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

PART B: WRITTEN-RESPONSE

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

Multiple-choice = 48 (48 questions)
Written-response = 32 (12 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. Consider the following reaction:

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$

State one factor that would increase the rate of the above reaction. Use collision theory to explain the increase in rate. **(2 marks)**

Response:

For example:

- catalyst: offers second reaction path of lower activation energy
- increase in temperature: increases fraction of particles with sufficient energy to react
- increase in surface area: increases probability of collisions
- increase in concentration of oxygen: increases probability of collisions

(**1 mark** for one of the above factors and **1 mark** for appropriate explanation.)

2. Define and give an example of a *homogeneous* reaction. **(2 marks)**

Response:

A reaction in which all reactants are in the same phase. ← **1 mark**

e.g. $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$ ← **1 mark**

3. Consider the following system:

$$CO_{2(g)} \rightleftarrows CO_{2(aq)} + \text{heat}$$

List **two** ways in which more CO_2 could be dissolved in water. **(2 marks)**

i)

ii)

Response:

For example:

i) decrease temperature
ii) increase pressure
iii) add water
iv) add more CO_2

} ← any two for **1 mark** each

4. In an experiment, 0.200 mol of $CO_{(g)}$ and 0.400 mol of $O_{2(g)}$ are placed in a 1.00 L container and the following equilibrium is achieved:

$$2CO_{(g)} + O_{2(g)} \rightleftarrows 2CO_{2(g)}$$

At equilibrium, the $[CO_2]$ is found to be 0.160 mol/L. Calculate the value of K_{eq}. **(3 marks)**

Response:

$$2CO_{(g)} + O_{2(g)} \rightleftarrows 2CO_{2(g)}$$

[**I**]	0.200	0.400	0.000
[**C**]	−0.160	−0.080	+0.160
[**E**]	0.040	0.320	0.160

} ← **1 ½ marks**

$$K_{eq} = \frac{[CO_2]^2}{[CO]^2\,[O_2]} = \frac{(0.160)^2}{(0.040)^2\,(0.320)}$$

$$= 5.0 \times 10^1$$

} ← **1 ½ marks**

5. In an experiment, a student pipettes a sample of saturated $MgBr_2$ solution into a beaker and evaporates the sample to dryness. He recorded the following data:

Volume of saturated $MgBr_{2(aq)}$	25.00 mL
Mass of beaker	89.05 g
Mass of beaker and residue	93.47 g

Calculate the solubility of $MgBr_2$ in moles per litre. **(3 marks)**

Response:

$$\text{Mass of } MgBr_2 = \begin{array}{r} 93.47\ \text{g} \\ -89.05\ \text{g} \\ \hline 4.42\ \text{g} \end{array} \quad \left.\right\} \leftarrow \textbf{1 mark}$$

$$\text{Molar mass of } MgBr_2 = 184.1\ \text{g/mol}$$

$$\text{Mol } MgBr_2 = 4.42\text{g} \times \frac{1\ \text{mol}}{184.1\ \text{g}}$$

$$= 2.40 \times 10^{-2}\ \text{mol} \qquad \leftarrow \textbf{1 mark}$$

$$\text{Solubility} = \frac{2.40 \times 10^{-2}\ \text{mol}}{0.02500\ \text{L}} = 0.960\ \text{mol/L} \qquad \leftarrow \textbf{1 mark}$$

6. What is the solubility of $CaCO_3$ in g/L? **(3 marks)**

Response:

$$CaCO_3 \rightleftarrows Ca^{2+} + CO_3^{2-} \qquad \leftarrow \tfrac{1}{2} \textbf{ mark}$$

$$\left.\begin{aligned} \text{Solubility} &= \sqrt{K_{sp}} \\ &= 7.07\times10^{-5}\ \frac{\text{mol}}{\text{L}} \end{aligned}\right\} \leftarrow \textbf{1 mark}$$

$$= 7.07\times10^{-5}\left(\frac{100.1\text{ g}}{1\text{ mol}}\right) \leftarrow \textbf{1 mark}$$

$$= 7.08\times10^{-3}\ \text{g/L} \qquad \leftarrow \tfrac{1}{2} \textbf{ mark}$$

$$= 7.1\times10^{-3}\ \text{g/L}$$

7. Neutral red, HInd, is an acid-base indicator.

a) Write an equation to represent the equilibrium of this indicator in water. **(1 mark)**

Response:

$$HInd + H_2O \rightleftarrows H_3O^+ + Ind^-$$

b) What colour would this indicator be in 0.1 M NaOH ? **(1 mark)**

Response:

The indicator would be amber.

8. Calculate the pH of 0.20 M CH_3COOH. **(3 marks)**

Response:

	$CH_3COOH + H_2O \rightleftarrows H_3O^+ + CH_3COO^-$		
[**I**]	0.20	0	0
[**C**]	$-x$	$+x$	$+x$
[**E**]	$0.20 - x \approx 0.20$	x	x

← **1 ½ marks**

$$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]} = \frac{(x)(x)}{0.20} = 1.8 \times 10^{-5}$$

$$x = 1.9 \times 10^{-3}$$

$$[H_3O^+] = 1.9 \times 10^{-3} \text{ M}$$

$$\text{pH} = 2.72$$

← **1 ½ marks**

9. Explain why 'normal' rain water is slightly acidic. Use an equation to support your answer. **(2 marks)**

Response:

CO_2 dissolves in water to make an acidic solution. ← **1 mark**

$CO_2 + H_2O \rightleftarrows H_2CO_3$ ← **1 mark**

or

$H_2CO_3 + H_2O \rightleftarrows H_3O^+ + HCO_3^-$

10. Calculate the mass of solid NaOH needed to neutralize 250.0 mL of 0.125 M $H_2C_2O_4$. **(3 marks)**

Response:

$$\text{mol } H_2C_2O_4 = 0.2500 \text{ L} \times 0.125 \text{ mol/L} = 0.03125 \text{ mol} \quad \leftarrow \textbf{1 mark}$$

$$\text{mol NaOH} = 0.03125 \text{ mol } H_2C_2O_4 \times \frac{2 \text{ mol NaOH}}{\text{mol } H_2C_2O_4} = 0.0625 \text{ mol} \quad \leftarrow \textbf{1 mark}$$

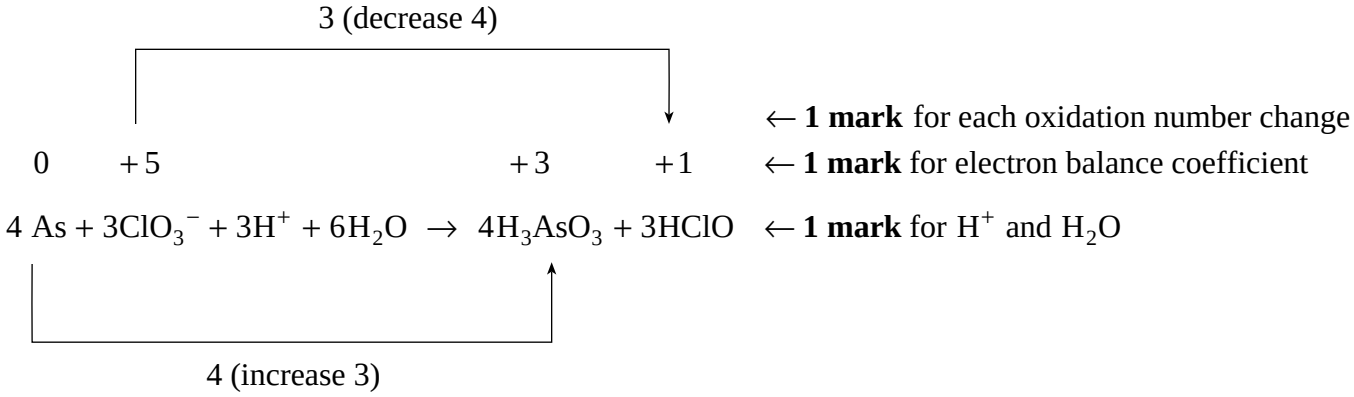
$$\text{g NaOH} = 0.0625 \text{ mol NaOH} \times \frac{40.0 \text{ g NaOH}}{1 \text{ mol NaOH}} = 2.50 \text{ g NaOH} \quad \leftarrow \textbf{1 mark}$$

11. Balance the following redox reaction occurring in an acidic solution. **(4 marks)**

$$As + ClO_3^- \rightarrow H_3AsO_3 + HClO$$

Response:

Oxidation Method:



← **1 mark** for each oxidation number change
← **1 mark** for electron balance coefficient
← **1 mark** for H^+ and H_2O

or

Half-cell Method:

1 mark

$$4\left(As + 3H_2O \rightarrow H_3AsO_3 + 3H^+ + 3e^-\right) \quad \leftarrow \textbf{1 mark}$$

$$3\left(ClO_3^- + 5H^+ + 4e^- \rightarrow HClO + 2H_2O\right) \quad \leftarrow \textbf{1 mark}$$

$$4\,As + 6H_2O + 3ClO_3^- + 3H^+ \rightarrow 4H_3AsO_3 + 3HClO \quad \leftarrow \textbf{1 mark}$$

12. In the electrolysis of 1.0 M LiF, the products are oxygen gas and hydrogen gas.

a) Write the anode half-reaction and include the $E°$ value. **(1 mark)**

Response:

$$H_2O \rightarrow \tfrac{1}{2}O_2 + 2H^+ + 2e^- \qquad -0.82\ V$$

b) Write the cathode half-reaction and include the $E°$ value. **(1 mark)**

Response:

$$2H_2O + 2e^- \rightleftarrows H_2 + 2OH^-\left(10^{-7}\ M\right) \qquad -0.41\ V$$

c) Calculate the minimum voltage required for this electrolysis. **(1 mark)**

Response:

Minimum voltage is >1.23 volts.

END OF KEY