Chemistry 12

June 2002 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.	A	U	1	1	A1	25.	B	K	1	4	K1
2.	C	K	1	1	A6	26.	A	U	2	4	K8
3.	C	U	1	1	B5	27.	A	K	1	4	L2
4.	B	U	1	1	B6	28.	D	U	2	4	L12
5.	B	U	1	1	C5	29.	D	K	1	4	M2
6.	C	H	2	1	C4, D2	30.	A	K	1	4	N1
7.	A	U	1	2	D3	31.	B	U	1	4	N3
8.	D	U	1	2	E2	32.	B	H	2	4	O3
9.	B	H	1	2	E3	33.	B	U	1	4	O4
10.	D	U	2	2	D7	34.	C	H	1	4	P1
11.	D	U	1	2	F1	35.	D	U	2	4	P3
12.	B	K	1	2	F2	36.	D	K	1	4	Q2
13.	C	U	1	2	F4	37.	C	K	1	4	R1
14.	A	U	2	2	F5	38.	D	K	1	5	S5
15.	B	K	1	3	G2	39.	D	U	2	5	S2
16.	B	U	1	3	G8	40.	C	U	1	5	S6
17.	B	U	2	3	H1	41.	C	U	1	5	S6, U9
18.	C	U	1	3	H3	42.	B	K	1	5	U3
19.	C	U	1	3	H7	43.	C	H	2	5	U5
20.	B	K	1	3	I2	44.	D	U	1	5	T1, U2
21.	B	U	2	3	I3	45.	D	U	1	5	U2
22.	C	U	1	3	I6	46.	A	H	1	5	U9
23.	B	K	1	4	J4	47.	A	U	2	5	U10
24.	C	U	1	4	J11	48.	A	U	1	5	W4

Multiple Choice = 60 marks (48 questions)

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	3	1	A3
2.	2	K	2	1	B9
3.	3	K	2	2	D7
4.	4	U	4	2	F7
5.	5	U	3	3	E2, H5
6.	6	U	3	3	I4
7.	7	U	4	4	J8, K8
8.	8	U	2	4	L1
9.	9	U	5	4	M3
10.	10	U	3	4	Q5
11.	11	U	4	5	T2
12.	12	U	3	5	W1, W7
13.	13	H	2	5	S6, U9

Written Response = 40 marks

Multiple Choice = 60 (48 questions)
Written Response = 40 (13 questions)
EXAMINATION TOTAL = 100 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: 40 marks **Suggested Time: 50 minutes**

INSTRUCTIONS:	You will be 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 reaction: **(3 marks)**

$$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2AlCl_{3(aq)} + 3H_{2(g)}$$

A $10.0\,g$ sample of Al reacts completely in excess HCl in $300.0\,s$.
What is the rate of production of H_2 in mol/s ?

Solution:

For Example:

$$\text{mol Al} = 10.0\,g \times \frac{1\,\text{mol}}{27.0\,g} = 0.370\,\text{mol Al}$$

$$\text{mol } H_2 = 0.370\,\text{mol Al} \times \frac{3\,\text{mol } H_2}{2\,\text{mol Al}}$$

$$= 0.556\,\text{mol } H_2$$

$$\text{rate} = \frac{\text{change in moles}}{\text{time}}$$

$$= \frac{0.556\,\text{mol } H_2}{300.0\,s}$$

$$= 1.85 \times 10^{-3}\,\frac{\text{mol } H_2}{s}$$

← **3 marks**

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

2. Using collision theory, give **two** reasons why reactions occur more rapidly at a higher temperature. **(2 marks)**

Solution:

For Example:

There is a greater fraction of collisions with sufficient energy.

There are more frequent collisions.

← **2 marks**

3. Chemical reactions tend toward a position of minimum enthalpy and maximum entropy.

   a) What is meant by the term *enthalpy*? **(1 mark)**

Solution:

For Example:

Enthalpy is a measure of heat content. ← **1 mark**

   b) What is meant by the term *entropy*? **(1 mark)**

Solution:

For Example:

Entropy is a measure of randomness. ← **1 mark**

4. Consider the following: **(4 marks)**

$$H_{2(g)} + Br_{2(g)} \rightleftarrows 2HBr_{(g)} \qquad K_{eq} = 12.0$$

Initially, $0.080\,\text{mol}$ H_2 and $0.080\,\text{mol}$ Br_2 are placed into a $4.00\,\text{L}$ container. What is the $[HBr]$ at equilibrium?

Solution:

For Example:

	H_2	+	Br_2	$\rightleftarrows$	$2HBr$
$[I]$	0.020		0.020		0
$[C]$	$-x$		$-x$		$+2x$
$[E]$	$0.020 - x$		$0.020 - x$		$2x$

$$K_{eq} = \frac{[HBr]^2}{[H_2][Br_2]} = \frac{(2x)^2}{(0.020 - x)^2} = 12.0$$

$$\sqrt{\frac{(2x)^2}{(0.020 - x)}} = \sqrt{12.0}$$

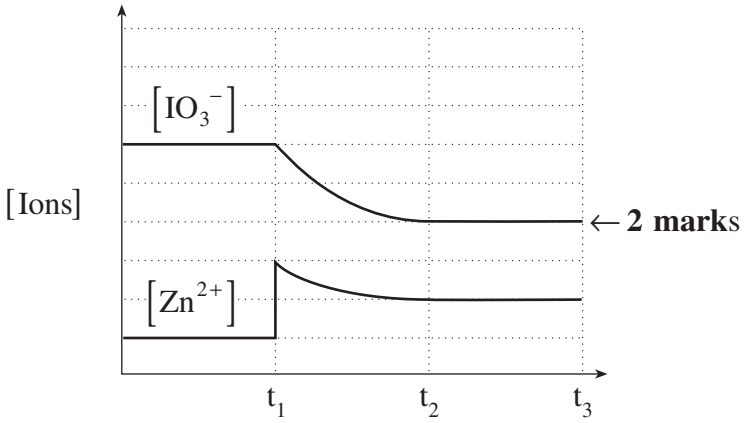
$$x = 0.0127$$

$$[HBr] = 2x = 0.025\,\text{M}$$

← **4 marks**

5. Consider the following equilibrium and accompanying graph:

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



a) Identify the stress applied at t_1 . **(1 mark)**

Solution:

For Example:

More $Zn^{2+}_{(aq)}$ has been added. ← **1 mark**

b) Complete the above graph from t_1 to t_3 for the $[IO_3^-]$. **(2 marks)**

Solution:

For Example:

See graph above.

6. Calculate the solubility of $SrSO_4$ in grams per litre. **(3 marks)**

Solution:

For Example:

$$SrSO_{4(s)} \rightleftarrows Sr^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$$

$$s \qquad\qquad s$$

$$K_{sp} = \left[Sr^{2+}\right]\left[SO_4^{2-}\right] = 3.4 \times 10^{-7}$$

$$s^2 = 3.4 \times 10^{-7}$$

$$\text{Solubility} = s = 5.8 \times 10^{-4}\ \text{M}$$

$$\text{Solubility in g/L} = 5.8 \times 10^{-4}\ \text{mol/L} \times \frac{183.7\,\text{g}}{\text{mol}}$$

$$= 0.11\,\text{g/L}$$

← **3 marks**

7. The cyanide ion, CN^-, is a Brønsted-Lowry base.

a) Define *Brønsted-Lowry base*. **(1 mark)**

Solution:

For Example:

A Brønsted-Lowry base is a proton acceptor. ← **1 mark**

b) Write the equation representing the reaction of CN^- with water. **(2 marks)**

Solution:

For Example:

$CN^- + H_2O \rightleftarrows HCN + OH^-$ ← **2 marks**

c) Identify a conjugate pair in b) above. **(1 mark)**

Solution:

For Example:

CN^- and HCN **OR** H_2O and OH^- ← **1 mark**

8. Write an equation to show the ionization of water. **(2 marks)**

Solution:

For Example:

$$2H_2O_{(\ell)} \rightleftarrows H_3O^+_{(aq)} + OH^-_{(aq)} \quad \leftarrow \textbf{2 marks}$$

9. Calculate the pH of 1.50 M NH_3 . **(5 marks)**

Solution:

For Example:

	NH_3	+	H_2O	$\rightleftarrows$	NH_4^+	+	OH^-
[I]	1.50				0		0
[C]	$-x$				$+x$		$+x$
[E]	$1.50 - x$				x		x

← **2 marks**

$$K_b = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.79 \times 10^{-5}$$ ← **1 mark**

$$K_b = \frac{\left[NH_4^+\right]\left[OH^-\right]}{\left[NH_3\right]}$$

$$= \frac{x^2}{1.50 - x}$$

$$x = \left[OH^-\right] = 5.18 \times 10^{-3}$$

$$pOH = 2.29$$

$$pH = 11.71$$

← **2 marks**

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

10. Consider the following buffer equilibrium: **(3 marks)**

$$\underset{\text{high concentration}}{HF_{(aq)}} + H_2O_{(\ell)} \rightleftarrows \underset{\text{low concentration}}{H_3O^+_{(aq)}} + \underset{\text{high concentration}}{F^-_{(aq)}}$$

Using Le Châtelier's Principle, explain what happens to the pH of the buffer solution when a small amount of NaOH is added.

Solution:

For Example:

NaOH causes $\left[H_3O^+\right]$ to decrease.	← **1 mark**
The equilibrium shifts right.	← **1 mark**
The pH almost returns to the former value.	← **1 mark**

11. Balance the following redox equation: **(4 marks)**

$$Ag + NO_3^- \rightarrow Ag^+ + NO \qquad \text{(acidic)}$$

Solution:

For Example:

$$3 \times \left(Ag \rightarrow Ag^+ + 3e^-\right) \qquad \leftarrow \textbf{2 marks (1 mark for each half-reaction)}$$

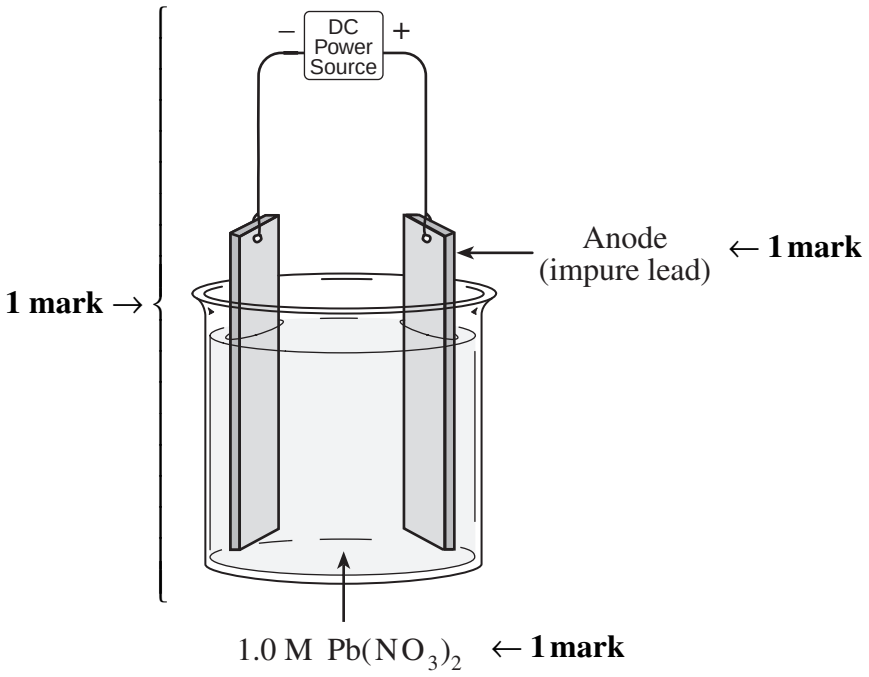
$$3e^- + 4H^+ + NO_3^- \rightarrow NO + 2H_2O \qquad \leftarrow \textbf{1 mark for balancing electrons}$$

$$3Ag + NO_3^- + 4H^+ \rightarrow NO + 2H_2O + 3Ag^+ \qquad \leftarrow \textbf{1 mark for addition}$$

12. Draw a diagram of an operating electrolytic cell used to extract pure lead from an impure lead sample. Identify the electrolyte and the material used for the anode. **(3 marks)**

Solution:

For Example:



13. A sample of copper is placed in $HNO_{3(aq)}$ and another sample of copper is placed in $HCl_{(aq)}$.

a) In which acid does the copper react? $\left(\frac{1}{2}\text{ mark}\right)$

Solution:

For Example:

Copper reacts in $HNO_{3(aq)}$. $\leftarrow \frac{1}{2}$ **mark**

b) Calculate E° for the reaction that occurs. $\left(1\frac{1}{2}\text{ marks}\right)$

Solution:

For Example:

E° is $+0.62$ volts $\leftarrow 1\frac{1}{2}$ **marks**

END OF KEY