Chemistry 12

June 1999 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	CO	PLO	Q	K	C	CO	PLO
1.	D	K	1	A2	25.	D	K	4	L1
2.	A	H	1	A2	26.	C	K	4	L3
3.	B	U	1	A6	27.	D	H	4	L4
4.	C	U	1	B6	28.	C	U	4	K5, J8
5.	A	H	1	B3, 9	29.	C	U	4	L12
6.	D	K	1	C3	30.	A	U	4	M1, N4
7.	C	U	2	D7	31.	C	U	4	N3
8.	C	U	2	E2	32.	B	K	4	O5
9.	C	U	2	E2, 5	33.	B	K	4	O2
10.	A	U	2	E4	34.	B	U	4	P5
11.	D	U	2	F2	35.	A	K	4	Q1
12.	A	H	2	F4	36.	B	K	4	R1
13.	B	U	2	F7	37.	C	U	5	S1
14.	D	U	3	G8	38.	A	U	5	S2
15.	B	U	3	H1	39.	C	U	5	S2
16.	D	U	3	H7	40.	B	U	5	S6
17.	B	U	3	I3	41.	C	K	5	T1
18.	D	K	3	I6	42.	B	U	5	T4
19.	D	H	4	J1	43.	B	K	5	V2
20.	B	U	4	J7	44.	C	U	5	U10
21.	A	U	4	J8	45.	A	U	5	U2
22.	A	U	4	K1	46.	A	K	5	U11
23.	B	U	4	K6	47.	C	U	5	W4
24.	A	K	4	K11	48.	C	K	5	W1

Multiple Choice = 48 marks

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	3	1	B9
2.	2	U	4	2	D3, 4, F5
3.	3	K	2	2	E2
4.	4	U	2	3	H3
5.	5	U	4	3	I4
6.	6	U	2	4	K7
7.	7	U	4	4	M3, 4, 5
8.	8	U	3	4	P3
9.	9	U	4	5	T6
10.	10	U	2	5	U1, 7
11.	11	H	2	5	W4

Written Response = 32 marks

Multiple Choice = 48 (48 questions)
Written Response = 32 (11 questions)
EXAMINATION TOTAL = 80 marks

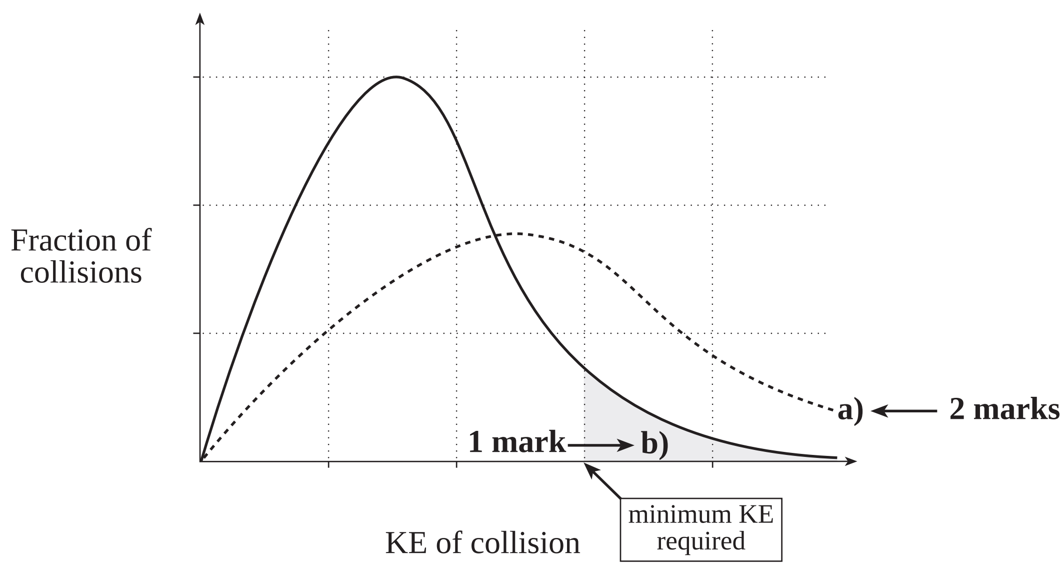
LEGEND:
Q = Question Number **K** = Keyed Response **C** = Cognitive Level
B = Score Box Number **S** = Score **CO** = Curriculum Organizer
PLO = Prescribed Learning Outcome

PART B: WRITTEN RESPONSE

Value: 32 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 calculation, full marks will NOT be given for providing only an answer.**

1. Consider the following KE distribution curve for colliding particles:



a) On the diagram above, sketch a line for the distribution of collisions at a higher temperature. **(2 marks)**

Solution:

See diagram.

b) Shade in the area representing the collisions that could result in forming an activated complex at the lower temperature. **(1 mark)**

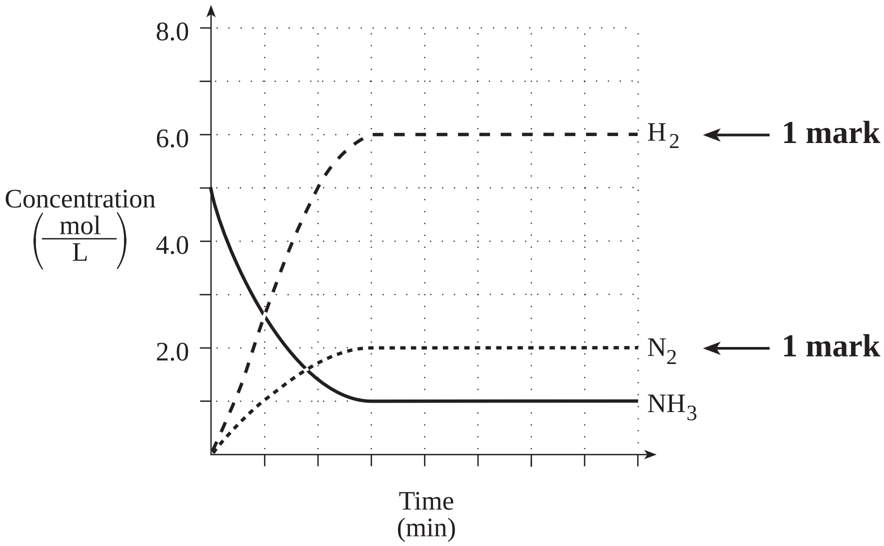
Solution:

See diagram.

2. Consider the following equilibrium system:

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)} + \text{energy}$$

A $1.00\ \text{L}$ container is filled with $5.0\ \text{mol}\ NH_3$ and the system proceeds to equilibrium as indicated by the graph.



a) Draw and label the graph for N_2 and H_2. **(2 marks)**

Solution:

See diagram.

b) Calculate the K_{eq} for $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$. **(2 marks)**

Solution:

$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$= \frac{(1.0)^2}{(2.0)(6.0)^3}$$

$$= 2.3\times10^{-3}$$

3. State Le Chatelier's Principle. **(2 marks)**

Solution:

***For Example*:**

When a system at equilibrium is subjected to a stress, processes occur that tend to counteract the stress and re-establish equilibrium. } ← **2 marks**

4. Write the net ionic equation representing the reaction that occurs when $50.0\,\text{mL}$ of $0.20\,\text{M}$ $ZnSO_4$ and $50.0\,\text{mL}$ of $0.20\,\text{M}$ BaS are combined. **(2 marks)**

Solution:

***For Example*:**

$$Zn^{2+}_{(aq)} + SO_4{}^{2-}_{(aq)} + Ba^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow ZnS_{(s)} + BaSO_{4(s)}$$ ← **2 marks**

5. When $1.00\,\text{g}$ of $MgCO_3$ is added to $2.0\,\text{L}$ of water, some, but not all, will dissolve to form a saturated solution. Calculate the mass of solid that remains undissolved. **(4 marks)**

Solution:

$$MgCO_3 \rightleftarrows \underset{s}{Mg^{2+}} + \underset{s}{CO_3^{2-}}$$

$$\left.\begin{aligned} K_{sp} &= [Mg^{2+}][CO_3^{2-}] \\ &= s^2 \\ s^2 &= 6.8\times10^{-6} \\ s &= 2.6\times10^{-3}\ \text{mol/L} \end{aligned}\right\} \leftarrow \mathbf{1\tfrac{1}{2}\ marks}$$

$$\left.\begin{aligned} \text{Mass dissolved} &= \left(2.6\times10^{-3}\ \text{mol/L}\right)\left(2.0\,\text{L}\times84.3\,\text{g/mol}\right) \\ &= 0.44\,\text{g} \end{aligned}\right\} \leftarrow \mathbf{1\tfrac{1}{2}\ marks}$$

$$\left.\begin{aligned} \text{Therefore mass undissolved} &= 1.00\,\text{g} - 0.44\,\text{g} \\ &= 0.56\,\text{g} \end{aligned}\right\} \leftarrow \mathbf{1\ mark}$$

6. In aqueous solutions, H_3O^+ is the strongest acid present. This phenomenon is called the levelling effect. Explain why this occurs. **(2 marks)**

Solution:

***For Example*:**

A strong acid such as HCl donates all of its protons to water forming H_3O^+. Hence, the strongest acid is the hydronium ion. } ← **2 marks**

7. A $1.00\,\text{M}$ OCl^- solution has an $[OH^-]$ of $5.75\times10^{-4}\,\text{M}$.

a) Calculate K_b for OCl^-. **(3 marks)**

Solution:

	OCl^-	+	H_2O	$\rightleftarrows$	$HOCl$	+	OH^-
[I]	1.00				0		0
[C]	-5.75×10^{-4}				$+5.75\times10^{-4}$		$+5.75\times10^{-4}$
[E]	1.00				5.75×10^{-4}		5.75×10^{-4}

← **1 ½ marks**

$$K_b = \frac{[HOCl][OH^-]}{[OCl^-]}$$

$$= \frac{\left(5.75\times10^{-4}\right)^2}{1.00}$$

$$= 3.31\times10^{-7}$$

← **1 ½ marks**

b) Calculate K_a for $HOCl$. **(1 mark)**

Solution:

$$K_a = \frac{K_w}{K_b}$$

$$= \frac{1.0\times10^{-14}}{3.31\times10^{-7}}$$

$$= 3.0\times10^{-8}$$

← **1 mark**

8. Calculate the mass of NaOH needed to prepare 2.0 L of a solution with a pH of 12.00.

(3 marks)

Solution:

$$\text{pH} = 12.00. \text{ Therefore}$$

$$[\text{OH}^-] = 1.0 \times 10^{-2} \text{ mol/L} \qquad \leftarrow \textbf{1 mark}$$

$$\text{moles OH}^- = (1.0 \times 10^{-2} \text{ mol/L})(2.0 \text{ L}) = 2.0 \times 10^{-2} \qquad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned} \text{Mass NaOH} &= (2.0 \times 10^{-2} \text{ mol})\left(\frac{40.0 \text{ g}}{\text{mol}}\right) \\ &= 8.0 \times 10^{-1} \text{ g} \end{aligned}\right\} \leftarrow \textbf{1 mark}$$

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

9. The data below were obtained in a redox titration of a $25.00\,\text{mL}$ sample containing Sn^{2+} ions using $0.125\,\text{M}$ $KMnO_4$ according to the following reaction:

$$2MnO_4^- + 16H^+ + 5Sn^{2+} \rightarrow 2Mn^{2+} + 8H_2O + 5Sn^{4+}$$

	Volume of $KMnO_4$ used (mL)		
	Trial #1	Trial #2	Trial #3
Initial buret reading	2.00	13.80	24.55
Final buret reading	13.80	24.55	35.32

Calculate the $\left[Sn^{2+}\right]$ in the original sample. **(4 marks)**

Solution:

Average volume of $KMnO_4$ in Trials 2 and 3 $= 0.01076\,\text{L}$ ← **1 mark**

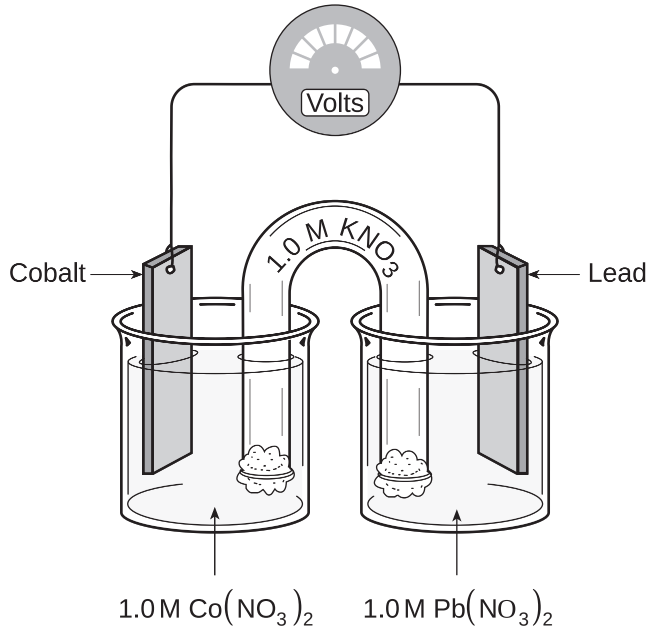
Moles of $KMnO_4 = (0.125\,\text{M})(0.01076\,\text{L}) = 1.345\times10^{-3}\,\text{mol}$ ← **1 mark**

Moles of $Sn^{2+} = \frac{5}{2}\left(1.345\times10^{-3}\,\text{mol}\right) = 3.363\times10^{-3}\,\text{mol}$ ← **1 mark**

Molarity of $Sn^{2+} = \dfrac{\left(3.363\times10^{-3}\,\text{mol}\right)}{0.025\,\text{L}} = 0.134\,\text{M}$ ← **1 mark**

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

10. Consider the following electrochemical cell:



a) Calculate the initial cell voltage. **(1 mark)**

Solution:

0.15 Volts

b) What is the purpose of the salt bridge? **(1 mark)**

Solution:

***For Example*:**

The salt bridge allows ion migration in order to equalize the charge.

11. Consider the electrolysis of $1.0\,\text{M}\ H_2SO_4$ using inert platinum electrodes.

a) Write the oxidation half-reaction. **(1 mark)**

Solution:

$H_2O \rightarrow \frac{1}{2}O_2 + 2H^+ + 2e^-$ $\leftarrow$ **1 mark**

b) Write the reduction half-reaction. **(1 mark)**

Solution:

$2H^+ + 2e^- \rightarrow H_2$ $\leftarrow$ **1 mark**

END OF KEY