Chemistry 12

April 1998 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.	B	H	4	L4, 6
2.	C	U	1	B9	26.	B	U	4	L7
3.	C	K	1	B9	27.	B	K	4	L9
4.	D	U	1	C3	28.	C	U	4	L11
5.	C	K	2	D4	29.	A	U	4	M2
6.	C	U	2	D7	30.	C	U	4	N4
7.	D	U	2	D9	31.	D	U	4	O2
8.	B	U	2	E2	32.	B	U	4	O4
9.	B	K	2	F2	33.	A	U	4	P2
10.	A	U	2	F3	34.	C	U	4	P5
11.	B	U	2	E2	35.	A	U	4	Q2
12.	C	U	2	F6	36.	A	K	4	R1
13.	A	K	3	G6	37.	B	U	5	S2
14.	D	U	3	G2, H5	38.	D	U	5	S1
15.	A	U	3	H2	39.	D	U	5	S1
16.	A	U	3	H4	40.	C	U	5	S2
17.	B	H	3	H5	41.	A	H	5	S4, 5
18.	C	U	3	I4	42.	A	U	5	U10
19.	D	U	3	I4	43.	A	H	5	T4
20.	D	H	3	H3, J3	44.	B	U	5	T5
21.	C	K	4	J6	45.	A	K	5	U11
22.	D	K	4	K3	46.	A	U	5	U5
23.	B	U	4	K2, 6	47.	D	U	5	U9
24.	D	U	4	K8	48.	B	U	5	W2, 4

Multiple Choice = 48 marks

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	4	1	B6, C4
2.	2	K	2	2	E2
3.	3	U	2	2	F7
4.	4	H	5	3	I3, 7, T2
5.	5	K	3	4	K4
6.	6	U	4	4	M1, 3
7.	7	U	4	4	M4, N1, 2
8.	8	U	3	5	T1, 3
9.	9	U	2	5	V4
10.	10	H	3	5	W2, O3, W4

Written Response = 32 marks

Multiple Choice = 48 (48 questions)
Written Response = 32 (10 questions)
EXAMINATION TOTAL = 80 marks

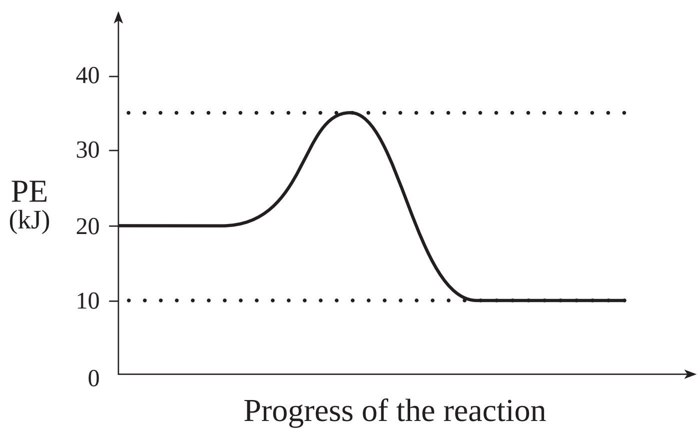
LEGEND:
Q = Question Number **K** = Keyed Response **C** = Cognitive Level
B = Score Box Number **S** = Score **CO** = Curriculum Organizer
PLO = Prescribed Learning Outcome

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 potential energy diagram for a reversible reaction:



a) Calculate the activation energy for the forward reaction. **(1 mark)**

Solution:

15 kJ.

b) Calculate ΔH for the forward reaction. **(1 mark)**

Solution:

–10 kJ.

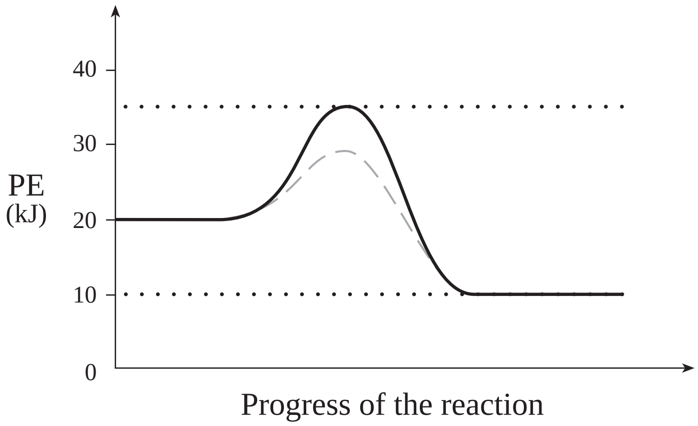
c) Calculate the activation energy for the reverse reaction. **(1 mark)**

Solution:

25 kJ.

d) On the diagram above, sketch a curve that could result when a catalyst is added. **(1 mark)**

Solution:



← 1 mark for diagram

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

Solution:

For example:

When a system at equilibrium $\left(\frac{1}{2}\right.$ **mark**$\left.\right)$ is subjected to a stress, $\left(\frac{1}{2}\right.$ **mark**$\left.\right)$ the system shifts so as to offset the stress $\left(\frac{1}{2}\right.$ **mark**$\left.\right)$ and establish a new equilibrium $\left(\frac{1}{2}\right.$ **mark**$\left.\right)$.

3. Consider the following equilibrium:

$$H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)} \qquad K_{eq} = 7.1\times10^{2}$$

At equilibrium, the $[H_2] = 0.012$ mol/L and $[HI] = 0.40$ mol/L. What is the equilibrium concentration of I_2? **(2 marks)**

Solution:

$$K_{eq} = \frac{[HI]^2}{[H_2][I_2]}$$

$$\therefore\ [I_2] = \frac{[HI]^2}{[H_2]K_{eq}} = \frac{(0.40)^2}{(0.012)(7.1\times10^2)} = 0.019 \text{ mol/L}$$

← **2 marks**

NOTE: $\left(\frac{1}{2}\right.$ mark$\left.\right)$ is deducted for incorrect significant figures.

4. Consider the following reaction:

$$Cu_{(s)} + 2AgCH_3COO_{(aq)} \rightarrow Cu(CH_3COO)_{2(aq)} + 2Ag_{(s)}$$

A piece of Cu wire is placed into 1.00 L of a saturated solution of silver acetate, $AgCH_3COO$. When all the Ag^+ has reacted, 2.00 g of Cu has been used.

a) Write the net ionic equation for the reaction between Cu and Ag^+. **(1 mark)**

Solution:

$Cu_{(s)} + 2Ag^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$ ← **1 mark**

b) Calculate the K_{sp} of $AgCH_3COO$. **(4 marks)**

Solution:

$$AgCH_3COO_{(s)} \rightleftarrows Ag^+_{(aq)} + CH_3COO^-_{(aq)}$$

$$\text{mol of Cu reacted} = 2.00\ \text{g}\left(\frac{1\ \text{mol}}{63.5\ \text{g}}\right) = 3.15\times10^{-2}\ \text{mol}$$

$$\text{mol of Ag}^+\text{ reacted} = 3.15\times10^{-2}\ \text{mol Cu}\left(\frac{2\ \text{mol Ag}^+}{1\ \text{mol Cu}}\right)$$

$$= 6.30\times10^{-2}\ \text{mol Ag}^+$$

← **1 ½ marks**

$$[Ag^+] = [CH_3COO^-] = 6.30\times10^{-2}\ \text{M}$$

← **1 mark**

$$K_{sp} = [Ag^+][CH_3COO^-]$$

$$= (6.30\times10^{-2})^2$$

$$= 3.97\times10^{-3}$$

← **1 ½ marks**

5. a) Define the term *weak Brönsted-Lowry base*. **(2 marks)**

Solution:
For example:

A weak Brönsted-Lowry base is a proton acceptor that reacts with water less than 100%. ← **2 marks**

b) Give an example of a compound that acts as a weak base. **(1 mark)**

Solution:
For example:

An example of a compound that acts as a weak base is NH_3. ← **1 mark**

6. Lactic acid, C_2H_5OCOOH, is a weak acid produced by the body. At $25°C$, 0.0100 M C_2H_5OCOOH has a pH of 2.95. Calculate the value of K_a for lactic acid.

(4 marks)

Solution:

$$[H_3O^+] = \text{antilog}(-2.95) = 1.122\times10^{-3}\text{ M}$$ ← **1 mark**

$$C_2H_5OCOOH_{(aq)} + H_2O_{(\ell)} \rightleftarrows C_2H_5OCOO^-_{(aq)} + H_3O^+_{(aq)}$$

	C_2H_5OCOOH	$C_2H_5OCOO^-$	H_3O^+
[I]	0.0100	0	0
[C]	-1.122×10^{-3}	$+1.122\times10^{-3}$	$+1.122\times10^{-3}$
[E]	8.88×10^{-3}	1.122×10^{-3}	1.122×10^{-3}

← **1 ½ marks**

$$K_a = \frac{[C_2H_5OCOO^-][H_3O^+]}{[C_2H_5OCOOH]}$$

$$= \frac{(1.122\times10^{-3})(1.122\times10^{-3})}{(8.88\times10^{-3})}$$

$$= 1.4\times10^{-4}$$

← **1 ½ marks**

7. The salt NaCN dissolves in water and forms a slightly basic solution.

a) Write the dissociation equation for NaCN in water. **(1 mark)**

Solution:

$$\text{NaCN}_{(s)} \rightarrow \text{Na}^{+}_{(aq)} + \text{CN}^{-}_{(aq)} \quad \leftarrow \textbf{1 mark}$$

b) Write the net ionic equation for the hydrolysis reaction. **(1 mark)**

Solution:

$$\text{CN}^{-}_{(aq)} + \text{H}_2\text{O}_{(\ell)} \rightleftarrows \text{HCN}_{(aq)} + \text{OH}^{-}_{(aq)} \quad \leftarrow \textbf{1 mark}$$

c) Write the K_b expression and calculate its value. **(2 marks)**

Solution:

$$\left.\begin{aligned} K_b &= \frac{[\text{HCN}][\text{OH}^-]}{[\text{CN}^-]} \\ K_b &= \frac{K_w}{K_a} \\ &= \frac{1.0\times10^{-14}}{4.9\times10^{-10}} \\ &= 2.0\times10^{-5} \end{aligned}\right\} \leftarrow \textbf{2 marks}$$

NOTE: $\left(\frac{1}{2}\right.$ mark$\left.\right)$ is deducted for incorrect significant figures.

8. A redox reaction that occurs in an alkaline dry cell is:

$$Zn + 2MnO_2 \rightarrow Mn_2O_3 + ZnO \quad (\text{basic})$$

Write the balanced equation for the reduction half-reaction occurring in basic solution.

(3 marks)

Solution:

$2MnO_2 + 2H^+ + 2e^- \rightarrow Mn_2O_3 + H_2O$ $\leftarrow$ **2 marks in acid**

$2MnO_2 + H_2O + 2e^- \rightarrow Mn_2O_3 + 2OH^-$ $\leftarrow$ **1 mark for changing to basic**

9. a) Identify a metal that can be used to cathodically protect the iron hull of a ship. **(1 mark)**

Solution:
For example:

Mg ← **1 mark**

or

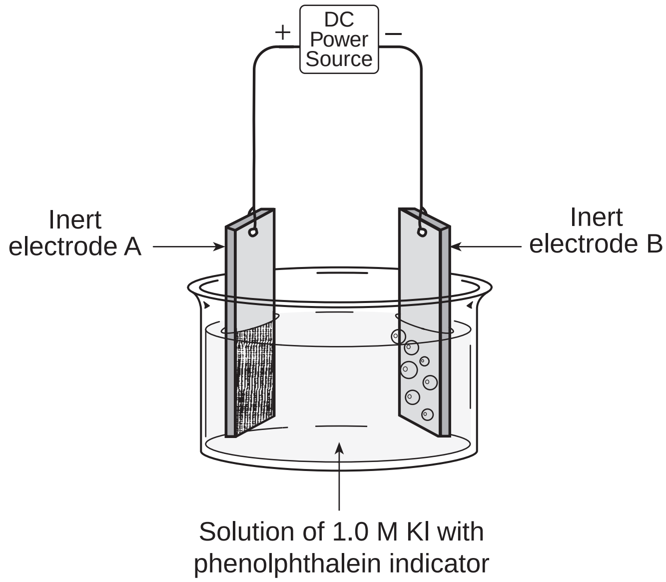
Zn

b) Explain how the metal you chose prevents the iron from rusting. **(1 mark)**

Solution:
For example:

Attaching a more active metal causes the iron to become a cathode by supplying it with electrons. ← **1 mark**

10. Consider the following cell used for the electrolysis of 1.0 M KI solution containing a few drops of phenolphthalein indicator.



a) Write the equation for the half-reaction taking place at electrode **A**. **(1 mark)**

Solution:

$2I^- \rightarrow I_2 + 2e^-$ ← **1 mark**

b) As the cell operates, gas bubbles form and the solution turns pink around electrode **B**. **(2 marks)**

i) Identify the gas that forms.

Solution:

Hydrogen gas. ← **1 mark**

ii) Explain why the solution turns pink.

Solution:

The pink colour is due to the production of the hydroxide ion. ← **1 mark**

END OF KEY