APRIL 1995 CHEMISTRY 12 PROVINCIAL EXAMINATION
ANSWER KEY / SCORING GUIDE

TOPICS
1. Kinetics
2. Equilibrium
3. Solubility
4. Acids, Bases, Salts
5. Oxidation – Reduction

PART A: MULTIPLE-CHOICE

Q	C	T	K	S	CGR	Q	C	T	K	S	CGR
1.	K	1	A	1	I-D-2	25.	H	4	A	1	IV-D-12
2.	U	1	B	1	I-A-4	26.	U	4	A	1	IV-F-13
3.	U	1	D	1	I-B-1	27.	U	4	A	1	IV-G-3
4.	U	1	C	1	I-C-1	28.	K	4	C	1	IV-H-2
5.	U	1	C	1	I-B-3	29.	U	4	B	1	IV-H-9
6.	K	2	B	1	II-A-1	30.	U	4	B	1	IV-H-15
7.	U	2	A	1	II-C-4	31.	U	4	D	1	IV-J-1
8.	U	2	B	1	II-D-3	32.	H	4	A	1	IV-I-2, 3
9.	U	2	C	1	II-E-3	33.	U	4	C	1	IV-K-2
10.	U	2	B	1	II-I-2	34.	K	4	B	1	IV-L-5
11.	H	2	A	1	II-F-2	35.	H	4	C	1	IV-J-3
12.	K	2	A	1	II-H-1	36.	U	4	B	1	IV-L-2
13.	U	2	D	1	II-G-1, J-1	37.	U	5	B	1	V-A-4, 6
14.	U	3	D	1	III-A-8	38.	U	5	D	1	V-B-3
15.	U	3	A	1	III-B-3	39.	H	5	D	1	V-B-2
16.	U	3	B	1	III-B-4	40.	U	5	A	1	V-C-1
17.	H	3	D	1	III-B-6	41.	U	5	C	1	V-D-1
18.	U	3	A	1	III-D-2	42.	U	5	D	1	V-E-1
19.	U	3	B	1	III-D-3	43.	U	5	D	1	V-G-2
20.	U	3	C	1	III-E-1	44.	U	5	A	1	V-G-5
21.	K	4	C	1	IV-A-5, V-H-1	45.	U	5	B	1	V-G-7
22.	U	4	B	1	IV-B-2	46.	U	5	D	1	V-H-3
23.	K	4	C	1	IV-D-8	47.	U	5	A	1	V-J-4
24.	U	4	C	1	IV-D-7	48.	U	5	B	1	V-J-2

PART B: WRITTEN-RESPONSE

Q	B	C	T	S	CGR	Q	B	C	T	S	CGR
1.	1	U	1	4	I-E-2	7.	7	U	4	2	IV-B-3, F-8, 11
2.	2	U	2	2	II-B-2, II-C-1	8.	8	U	4	2	IV-H-9
3.	3	U	2	3	II-J-3	9.	9	U	4	4	IV-J-5
4.	4	U	3	2	III-E-2	10.	10	U	5	3	V-D-2, 3
5.	5	U	4	4	III-D-7	11.	11	U	5	4	V-F-1
6.	6	U	4	2	IV-C-2						

Multiple-choice = 48 (48 questions)
Written-response = 32 (11 questions)
Total = 80 marks

LEGEND:

Q = Question
K = Keyed response
B = Score box number
C = Cognitive level
S = Score
T = Topic
CGR = Curriculum Guide Reference

PART B: WRITTEN-RESPONSE

1. Nitric oxide (NO) is involved in the decomposition of ozone (O_3) by the following mechanism:

Step 1	$O_3 + \text{sunlight} \rightarrow O_2 + O$
Step 2	$O_3 + NO \rightarrow NO_2 + O_2$
Step 3	$NO_2 + O \rightarrow NO + O_2$

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

Response:

$\text{Sunlight} + 2O_{3(g)} \rightarrow 3O_{2(g)}$

b) Identify a catalyst. **(1 mark)**

Response:

NO is the catalyst.

c) Identify a reaction intermediate. (**1 mark)**

Response:

NO_2 or O are reaction intermediates.

d) What is the function of sunlight in this reaction? (**1 mark)**

Response:

For example:

To supply activation energy.

2. a) Why are chemical equilibria referred to as dynamic? **(1 mark)**

Response:

Both the forward and reversed reactions continue to occur.

b) How is a chemical system at equilibrium recognized? (**1 mark)**

Response:

A chemical system at equilibrium is recognized by its constant macroscopic properties.

3. Consider the following equilibrium system:

$$C_{(s)} + 2H_{2(g)} \rightleftarrows CH_{4(g)} \qquad K_{eq} = 8.1 \times 10^{8} \text{ at } 25°C$$

A student places 4.5 mol of carbon, 3.6×10^{-3} mol of hydrogen and 5.1 mol of methane in a 1.0 L flask. The student predicts that the $[CH_4]$ increases as equilibrium is established. Do you agree? Explain your answer using appropriate calculations. **(3 marks)**

Response:

$$\text{Trial } K_{eq} = \frac{[CH_4]}{[H_2]^2} \qquad \leftarrow \tfrac{1}{2} \textbf{ mark}$$

$$= \frac{5.1}{\left(3.6 \times 10^{-3}\right)^2} \qquad \leftarrow \textbf{1 mark}$$

$$= 3.9 \times 10^{5}$$

Since Trial K_{eq} is less than the Actual K_{eq}, the forward reaction is favoured and the $[CH_4]$ increases. $\leftarrow$ **1 mark**

Yes, I agree with the student. $\leftarrow \tfrac{1}{2}$ **mark**

4. Consider the following solubility equilibrium:

$$AgIO_{3(s)} + \text{heat} \rightleftarrows Ag^{+}_{(aq)} + IO^{-}_{3(aq)}$$

State **two** methods by which more $AgIO_3$ solid may be precipitated out of solution. **(2 marks)**

Response:

For example:

Decrease temperature. ← **1 mark**

Add a soluble compound with a common ion.

- $AgNO_3$
- $NaIO_3$

} ← **1 mark** for either one

5. Calculate the maximum moles of Br^- that can exist in 0.500 L of $0.10\ M\ Pb(NO_3)_2$. **(4 marks)**

Response:

Since $Pb(NO_3)_2 \rightarrow Pb^{2+} + 2NO_3^-$

$$[Pb^{2+}] = 0.10\ M \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$PbBr_{2(s)} \rightleftarrows Pb^{2+}_{(aq)} + 2Br^{-}_{(aq)} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$K_{sp} = [Pb^{2+}][Br^-]^2 \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$6.6\times10^{-6} = (0.10\ M)[Br^-]^2 \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$[Br^-] = 8.1\times10^{-3}\ M \qquad \leftarrow \textbf{1 mark}$$

$$\text{mol}\ Br^- = 8.1\times10^{-3}\ M \times 0.500\ L = 4.1\times10^{-3}\ \text{mol} \qquad \leftarrow \textbf{1 mark}$$

($-\tfrac{1}{2}$ **mark** for incorrect sig. figs.)

6. In an acid-base reaction, the **two Brönsted-Lowry acids** are hydrofluoric acid (HF) and the hydrogen sulphite ion $\left(HSO_3^-\right)$. Write the equation for this reaction. **(2 marks)**

Response:

$$HF + SO_3^{2-} \rightleftarrows HSO_3^- + F^-$$

7. a) Write an equilibrium equation to represent the hydrolysis of ammonia in water. **(1 mark)**

Response:

$$NH_3 + H_2O \rightleftarrows NH_4^+ + OH^-$$

b) Calculate the value of the equilibrium constant. **(1 mark)**

Response:

$$K_b = \frac{1.0 \times 10^{-14}}{5.7 \times 10^{-10}} = 1.8 \times 10^{-5}$$

8. Tomato juice has a pH of 4.20. Calculate the $\left[H_3O^+\right]$ and $\left[OH^-\right]$ in tomato juice. **(2 marks)**

Response:

$4.20 = -\log\left[H_3O^+\right] \qquad 6.3\times10^{-5}\ \text{M} = \left[H_3O^+\right]$ ← **1 mark**

$1.0\times10^{-14} = \left[H_3O^+\right]\left[OH^-\right], \quad \left[OH^-\right] = 1.6\times10^{-10}\ \text{M}$ ← **1 mark**

(−½ **mark** for incorrect sig. figs.)

9. Calculate the pH of a solution prepared by adding 60.0 mL of 0.150 M HCl to 140.0 mL of 0.100 M KOH. **(4 marks)**

Response:

$\text{mol HCl} = (0.0600\ \text{L})(0.150\ \text{M}) = 0.00900\ \text{mol}$ ← ½ **mark**

$\text{mol KOH}\ (0.1400\ \text{L})(0.100\ \text{M}) = 0.0140\ \text{mol}$ ← ½ **mark**

$\text{mol excess KOH} = 0.0050\ \text{mol}$ ← **1 mark**

$[\text{KOH}] = 0.0050\ \text{mol}/0.2000\ \text{L} = 0.025\ \text{M}$ ← **1 mark**

$\text{pOH} = -\log\left[OH^-\right] = 1.60$ ← ½ **mark**

$\text{pH} = 14.00 - \text{pOH} = 12.40$ ← ½ **mark**

10. Balance the following redox reaction. **(3 marks)**

$$Cu + NO_3^- \rightarrow Cu^{2+} + NO \qquad \text{(in acid)}$$

Response:

$3\left(Cu \rightarrow Cu^{2+} + 2e^-\right)$ ← **½ mark** for each half-reaction

$2\left(NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O\right)$ ← **1 mark** for balancing electrons

$3Cu + 2NO_3^- + 8H^+ \rightarrow 3Cu^{2+} + 2NO + 4H_2O$ ← **1 mark**

11. In a titration, a 1.00 mL sample of an antiseptic solution containing hydrogen peroxide required 17.6 mL of a 0.0200 M solution of $KMnO_4$ to reach the endpoint. The equation for the reaction is

$$5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 5O_2 + 2Mn^{2+} + 8H_2O$$

a) Identify the reducing agent. **(1 mark)**

Response:

H_2O_2

b) Calculate the concentration of H_2O_2 in the antiseptic solution. **(3 marks)**

Response:

$\text{mol } MnO_4^- = 0.0200 \text{ M} \times 0.0176 \text{ L} = 0.000352 \text{ mol}$ ← **1 mark**

$\text{mol } H_2O_2 = 0.000352 \text{ mol } MnO_4^- \times 5 \text{ mol } H_2O_2 / 2 \text{ mol } MnO_4^- = 0.000880 \text{ mol}$ ← **1 mark**

$[H_2O_2] = \dfrac{0.000880 \text{ mol}}{0.00100 \text{ L}} = 0.880 \text{ M}$ ← **1 mark**

END OF KEY