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Place Personal Education Number (PEN) here.

Chemistry 12

AUGUST 2005

Course Code = CH

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BRITISH COLUMBIA

Student Instructions

1. Place the stickers with your Personal Education Number (PEN) in the allotted spaces above. **Under no circumstance is your name or identification, other than your Personal Education 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. 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 .
5. 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.

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Chemistry 12

AUGUST 2005

Course Code = CH

Question 1							
0	1	2	3	4	5	(.5)	NR
☐	☐	☐	☐	☐	☐	☐	☐

Question 2					
0	1	2	3	(.5)	NR
☐	☐	☐	☐	☐	☐

Question 3					
0	1	2	3	(.5)	NR
☐	☐	☐	☐	☐	☐

Question 4						
0	1	2	3	4	(.5)	NR
☐	☐	☐	☐	☐	☐	☐

Question 5							
0	1	2	3	4	5	(.5)	NR
☐	☐	☐	☐	☐	☐	☐	☐

Question 6					
0	1	2	3	(.5)	NR
☐	☐	☐	☐	☐	☐

Question 7						
0	1	2	3	4	(.5)	NR
☐	☐	☐	☐	☐	☐	☐

Question 8					
0	1	2	3	(.5)	NR
☐	☐	☐	☐	☐	☐

General Instructions

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

2. 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.

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

4. Ensure that you use language and content appropriate to the purpose and audience of this examination. Failure to comply may result in your paper being awarded a zero.

5. This examination is designed to be completed in **two hours**. *Students may, however, take up to 30 minutes of additional time to finish*.

CHEMISTRY 12 PROVINCIAL EXAMINATION

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

		Value	Suggested Time
PART A:	60 multiple-choice questions	60	80
PART B:	8 written-response questions	30	40
	Total:	**90 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 Brønsted-Lowry Acids and Bases
   - Acid-Base Indicators
   - Standard Reduction Potentials of Half-cells

   No other reference materials or tables are allowed.

3. **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 be capable of performing graphing functions. Computers, calculators with a QWERTY keyboard or symbolic manipulation abilities, and electronic writing pads will not be allowed. Students must not bring any external devices (peripherals) to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, CD-ROMs, libraries or external keyboards. Students may have more than one calculator available during the examination, of which one may be a scientific calculator. Calculators may not be shared and 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.

   Calculators must not have any information programmed into memory that would not be acceptable in paper form. Specifically, calculators must not have any built-in notes, definitions, or libraries. There is no requirement to clear memories at the beginning of the examination but the use of calculators with built-in notes is equivalent to the use of notes in paper form. Any student deemed to have cheated on a provincial examination will receive a “0” on that examination and will be permanently disqualified from the Provincial Examination Scholarship Program.

PART A: MULTIPLE CHOICE

Value: 60 marks **Suggested Time: 80 minutes**

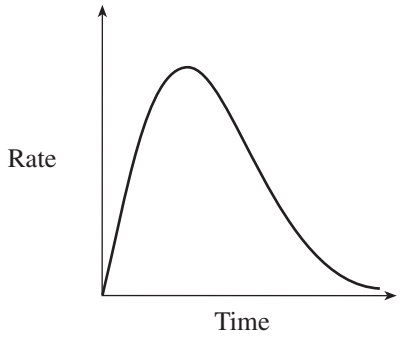
INSTRUCTIONS:	For each question, select the **best** answer and record your choice on the Response Form provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. Which of the following could **not** be units for reaction rate?

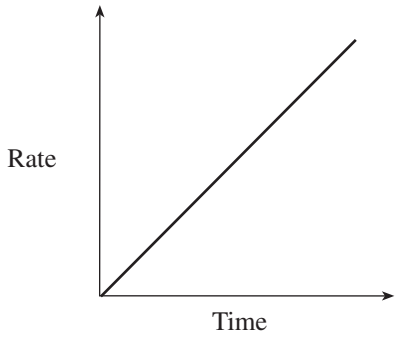
   A. sec^{-1}
   B. g/mL
   C. M/min
   D. °C/hour

2. Which of the following represents the typical mathematical relationship between reaction rate and time?

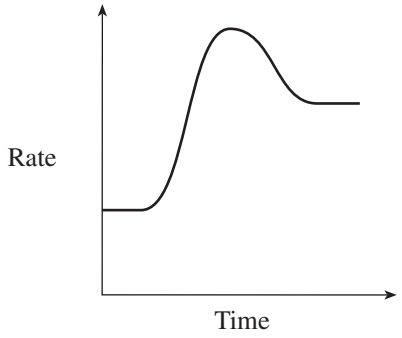
A.



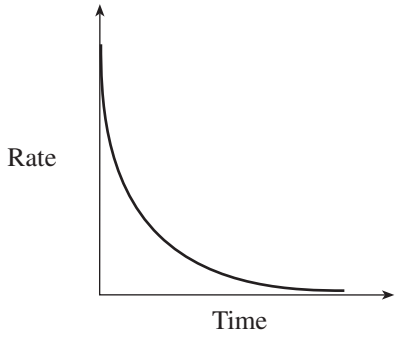
B.



C.



D.



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3. Consider the following reaction:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

In two different experiments, equal moles of Zn and equal volumes of HCl are reacted. After 2 minutes, the volume of H_2 produced is recorded as follows:

	Zn	Temp	[HCl]	Volume H_2 (mL)
Experiment 1	strip	10°C	10.0 M	10.6
Experiment 2	powdered	15°C	3.0 M	7.3

Which of the following factors explains why the rate in Experiment 1 is different than the rate in Experiment 2?

A. [HCl]
B. temperature
C. nature of reactants
D. surface area of Zn

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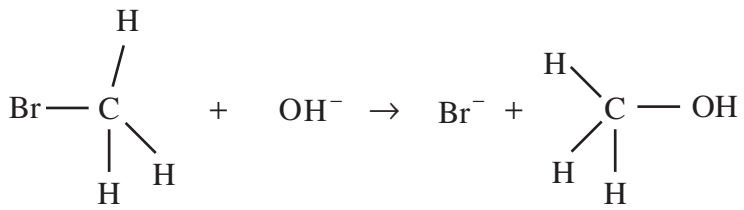
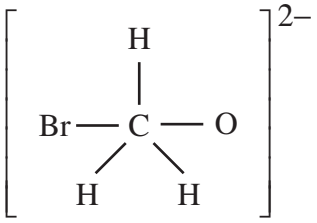
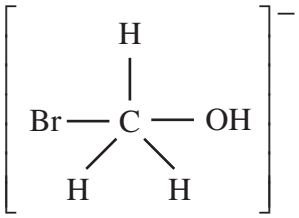
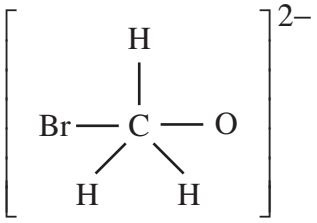
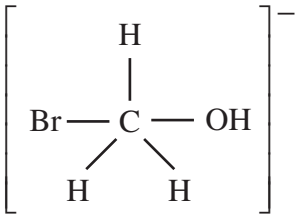
4. Consider the following reaction:



Which of the following could be true of the activated complex?

	Structure	PE (relative to reactants)
A.		lower
B.		lower
C.		higher
D.		higher

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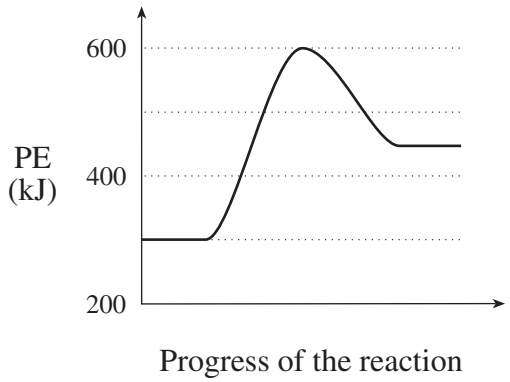
5. Consider the following PE diagram:



Which of the following is true for the forward reaction?

	ΔH	E_a (kJ)
A.	−150	300
B.	−150	600
C.	+150	300
D.	+150	600

6. Which of the following would have a positive value for ΔH?

I.	the evaporation of water
II.	the burning of a match
III.	the explosive reaction between H_2 and O_2
IV.	a chemical cold pack

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

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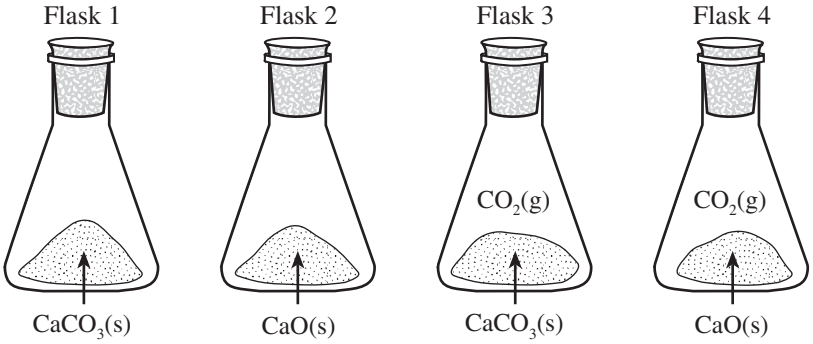
7. Which of the following represents the value for the activation energy of the forward reaction in an equilibrium system?

A. $E_{a(forward)} = E_{a(reverse)} + (\Delta H)$
B. $E_{a(forward)} = E_{a(reverse)} - (\Delta H)$
C. $E_{a(forward)} = (\Delta H) - E_{a(reverse)}$
D. $E_{a(forward)} = -(\Delta H) - E_{a(reverse)}$

8. Consider the following equilibrium:

$$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g)$$

In which of the flasks will this equilibrium be established?



A. 1, 2, 3 only
B. 1, 2, 4 only
C. 1, 3, 4 only
D. 3, 4 only

9. Which of the following forward reactions demonstrates decreasing enthalpy and increasing entropy?

A. $Hg(\ell) + \frac{1}{2}O_2(g) \overset{?}{\rightleftarrows} HgO(s) \qquad \Delta H = -91\,kJ$

B. $2HCl(g) \overset{?}{\rightleftarrows} H_2(g) + Cl_2(g) \qquad \Delta H = +185\,kJ$

C. $2HgO(s) \overset{?}{\rightleftarrows} 2Hg(\ell) + O_2(g) \qquad \Delta H = +182\,kJ$

D. $2SO_3(g) \overset{?}{\rightleftarrows} 2SO_2(g) + O_2(g) \qquad \Delta H = -200\,kJ$

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Use the following equilibrium system to answer questions 10 to 12.

$$4NH_3(g) + 3O_2(g) \rightleftarrows 2N_2(g) + 6H_2O(\ell) \qquad \Delta H = -1530\,kJ$$

10. Which of the following would cause the amount of NH_3 at equilibrium to increase?

    A. an increase in $[O_2]$
    B. a decrease in volume
    C. a decrease in temperature
    D. an increase in temperature

11. What happens when O_2 is added to the above system?

	Equilibrium	$[N_2]$
A.	no shift	unchanged
B.	shifts right	decreases
C.	shifts right	increases
D.	shifts left	increases

12. If some O_2 is injected into the system, what happens to the forward and reverse reaction rates during the shift to re-establish equilibrium?

	Forward Reaction Rate	Reverse Reaction Rate
A.	increases	decreases
B.	decreases	decreases
C.	increases	increases
D.	decreases	increases

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13. Consider the equilibrium expression $K_{eq\mathbf{1}}$ for reaction 1:

$$SO_2(g) + \tfrac{1}{2}O_2(g) \rightleftarrows SO_3(g)$$

and the equilibrium expression $K_{eq\mathbf{2}}$ for reaction 2:

$$2SO_3(g) \rightleftarrows O_2(g) + 2SO_2(g)$$

How is $K_{eq\mathbf{2}}$ related to $K_{eq\mathbf{1}}$?

A. $K_{eq\mathbf{2}} = K_{eq\mathbf{1}}$

B. $K_{eq\mathbf{2}} = \left(K_{eq\mathbf{1}}\right)^2$

C. $K_{eq\mathbf{2}} = \left(\dfrac{1}{K_{eq\mathbf{1}}}\right)$

D. $K_{eq\mathbf{2}} = \left(\dfrac{1}{K_{eq\mathbf{1}}}\right)^2$

14. Which of the following describes how a K_{eq} value is related to the relative concentrations of reactants and products?

	K_{eq} value	Relative Concentration
I.	large	[products] > [reactants]
II.	large	[reactants] > [products]
III.	small	[products] > [reactants]
IV.	small	[reactants] > [products]

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

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15. Consider the following equilibrium system:

$$N_2(g) + O_2(g) \rightleftarrows 2NO(g)$$

Under certain conditions, $K_{eq} = 1.0 \times 10^{-30}$. When conditions are changed, K_{eq} becomes 0.10. Which of the following could account for this?

A. $[N_2]$ was changed.
B. A catalyst was added.
C. Pressure was changed.
D. Temperature was changed.

16. Consider the following equilibrium system:

$$2H_2S(g) \rightleftarrows 2H_2(g) + S_2(g)$$

At equilibrium, a $2.0\,L$ reaction vessel contained 1.2×10^{-3} mol H_2S, 7.2×10^{-6} mol H_2 and 6.0×10^{-2} mol S_2. What is the value of K_{eq}?

A. 6.5×10^{-10}
B. 1.1×10^{-6}
C. 2.2×0^{-6}
D. 9.3×10^{5}

17. Consider the following equilibrium equation:

$$CaCO_3(s) \rightleftarrows CaO(s) + CO_2(g) \qquad K_{eq} = 0.10$$

Initially, $30.0\,g$ $CaCO_3$ were placed in a $2.0\,L$ container. What mass of CO_2 will be present at equilibrium?

A. $0.10\,g$ CO_2
B. $8.8\,g\,CO_2$
C. $15\,g$ CO_2
D. $2.2\,g$ CO_2

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18. The solubility of a solute is best determined from which type of solution?

A. a saturated solution
B. any solution at 25°C
C. an unsaturated solution
D. a supersaturated solution

19. What will be the $[Cl^-]$ when equal volumes of 0.10 M NaCl and 0.20 M $AlCl_3$ are combined?

A. 0.35 M
B. 0.15 M
C. 0.30 M
D. 0.70 M

20. Which equation represents the reaction between 0.2 M Na_2CO_3 and 0.2 M $Ba(NO_3)_2$?

A. $Na^+(aq) + NO_3^-(aq) \rightarrow NaNO_3(s)$
B. $Ba^{2+}(aq) + CO_3^{2-}(aq) \rightarrow BaCO_3(s)$
C. $Na_2CO_3(s) \rightarrow 2Na^+(aq) + CO_3^{2-}(aq)$
D. $Ba(NO_3)_2(aq) + Na_2CO_3(aq) \rightarrow BaCO_3(aq) + 2NaNO_3(s)$

21. Which of the following solutions could be used to separate the anions SO_4^{2-} and CO_3^{2-} from each other by precipitation?

A. $NaNO_3(aq)$
B. $AgNO_3(aq)$
C. $Fe(NO_3)_3(aq)$
D. $Ba(NO_3)_2(aq)$

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22. Which pair of ions would be suitable for removing the cations responsible for hard water?

A. H^+ and Cl^-
B. NO_3^- and I^-
C. S^{2-} and SO_4^{2-}
D. CO_3^{2-} and PO_4^{3-}

23. What is the K_{sp} expression for $Zn(OH)_2$?

A. $K_{sp} = [Zn^{2+}][OH^-]^2$
B. $K_{sp} = [Zn^{2+}]^2[OH^-]$
C. $K_{sp} = [Zn^{2+}][2OH^-]^2$
D. $K_{sp} = [Zn^{2+}] + 2[OH^-]^2$

24. Which compound will have the lowest solubility?

A. BeS
B. FeS
C. ZnS
D. Cs_2S

25. A solution is found to have an initial $[Pb^{2+}]$ of 6.6×10^{-3} M and a $[Br^-]$ of 5.0×10^{-4} M. What will be observed as the ions interact?

	Observation	Reason
A.	precipitate	Trial $K_{sp} > K_{sp}$
B.	precipitate	Trial $K_{sp} < K_{sp}$
C.	no precipitate	Trial $K_{sp} > K_{sp}$
D.	no precipitate	Trial $K_{sp} < K_{sp}$

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26. Which relationship can be used to calculate the maximum $[Ba^{2+}]$ that can exist in a solution of Na_3PO_4 ?

A. $[Ba^{2+}] = \sqrt[3]{\frac{K_{sp}}{[PO_4^{3-}]^2}}$

B. $[Ba^{2+}] = \sqrt{\frac{K_{sp}}{[PO_4^{3-}]}}$

C. $[Ba^{2+}] = \frac{K_{sp}}{[PO_4^{3-}]}$

D. $[Ba^{2+}] = \sqrt[3]{K_{sp}[PO_4^{3-}]^2}$

27. What is produced when CH_3NH_2 acts as a base in water?

A. CH_3NH^-

B. $CH_3NH_3^+$

C. $CH_3NH_2^+$

D. $CH_2NH_2^-$

28. What species will form when H^+ ions are in the presence of H_2O molecules?

A. HO^+

B. H_2O^+

C. H_3O^+

D. $H_2O_2^+$

29. What is the conjugate acid of the base $HAsO_4^{2-}$?

A. AsO_4^{3-}

B. $H_2AsO_4^{2-}$

C. $H_2AsO_4^-$

D. H_3AsO_4

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30. Which solution will have the greatest electrical conductivity?

A. 0.50 M HCl
B. 0.10 M RbOH
C. 0.50 M K_3PO_4
D. 2.0 M $C_6H_{12}O_6$

31. The following equilibrium favours the formation of products:

$$NH_2OH + CH_3NH_3^+ \rightleftarrows CH_3NH_2 + NH_3OH^+$$

Which species is the strongest acid?

A. NH_3OH^+
B. NH_2OH
C. CH_3NH_2
D. $CH_3NH_3^+$

32. Which of the following solutions would have the greatest $[OH^-]$?

A. 0.1M HCO_3^-
B. 0.1M HPO_4^{2-}
C. 0.1M $H_2PO_4^-$
D. 0.1M $H_2BO_3^-$

33. Given that the ionization of water is endothermic, which of the following is true if temperature is decreased?

	K_w	Reason
A.	decreases	equilibrium shifts left
B.	decreases	equilibrium shifts right
C.	increases	equilibrium shifts left
D.	increases	equilibrium shifts right

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34. Which of the following would be a typical pH of soda pop?

A. 1.0
B. 3.2
C. 6.8
D. 7.2

35. What is the $[KOH]$ in a KOH solution that has a $pH = 12.00$?

A. $0.010\,M$
B. $0.56\,M$
C. $2.0\,M$
D. $1.0 \times 10^{-12}\,M$

36. What is the $[H_3O^+]$ in $0.70\,M$ HCN ?

A. $0.70\,M$
B. $1.9 \times 10^{-5}\,M$
C. $1.0 \times 10^{-7}\,M$
D. $3.4 \times 10^{-10}\,M$

37. The S^{2-} ion is a relatively strong base with an equilibrium constant of 7.7×10^{-1}. What is the K_a value for HS^- ?

A. 1.3×10^{-14}
B. 9.1×10^{-8}
C. 1.1×10^{-7}
D. 7.7×10^{13}

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38. Which of the following is true as a result of the predominant hydrolysis of $NaHCO_3$?

	Solution	Reason
A.	basic	$K_a > K_b$
B.	basic	$K_b > K_a$
C.	acidic	$K_a > K_b$
D.	acidic	$K_b > K_a$

39. A salt forms in the reaction between $HF(aq)$ and $NaOH(aq)$. What is the net ionic equation for the hydrolysis of this salt?

A. $NaF(aq) \rightleftarrows Na^+(aq) + F^-(aq)$

B. $HF(aq) + H_2O(\ell) \rightleftarrows H_3O^+(aq) + F^-(aq)$

C. $F^-(aq) + H_2O(\ell) \rightleftarrows HF(aq) + OH^-(aq)$

D. $HF(aq) + NaOH(aq) \rightleftarrows NaF(aq) + H_2O(\ell)$

40. What is the K_a for the indicator that is yellow in its basic form and blue in its acid form?

A. 6×10^{-13}

B. 2×10^{-9}

C. 2×10^{-7}

D. 3×10^{-5}

41. What term is used to describe the point at which a chemical indicator changes colour?

A. titration point
B. transition point
C. equivalence point
D. stoichiometric point

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42. When 25.0 mL samples of the strong acid H_2SO_4 were titrated with 0.25 M NaOH the following results were obtained:

Titration	Volume of NaOH(aq)
1	47.2 mL
2	39.9 mL
3	40.1 mL

What is the concentration of the H_2SO_4 sample?

A. 0.20 M
B. 0.21 M
C. 0.40 M
D. 0.42 M

43. Which of the following equations describes the predominant reaction that occurs at the equivalence point of a titration between $CH_3COOH(aq)$ and $NaOH(aq)$?

A. $H^+(aq) + OH^-(aq) \rightleftarrows H_2O(\ell)$

B. $CH_3COO^-(aq) + H_2O(\ell) \rightleftarrows CH_3COOH(aq) + OH^-(aq)$

C. $CH_3COOH(aq) + NaOH(aq) \rightleftarrows NaCH_3COO(aq) + H_2O(\ell)$

D. $H^+(aq) + CH_3COO^-(aq) + Na^+(aq) + OH^-(aq) \rightleftarrows Na^+(aq) + CH_3COO^-(aq) + H_2O(\ell)$

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Use the following equilibrium equation and data to answer questions 44 and 45.

$HCN(aq)$	+	$H_2O(\ell)$	$\rightleftarrows$	$H_3O^+(aq)$	+	$CN^-(aq)$
1.0 M				2.2×10^{-5} M		2.2×10^{-5} M

44. Why is the solution above **not** considered to be a true buffer solution?

A. excessive [HCN]
B. excessive $[H_3O^+]$
C. insufficient $[CN^-]$
D. insufficient [HCN]

45. What could be added to 1.0 L of this solution in order for it to behave as a true buffer?

A. 1.0 mol HCl
B. 1.0 mol HCN
C. 1.0 mol H_3O^+
D. 1.0 mol NaCN

---

46. Which of the following equations correctly represents the reaction of a metallic oxide with water?

A. $K_2O + H_2O \rightarrow 2KOH$
B. $SO_3 + H_2O \rightarrow H_2SO_4$
C. $Na_2O + H_2O \rightarrow Na_2O_2 + H_2$
D. $NaOH + H_2O \rightarrow Na + 2H_2O$

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47. Identify the substance that is oxidized in the following equation:

$$Br_2 + SO_2 + Na_2SO_4 + 2H_2O \rightarrow 2H_2SO_4 + 2NaBr$$

A. Br_2
B. SO_2
C. H_2O
D. Na_2SO_4

48. What is the reducing agent in the following equation?

$$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$$

A. I_2
B. I^-
C. Fe^{2+}
D. Fe^{3+}

49. What is the oxidation number of C in the $C_3H_5O_2^-$ ion ?

A. $-\frac{1}{3}$
B. $-\frac{2}{3}$
C. -1
D. -2

50. A solution of $Ag(NO_3)_2$ (an unusual form of silver) reacts with gold metal while a solution of $AgNO_3$ does not react with gold. What is the order of oxidizing agents when arranged from strongest to weakest?

A. Ag^+, Au^{3+}, Ag^{2+}
B. Au^{3+}, Ag^{2+}, Ag^+
C. Ag^{2+}, Au^{3+}, Ag^+
D. Ag^{2+}, Ag^+, Au^{3+}

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51. Which of the following best describes what happens when lead solid is placed in a 1.0 M solution of $Cu(NO_3)_2$?

A. Bubbles form on the lead.
B. No changes are observed.
C. Copper solid forms on the lead and the solution changes colour.
D. The mass of lead solid increases and the solution does not change colour.

52. Consider the following redox reaction:

$$2KClO_3 + 2H_2C_2O_4 \rightarrow 2ClO_2 + 2CO_2 + K_2C_2O_4 + 2H_2O$$

What is the oxidation half-reaction?

A. $2e^- + H_2C_2O_4 \rightarrow 2H^+ + 2CO_2$
B. $H_2C_2O_4 \rightarrow 2H^+ + 2CO_2 + 2e^-$
C. $2H^+ + ClO_3^- \rightarrow ClO_2 + H_2O + e^-$
D. $e^- + 2H^+ + ClO_3^- \rightarrow ClO_2 + H_2O$

53. A 0.108 g sample of impure NaI is analyzed by titration with 0.0100 M $CuSO_4$ solution according to the following equation:

$$4I^- + 2Cu^{2+} \rightarrow 2CuI + I_2$$

How many moles of NaI are present in the sample if the titration requires 29.4 mL of $CuSO_4$ solution?

A. 7.20×10^{-4} mol
B. 5.88×10^{-4} mol
C. 2.94×10^{-4} mol
D. 8.81×10^{-2} mol

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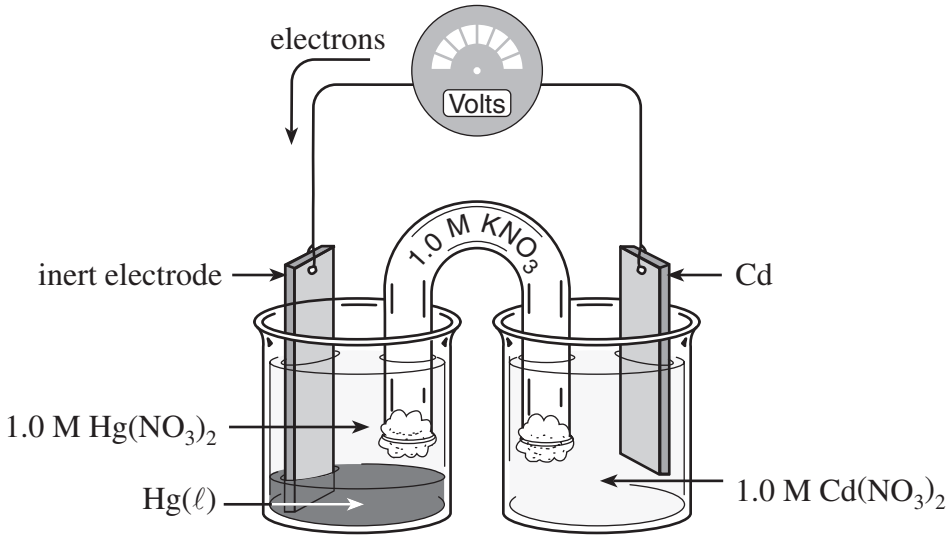
Use the following cell diagram for questions 54 to 56.



54. Which of the following is the correct anode half-cell reaction?

A. $Cd^{2+} + 2e^- \rightarrow Cd$
B. $Hg^{2+} + 2e^- \rightarrow Hg$
C. $Hg \rightarrow Hg^{2+} + 2e^-$
D. $Cd \rightarrow Cd^{2+} + 2e^-$

55. Which of the following describes the change in mass of the $Hg(\ell)$ and the movement of nitrate ions?

	Mass of $Hg(\ell)$	Nitrate Ions
A.	increases	towards the Cd electrode
B.	decreases	towards the Cd electrode
C.	increases	towards the inert electrode
D.	decreases	towards the inert electrode

56. If the standard cell voltage is $1.25\,V$, what is the reduction half-cell potential for Cd?

A. $-0.40\,V$
B. $+0.40\,V$
C. $+1.25\,V$
D. $+2.10\,V$

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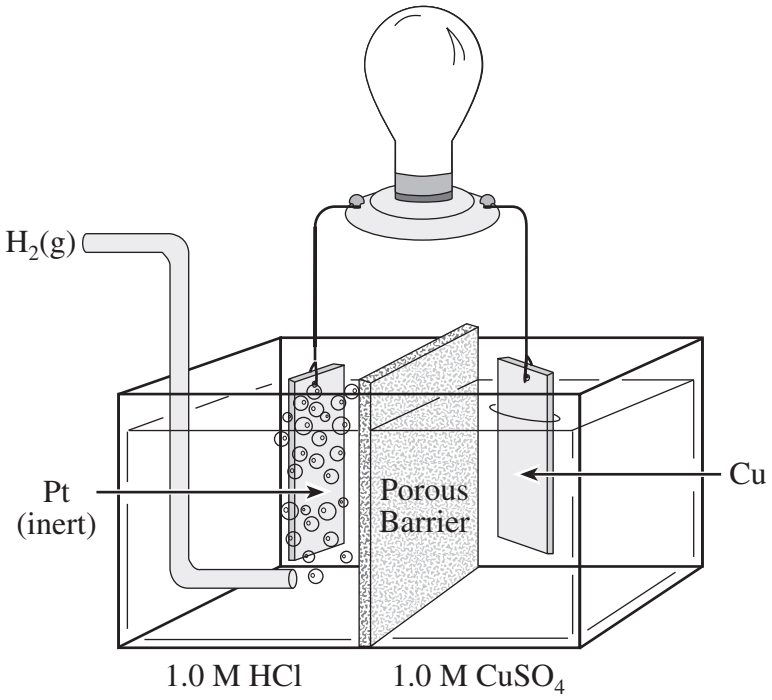
57. Consider the following electrochemical cell:



Which of the following could be used to confirm the ion migration through the porous barrier?

A. adding phenolphthalein to the copper half-cell
B. adding phenolphthalein to the hydrogen half-cell
C. adding barium nitrate solution to the copper half-cell
D. adding barium nitrate solution to the hydrogen half-cell

58. Which of the following is an example of *corrosion*?

A. copper spontaneously oxidizing
B. sulphur spontaneously oxidizing
C. copper non-spontaneously oxidizing
D. sulphur non-spontaneously oxidizing

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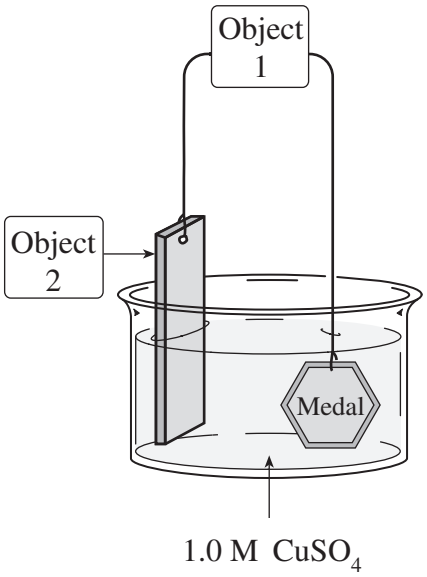
59. A student brought an old silver medal to the Chemistry Lab to plate it with copper. He set up a cell like the one in the following diagram:



Which of the following combinations should produce the best result?

	Object 1	Electron Flow	Object 2
A.	AC power supply	towards the medal	Ag
B.	DC power supply	towards the medal	copper
C.	DC power supply	from the medal	copper
D.	voltmeter	from the medal	Pt

60. Which of the following occurs when a solution of $NiSO_4$ is electrolyzed using inert carbon electrodes?

A. The cathode dissolves.

B. Hydrogen gas is produced.

C. The pH of the solution decreases.

D. The Ni^{2+} concentration increases.

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

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PART B: WRITTEN RESPONSE

Value: 30 marks **Suggested Time: 40 minutes**

INSTRUCTIONS:	You are 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 calculations, full marks will NOT be given for providing only an answer.**

1. Consider the following reaction mechanism:

Step 1	$Cl_2 \rightarrow 2Cl$	(fast)
Step 2	$Cl + CO \rightarrow COCl$	(slow)
Step 3	$COCl + Cl_2 \rightarrow COCl_2 + Cl$	(fast)

Identify a reaction intermediate in the reaction mechanism and write the equation for the overall reaction. Explain why increasing the $[CO]$ will increase the reaction rate, but increasing the $[Cl_2]$ will not. **(5 marks)**

Reaction Intermediate: _____

Overall Reaction Equation: _____

Explanation: _____

_____

_____

_____

_____

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2. Consider the following equilibrium:

$$CO(g) + H_2O(g) \rightleftarrows CO_2(g) + H_2(g) \qquad K_{eq} = 4.6$$

Initially, 0.50 mol CO, 0.50 mol H_2O, 0.62 mol CO_2 and 0.62 mol H_2 are placed in a 1.0 L container, and the reaction proceeds towards products.
Calculate the equilibrium $[H_2]$. **(3 marks)**

3. A solution is prepared by mixing equal moles of $Ba(NO_3)_2$, K_2SO_4 and BaS and precipitation occurs. Identify the precipitate(s) and write the net ionic equation(s) for the reaction(s). **(3 marks)**

Precipitate(s):

Net Ionic Equation(s):

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4. Write balanced equations to show water acting as an acid with $CH_3CH_2NH_2$, then water acting as a base with H_2O_2. **(4 marks)**

As an acid: _____

As a base: _____

5. Calculate the initial concentration of a solution of NH_3 which has a $pH = 11.33$ and $K_b = 1.8 \times 10^{-5}$. Begin by writing the equation for the predominant reaction. **(5 marks)**

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6. A sample of the strong acid $HCl(aq)$ is titrated with a sample of $NH_3(aq)$, a weak base. Write the formula, complete ionic and net ionic equations for the titration reaction. **(3 marks)**

7. In an unusual compound, IPO_4, iodine exists as Iodine(III). The compound decomposes as follows:

$$IPO_4 \rightarrow I_2 + IO_3^- + PO_4^{3-} \text{ (acidic)}$$

Balance this redox equation in acidic solution. **(4 marks)**

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8. In separate electrolysis experiments, 1.0 M NaCl, 1.0 M KNO_3, 1.0 M Li_2SO_4, and 1.0 M Cs_3PO_4 all produced the same gas at their cathodes. Write the equation for the formation of this gas and explain why this same reaction occurs in all four cases. **(3 marks)**

END OF EXAMINATION

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