Chemistry 12

August 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	A1	31.	A	K	1	4	K3, K4
2.	B	U	1	1	A3	32.	D	U	1	4	K5
3.	D	U	1	1	A5	33.	B	U	1	4	L3
4.	A	U	1	1	A6, C4	34.	C	U	1	4	L5, 6
5.	B	K	1	1	B5	35.	D	K	1	4	L10
6.	C	K	1	1	B7, 8	36.	D	U	1	4	M1
7.	D	U	1	1	C5	37.	A	U	1	4	N1
8.	B	U	1	2	D2	38.	D	H	1	4	N2, N3, N4
9.	C	K	1	2	D8	39.	B	U	1	4	N3
10.	B	U	1	2	D9, 7	40.	B	H	1	4	O3
11.	A	U	1	2	E2	41.	D	U	1	4	O4
12.	C	H	1	2	E3	42.	A	K	1	4	P1
13.	C	U	1	2	E5	43.	D	U	1	4	P3
14.	A	U	1	2	F2	44.	C	U	1	4	P4
15.	C	U	1	2	E2, F4	45.	A	U	1	4	Q2
16.	A	U	1	2	F5	46.	B	K	1	4	R3
17.	B	H	1	2	F6	47.	A	U	1	5	S1
18.	A	U	1	3	G1, H1	48.	B	U	1	5	S1
19.	C	U	1	3	G3	49.	A	U	1	5	S2
20.	C	U	1	3	G6	50.	D	U	1	5	S3
21.	A	U	1	3	H2	51.	B	U	1	5	S6
22.	A	U	1	3	H3	52.	D	U	1	5	T1
23.	B	U	1	3	I2, H2	53.	D	U	1	5	T6
24.	D	U	1	3	I4	54.	C	H	1	5	U4
25.	C	U	1	3	I6	55.	D	U	1	5	U5
26.	C	U	1	3	I7	56.	C	U	1	5	U9
27.	D	U	1	4	J1	57.	C	K	1	5	W1
28.	D	K	1	4	J5	58.	A	U	1	5	W4
29.	B	U	1	4	J12	59.	A	U	1	5	W8
30.	B	H	1	4	K1	60.	B	U	1	5	W5

Multiple Choice = 60 marks

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	4	1	C4, 5
2.	2	U	4	2	F8
3.	3	U	3	3	I1, 4
4.	4	U	4	4	K3, 4
5.	5	U	5	4	M3
6.	6	U	3	4	Q5
7.	7	U	4	5	S6, T4
8.	8	U	3	5	U1

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. Consider the following overall reaction which is exothermic:

$$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$$

a) Complete the proposed two-step reaction mechanism. **(2 marks)**

Solution:

For Example:

Step 1	$NO + NO \rightarrow N_2O_2$
Step 2	$\mathbf{N_2O_2 + O_2 \rightarrow 2NO_2}$

← **2 marks**

b) Describe how adding a catalyst would affect the activation energy and ΔH for the overall reaction? **(2 marks)**

Solution:

For Example:

A catalyst provides a different mechanism with a lower E_a. ← **1 mark**

Catalyst has no effect on ΔH. ← **1 mark**

2. Consider the following equilibrium:

$$N_{2(g)} + O_{2(g)} \rightleftarrows 2NO_{(g)} \qquad K_{eq} = 8.1 \times 10^{-3}$$

A $2.0\,L$ container is filled with $0.15\,mol$ N_2, $0.15\,mol$ O_2 and $0.050\,mol$ NO. Does the $[NO]$ increase or decrease as equilibrium is established? Support your answer with appropriate calculations. **(4 marks)**

Solution:

For Example:

$K_{eq} = \dfrac{[NO]^2}{[N_2][O_2]} = 8.1 \times 10^{-3}$ ← **$\frac{1}{2}$ mark**

Trial $K_{eq} = \dfrac{(0.025)^2}{(0.075)(0.075)} = 0.11$ ← **1 $\frac{1}{2}$ marks**

Trial $K_{eq} > K_{eq}$ so reaction proceeds to the left ← **1 mark**

$[NO]$ decreases ← **1 mark**

3. Calculate the iodate ion concentration in a saturated copper (II) iodate solution at 25°C. **(3 marks)**

Solution:

For Example:

$$Cu(IO_3)_{2(s)} \rightleftarrows Cu^{2+}_{(aq)} + 2IO_3^-{}_{(aq)}$$

$$K_{sp} = [Cu^{2+}][IO_3^-]^2 = 6.9 \times 10^{-8} \quad \leftarrow \textbf{1 mark}$$

$$6.9 \times 10^{-8} = (x)(2x)^2$$

$$4x^3 = 6.9 \times 10^{-8}$$

$$x = 2.6 \times 10^{-3}\,M \quad \leftarrow \textbf{1 mark}$$

$$[IO_3^-] = 2 \times 2.6 \times 10^{-3}\,M$$

$$= 5.2 \times 10^{-3}\,M \quad \leftarrow \textbf{1 mark}$$

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

4. Describe **two** lab tests and how their outcomes could be used to distinguish between a strong acid and a weak acid of equal molar concentrations. **(4 marks)**

Solution:

For Example:

(Any **two** of the following for **4 marks**.)

Test: Electrical conductivity

Outcome: Strong acid has a greater conductivity than the weak acid.

Test: Reaction with Mg

Outcome: Strong acid has a greater reaction rate than the weak acid.

Test: Compare pH using a pH metre

Outcome: Strong acid has a lower pH than the weak acid.

5. Calculate the pH of a sample of 1.5 M CH_3COOH. Begin by writing the equation for the predominant equilibrium reaction. **(5 marks)**

Solution:

For Example:

	$CH_3COOH_{(aq)}$	+	$H_2O_{(\ell)}$	$\rightleftarrows$	$H_3O^+_{(aq)}$	+	$CH_3COO^-_{(aq)}$	
								← **1 mark**
[I]	1.5				0		0	
[C]	$-x$				$+x$		$+x$	
[E]	$1.5 - x$				x		x	← **1 mark**

(assume x is negligible)

$$K_a = \frac{\left[H_3O^+\right]\left[CH_3COO^-\right]}{\left[CH_3COOH\right]}$$

$$1.8 \times 10^{-5} = \frac{(x)(x)}{1.5} \quad \leftarrow \textbf{1 mark}$$

$$x = \left[H_3O^+\right] = 5.2 \times 10^{-3}\,\text{M} \quad \leftarrow \textbf{1 mark}$$

$$\text{pH} = 2.28 \quad \leftarrow \textbf{1 mark}$$

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

6. State the sequence of events that occur when a small amount of $HCl_{(aq)}$ is added to a buffer such as:

$$NH_{3(aq)} + H_2O_{(\ell)} \rightleftarrows NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

Be sure to describe the stress, the shift and the effect on pH that occur. **(3 marks)**

Solution:

For Example:

1. The $[OH^-]$ decreases because of the added H_3O^+ . ← **1 mark**
2. Equilibrium shifts right. ← **1 mark**
3. $[OH^-]$ returns almost to the previous level so that pH decreases slightly. } ← **1 mark**

7. A $2.000\,g$ strip of cobalt metal is suspended in $100.0\,mL$ of $0.20\,M$ $AgNO_3$ and a reaction occurs. When the reaction is complete, there is an excess of cobalt. The excess cobalt is removed from the solution, washed and dried and its mass is found to be $1.411\,g$.

   a) Using the table of Standard Reduction Potentials of Half-cells, write the balanced net ionic equation for the redox reaction. **(2 marks)**

Solution:

For Example:

$$Co \rightleftarrows Co^{2+} + 2e^-$$

$$2\left(Ag^+ + e^- \rightleftarrows Ag\right)$$

$$Co + 2Ag^+ \rightarrow Co^{2+} + 2Ag \qquad \leftarrow \textbf{2 marks}$$

   b) Using the experimental data, calculate the moles of Co and Ag^+ reacting, and show how these values support the balanced equation. **(2 marks)**

Solution:

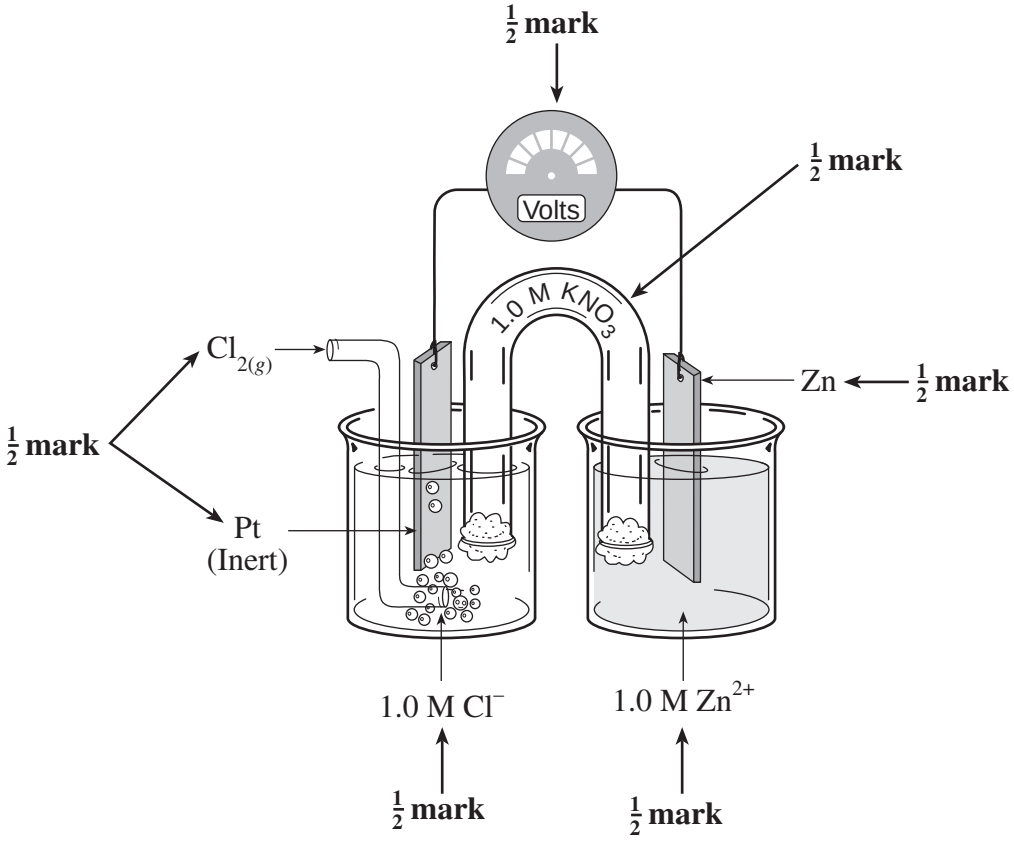
For Example:

$$\left.\begin{aligned} \text{Mass of cobalt used} &= 2.000\,g - 1.411\,g = 0.589\,g \\ \text{Moles of Co used} &= 0.589\,g \times \frac{1\,mol}{58.9\,g} = 0.010\,\text{moles} \\ \text{Moles of } AgNO_3 \text{ used} &= 0.20\,mol/L \times 0.10\,L = 0.020\,\text{moles} \\ \text{Mole ratio} &= 1{:}2\text{, as in the balanced equation} \end{aligned}\right\} \leftarrow \textbf{2 marks}$$

8. Draw a diagram of a standard electrochemical cell which could make use of the reaction $Zn_{(s)} + Cl_{2(g)} \rightarrow Zn^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$. Identify all of the chemical species in the cell. **(3 marks)**

Solution:

For Example:



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