Chemistry 12

January 2004 Provincial Examination

ANSWER KEY / SCORING GUIDE

CURRICULUM:

Organizers	Sub-Organizers
1. Reaction Kinetics	A, B, C
2. Dynamic Equilibrium	D, E, F
3. Solubility Equilibria	G, H, I
4. Acids, Bases, and Salts	J, K, L, M, N, O, P, Q, R
5. Oxidation – Reduction	S, T, U, V, W

Part A: Multiple Choice

Q	K	C	S	CO	PLO	Q	K	C	S	CO	PLO
1.	D	K	1	1	A6	31.	D	U	1	4	K6
2.	B	U	1	1	A4	32.	A	U	1	4	K6, M2
3.	D	U	1	1	B3	33.	C	U	1	4	L10
4.	B	U	1	1	B6, C4	34.	A	U	1	4	L12
5.	D	U	1	1	C2	35.	**D**	**E**	**L**	**E**	**T** **E** **D**
6.	D	U	1	1	C5, B2	36.	B	U	1	4	M4
7.	D	U	1	2	D2	37.	D	U	1	4	N1
8.	C	H	1	2	D4	38.	A	U	1	4	N3
9.	C	U	1	2	D7	39.	C	K	1	4	O1
10.	B	K	1	2	D9	40.	C	U	1	4	O4
11.	A	U	1	2	E4	41.	D	K	1	4	P5
12.	B	U	1	2	E3	42.	B	U	1	4	P3
13.	B	U	1	2	F2	43.	B	H	1	4	Q1
14.	A	U	1	2	F3	44.	A	H	1	4	Q4
15.	C	U	1	2	F5	45.	C	K	1	4	R1
16.	B	U	1	2	F7	46.	D	K	1	4	R4
17.	D	U	1	2	F8	47.	C	U	1	5	S1, 2
18.	D	U	1	3	G1	48.	A	U	1	5	S1
19.	B	U	1	3	G4	49.	C	U	1	5	S2
20.	A	U	1	3	H1	50.	C	U	1	5	S2
21.	D	U	1	3	H2	51.	B	U	1	5	S4
22.	B	U	1	3	H6	52.	C	U	1	5	S6
23.	A	U	1	3	I2	53.	C	U	1	5	T3
24.	**D**	**E**	**L**	**E**	**T** **E** **D**	54.	C	H	1	5	U2
25.	B	U	1	3	I5	55.	D	U	1	5	U2, L11
26.	A	U	1	3	I6	56.	B	K	1	5	U6
27.	D	U	1	4	J2	57.	B	U	1	5	U3, 5
28.	A	K	1	4	J6	58.	C	U	1	5	V3
29.	A	U	1	4	J8	59.	A	K	1	5	W1
30.	A	H	1	4	K1, 3, 4	60.	A	U	1	5	W4

Multiple Choice = 60 marks

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	5	1	A3, 5
2.	2	U	3	2	E2
3.	3	U	3	3	H2, 3, I6
4.	4	U	4	4	J7, K6, 8
5.	5	U	5	4	M3, N2
6.	6	U	3	4	P1
7.	7	U	4	5	T2
8.	8	U/H	3	5	W6

Written Response = 30 marks

Multiple Choice = 60 (60 questions)
Written Response = 30 (8 questions)
EXAMINATION TOTAL = 90 marks

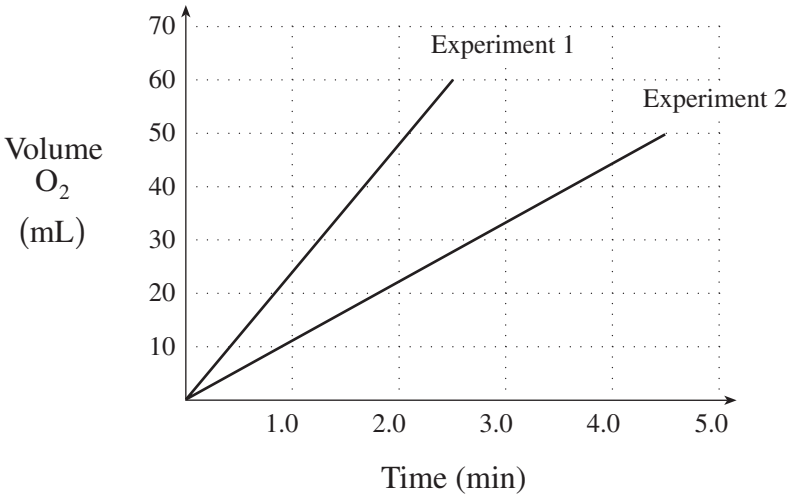
LEGEND:
Q = Question Number **K** = Keyed Response **C** = Cognitive Level
B = Score Box Number **S** = Score **CO** = Curriculum Organizer
PLO = Prescribed Learning Outcome

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. The release of $O_{2(g)}$ resulting from the decomposition of bleach was measured in two different experiments. Data was collected and the following graph was drawn:



a) Calculate the average rate of reaction for each experiment. **(2 marks)**

Solution:

For Example:

Experiment 1: $\dfrac{60\,\text{mL}}{2.5\,\text{min}} = 24\,\text{mL/min}$ ← **1 mark**

Experiment 2: $\dfrac{50\,\text{mL}}{4.5\,\text{min}} = 11\,\text{mL/min}$ ← **1 mark**

b) Identify a variable from Experiment 1 and how it was changed to produce the different reaction rate for Experiment 2. Explain using collision theory. **(3 marks)**

Solution:

For Example:

Variable/Change	**Explanation**
Temperature is decreased.	Lower fraction of effective collisions.
OR	
Concentration of reactants was decreased.	Fewer collisions.

← **3 marks**

2. Consider the following equilibrium system:

$$C_{(s)} + 2H_{2(g)} \rightleftarrows CH_{4(g)} \qquad \Delta H = -75\,kJ$$

State **three** different ways to make more $C_{(s)}$ react. **(3 marks)**

Solution:

For Example:

Any three of the following:

- add H_2
- remove CH_4
- decrease temperature
- increase pressure/decrease volume

← **3 marks**

3. Sufficient $Na_2SO_{4(s)}$ is added to $0.10\,M\ Ba(NO_3)_2$ to cause a precipitate to form.

a) Write the net ionic equation for the precipitate formation. **(1 mark)**

Solution:

For Example:

$$Ba^{2+}_{(aq)} + SO_4{}^{2-}_{(aq)} \rightarrow BaSO_{4(s)} \qquad \leftarrow \textbf{1 mark}$$

b) Calculate the $\left[SO_4{}^{2-}\right]$ at the moment the precipitate starts to form. **(2 marks)**

Solution:

For Example:

$$\left[SO_4{}^{2-}\right] = \frac{K_{sp}}{\left[Ba^{2+}\right]}$$

$$= \frac{1.1 \times 10^{-10}}{0.10}$$

$$= 1.1 \times 10^{-9}\,M$$

$\leftarrow$ **1 mark**

$\leftarrow$ **1 mark**

4. a) Write the equation to represent the reaction that results when NH_4^+ ions are mixed with HCO_3^- ions. **(2 marks)**

Solution:

For Example:

$$NH_4^+{}_{(aq)} + HCO_3^-{}_{(aq)} \rightleftarrows NH_{3(aq)} + H_2CO_{3(aq)}$$ ← **2 marks**

b) Identify the **two** bases in the reaction in part a). **(1 mark)**

Solution:

For Example:

HCO_3^- and NH_3 ← **1 mark**

c) Predict whether the reaction will favour the reactants or products. Justify your answer. **(1 mark)**

Solution:

For Example:

Prediction: Reactants ← $\frac{1}{2}$ **mark**

Justification: $K_{a_{H_2CO_3}} > K_{a_{NH_4^+}}$ ← $\frac{1}{2}$ **mark**

5. Calculate the pH of 0.60 M NH_4I. Start by writing the equation for the predominant equilibrium reaction. **(5 marks)**

Solution:

For Example:

	$NH_4^+{}_{(aq)}$	+	$H_2O_{(\ell)}$	$\rightleftarrows$	$H_3O^+{}_{(aq)}$	+	$NH_{3(aq)}$	
								← **1 mark**
[I]	0.60				0		0	
[C]	$-x$				$+x$		$+x$	← **1 mark**
[E]	$0.60 - x$				x		x	

(assume x is negligible)

$$K_a = \frac{\left[H_3O^+\right]\left[NH_3\right]}{\left[NH_4^+\right]}$$

$$5.6 \times 10^{-10} = \frac{(x)(x)}{(0.60)} \quad \leftarrow \textbf{1 mark}$$

$$x = \left[H_3O^+\right] = 1.83 \times 10^{-5}\ \text{M} \quad \leftarrow \textbf{1 mark}$$

$$\text{pH} = 4.74 \quad \leftarrow \textbf{1 mark}$$

(Deduct **$\frac{1}{2}$ mark** for incorrect significant figures.)

6. A solution of $NaOH_{(aq)}$ was standardized by titration using oxalic acid $\left(H_2C_2O_{4(s)}\right)$ as the primary standard. The following data was collected:

$$\text{Mass of } H_2C_2O_{4(s)} \text{ used} = 1.02\,\text{g}$$

$$\text{Volume of } NaOH_{(aq)} \text{ used} = 40.6\,\text{mL}$$

Calculate the concentration of the $NaOH_{(aq)}$. **(3 marks)**

Solution:

For Example:

$$H_2C_2O_{4(s)} + 2NaOH_{(aq)} \rightarrow Na_2C_2O_{4(aq)} + 2H_2O_{(\ell)}$$

$$\text{Moles of } H_2C_2O_{4(s)} = 1.02\,\text{g} \times \frac{\text{mol}}{90.0\,\text{g}} = 1.133 \times 10^{-2}\ \text{mol} \qquad \leftarrow \textbf{1 mark}$$

$$\text{Moles of NaOH} = 2\left(1.13 \times 10^{-2}\ \text{mol}\right) = 2.267 \times 10^{-2}\ \text{mol} \qquad \leftarrow \textbf{1 mark}$$

$$\left[\text{NaOH}\right] = \frac{2.26 \times 10^{-2}\ \text{mol}}{0.0406\,\text{L}} = 0.558\,\text{M} \qquad \leftarrow \textbf{1 mark}$$

$\left(\text{Deduct } \mathbf{\frac{1}{2}}\ \textbf{mark} \text{ for incorrect significant figures.}\right)$

7. Balance the following skeletal redox equation in acidic solution: **(4 marks)**

$$MnO_4^- + As_2O_3 \rightarrow Mn^{2+} + AsO_4^{3-} \qquad \text{(acidic)}$$

Solution:

For Example:

$$\left(5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + 4H_2O\right) \times 4$$

$$\left(5H_2O + As_2O_3 \rightarrow 2AsO_4^{3-} + 10\,H^+ + 4e^-\right) \times 5$$

$$\cancel{20e^-} + 32H^+ + 4MnO_4^- + 25H_2O + 5As_2O_3 \rightarrow 4Mn^{2+} + 16H_2O + 10AsO_4^{3-} + 50\,H^+ + \cancel{20e^-}$$

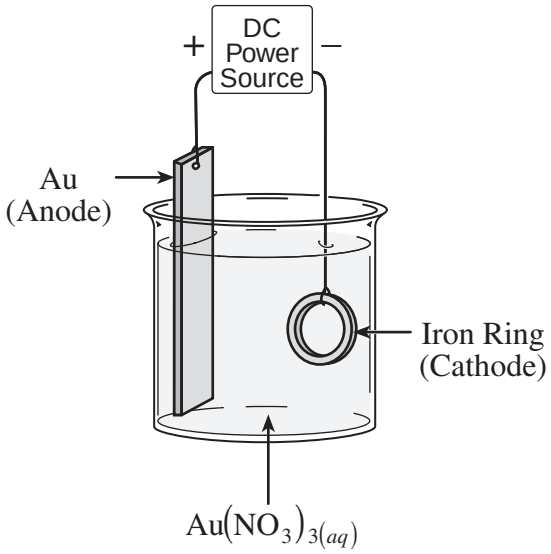
$$4MnO_4^- + 9H_2O + 5As_2O_3 \rightarrow 4Mn^{2+} + 10AsO_4^{3-} + 18H^+$$

← **4 marks**

8. Draw an electrolytic cell that could be used to plate an iron ring with gold.
Be sure to include all of the necessary parts. In addition, label the anode, solution used and composition of the electrodes. **(3 marks)**

Solution:

For Example:



← **3 marks**

END OF KEY