Chemistry 12

August 2006 — Form A

Provincial Examination — Answer Key

Cognitive Processes

K = Knowledge
U = Understanding
H = Higher Mental Processes

Question Types

50 = Multiple Choice (MC)
8 = Written Response (WR)

Topics		Prescribed Learning Outcomes (PLOs)	Weightings
1.	Reaction Kinetics	A, B, C	12%
2.	Dynamic Equilibrium	D, E, F	16%
3.	Solubility Equilibria	G, H, I	16%
4.	Acids, Bases, and Salts	J, K, L, M, N, O, P, Q, R	33%
5.	Oxidation – Reduction	S, T, U, V, W	23%

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
1.	C	K	1	1	A2	MC
2.	A	U	1	1	A3	MC
3.	D	U	1	1	B5	MC
4.	A	U	1	1	C2	MC
5.	B	U	1	1	C5	MC
6.	C	U	1	2	D2	MC
7.	B	H	1	2	D9	MC
8.	A	U	1	2	D7	MC
9.	C	U	1	2	E2	MC
10.	C	U	1	2	E5	MC
11.	D	H	1	2	F3, F5	MC
12.	B	U	1	2	F5	MC
13.	B	U	1	2	F6	MC
14.	A	U	1	2	F8	MC
15.	A	K	1	3	G2	MC
16.	D	U	1	3	H1	MC
17.	B	U	1	3	H3	MC
18.	C	H	1	3	H5	MC
19.	C	U	1	3	I2	MC
20.	B	U	1	3	I3	MC
21.	D	U	1	3	I4, H1	MC
22.	A	K	1	4	J6	MC
23.	B	U	1	4	J8	MC
24.	C	U	1	4	K6	MC
25.	D	U	1	4	K9, N3	MC
26.	B	U	1	4	K11	MC

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
27.	D	U	1	4	L4	MC
28.	C	K	1	4	L9	MC
29.	C	H	1	4	L12	MC
30.	B	U	1	4	M2, K2	MC
31.	C	U	1	4	N2	MC
32.	B	U	1	4	N3	MC
33.	A	U	1	4	O3	MC
34.	C	U	1	4	O4	MC
35.	B	K	1	4	P1	MC
36.	C	H	1	4	P4, H3	MC
37.	B	U	1	4	Q3	MC
38.	B	U	1	4	R2	MC
39.	D	K	1	5	S1	MC
40.	C	U	1	5	S2	MC
41.	A	U	1	5	S6	MC
42.	D	U	1	5	T1	MC
43.	C	U	1	5	T5	MC
44.	C	U	1	5	T6	MC
45.	B	U	1	5	U2	MC
46.	D	U	1	5	U3, 4	MC
47.	C	U	1	5	U9	MC
48.	C	H	1	5	U7	MC
49.	B	K	1	5	V1	MC
50.	B	U	1	5	W3	MC

Chemistry 12

August 2006

Provincial Examination — Written-Response Answer Key / Scoring Guide

Cognitive Processes

K = Knowledge
U = Understanding
H = Higher Mental Processes

Question Types

8 = Written Response (WR)

Topics		Prescribed Learning Outcomes (PLOs)	Weightings
1.	Reaction Kinetics	A, B, C	12%
2.	Dynamic Equilibrium	D, E, F	16%
3.	Solubility Equilibria	G, H, I	16%
4.	Acids, Bases, and Salts	J, K, L, M, N, O, P, Q, R	33%
5.	Oxidation – Reduction	S, T, U, V, W	23%

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
1.	–	U	4	1	A5, B9	WR
2.	–	U	4	2	F7	WR
3.	–	U	4	3	I4, 6	WR
4.	–	U	3	4	K8, J11	WR
5.	–	U	5	4	M3	WR
6.	–	U	3	4	P2	WR
7.	–	U	4	5	T2	WR
8.	–	U	3	5	W3, 5, 9	WR

1. Consider the reaction: $2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$

State two different methods that would increase the rate of this reaction.
Explain each in terms of collision theory. **(4 marks)**

Method 1: _____

Explanation: _____

Method 2: _____

Explanation: _____

For Example:

Method: Increase surface area of Zn.
Explanation: There are more sites for successful collisions between reactants.

Method: Increase temperature.
Explanation: A larger fraction of collisions has sufficient energy to react.

← **4 marks**

2. Consider the equilibrium: $CO_2(g) + H_2(g) \rightleftarrows CO(g) + H_2O(g)$ $K_{eq} = 1.60$

Initially, 8.2 mol of CO and 8.2 mol of H_2O are placed in a 2.0 L container and allowed to react. Calculate the equilibrium concentrations of CO_2 and CO. **(4 marks)**

Solution:

For Example:

$$[CO] = [H_2O] = \frac{8.2\,\text{mol}}{2.0\,\text{L}} = 4.1\text{M}$$

	$CO_2(g)$	+	$H_2(g)$	$\rightleftarrows$	$CO(g)$	+	$H_2O(g)$
[I]	0		0		4.1		4.1
[C]	$+x$		$+x$		$-x$		$-x$
[E]	x		x		$4.1-x$		$4.1-x$

← **1 mark**

$$K_{eq} = \frac{[CO][H_2O]}{[CO_2][H_2]}$$

$$\sqrt{1.60} = \sqrt{\frac{(4.1-x)^2}{x^2}}$$ ← **1 mark**

$$x = 1.8$$ ← **1 mark**

$$[CO_2] = 1.8\,\text{M},\ [CO] = 4.1 - x = 2.3\,\text{M}$$ ← **1 mark**

3. What is the maximum $\left[Pb^{2+}\right]$ that can exist in a saturated solution of $BaSO_4$ without causing precipitate formation? **(4 marks)**

Solution:

For Example:

$$BaSO_4(s) \rightleftarrows Ba^{2+} + SO_4{}^{2-}$$

$$K_{sp} = \left[Ba^{2+}\right]\left[SO_4{}^{2-}\right] = 1.1 \times 10^{-10} \quad \leftarrow \textbf{1 mark}$$

$$x^2 = 1.1 \times 10^{-10}$$

$$x = 1.05 \times 10^{-5} = \left[SO_4{}^{2-}\right] \quad \leftarrow \textbf{1 mark}$$

$$\left[Pb^{2+}\right] = \frac{K_{sp}}{\left[SO_4{}^{2-}\right]} \quad \leftarrow \textbf{1 mark}$$

$$= \frac{1.8 \times 10^{-8}}{1.05 \times 10^{-5}}$$

$$= 1.7 \times 10^{-3}\,M \quad \leftarrow \textbf{1 mark}$$

4. Given the reactants:

$H_2C_2O_4 + HCOO^- \rightleftarrows$

Complete the acid-base equilibrium equation in the box above.
Determine whether reactants or products will be favoured and explain why. **(3 marks)**

Solution:

For Example:

$H_2C_2O_4 + HCOO^- \rightleftarrows HC_2O_4^- + HCOOH$ ← **1 mark**

The equilibrium favours the products because $H_2C_2O_4$ is a stronger acid than $HCOOH$. ← **2 marks**

5. Calculate the pH of a 0.30 M H_2S solution. Begin by writing the equation for the predominant reaction. **(5 marks)**

Solution:

For Example:

	$H_2S(aq)$	+	$H_2O(\ell)$	$\rightleftarrows$	$H_3O^+(aq)$	+	$HS^-(aq)$	
								← **1 mark**
[I]	0.30				0		0	
[C]	$-x$				$+x$		$+x$	
[E]	$0.30 - x$				x		x	← **1 mark**

(assume x is negligible)

$$K_a = \frac{[H_3O^+][HS^-]}{[H_2S]}$$

$$9.1 \times 10^{-8} = \frac{(x)(x)}{0.30}$$ ← **1 mark**

$$x = 1.65 \times 10^{-4}\ \text{M} = [H_3O^+]$$ ← **1 mark**

$$\text{pH} = 3.78$$ ← **1 mark**

6. What mass of $NaOH(s)$ is required to just neutralize $50.0\,mL$ of $2.0\,M\ H_2SO_4$?
Begin by writing the balanced equation for the neutralization reaction. **(3 marks)**

Solution:

For Example:

$$H_2SO_4(aq) + 2NaOH(s) \rightarrow Na_2SO_4(aq) + 2\,H_2O(\ell)$$ ← **1 mark**

$$\text{Mass of NaOH} = \frac{2.0\,\text{mol}}{\text{L}}\,H_2SO_4 \times 0.0500\,\text{L} \times \frac{2\,\text{mol NaOH}}{1\,\text{mol}\ H_2SO_4} \times \frac{40.0\,\text{g}}{\text{mol NaOH}}$$ ← **2 marks**

$$= 8.0\,\text{g}$$

7. Balance the following in acidic solution.

$$FeS + NO_2^- \rightarrow NO + SO_4^{2-} + Fe^{3+} \quad \text{(acidic)}$$

(4 marks)

Solution:

For Example:

$$\left(4H_2O + FeS \rightarrow SO_4^{2-} + Fe^{3+} + 8H^+ + 9e^-\right) \times 1$$

$$\underline{\left(e^- + 2H^+ + NO_2^- \rightarrow NO + H_2O\right) \times 9}$$

$$\cancel{4H_2O} + FeS + \cancel{18H^+} + 9NO_2^- \rightarrow 9NO + \cancel{9H_2O} + SO_4^{2-} + Fe^{3+} + \cancel{8H^+}$$

$$FeS + 10H^+ + 9NO_2^- \rightarrow 9NO + 5H_2O + SO_4^{2-} + Fe^{3+}$$

← **3 marks**

← **1 mark**

8. The electrolysis of copper(II) sulphate solution using copper electrodes is used in the refining of copper. Write the anode and cathode half-reactions and describe what would be observed at each electrode as the cell operates. **(3 marks)**

Anode Half-Reaction: _____

Cathode Half-Reaction: _____

Observations:

anode: _____

cathode: _____

Solution:

For Example:

Anode half-reaction: $Cu \rightarrow Cu^{2+} + 2e^-$ ← **1 mark**

Cathode half-reaction: $Cu^{2+} + 2e^- \rightarrow Cu$ ← **1 mark**

Observations: The anode would decrease in size and the cathode would increase in size. ← **1 mark**

END OF KEY