Chemistry 12
2008/09 Released Exam
June 2009 — Form A
Provincial Examination — Answer Key

Cognitive Processes	Weightings	Question Types
K = Knowledge	11%	**50** = Multiple Choice (MC)
U = Understanding	78%	**8** = Written Response (WR)
H = Higher Mental Processes	11%	

Topics	Prescribed Learning Outcomes (PLOs)	Weightings
1. Reaction Kinetics	A1–8	12%
2. Dynamic Equilibrium	B1–6	16%
3. Solubility Equilibria	C1–8	16%
4. Acids, Bases, and Salts	D1–6, E, F1–8	33%
5. Oxidation – Reduction	G1–4, H1–5	23%

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type	Question Source
1.	C	K	1	1	A1	MC	
2.	B	U	1	1	A2	MC	
3.	D	K	1	1	A4	MC	
4.	C	U	1	1	A4	MC	
5.	A	U	1	1	A6	MC	
6.	B	K	1	2	B1	MC	
7.	A	H	1	2	B2/H4	MC	
8.	A	U	1	2	B2	MC	
9.	A	U	1	2	B3	MC	
10.	A	U	1	2	B3	MC	
11.	D	H	1	2	B5	MC	
12.	D	U	1	2	B5	MC	
13.	C	U	1	2	B5,3	MC	
14.	B	U	1	2	B6	MC	
15.	A	U	1	3	C1,4	MC	
16.	B	K	1	3	C1	MC	
17.	D	U	1	3	C4	MC	
18.	C	H	1	3	C6,4	MC	
19.	B	H	1	3	C7,4	MC	
20.	A	U	1	3	C7	MC	
21.	C	U	1	3	C7	MC	
22.	A	U	1	4	D1	MC	
23.	D	U	1	4	D3	MC	
24.	D	U	1	4	D4	MC	
25.	B	U	1	4	D5	MC	
26.	A	U	1	4	D6	MC	

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type	Question Source
27.	D	K	1	4	E1	MC	
28.	A	H	1	4	E1	MC	
29.	D	U	1	4	E2	MC	
30.	A	H	1	4	E3/F5	MC	
31.	C	U	1	4	E3,2	MC	
32.	D	U	1	4	F4,5	MC	
33.	C	U	1	4	F5	MC	
34.	B	K	1	4	F1	MC	
35.	C	U	1	4	F3	MC	
36.	A	U	1	4	F1	MC	
37.	A	U	1	4	F6	MC	
38.	C	U	1	4	F8	MC	
39.	C	K	1	5	G1	MC	
40.	D	U	1	5	G1	MC	
41.	A	U	1	5	G1	MC	
42.	C	H	1	5	G2	MC	
43.	C	U	1	5	G3	MC	
44.	D	U	1	5	G4	MC	
45.	B	K	1	5	H1	MC	
46.	C	U	1	5	H1	MC	
47.	B	H	1	5	H1/E2	MC	
48.	A	U	1	5	H1	MC	
49.	D	U	1	5	H3	MC	
50.	A	U	1	5	H4	MC	

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type	Question Source
1.	–	U	4	1	A2	WR	
2.	–	U	4	2	B6	WR	
3.	–	U	4	3	C5/B3	WR	
4.	–	U	3	4	D4,1	WR	
5.	–	U	5	4	E4	WR	
6.	–	U	3	4	F1	WR	
7.	–	U	4	5	G3	WR	
8.	–	U	3	5	H4	WR	

1. **(4 marks)**

A student burned a paraffin candle $(C_{25}H_{52})$ in an open beaker according to the following equation:

$$C_{25}H_{52}(s) + 38\,O_2(g) \rightarrow 25\,CO_2(g) + 26\,H_2O(g)$$

The following data was recorded:

Time (min)	Mass of candle and beaker (g)
0.0	175.00
2.0	173.20

Calculate the rate of paraffin consumption in moles of $C_{25}H_{52}$ per minute $(\text{mol } C_{25}H_{52}/\text{min})$; then, calculate how long it would take to produce $0.70\text{ g } CO_2$.

Solution:

For Example:

$$\text{rate} = \frac{(175.00 - 173.20)\,\text{g}}{2.0\,\text{min}} \times \frac{1\,\text{mol}}{352.0\,\text{g}} = 0.0026\,\text{mol}\,C_{25}H_{52}/\text{min} \qquad \leftarrow \textbf{2 marks}$$

$$\text{time} = 0.70\,\text{g}\,CO_2 \times \frac{1\,\text{mol } CO_2}{44.0\,\text{g}\,CO_2} \times \frac{1\,\text{mol } C_{25}H_{52}}{25\,\text{mol } CO_2} \times \frac{1\,\text{min}}{0.0026\,\text{mol } C_{25}H_{52}} \qquad \leftarrow \textbf{2 marks}$$

$$= 0.25\,\text{min}$$

2. **(4 marks)**

Consider the following equilibrium:

$$CO(g) + 3H_2(g) \rightleftarrows CH_4(g) + H_2O(g)$$

Initially, 0.200 mol CO and 0.600 mol H_2 are placed in a 2.00 L container. At equilibrium, $[H_2O] = 0.039\,M$. Calculate the value of K_{eq}.

Solution:

For Example:

	$CO(g)$	+	$3H_2(g)$	$\rightleftarrows$	$CH_4(g)$	+	$H_2O(g)$
[I]	0.100		0.300		0		0
[C]	−0.039		−0.117		+0.039		+0.039
[E]	0.061		0.183		0.039		0.039

← **2 marks**

$$K_{eq} = \frac{[CH_4][H_2O]}{[CO][H_2]^3}$$

$$= \frac{(0.039)(0.039)}{(0.061)(0.183)^3}$$

← **1 mark**

$$= 4.1$$

← **1 mark**

3. **(4 marks)**

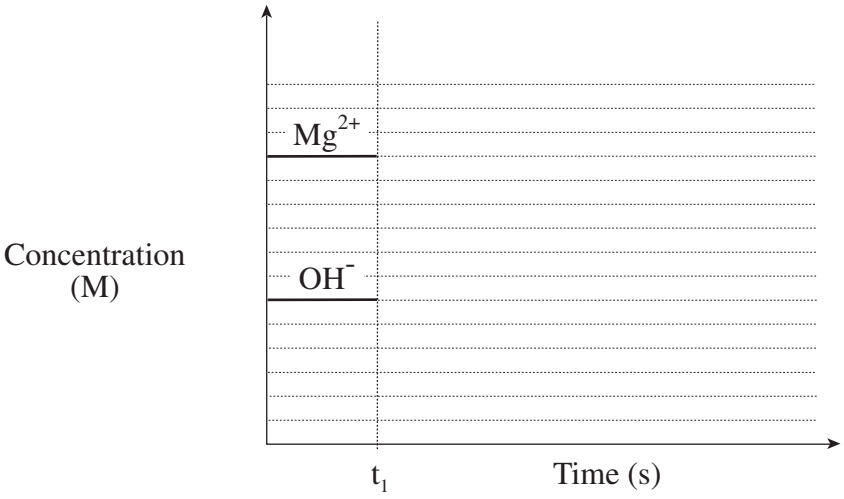
Consider the following equilibrium:

$$Mg(OH)_2(s) \rightleftarrows Mg^{2+}(aq) + 2OH^-(aq)$$

What happens to the amount of solid $Mg(OH)_2$ when some HCl is added? _____

_____

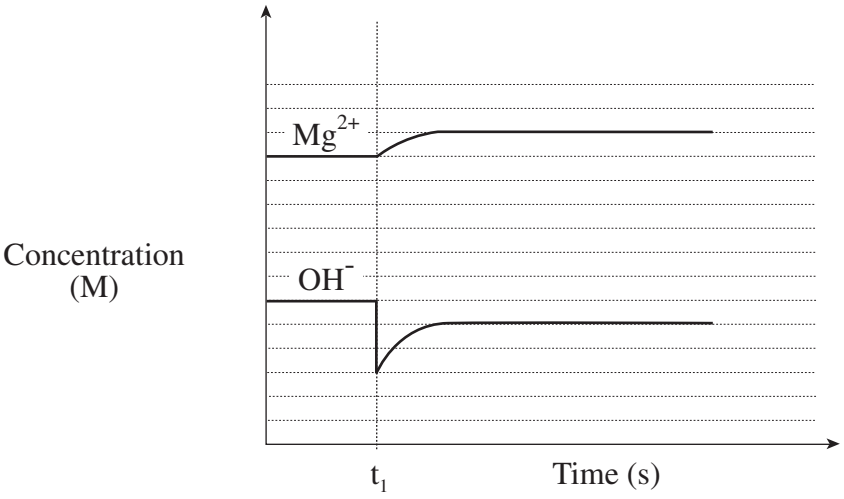
On the graph below, sketch the effect of adding HCl at time t_1.



Solution:

For Example:

The amount of solid $Mg(OH)_2$ decreases. **← 1 mark**



← 3 marks

4. **(3 marks)**

A solution of $Sr(OH)_2(aq)$ is titrated with H_2SO_4.
Explain what will happen to the electrical conductivity during the titration.
Begin by writing the balanced formula equation, including states, to support your answer.

Solution:

For Example:

$Sr(OH)_2(aq) + H_2SO_4(aq) \rightarrow SrSO_4(s) + 2H_2O(l)$ ← **2 marks**

The concentration of ions in solution decreases, which decreases the electrical conductivit ← **1 mark**

5. **(5 marks)**

Aniline ($C_6H_5NH_2$) is a weak base with a $K_b = 4.3 \times 10^{-10}$.
Calculate the concentration of an aniline solution that has a $pH = 8.80$.
Begin by writing the equation for the predominant equilibrium.

Solution:

For Example:

	$C_6H_5NH_2(aq)$	+ $H_2O(\ell)$	$\rightleftarrows$	$C_6H_5NH_3^+(aq)$	+	$OH^-(aq)$	
[I]	x			0		0	← **1 mark**
[C]	-6.31×10^{-6}			$+6.31 \times 10^{-6}$		$+6.31 \times 10^{-6}$	
[E]	$x - 6.31 \times 10^{-6}$			6.31×10^{-6}		6.31×10^{-6}	← **1 mark**

↑

$\boxed{pH = 8.80 \rightarrow pOH = 5.20 \rightarrow [OH^-] = 6.31 \times 10^{-6}\,M}$ ← **1 mark**

$$K_b = \frac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]}$$ ← **1 mark**

$$4.3 \times 10^{-10} = \frac{(6.31 \times 10^{-6})(6.31 \times 10^{-6})}{(x - 6.31 \times 10^{-6})}$$ ← **1 mark**

$$x = [C_6H_5NH_2] = 9.3 \times 10^{-2}\,M$$

6. **(3 marks)**

Calculate the $[OH^-]$ that results when $800.0\,mL$ of $0.010\,M$ HCl is mixed with $1.216\,g$ $Sr(OH)_2$. (Assume no volume change on mixing.)

Solution:

For Example:

$$\text{mol } H^+ : 0.010\,\frac{mol}{L} \times 0.8000\,L = 0.0080 \text{ mol } H^+ \quad \leftarrow \textbf{1 mark}$$

$$\text{mol } OH^- : 1.216\,g \times \frac{mol}{121.6\,g} \times 2 = 0.02000 \text{ mol } OH^- \quad \leftarrow \textbf{1 mark}$$

$$\text{excess } OH^- = 0.0120 \text{ mol } OH^- \quad \leftarrow \tfrac{\mathbf{1}}{\mathbf{2}} \textbf{ mark}$$

$$[OH^-] = \frac{0.0120 \text{ mol}}{0.8000 \text{ L}}$$

$$= 0.0150 \text{ M} \quad \leftarrow \tfrac{\mathbf{1}}{\mathbf{2}} \textbf{ mark}$$

7. **(4 marks)**

Balance the following redox equation in acidic solution:

$$TeO_4^- + In \rightarrow In_2O_3 + Te \qquad \text{(acidic)}$$

Solution:

For Example:

$$\left(7e^- + 8H^+ + TeO_4^- \rightarrow Te + 4H_2O\right) \times 6$$

$$\left(3H_2O + 2In \rightarrow In_2O_3 + 6H^+ + 6e^-\right) \times 7$$

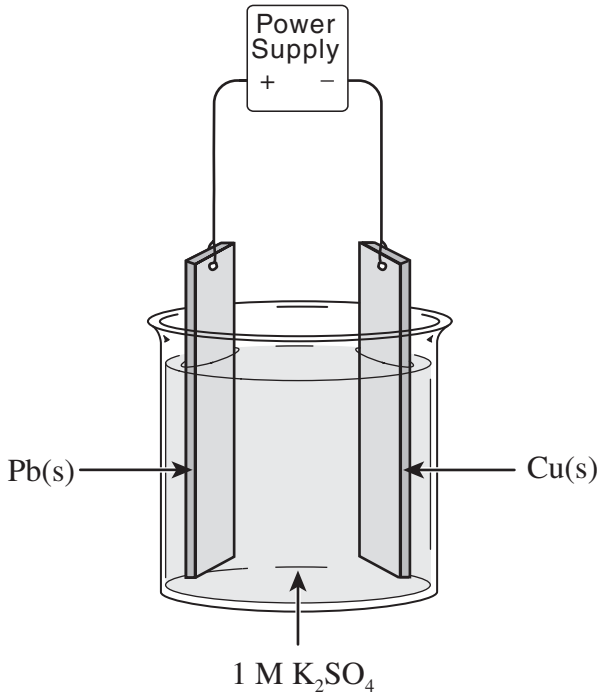
$$48H^+ + 6TeO_4^- + 21H_2O + 14In \rightarrow 6Te + 24H_2O + 7In_2O_3 + 42H^+$$

$$6H^+ + 6TeO_4^- + 14In \rightarrow 6Te + 3H_2O + 7In_2O_3$$

← **4 marks**

8. **(3 marks)**

Consider the following cell diagram:



Write the overall cell reaction.

Write the formula for a precipitate that forms as the cell operates.

Solution:

For Example:

Write the overall cell reaction.

$2H_2O + Pb \rightarrow Pb^{2+} + H_2 + 2OH^-$ ← **2 marks**

Write the formula for a precipitate that forms as the cell operates.

$PbSO_4$ or $Pb(OH)_2$ ← **1 mark**