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

PART B: WRITTEN-RESPONSE

Q	B	C	T	S	CGR	Q	B	C	T	S	CGR
1.	1	K	1	2	I-C-1	8.	8	U	4	2	IV-F-14, G-2
2.	2	H	1	2	I-D-3	9.	9	U	4	2	IV-F-7, H-9
3.	3	U	2	2	II-B-2	10.	10	U	4	4	IV-H-15
4.	4	U	2	2	II-J-3	11.	11	H	5	2	V-D-1, 4
5.	5	U	3	3	III-B-4, 5	12.	12	U	5	2	V-E-1
6.	6	U	3	4	III-D-6	13.	13	K	5	3	V-J-4
7.	7	U	4	2	IV-C-3						

Multiple-choice = 48 (48 questions)
Written-response = 32 (13 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. State **two** reasons why some collisions may **not** result in a chemical reaction. **(2 marks)**

   Reason I:

   Reason II:

Response:

For example:

Reason I: unfavourable collision geometry/orientation ← **1 mark**

Reason II: insufficient collision energy/low KE ← **1 mark**

2. Describe the relationship between activation energy and the rate of a chemical reaction. **(2 marks)**

Response:

For example:

If the activation energy is lower, then the rate of reaction is greater.

3. What is “equal” in a chemical reaction that has reached a state of equilibrium? **(2 marks)**

Response:

The rates of the forward and reverse reactions.

4. Consider the following equilibrium:

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)} \qquad K_{eq} = 626 \text{ at } 200^\circ C$$

At equilibrium, $[N_2]$ is 1.06 mol/L and $[H_2]$ is 0.456 mol/L. Calculate $[NH_3]$ in the equilibrium mixture. **(2 marks)**

Response:

$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3} \qquad \leftarrow \tfrac{1}{2} \textbf{ mark}$$

$$626 = \frac{[NH_3]^2}{(1.06)(0.456)^3} \qquad \leftarrow \tfrac{1}{2} \textbf{ mark}$$

$$[NH_3] = 7.93 \qquad \leftarrow \textbf{1 mark}$$

5. A 1.0 M solution of sodium sulphite is added to a 1.0 M solution of copper(II) chloride resulting in the formation of a precipitate.

a) Identify the precipitate. **(1 mark)**

Response:

Copper(II) sulphite or $CuSO_3$

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

Response:

$$2Na^+_{(aq)} + SO_3{}^{2-}_{(aq)} + Cu^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow CuSO_{3(s)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)}$$

or

$$Na^+_{(aq)} + SO_3{}^{2-}_{(aq)} + Cu^{2+}_{(aq)} + Cl^-_{(aq)} \rightarrow CuSO_{3(s)} + Na^+_{(aq)} + Cl^-_{(aq)}$$

c) Identify all spectator ions. **(1 mark)**

Response:

Na^+, Cl^-

6. In an experiment, 100.0 mL samples containing silver ions are titrated with 0.200 M KSCN. The equation for the reaction is

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

The following data are recorded.

Trial	Volume KSCN (mL)
1	23.10
2	22.62
3	22.58

Calculate the concentration of the silver ion in the solution. **(4 marks)**

Response:

$$\text{Average volume} = \frac{22.62 + 22.58}{2} = 22.60 \text{ mL} \quad \leftarrow \textbf{1 mark}$$

$$\text{mol } SCN^{-} = 0.02260 \text{ L} \times \frac{0.200 \text{ mol}}{\text{L}} \quad \leftarrow \textbf{1 mark}$$

$$= 0.00452 \text{ mol}$$

$$\text{mol } Ag^{+} = 0.00452 \text{ mol} \quad \leftarrow \textbf{1 mark}$$

$$\therefore \left[Ag^{+}\right] = \frac{0.00452 \text{ mol}}{0.1000 \text{ L}} = 0.0452 \text{ M} \quad \leftarrow \textbf{1 mark}$$

NOTE: Deduct ½ point for incorrect significant figures.

7. a) Write the Brönsted-Lowry acid-base equation for the reaction between $HCN_{(aq)}$ and $NH_{3(aq)}$. **(1 mark)**

Response:

$$HCN_{(aq)} + NH_{3(aq)} \rightleftarrows NH_{4(aq)}^{+} + CN_{(aq)}^{-}$$

b) Write a conjugate acid-base pair from the equation above. **(1 mark)**

Response:

HCN and CN^- or NH_4^+ and NH_3

8. a) Write the formula of an amphiprotic anion that will act as an acid when added to water.
(1 mark)

Response:

For example:

$H_2PO_4^-$

or

HSO_3^-

b) Write a hydrolysis equation to represent the anion selected in part (a) above behaving as an acid.
(1 mark)

Response:

For example:

$H_2PO_4^- + H_2O \rightleftarrows H_3O^+ + HPO_4^{2-}$

or

$HSO_3^- + H_2O \rightleftarrows H_3O^+ + SO_3^{2-}$

9. Calculate the pH of a solution prepared by dissolving 0.050 mol of NaOH in enough water to make 500.0 mL of solution. **(2 marks)**

Response:

For example:

$$\left[OH^-\right] = 0.050\,\text{mol} / 0.500\ \text{L} = 0.100\ \text{M} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$K_w = \left[H_3O^+\right]\left[OH^-\right] \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$(0.10\text{M})\left[H_3O^+\right] = 1.0\times10^{-14}$$

$$\left[H_3O^+\right] = 1.0\times10^{-13}\text{M} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$\text{pH} = 13.00 \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

NOTE: Deduct ½ point for incorrect significant figures.

10. Calculate the pH of 0.50 M H_2S. **(4 marks)**

Response:

For example:

	H_2S	$\rightleftarrows$	H^+	+	HS^-
I	0.50		0		0
Δ C	$-x$		x		x
E	$0.50 - x$		x		x

← **1 ½ marks**

$(x$ is small, therefore $0.50 - x \approx 0.50)$ ← **½ mark**

$$K_a = \frac{[H^+][HS^-]}{[H_2S]}$$ ← **½ mark** for expression

$$9.1 \times 10^{-8} = \frac{x^2}{0.50}$$ ← **½ mark** for substitution

$x = 2.13 \times 10^{-4}$ M $= [H^+]$ ← **½ mark** for solving $[H^+]$

$pH = -\log[H^+] = 3.67$ ← **½ mark** for calculating pH

11. Consider the following equation:

$$2NO_2 \rightarrow N_2O_4$$

a) Does the above represent a redox reaction? _____ **(½ mark)**

Response:

No.

b) Explain. **(1 ½ marks)**

Response:

The oxidation number of nitrogen in NO_2 and in N_2O_4 is $+4$. With no change in the oxidation number there is no loss or gain of electrons.

12. Balance the following half-reaction in acidic conditions. **(2 marks)**

$$Br_2 \rightarrow BrO_3^-$$

Response:

$$Br_2 + 6H_2O \rightarrow 2BrO_3^- + 12H^+ + 10e^- \quad \leftarrow \textbf{2 marks}$$

One-half mark for each step: balancing bromine
balancing oxygen
balancing hydrogen
balancing charge

13. Consider the electrolysis of **molten** magnesium chloride.

a) Identify the product formed at the anode. **(1 mark)**

Response:

Chlorine gas or Cl_2

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

Response:

$Mg^{2+} + 2e^- \rightarrow Mg$

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

Response:

$MgCl_{2(l)} \rightarrow Mg_{(l)} + Cl_{2(g)}$

or

$Mg^{2+}_{(l)} + 2Cl^-_{(l)} \rightarrow Mg_{(l)} + Cl_{2(g)}$

END OF KEY