

Chemistry 12  
August 2008 — 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
1.	C	U	1	1	A2	MC
2.	B	U	1	1	A3	MC
3.	B	U	1	1	A4	MC
4.	D	U	1	1	A7	MC
5.	D	U	1	1	A6	MC
6.	C	U	1	2	B1	MC
7.	A	K	1	2	B2	MC
8.	B	U	1	2	B3	MC
9.	C	U	1	2	B3	MC
10.	A	H	1	2	B3	MC
11.	D	U	1	2	B5	MC
12.	B	U	1	2	B6	MC
13.	C	U	1	2	B6	MC
14.	A	H	1	2	B6,3	MC
15.	B	H	1	3	C1/D4	MC
16.	A	U	1	3	C3	MC
17.	B	U	1	3	C4	MC
18.	A	H	1	3	C5/F1	MC
19.	B	U	1	3	C6	MC
20.	A	U	1	3	C7	MC
21.	C	U	1	3	C7	MC
22.	A	U	1	4	D1/F3	MC
23.	D	K	1	4	D3	MC
24.	A	K	1	4	D4	MC
25.	B	U	1	4	D5	MC
26.	C	U	1	4	D6,5	MC

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
27.	B	K	1	4	E1	MC
28.	C	H	1	4	E1, 2	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	MC
33.	D	U	1	4	F5	MC
34.	A	K	1	4	F2	MC
35.	B	U	1	4	F3	MC
36.	A	U	1	4	F1	MC
37.	A	U	1	4	F6	MC
38.	D	U	1	4	F8	MC
39.	A	K	1	5	G1	MC
40.	D	U	1	5	G1	MC
41.	C	U	1	5	G1	MC
42.	C	H	1	5	G2	MC
43.	C	U	1	5	G3	MC
44.	A	U	1	5	G4	MC
45.	A	K	1	5	H1	MC
46.	A	U	1	5	H1	MC
47.	B	U	1	5	H1	MC
48.	C	H	1	5	H1/C4	MC
49.	C	U	1	5	H3	MC
50.	B	U	1	5	H4	MC

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
1.	–	U	4	1	A2	WR
2.	–	U	4	2	B6	WR
3.	–	U	4	3	C7	WR
4.	–	U	3	4	D5	WR
5.	–	U	5	4	F5	WR
6.	–	U	3	4	F1	WR
7.	–	U	4	5	G3	WR
8.	–	U	3	5	H4	WR

Chemistry 12  
2007/08 Released Exam  
August 2008  
Provincial Examination — Scoring Guide

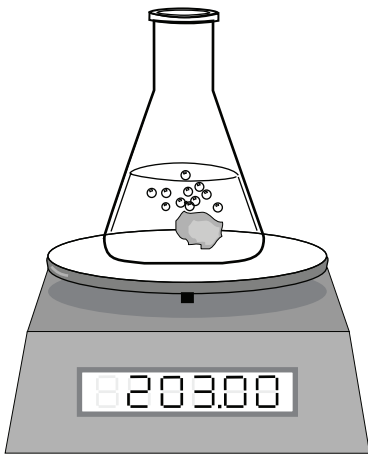
1. (4 marks)

Solid sodium bicarbonate and acetic acid were reacted in an open flask as follows:



The following data was recorded:

Time (s)	Mass of Flask and Contents (g)
0.00	203.00 g
30.0	202.95 g
60.0	202.93 g
90.0	202.92 g



Calculate the overall rate of reaction in grams of  $\text{NaHCO}_3$  per minute.

**Solution:**

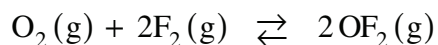
*For Example:*

$$\text{rate} = \frac{0.08 \text{ g CO}_2}{90 \text{ s}} \times \frac{60 \text{ s}}{\text{min}} = 0.053 \text{ g CO}_2/\text{min} \quad \leftarrow 2 \text{ marks}$$

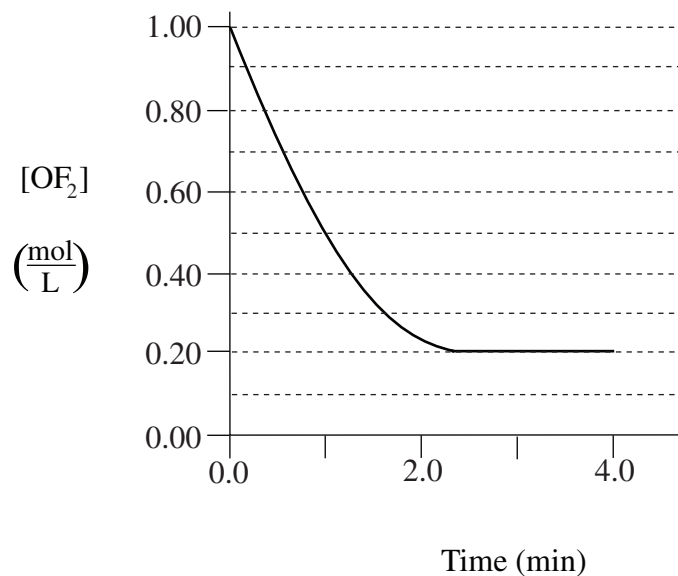
$$\begin{aligned} \text{rate} &= \frac{0.053 \text{ g CO}_2}{\text{min}} \times \frac{1 \text{ mol CO}_2}{44 \text{ g CO}_2} \times \frac{1 \text{ mol NaHCO}_3}{1 \text{ mol CO}_2} \times \frac{84 \text{ g NaHCO}_3}{\text{mol}} \\ &= 0.1 \text{ g NaHCO}_3/\text{min} \quad \leftarrow 2 \text{ marks} \end{aligned}$$

2. (4 marks)

Consider the following equilibrium:



Initially,  $\text{OF}_2$  was placed in a 1.00 L container and allowed to react. The amount of  $\text{OF}_2$  was monitored over 4.0 minutes and the following graph was produced:



Calculate the value of  $K_{eq}$ .

**Solution:**

*For Example:*

	$\text{O}_2(\text{g})$	+	$2\text{F}_2(\text{g})$	$\rightleftharpoons$	$2\text{OF}_2(\text{g})$	} ← 2 marks
[I]	0		0		1.00 M	
[C]	+0.40		+0.80 M		-0.80 M	
[E]	0.40		0.80		0.20	

$$K_{eq} = \frac{[\text{OF}_2]^2}{[\text{O}_2][\text{F}_2]^2}$$

$$= \frac{(0.20)^2}{(0.40)(0.80)^2}$$

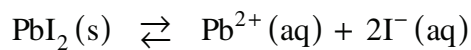
$$= 0.16$$

← 1 mark

← 1 mark

3. (4 marks)

Consider the equilibrium for a saturated solution of  $\text{PbI}_2$ :



What is the maximum  $[\text{Ag}^{+}]$  that can exist in a saturated solution of  $\text{PbI}_2$  without causing a precipitate to form?

**Solution:**

*For Example:*

For the  $\text{PbI}_2$ :

$$K_{sp} = [\text{Pb}^{2+}][\text{I}^{-}]^2 = 8.5 \times 10^{-9}$$

$s$  = solubility

$$4s^3 = 8.5 \times 10^{-9}$$

$$s = \sqrt[3]{\frac{8.5 \times 10^{-9}}{4}} = \sqrt[3]{2.1 \times 10^{-9}}$$

$$s = 1.286 \times 10^{-3} \text{ M}$$

$$[\text{I}^{-}] = 2s = 2.57 \times 10^{-3} \text{ M}$$

← 1 mark

← 1 mark

For  $\text{AgI}$ :

$$K_{sp} = [\text{Ag}^{+}][\text{I}^{-}] = 8.5 \times 10^{-17}$$

$$[\text{Ag}^{+}] = \frac{8.5 \times 10^{-17}}{2.57 \times 10^{-3}}$$

$$[\text{Ag}^{+}] = 3.3 \times 10^{-14} \text{ M}$$

← 1 mark

← 1 mark

4. (3 marks)

Complete the following equilibrium, then predict whether the reactants or products will be favoured and explain why.



**Solution:**

*For Example:*



The equilibrium favours the reactants ← 1 mark

since the  $K_a \text{ H}_2\text{SO}_3 > K_a \text{ HSO}_4^-$  ← 1 mark

5. (5 marks)

Calculate the initial concentration of a KF salt solution that has a pH = 8.65 .  
Begin by writing the equation for the predominant equilibrium reaction.

**Solution:**

*For Example:*

	$F^-(aq)$	+ $H_2O(l)$	$\rightleftharpoons$	$HF(aq)$	+ $OH^-(aq)$	$\leftarrow$ 1 mark
[I]	$x$			0	0	
[C]	$-4.47 \times 10^{-6}$			$+4.47 \times 10^{-6}$	$+4.47 \times 10^{-6}$	
[E]	$x - 4.47 \times 10^{-6}$			$4.47 \times 10^{-6}$	$4.47 \times 10^{-6}$	$\leftarrow$ 1 mark

(it may be assumed that  $4.47 \times 10^{-6}$  is negligible)

$$\begin{array}{|c} \uparrow \\ \hline \text{pOH} = 5.35 \\ \hline \text{pH} = 8.65 \end{array}$$

$\leftarrow$  1 mark

$$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{3.5 \times 10^{-4}} = 2.86 \times 10^{-11}$$

$$K_b = \frac{[HF][OH^-]}{[F^-]}$$

$$2.86 \times 10^{-11} = \frac{(4.47 \times 10^{-6})(4.47 \times 10^{-6})}{x}$$

$\leftarrow$  1 mark

$\leftarrow$  1 mark

$$x = 0.70 \text{ M} = [F^-] = [KF]$$

6. (3 marks)

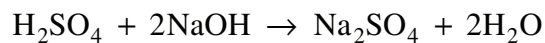
In three separate trials, 10.00 mL samples of  $\text{H}_2\text{SO}_4$  were titrated with 0.40 M NaOH and the results are tabulated below.

Trial	Volume of 0.40 M NaOH
1	18.20 mL
2	16.90 mL
3	17.10 mL

Calculate the concentration of the  $\text{H}_2\text{SO}_4$ .

**Solution:**

*For Example:*



average volume of NaOH = 17.00 mL

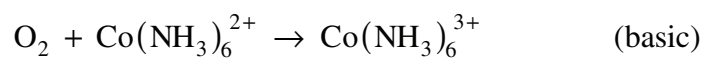
← 1 mark

$$[\text{H}_2\text{SO}_4] = \frac{0.40 \text{ mol NaOH}}{\text{L}} \times 0.01700 \text{ L} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{1}{0.0100 \text{ L}} \quad \left. \vphantom{\frac{0.40 \text{ mol NaOH}}{\text{L}}} \right\} \leftarrow 2 \text{ marks}$$

= 0.34 M

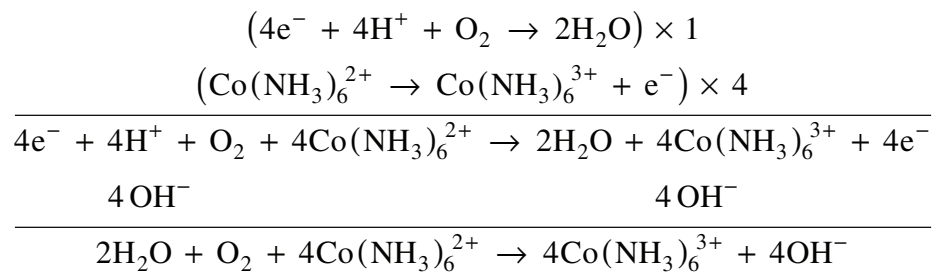
7. (4 marks)

Balance the following redox equation in basic solution:



**Solution:**

*For Example:*



8. (3 marks)

A solution of  $\text{MnSO}_4$  is electrolyzed using inert electrodes. Write the anode and cathode half-reactions and describe any observations at the cathode.

Anode half-reaction: \_\_\_\_\_

Cathode half-reaction: \_\_\_\_\_

Cathode observation: \_\_\_\_\_

**Solution:**

*For Example:*

Anode half-reaction:  $\text{H}_2\text{O} \rightarrow \frac{1}{2}\text{O}_2 + 2\text{H}^+ + 2\text{e}^-$  ← 1 mark

Cathode half-reaction:  $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$  ← 1 mark

Cathode observation: gas bubbles form ← 1 mark

(Note: no mark for a conclusion such as “hydrogen is produced.”  
Must be an observation.)