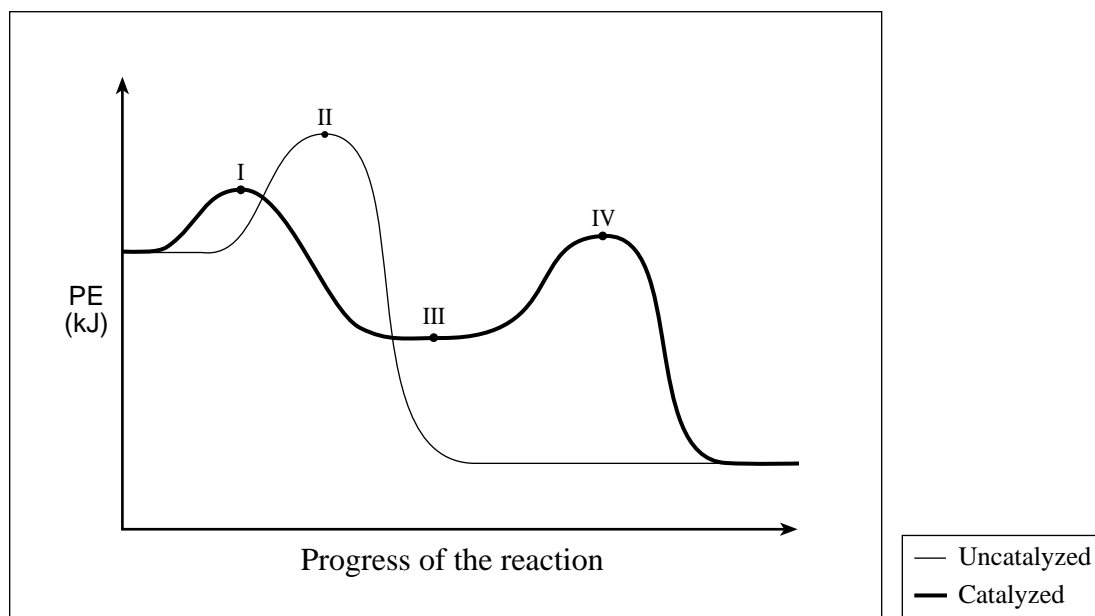
6. Select the **true** statement concerning the above potential energy diagram.

   A.   The catalyzed reaction has a larger ΔH.
   B.   The uncatalyzed reaction has a larger ΔH.
   C.   The catalyzed reaction has a greater rate of reaction.
   D.   The uncatalyzed reaction has a greater rate of reaction.

7. Which point on the diagram above represents the potential energy of the activated complex formed in the uncatalyzed reaction?

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

   _____

8. Which of the following is characteristic of all systems at equilibrium?

   A.   Activation energy is not required.
   B.   Changes do not occur at the microscopic level.
   C.   Two opposing reactions occur at the same rate.
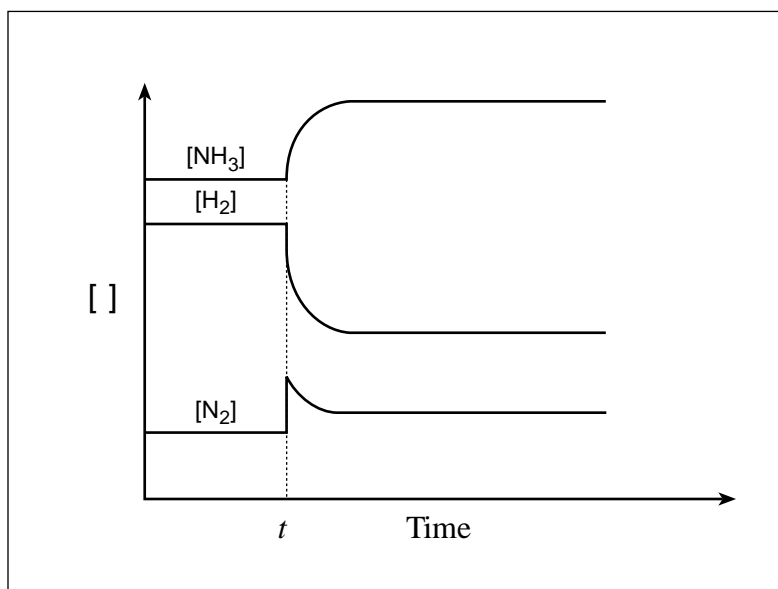   D.   Temperature and pressure affect the equilibrium position equally.

OVER

9. Consider the following equilibrium system:

$$NH_{3(aq)} + H_2O_{(l)} \rightleftarrows NH_{4(aq)}^+ + OH_{(aq)}^-$$
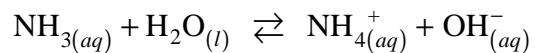
Which of the following when added to the above equilibrium system, would cause an increase in $\left[OH^-\right]$?
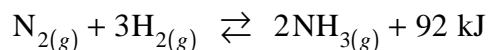
A. NH_3
B. H_2O
C. NH_4^+
D. HCl

10. Consider the following graph which relates to this equilibrium:

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)} \qquad \Delta H = -92 \text{ kJ}$$

Which of the following caused the changes in the concentrations at time t ?

A. addition of N_2
B. removal of H_2
C. decrease in temperature
D. decrease in reaction volume

11. Consider the following equilibrium system:

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

Which of the following sets of conditions will favour the formation of the product?

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

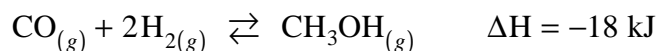12. Consider the following system and concentrations at equilibrium:

$$2NO_{(g)} + Br_{2(g)} \rightleftarrows 2NOBr_{(g)}$$
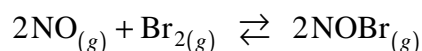
Substance	Equilibrium Concentration
NO	1.2×10^{-2} mol/L
Br_2	3.4×10^{-2} mol/L
NOBr	5.8×10^{-1} mol/L

What is the value of K_{eq} for the above system?

A. 1.5×10^{-5}
B. 8.2×10^{2}
C. 1.4×10^{3}
D. 6.9×10^{4}

13. Consider the following equilibrium system:

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

In order to increase the value of K_{eq} for this reaction, you could

A. increase $[CO]$.
B. increase the volume.
C. decrease $[CH_3OH]$.
D. decrease the temperature.

14. Consider the following equilibrium system:

$$PbI_{2(s)} + heat \rightleftarrows Pb^{2+}_{(aq)} + 2I^-_{(aq)}$$
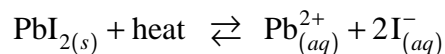
Which of the following changes would result in more PbI_2 dissolving?

A. adding more PbI_2
B. increasing the pressure
C. adding some $Pb(NO_3)_2$
D. increasing the temperature

15. A soluble magnesium salt is

A. $MgSO_3$
B. $MgCO_3$
C. $Mg(NO_3)_2$
D. $Mg_3(PO_4)_2$

16. What is the $[Co^{2+}]$ and $[Cl^-]$ when 0.35 mol of $CoCl_2$ is dissolved in enough water to make 100.0 mL of solution?

A. $[Co^{2+}] = 3.5$ M and $[Cl^-] = 3.5$ M
B. $[Co^{2+}] = 3.5$ M and $[Cl^-] = 7.0$ M
C. $[Co^{2+}] = 0.35$ M and $[Cl^-] = 0.35$ M
D. $[Co^{2+}] = 0.35$ M and $[Cl^-] = 0.70$ M

17. If equal volumes of 0.2 M KBr and 0.2 M $FeSO_4$ are mixed, then

A. no precipitate will be observed.
B. a precipitate of $FeBr_2$ will be observed.
C. a precipitate of K_2SO_4 will be observed.
D. a precipitate of both K_2SO_4 and $FeBr_2$ will be observed.

18. In an experiment, 20.0 mL of 0.0060 M $CaCl_2$ and 20.0 mL of 0.0050 M Na_2SO_4 are mixed together. The trial ion product $\left(\text{trial } K_{sp}\right)$ is

    A. 7.5×10^{-6} and a precipitate will form.
    B. 7.5×10^{-6} and a precipitate will not form.
    C. 3.0×10^{-5} and a precipitate will form.
    D. 3.0×10^{-5} and a precipitate will not form.

19. Which of the following ions could be added to an aqueous mixture containing Pb^{2+} and Ba^{2+} to separate the ions by precipitating one of them?

    A. I^-
    B. NO_3^-
    C. PO_4^{3-}
    D. SO_4^{2-}

20. In which of the following would solid AgCl be **most** soluble?

    A.   1 M HCl
    B.   1 M $MgCl_2$
    C.   1 M $AgNO_3$
    D.   1 M NH_4NO_3

21. Which of the following is a property of a base?

    A.   a sour taste
    B.   turns litmus red
    C.   the ability to neutralize CH_3COOH
    D.   the ability to react with Zn to produce $H_{2(g)}$

22. Consider the following acid-base reaction:

$$HSO_3^- + HF \rightleftharpoons H_2SO_3 + F^-$$
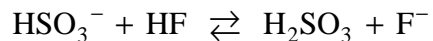
The order of Brönsted-Lowry acids and bases in this equation is

A. acid + base $\rightleftharpoons$ acid + base
B. acid + base $\rightleftharpoons$ base + acid
C. base + acid $\rightleftharpoons$ base + acid
D. base + acid $\rightleftharpoons$ acid + base

23. Which equation represents a neutralization reaction?

A. $Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2(s)}$

B. $HCl_{(aq)} + NH_{3(aq)} \rightarrow NH_4Cl_{(aq)}$

C. $BaI_{2(aq)} + MgSO_{4(aq)} \rightarrow BaSO_{4(s)} + MgI_{2(aq)}$

D. $MnO_4^-{}_{(aq)} + 5Fe^{2+}_{(aq)} + 8H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 5Fe^{3+}_{(aq)} + 4H_2O_{(l)}$

24. The conjugate acid of OH^- is

A. H^+
B. O^{2-}
C. H_2O
D. H_3O^+

25. Which of the following 0.10 M solutions will have the **greatest** electrical conductivity?

A. HF
B. NH_3
C. NaOH
D. C_6H_5COOH

26. Which of the following 0.10 M solutions is the **most** acidic?

    A. $AlCl_3$
    B. $FeCl_3$
    C. $CrCl_3$
    D. NH_4Cl

27. The amphiprotic ion $HSeO_3^-$ can undergo hydrolysis according to the following equations:

$HSeO_3^- + H_2O \rightleftarrows H_2SeO_3 + OH^-$	K_1
$HSeO_3^- + H_2O \rightleftarrows SeO_3^{2-} + H_3O^+$	K_2

An aqueous solution of $HSeO_3^-$ is found to be acidic. This observation indicates that when it is added to water, $HSeO_3^-$ behaves **mainly** as a

    A. proton donor, and K_1 is less than K_2
    B. proton donor, and K_1 is greater than K_2
    C. proton acceptor, and K_1 is less than K_2
    D. proton acceptor, and K_1 is greater than K_2

28. If OH^- is added to a solution, the $\left[H_3O^+\right]$ will

    A. remain constant.
    B. adjust such that $\left[H_3O^+\right] = \dfrac{\left[OH^-\right]}{K_w}$
    C. increase such that $\left[H_3O^+\right]\left[OH^-\right] = K_w$
    D. decrease such that $\left[H_3O^+\right]\left[OH^-\right] = K_w$

29. The pH of 0.20 M HNO_3 is

    A. 0.20
    B. 0.63
    C. 0.70
    D. 1.58

OVER

30. The K_b expression for HPO_4^{2-} is

A. $K_b = \dfrac{\left[PO_4^{3-}\right]\left[H_3O^+\right]}{\left[HPO_4^{2-}\right]}$

B. $K_b = \dfrac{\left[HPO_4^{2-}\right]\left[OH^-\right]}{\left[H_2PO_4^-\right]}$

C. $K_b = \dfrac{\left[H_2PO_4^-\right]\left[OH^-\right]}{\left[HPO_4^{2-}\right]}$

D. $K_b = \dfrac{\left[HPO_4^{2-}\right]\left[H_3O^+\right]}{\left[PO_4^{3-}\right]}$

Use the following diagram to answer question 31.
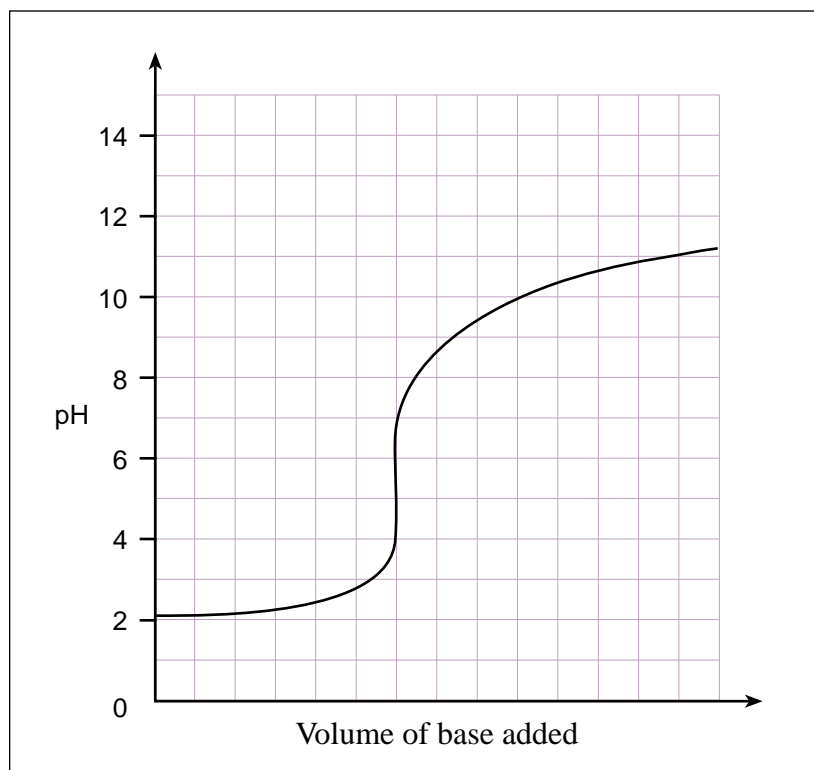
31. Which of the following indicators should be used in the titration represented by the above titration curve?

A. orange IV
B. methyl red
C. phenolphthalein
D. alizarin yellow

32. In a titration, 10.0 mL of $H_2SO_{4(aq)}$ is required to neutralize 0.0400 mol of NaOH. From this data, the $[H_2SO_4]$ is

    A. 0.0200 M
    B. 2.00 M
    C. 4.00 M
    D. 8.00 M

33. Which of the following acid-base indicators has a transition point between pH 7 and pH 9 ?

    A. ethyl red, $K_a = 8.0 \times 10^{-2}$
    B. congo red, $K_a = 9.0 \times 10^{-3}$
    C. cresol red, $K_a = 1.0 \times 10^{-8}$
    D. alizarin blue, $K_a = 7.0 \times 10^{-11}$

34. Which of the following acid-base pairs would result in an equivalence point with pH greater than 7.0 ?

    A. HCl and LiOH
    B. HNO_3 and NH_3
    C. $HClO_4$ and NaOH
    D. CH_3COOH and KOH

35. Which of the following represents a buffer equilibrium?

    A. $HI + H_2O \rightleftarrows H_3O^+ + I^-$
    B. $HCl + H_2O \rightleftarrows H_3O^+ + Cl^-$
    C. $HCN + H_2O \rightleftarrows H_3O^+ + CN^-$
    D. $HClO_4 + H_2O \rightleftarrows H_3O^+ + ClO_4^-$

36. Which of the following oxides forms a basic solution?

    A. K_2O
    B. CO_2
    C. SO_3
    D. NO_2

37. Consider the following redox equation:

$$Br_2 + SO_2 + Na_2SO_4 + 2H_2O \rightarrow 2H_2SO_4 + 2NaBr$$
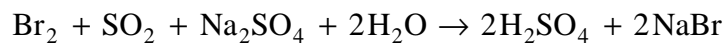
    Which of the following is gaining electrons?

    A. Br_2
    B. SO_2
    C. H_2O
    D. Na_2SO_4
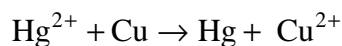
38. Referring to the Data Booklet, which of the following can act as an oxidizing agent but not as a reducing agent?

    A. Zn
    B. Cl^-
    C. Sn^{2+}
    D. Fe^{3+}

39. The reaction that occurs when pieces of lead, zinc, copper and silver are placed in a solution of $Ni(NO_3)_2$ is

    A. $Pb + Ni^{2+} \rightarrow Pb^{2+} + Ni$
    B. $Zn + Ni^{2+} \rightarrow Zn^{2+} + Ni$
    C. $Cu + Ni^{2+} \rightarrow Cu^{2+} + Ni$
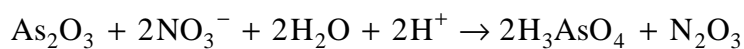   D. $2Ag + Ni^{2+} \rightarrow 2Ag^+ + Ni$

40. Consider the following redox reaction:

$$Hg^{2+} + Cu \rightarrow Hg + Cu^{2+}$$

In this reaction, Hg^{2+} is a

A. weaker reducing agent than Cu^{2+}
B. weaker oxidizing agent than Cu^{2+}
C. stronger reducing agent than Cu^{2+}
D. stronger oxidizing agent than Cu^{2+}

41. Consider the following redox reaction:

$$As_2O_3 + 2NO_3^- + 2H_2O + 2H^+ \rightarrow 2H_3AsO_4 + N_2O_3$$

In this reaction, nitrogen

A. loses electrons and increases in oxidation number.
B. gains electrons and increases in oxidation number.
C. loses electrons and decreases in oxidation number.
D. gains electrons and decreases in oxidation number.

42. In a redox reaction, ClO^- was converted to Cl^- in a basic solution. The balanced half-reaction for this process is

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

OVER

Use the following diagram to answer questions 43, 44 and 45.

$1.0 \text{ M Au(NO}_3)_{3(aq)}$ $1.0 \text{ M Pb(NO}_3)_{2(aq)}$
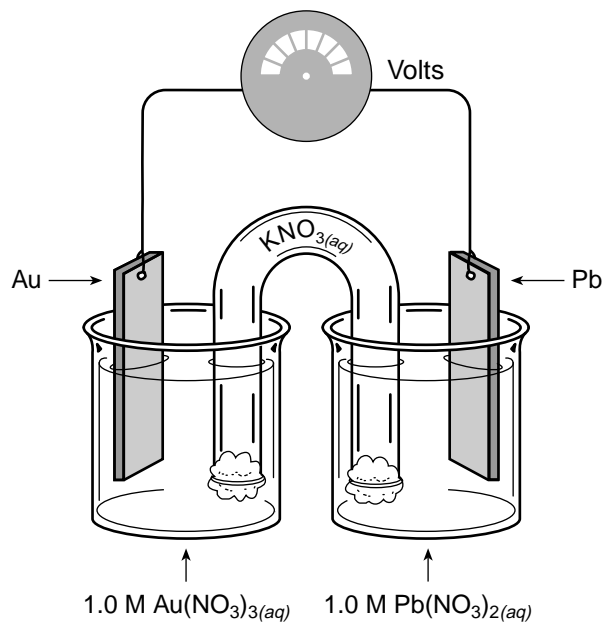
43. As the cell operates,

    A. NO_3^- and K^+ will migrate toward the Pb half-cell.

    B. NO_3^- and K^+ will migrate toward the Au half-cell.

    C. NO_3^- will migrate toward the Pb half-cell and K^+ will migrate toward the Au half-cell.

    D. NO_3^- will migrate toward the Au half-cell and K^+ will migrate toward the Pb half-cell.

44. The initial voltage is

    A.   −1.37 V
    B.   0.00 V
    C.   1.37 V
    D.   1.63 V

45. The direction of the electron flow is

    A.   from Au to Pb through the wire.
    B.   from Pb to Au through the wire.
    C.   from Au to Pb through the salt bridge.
    D.   from Pb to Au through the salt bridge.

46. A student attempted to determine the $E°$ (volts) of the following half-reaction:

$$Pd^{2+} + 2e^- \rightarrow Pd$$
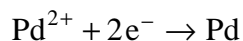
She recorded the following:

1. $Pd^{2+} + Cu \rightarrow Pd + Cu^{2+}$
2. $Pd^{2+} + Au \rightarrow$ no reaction
3. $Pd^{2+} + Hg \rightarrow$ no reaction

Based on the above, the $E°$ (volts) of a Pd half-cell is

A. less than 0.34 V.
B. greater than 1.50 V.
C. greater than 0.85 V but less than 1.50 V.
D. greater than 0.34 V but less than 0.85 V.

47. The principal function of a fuel cell is to

A. produce fuel.
B. electrolyze fuel.
C. produce hydrogen.
D. produce electricity.

48. If a piece of nickel is to be gold-plated using an electrolytic process, which half-reaction occurs at the cathode?

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

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 reaction:

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$
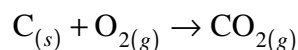
State one factor that would increase the rate of the above reaction. Use collision theory to explain the increase in rate. **(2 marks)**

_____

_____

_____

_____

_____

Score for Question 1:

1. _____
   (2)

2. Define and give an example of a *homogeneous* reaction. **(2 marks)**

_____

_____

_____

_____

_____

Score for Question 2:

2. _____
   (2)

3. Consider the following system:

$$CO_{2(g)} \rightleftarrows CO_{2(aq)} + \text{heat}$$

List **two** ways in which more CO_2 could be dissolved in water. **(2 marks)**

i) _____

ii) _____

4. In an experiment, 0.200 mol of $CO_{(g)}$ and 0.400 mol of $O_{2(g)}$ are placed in a 1.00 L container and the following equilibrium is achieved:

$$2CO_{(g)} + O_{2(g)} \rightleftarrows 2CO_{2(g)}$$
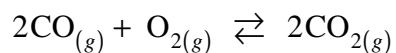
At equilibrium, the $[CO_2]$ is found to be 0.160 mol/L. Calculate the value of K_{eq}.
(3 marks)

OVER

5. In an experiment, a student pipettes a sample of saturated $MgBr_2$ solution into a beaker and evaporates the sample to dryness. He recorded the following data:

Volume of saturated $MgBr_{2(aq)}$	25.00 mL
Mass of beaker	89.05 g
Mass of beaker and residue	93.47 g

Calculate the solubility of $MgBr_2$ in moles per litre. **(3 marks)**

Score for
Question 5:

5. _____
(3)

6. What is the solubility of $CaCO_3$ in g/L? **(3 marks)**

Score for
Question 6:

6. _____
(3)

7. Neutral red, HInd, is an acid-base indicator.

   a) Write an equation to represent the equilibrium of this indicator in water. **(1 mark)**

   b) What colour would this indicator be in 0.1 M NaOH ? **(1 mark)**

8. Calculate the pH of 0.20 M CH$_3$COOH. **(3 marks)**

OVER

9. Explain why 'normal' rain water is slightly acidic. Use an equation to support your answer. **(2 marks)**

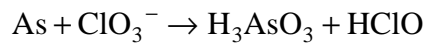10. Calculate the mass of solid NaOH needed to neutralize 250.0 mL of 0.125 M $H_2C_2O_4$. **(3 marks)**

11. Balance the following redox reaction occurring in an acidic solution. **(4 marks)**

$$As + ClO_3^- \rightarrow H_3AsO_3 + HClO$$

12. In the electrolysis of 1.0 M LiF, the products are oxygen gas and hydrogen gas.

a) Write the anode half-reaction and include the $E°$ value. **(1 mark)**

b) Write the cathode half-reaction and include the $E°$ value. **(1 mark)**

c) Calculate the minimum voltage required for this electrolysis. **(1 mark)**

END OF EXAMINATION