Chemistry 12

June 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.	C	U	1	A5	25.	A	K	4	L2
2.	D	U	1	B6	26.	D	U	4	L11
3.	C	U	1	B9	27.	A	H	4	L6
4.	A	K	1	A5	28.	A	U	4	L12
5.	A	K	2	D4	29.	C	U	4	M1
6.	B	U	2	D7	30.	D	H	4	N4
7.	A	U	2	E2	31.	C	K	4	O2
8.	B	U	2	E2	32.	C	U	4	O4
9.	B	U	2	F2	33.	D	U	4	P6
10.	D	K	2	F3	34.	B	U	4	P4
11.	B	U	2	F5	35.	C	U	4	Q5
12.	B	U	2	F7	36.	D	K	5	R1
13.	C	K	3	G1	37.	B	U	5	S1, S2
14.	B	U	3	G8	38.	C	U	5	S1
15.	A	U	3	H1	39.	D	U	5	S2
16.	B	U	3	G2	40.	A	U	5	S5
17.	D	U	3	I1	41.	C	U	5	S6
18.	D	U	3	I4	42.	D	U	5	T6
19.	A	U	3	I5	43.	D	U	5	U11
20.	B	K	4	J2	44.	D	U	5	U2
21.	A	K	4	J4	45.	A	U	5	U2, 5
22.	B	K	4	J12	46.	C	U	5	U3
23.	C	U	4	K6	47.	C	U	5	W4
24.	D	H	4	K8	48.	A	K	5	W2

Multiple Choice = 48 marks

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	K	2	1	B1
2.	2	U	2	1	C5
3.	3	H	4	2	E2, F5
4.	4	U	3	3	I7
5.	5	H	3	3	I6
6.	6	K	2	4	K10, 11
7.	7	U	4	4	M3, 4
8.	8	U	4	4	P1, 6
9.	9	U	3	5	T2
10.	10	K	2	5	W1
11.	11	U	3	5	U2, U11

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. A reaction does not always occur when two reactant particles collide. Give **two** reasons why.

(2 marks)

Solution

A reaction does not occur if there is insufficient energy. ← **1 mark**

A reaction does not occur if there is incorrect geometry. ← **1 mark**

2. Consider the following reaction mechanism:

$$\text{Step 1:} \quad NO + NO \rightarrow N_2O_2$$
$$\text{Step 2:} \quad N_2O_2 + H_2 \rightarrow N_2O + H_2O$$
$$\text{Step 3:} \quad N_2O + H_2 \rightarrow N_2 + H_2O$$

a) Write the equation for the overall reaction. **(1 mark)**

Solution

$2NO + 2H_2 \rightarrow N_2 + 2H_2O$ ← **1 mark**

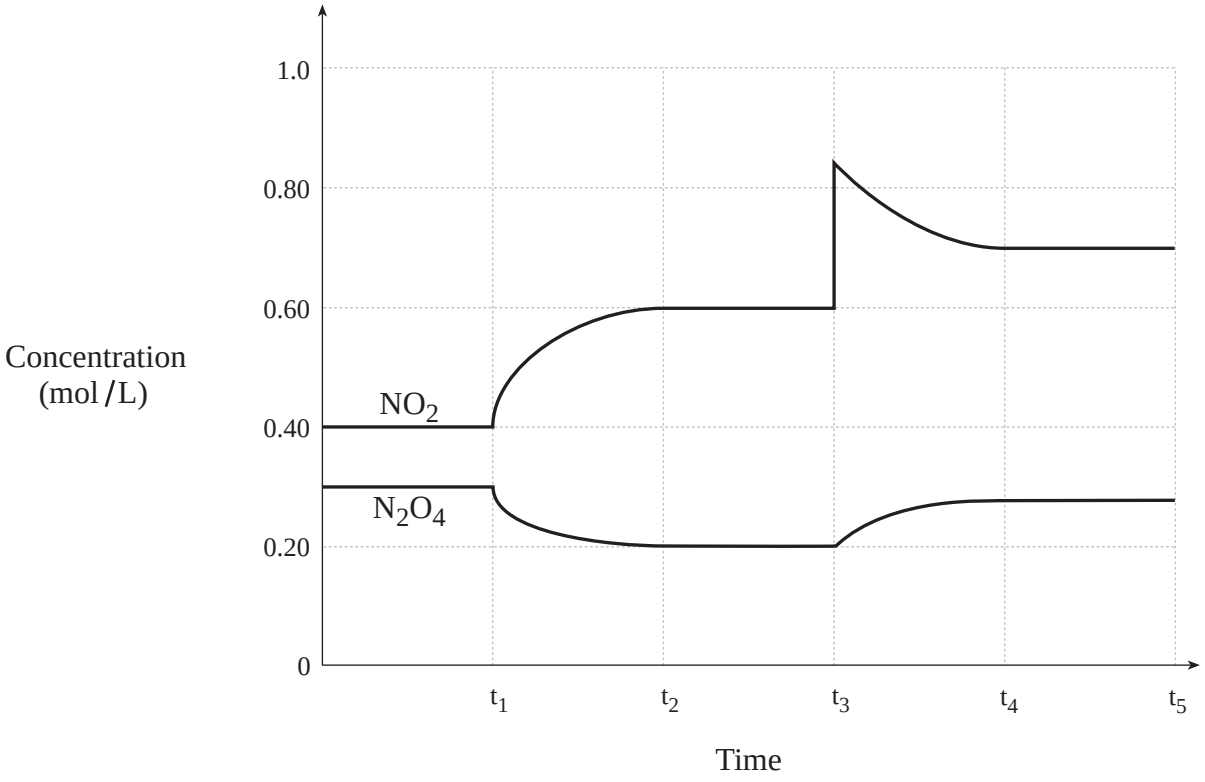
b) Identify the reaction intermediate(s). **(1 mark)**

Solution

N_2O_2 and N_2O ← $\frac{1}{2}$ **mark for each**

3. Consider the following graph for the reaction:

$$\text{energy} + N_2O_{4(g)} \rightleftarrows 2NO_{2(g)}$$



a) What is the stress imposed at time t_1 ? **(1 mark)**

Solution

Temperature is increased. ← **1 mark**

b) What is the stress imposed at time t_3 ? **(1 mark)**

Solution

NO_2 added. ← **1 mark**

c) Calculate K_{eq} for the equilibrium between t_2 and t_3. **(2 marks)**

Solution

$$K_{eq} = \frac{[NO_2]^2}{[N_2O_4]} = \frac{(0.60)^2}{(0.20)} = 1.8 \quad \leftarrow \textbf{2 marks}$$

4. Consider the following net ionic equation:

$$Ag^{+}_{(aq)} + SCN^{-}_{(aq)} \rightarrow AgSCN_{(s)}$$

A 20.00 mL sample of 0.200 M NH_4SCN is used to titrate a 30.00 mL sample containing Ag^{+}. Calculate the $\left[Ag^{+}\right]$ in the original sample. **(3 marks)**

Solution

$$\text{mol } SCN^{-} = 0.0200 \text{ L} \left(\frac{0.200 \text{ mol}}{1 \text{ L}}\right) = 4.00 \times 10^{-3} \text{ mol}$$

$$\text{mol } Ag^{+} = \text{mol } SCN^{-}$$

$$= 4.00 \times 10^{-3} \text{ mol}$$

$$\left[Ag^{+}\right] = \frac{4.00 \times 10^{-3} \text{ mol}}{0.0300 \text{ L}} = 0.133 \text{ M}$$

← **1 mark**

← **1 mark**

← **1 mark**

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

5. A solution contains 0.020 M Ba^{2+} and an unknown concentration of Sr^{2+}. When dilute Na_2CO_3 is slowly added to the mixture, both Ba^{2+} and Sr^{2+} start to precipitate at the same time. **(3 marks)**

a) Calculate the $\left[CO_3^{2-}\right]$ when $BaCO_3$ starts to precipitate.

Solution

$$BaCO_3 \rightleftarrows Ba^{2+} + CO_3^{2-}$$
$$0.020 \qquad x$$

$$K_{sp} = \left[Ba^{2+}\right]\left[CO_3^{2-}\right]$$
$$\left[CO_3^{2-}\right] = \frac{2.6\times10^{-9}}{0.020}$$
$$= 1.3\times10^{-7}\ \text{M}$$

$\leftarrow$ **1 $\frac{1}{2}$ marks**

b) Calculate the initial $\left[Sr^{2+}\right]$.

Solution

$$SrCO_3 \rightleftarrows Sr^{2+} + CO_3^{2-}$$
$$y \qquad 1.3\times10^{-7}$$

$$K_{sp} = \left[Sr^{2+}\right]\left[CO_3^{2-}\right]$$
$$\left[Sr^{2+}\right] = \frac{5.6\times10^{-10}}{1.3\times10^{-7}}$$
$$= 4.3\times10^{-3}\ \text{M}$$

$\leftarrow$ **1 $\frac{1}{2}$ marks**

6. a) Define the term *amphiprotic*. **(1 mark)**

Solution

For example:

The ability to act as both a proton donor or proton acceptor. ← **1 mark**

b) Give an example of an amphiprotic anion. **(1 mark)**

Solution

For example:

HCO_3^- ← **1 mark**

7. The salt Na_2CO_3 undergoes hydrolysis to produce a basic solution. Calculate the $\left[OH^-\right]$ in 0.100 M Na_2CO_3. **(4 marks)**

Solution

$$CO_3^{2-} + H_2O \rightleftarrows HCO_3^- + OH^-$$

[**I**]	0.100	0	0
[**C**]	$-x$	$+x$	$+x$
[**E**]	$0.100 - x$	x	x
	≈ 0.100		

← **1 $\frac{1}{2}$ marks**

$$K_b = \frac{K_w}{K_a} = \frac{1.0\times10^{-14}}{5.6\times10^{-11}} = 1.8\times10^{-4}$$ ← **1 mark**

$$K_b = \frac{\left[HCO_3^-\right]\left[OH^-\right]}{\left[CO_3^{2-}\right]}$$

$$1.8\times10^{-4} = \frac{(x)(x)}{(0.100)}$$

$$\left[OH^-\right] = x = 4.2\times10^{-3}$$

← **1 $\frac{1}{2}$ marks**

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

8. A student titrated a 25.00 mL sample of a 0.20 M HX (unknown) acid with 0.20 M NaOH. The following data were collected.

Volume of base added (mL)	pH
0.00	2.72
10.00	4.57
24.90	7.14
24.99	8.14
25.00	8.88
25.01	9.60
26.00	11.59
35.00	12.52

a) Describe the acid HX as strong or weak. Support your answer with two observations from the data table. **(3 marks)**

Solution

For example:

The unknown is a weak acid.
The initial pH of 2.72 indicates that a weak acid is being titrated.
The equivalence or stoichiometric point has a pH of 8.88 which indicates that a basic salt is produced during this reaction.
NaOH is a strong base and therefore the acid must be weak.

← **3 marks**

b) Select an appropriate indicator for this titration and identify the colour at the equivalence point. **(1 mark)**

Solution

For example:

Thymol blue would be a green colour.
or
Phenolphthalein would be a faint pink colour.

← **1 mark**

9. Balance the following redox reaction: **(3 marks)**

$$Ni + ClO_4^- \rightarrow Ni^{2+} + Cl^- \quad \text{(acid)}$$

Solution

For example:

1 mark for e^- balance

$$4 \times (Ni \rightarrow Ni^{2+} + 2e^-) \quad \leftarrow \tfrac{1}{2} \text{ mark}$$

$$1 \times (8e^- + 8H^+ + ClO_4^- \rightarrow Cl^- + 4H_2O) \quad \leftarrow \tfrac{1}{2} \text{ mark}$$

$$4Ni + 8H^+ + ClO_4^- \rightarrow 4Ni^{2+} + Cl^- + 4H_2O \quad \leftarrow \textbf{1 mark}$$

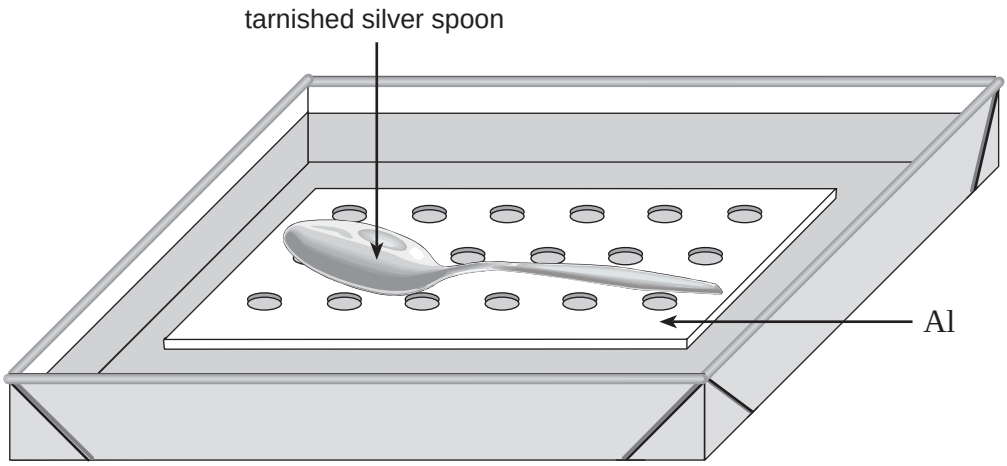
10. Define the term *electrolysis*. **(2 marks)**

Solution

For example:

The process of applying an electric current to cause a chemical reaction to occur. } ← **2 marks**

11. Consider the following diagram:



On a silver spoon, the black tarnish, Ag_2S, can be removed spontaneously by placing the spoon in contact with aluminum in a conducting solution.

a) Write the equations for the two half-reactions. **(2 marks)**

Solution

For example:

$Ag_2S + 2e^- \rightarrow 2Ag + S^{2-}$ $\leftarrow$ **1 mark**

$Al \rightarrow Al^{3+} + 3e^-$ $\leftarrow$ **1 mark**

b) Write the equation for the redox reaction. **(1 mark)**

Solution

$3Ag_2S + 2Al \rightarrow 6Ag + 2Al^{3+} + 3S^{2-}$ $\left.\right\}$ $\leftarrow$ **1 mark**

END OF KEY