INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

AUGUST 1998

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

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

		Value	Suggested Time
PART A:	48 multiple-choice questions	48	70
PART B:	10 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. Computers, calculators with a QWERTY keyboard, and electronic writing pads will not be allowed. Students must not bring any external devices to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, or external keyboards. Students may have more than one calculator available during the examination. Calculators may not be shared, and communication between calculators is prohibited during the examination. 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. Consider the following reaction:

$$HgO_{(s)} \rightarrow Hg_{(\ell)} + \frac{1}{2} O_{2(g)}$$

The rate of this reaction can be expressed as

A. $\text{rate} = \left[O_2\right]^{\frac{1}{2}}$

B. $\text{rate} = \frac{\Delta\left[O_2\right]}{\Delta t}$

C. $\text{rate} = \frac{\Delta\left[Hg\right]}{\Delta t}$

D. $\text{rate} = \frac{\Delta\left[HgO\right]}{\Delta t}$

2. Which of the following would react most rapidly?

A. Powdered Zn in 1.0 M HCl at 25° C
B. Powdered Zn in 2.0 M HCl at 40° C
C. A lump of Zn in 2.0 M HCl at 25° C
D. A lump of Zn in 1.0 M HCl at 40° C

3. When a collision occurs between two reactant species which possess between them the minimum kinetic energy, called activation energy, a product does not always form. This may be a result of

A. low temperature.
B. small surface area.
C. low concentrations.
D. unfavourable geometry.

OVER

4. Addition of a catalyst to a reaction increases the rate because it

   A. increases the value of ΔH.
   B. decreases the value of ΔH.
   C. provides an alternate reaction mechanism with a lower activation energy.
   D. provides an alternate reaction mechanism with a higher activation energy.

5. Consider the following equilibrium reaction:

$$PCl_{5(g)} + \text{energy} \rightleftarrows PCl_{3(g)} + Cl_{2(g)}$$

   The temperature of this system is decreased. What is the immediate effect on the reaction rates?

   A. Both forward and reverse rates increase.
   B. Both forward and reverse rates decrease.
   C. Forward rate decreases while reverse rate increases.
   D. Forward rate increases while reverse rate decreases.

6. Which of the following describes all chemical equilibrium systems?

   A. The mass of the reactants equals the mass of the products.
   B. The species are present in the same ratio as in the balanced equation.
   C. The rate of the forward reaction equals the rate of the reverse reaction.
   D. The concentration of the reactants equals the concentration of the products.

7. In which reaction is entropy decreasing?

   A. $H_2O_{(\ell)} \rightarrow H_2O_{(g)}$
   B. $N_2O_{4(g)} \rightarrow 2\,NO_{2(g)}$
   C. $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$
   D. $Fe^{3+}{}_{(aq)} + SCN^{-}{}_{(aq)} \rightarrow FeSCN^{2+}{}_{(aq)}$

8. Consider the following equilibrium:

$$C_{(s)} + 2\,H_{2(g)} \rightleftarrows CH_{4(g)}$$

The addition of H_2 will cause the equilibrium to shift to the

A. left and $[CH_4]$ will increase.
B. left and $[CH_4]$ will decrease.
C. right and $[CH_4]$ will increase.
D. right and $[CH_4]$ will decrease.

9. Consider the following equilibrium:

$$2\,HBr_{(g)} \rightleftarrows H_{2(g)} + Br_{2(g)}$$

Initially, 0.100 mol HBr is placed into a 2.0 L container. At equilibrium, there are 0.040 mol HBr present. The equilibrium concentration of H_2 is

A. 0.0050 mol/L
B. 0.010 mol/L
C. 0.015 mol/L
D. 0.030 mol/L

10. Consider the following equilibrium:

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

The equilibrium expression is

A. $K_{eq} = \dfrac{[SO_3]}{[SO_2][O_2]}$

B. $K_{eq} = \dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$

C. $K_{eq} = \dfrac{[SO_2][O_2]}{[SO_3]}$

D. $K_{eq} = \dfrac{[SO_2]^2[O_2]}{[SO_3]^2}$

OVER

11. Consider the following equilibrium:

$$\text{energy} + SbCl_{5(g)} \rightleftarrows SbCl_{3(g)} + Cl_{2(g)}$$

The K_{eq} decreases when

A. $SbCl_5$ is added.
B. $SbCl_5$ is removed.
C. the temperature is increased.
D. the temperature is decreased.

12. Consider the following equilibrium:

$$2NO_{(g)} + 2H_{2(g)} \rightleftarrows N_{2(g)} + 2H_2O_{(g)} \qquad K_{eq} = 1.3 \times 10^2$$

A 1.0 L container is initially filled with 1.0 mol of each of the species in the reaction. The equilibrium shifts to the

A. left because Trial $K_{eq} > K_{eq}$
B. left because Trial $K_{eq} < K_{eq}$
C. right because Trial $K_{eq} > K_{eq}$
D. right because Trial $K_{eq} < K_{eq}$

13. In 0.20 M Na_2CrO_4 , the ion concentrations are

	$\left[Na^+\right]$	$\left[CrO_4^{2-}\right]$
A.	0.40 M	0.20 M
B.	0.20 M	0.20 M
C.	0.20 M	0.40 M
D.	0.40 M	0.80 M

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

A. H_2S
B. KNO_3
C. $ZnSO_4$
D. $Ca(OH)_2$

15. Which of the following 0.20 M solutions will **not** form a precipitate when mixed with an equal volume of 0.20 M $Sr(OH)_2$?

A. CaS
B. NH_4Cl
C. Na_2SO_4
D. $Ba(NO_3)_2$

16. Consider the following equilibrium:

$$SrF_{2(s)} \rightleftarrows Sr^{2+}_{(aq)} + 2F^{-}_{(aq)}$$

The equilibrium will shift left upon the addition of

A. $H_2O_{(\ell)}$
B. $SrF_{2(s)}$
C. $SrCl_{2(s)}$
D. $NaNO_{3(s)}$

17. Two ions found in hard water are Ca^{2+} and Mg^{2+}. Which of the following will precipitate only one of these ions?

A. I^-
B. S^{2-}
C. SO_4^{2-}
D. CO_3^{2-}

18. At $25°C$, the solubility of AgBr is

A. 2.9×10^{-25} M
B. 5.4×10^{-13} M
C. 2.7×10^{-13} M
D. 7.3×10^{-7} M

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19. Which of the following saturated solutions has the greatest $\left[CO_3^{2-}\right]$?

A. $SrCO_3$
B. $CaCO_3$
C. $BaCO_3$
D. $MgCO_3$

20. Which of the following will neutralize H_2SO_4 and form a precipitate at the same time?

A. NH_3
B. KOH
C. $CaCl_2$
D. $Sr(OH)_2$

21. Both acidic and basic solutions

A. taste sour.
B. feel slippery.
C. conduct electricity.
D. turn blue litmus red.

22. The conjugate acid of the monohydrogen phosphate ion, HPO_4^{2-}, is

A. PO_4^{3-}
B. $H_2PO_4^{-}$
C. $H_2PO_4^{2-}$
D. $H_2PO_4^{3-}$

23. Which of the following is the strongest base?

A. HSO_4^{-}
B. HSO_3^{-}
C. HCO_3^{-}
D. $HC_2O_4^{-}$

24. Which of the following are amphiprotic in aqueous solution?

I	HBr
II	H_2O
III	HCO_3^-
IV	$H_2C_6H_5O_7^-$

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

25. What is the value of K_w at $25°C$?

A. 1.0×10^{-14}
B. 1.0×10^{-7}
C. 7
D. 14

26. Consider the following equilibrium:

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

A small amount of $Fe(H_2O)_6^{3+}$ is added to water and equilibrium is re-established. Which of the following represent the changes in the ion concentrations?

	$[H_3O^+]$	$[OH^-]$
A.	increases	increases
B.	increases	decreases
C.	decreases	decreases
D.	decreases	increases

OVER

27. Consider the following equilibrium:

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

When the temperature of water is changed, the pH decreases. Which of the following explains this pH change?

A. Temperature and K_w both increase.
B. Temperature and K_w both decrease.
C. Temperature increases and K_w decreases.
D. Temperature decreases and K_w increases.

28. The pOH of a 0.015 M HCl solution is

A. 0.97
B. 1.82
C. 12.18
D. 13.03

29. What is the value of K_b for $HC_6H_5O_7^{2-}$?

A. 5.9×10^{-10}
B. 2.4×10^{-8}
C. 4.1×10^{-7}
D. 1.7×10^{-5}

30. Which of the following will produce an acidic solution?

A. KNO_3
B. NH_4NO_3
C. $Ca(NO_3)_2$
D. $Ba(NO_3)_2$

31. Consider the following equilibrium for an indicator:

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

In a solution with a pH of 6.8, the colour of bromthymol blue is

A. blue because $[HInd] = [Ind^-]$
B. green because $[HInd] = [Ind^-]$
C. green because $[HInd] < [Ind^-]$
D. yellow because $[HInd] > [Ind^-]$

32. The indicator with $K_a = 4 \times 10^{-8}$ is

A. neutral red.
B. methyl orange.
C. indigo carmine.
D. phenolphthalein.

33. A 25.00 mL sample of $Sr(OH)_2$ is completely neutralized by 28.60 mL of 0.100 M HCl. The concentration of the $Sr(OH)_2$ is

A. 1.43×10^{-3} M
B. 2.86×10^{-3} M
C. 5.72×10^{-2} M
D. 1.14×10^{-1} M

34. A student mixes 15.0 mL of 0.100 M NaOH with 10.0 mL of 0.200 M HCl. The resulting solution is

A. basic.
B. acidic.
C. neutral.
D. amphiprotic.

OVER

35. A buffer solution can be prepared by combining equal moles of a

A. strong acid and a strong base.
B. weak acid and its conjugate base.
C. strong base and its conjugate acid.
D. strong acid and its conjugate base.

36. Which of the following could be the pH of a sample of acid rain?

A. 0
B. 4
C. 7
D. 10

37. A product of the oxidation of MnO_2 is

A. Mn
B. Mn^{2+}
C. MnO_4^-
D. Mn_2O_3

38. Consider the following:

$$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$$

In the redox reaction above,

A. hydrogen is both reduced and oxidized.
B. manganese is both reduced and oxidized.
C. manganese is reduced and hydrogen is oxidized.
D. manganese is oxidized and hydrogen is reduced.

39. The oxidation number of phosphorus in $Na_4P_2O_7$ is

A. −10
B. −5
C. +5
D. +10

40. Consider the following:

$$Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + SO_4^{2-} + 4H^+$$

In this redox reaction, the chemical species SO_2 is

A. reduced and the oxidation number of oxygen increases.
B. reduced and the oxidation number of oxygen decreases.
C. oxidized and the oxidation number of sulphur increases.
D. oxidized and the oxidation number of sulphur decreases.

41. In an experiment to determine the relative strength of oxidizing agents, three metals, Ag, Ru and Pd were placed into solutions containing a cation of the other two metals. The results were recorded in the following data table:

METAL \ SOLUTION	Pd^{2+}	Ru^{2+}	Ag^+
Ag	reaction	no reaction	
Ru	reaction		reaction
Pd		no reaction	no reaction

The relative strength of oxidizing agents is

A. $Ru > Ag > Pd$
B. $Pd > Ag > Ru$
C. $Ru^{2+} > Ag^+ > Pd^{2+}$
D. $Pd^{2+} > Ag^+ > Ru^{2+}$

42. Consider the following:

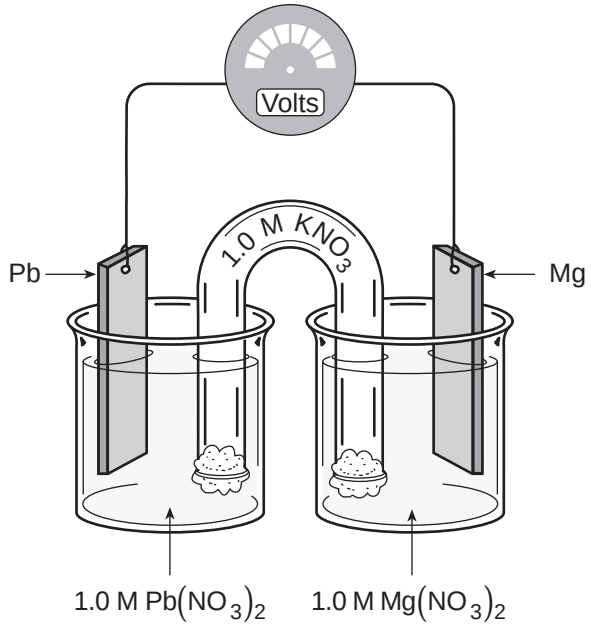
$$4ReO_3 + OsO_4 + 2H_2O \rightarrow 4ReO_4^- + OsO_2 + 4H^+$$

The equation for the oxidation half-reaction is

A. $ReO_3 + H_2O \rightarrow ReO_4^- + 2H^+ + e^-$
B. $ReO_3 + H_2O + e^- \rightarrow ReO_4^- + 2H^+$
C. $OsO_4 + 4H^+ \rightarrow OsO_2 + 2H_2O + 4e^-$
D. $OsO_4 + 4H^+ + 4e^- \rightarrow OsO_2 + 2H_2O$

OVER

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



43. In the electrochemical cell above, the reaction at the anode is

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

B $Pb^{2+} + 2e^- \rightarrow Pb$

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

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

44. The E° of the cell above is

A. -2.50 V

B. -2.24 V

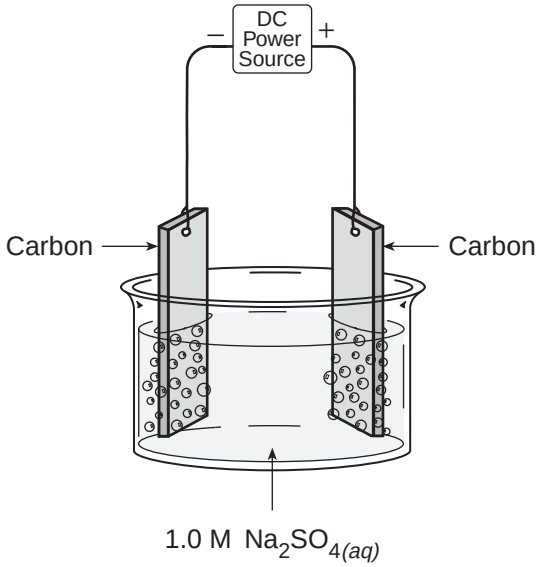
C. $+2.24$ V

D. $+2.50$ V

45. As the cell operates, the mass of

A. both the lead and magnesium electrodes increase.
B. both the lead and magnesium electrodes decrease.
C. the lead electrode decreases and the magnesium electrode increases.
D. the lead electrode increases and the magnesium electrode decreases.

Use the following diagram to answer question 46.



46. The gas produced at the anode is

A. oxygen.
B. hydrogen.
C. water vapour.
D. sulphur dioxide.

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47. The cathodic protection of iron may be accomplished by using

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

48. To determine $\left[Sn^{2+}\right]$ by redox titration, a suitable reagent that may be used is an acidified solution of

A. I^-
B. Co^{2+}
C. Cr^{3+}
D. $Cr_2O_7{}^{2-}$

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

OVER

PART B: WRITTEN RESPONSE

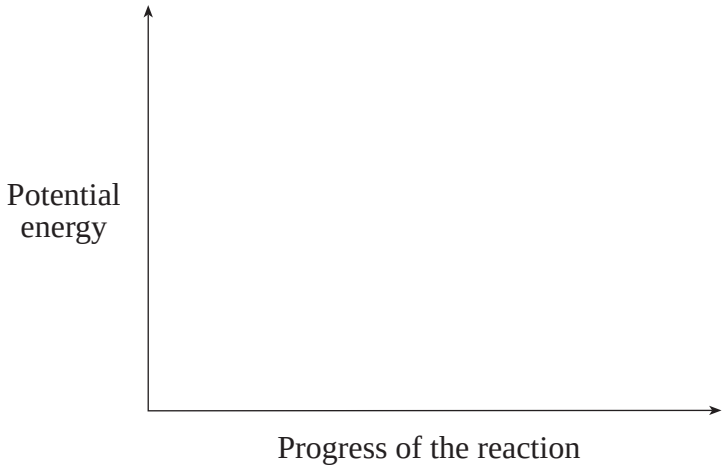
Value: 32 marks **Suggested Time: 50 minutes**

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. Sketch a potential energy diagram for an endothermic reaction in the space below.

   On your diagram, label:

   i) the energy of the activated complex
   ii) the activation energy
   iii) ΔH **(3 marks)**



2. Consider the following equilibrium:

$$H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)} \qquad K_{eq} = 49$$

A 1.00 L container is initially filled with 0.180 mol HI.
Calculate the concentration of HI at equilibrium. **(4 marks)**

OVER

3. What is the maximum $\left[Mg^{2+}\right]$ that can exist in a solution with a pOH of 2.00? **(3 marks)**

4. When 1.00 L of a saturated solution of CaF_2 was evaporated to dryness, 2.66×10^{-2} g of residue was formed. Calculate the value of K_{sp}. **(3 marks)**

5. Consider the reaction between HCO_3^- and $HC_2O_4^-$.

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

b) Identify the Brönsted-Lowry acids in the reaction above. **(1 mark)**

c) Explain why products are favoured in the reaction above. **(1 mark)**

_____

_____

OVER

6. A 3.50×10^{-3} M sample of the unknown acid, HA, has a pH of 2.90.
   Calculate the value of K_a and identify this acid. **(4 marks)**

7. a) Write two equations representing the acidic and basic hydrolysis of $NaHSO_{3(s)}$. **(2 marks)**

b) Use calculations to determine if the solution is acidic or basic. **(2 marks)**

OVER

8. Define the term *oxidation-reduction reaction*. **(2 marks)**

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

$$In_2O_3 \rightarrow In \quad \text{(basic)}$$

10. Consider the following:

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

A 20.00 mL sample of a solution containing $\left[Fe^{2+}\right]$ was titrated using 0.0184 M $KMnO_4$ and the following data were collected.

	TRIAL 1	TRIAL 2	TRIAL 3
Volume of $KMnO_{4(aq)}$ used	29.07 mL	26.55 mL	26.45 mL

Calculate the concentration of Fe^{2+} in the solution. **(3 marks)**

END OF EXAMINATION