KEY AND SCORING GUIDE

CHEMISTRY 12

PROVINCIAL EXAMINATION

JANUARY 1994

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ITEM CLASSIFICATION

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

PART A: MULTIPLE–CHOICE QUESTIONS

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

PART B: WRITTEN–RESPONSE QUESTIONS

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

NOTE: **Q** = Question number; **B** = Box number; **C** = Cognitive level; **T** = Topic;
K = Keyed Response; **S** = Score; **CGR** = Curriculum Guide Reference

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PART B: WRITTEN-RESPONSE QUESTIONS (32 marks total)

QUESTION:

1. Consider the following reaction:

$$Cu_{(s)} + 2AgNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$$

In a rate experiment, a coil of copper wire is placed into a solution of silver nitrate. The following data are recorded.

Time (hours)	Mass of Copper (g)
0.0	3.45
4.0	2.12

Calculate the rate of this reaction. **(2 marks)**

RESPONSE:

for a correct numerical answer. $\leftarrow$ **1 $\frac{1}{2}$ marks**

for correct units. $\leftarrow$ **$\frac{1}{2}$ mark**

e.g. 0.33 grams/hour

QUESTION:

2. Define "activated complex." **(2 marks)**

RESPONSE:

short-lived or unstable or high PE ←**1 mark**

chemical species ←**1 mark**

QUESTION:

3. Consider the following equilibrium system:

$$\underset{\text{yellow}}{Fe^{3+}_{(aq)}} + \underset{\text{colourless}}{SCN^{-}_{(aq)}} \rightleftarrows \underset{\text{red}}{FeSCN^{2+}_{(aq)}}$$

In an experiment, a student places the above equilibrium system into a cold water bath and notes that the intensity of the red colour increases. The student then concludes that the equilibrium is exothermic.

a) Do you agree or disagree? $\left(\mathbf{\frac{1}{2}\ mark}\right)$

b) Explain: $\left(\mathbf{1\frac{1}{2}\ marks}\right)$

RESPONSE:

agree with student $\leftarrow \mathbf{\frac{1}{2}\ mark}$

cold water bath caused shift in forward direction $\leftarrow \mathbf{\frac{1}{2}\ mark}$

when temp. is decreased, equil shifts in exo direction $\leftarrow$**1 mark**

QUESTION:

4. Consider the following equilibrium system:

$$PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)}$$

At 250°C, 0.40 mol of PCl_3 and 0.60 mol of Cl_2 are placed into a 1.0 litre container. At equilibrium, the $[PCl_5]$ = 0.11 mol/L. Calculate the value of K_{eq}. **(3 marks)**

RESPONSE:

$$PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)}$$

I	0.40	0.60	0.00	
C	−0.11	−0.11	+0.11	← **1 ½ marks** for ICE
E	0.29	0.49	0.11	

$K_{eq} = [PCl_5]/[PCl_3][Cl_2]$ ← **½ mark**

$= (0.11)/(0.29)(0.49)$ ← **½ mark** for substitution

$= 0.77$ ← **½ mark** for final answer

QUESTION:

5. A 100 ml solution containing 0.2 M Al^{3+}, 0.2 M NH_4^+ and 0.2 M Mg^{2+} is added to a 100 ml solution containing 0.2 M S^{2-}, 0.2 M Cl^- and 0.2 M OH^-. Identify the ions that do **not** form a precipitate. **(2 marks)**

RESPONSE:

NH_4^+ and Cl^- ←**2 marks**

QUESTION:

6. A science teacher needs 5.0 L of limewater for an experiment. Limewater is a saturated solution of $Ca(OH)_2$. Calculate the minimum mass of $Ca(OH)_2$ required to make this solution. $K_{sp} = 1.3 \times 10^{-6}$ **(5 marks)**

RESPONSE:

K_{sp} for $Ca(OH)_2 = 1.3 \times 10^{-6}$

Let s = solubility of $Ca(OH)_2 = \left[Ca^{2+}\right]$

$2s = \left[OH^-\right]$

$K_{sp} = \left[Ca^{2+}\right]\left[OH^-\right]^2 = (s)(2s)^2 = 4s^3$ ← **3 marks**

$4s^3 = 1.3 \times 10^{-6}$

$s = 6.87 \times 10^{-3}$ M

$Ca(OH)_2 = 74.1$ g/mol ← **½ mark**

$\#g = \left(6.87 \times 10^{-3} \text{mol/L}\right)\left(74.1 \text{ g/mol}\right)\left(5.0 \text{L}\right)$ ← **1 mark**

$= 2.5g$ ← **½ mark**

QUESTION:

7. Write the equation for the hydrogen carbonate ion acting as a weak acid. **(1 mark)**

RESPONSE:

Example:

$HCO_3^- + H_2O \rightleftarrows H_3O^+ + CO_3^{2-}$ ←**1 mark**

QUESTION:

8. a) A student prepares a buffer by dissolving solid sodium acetate, $NaCH_3COO$, in a solution of acetic acid, CH_3COOH. Write the **net** ionic equation for the buffer system. **(1 mark)**

   b) What happens to the concentrations of CH_3COOH and CH_3COO^- when a small amount of acid is added to this system? **(1 mark)** Explain the reason. **(1 mark)**

   c) What happens to the pH of the buffer when a small amount of acid is added? **(1 mark)**

RESPONSE:

a) $CH_3COOH + H_2O \rightleftarrows CH_3COO^- + H_3O^+$ ←**1 mark**

OR

$CH_3COO^- + H_2O \rightleftarrows CH_3COOH + OH^-$ ←**1 mark**

b) The CH_3COOH will increase while the CH_3COO^- will decrease. ←**1 mark**
The added H_3O^+ reacts with CH_3COO^- to produce CH_3COOH. ←**1 mark**

c) The pH remains relatively constant. ←**1 mark**

QUESTION:

9. Determine the pH of a 0.10 M solution of hydrogen cyanide. **(4 marks)**

RESPONSE:

	HCN	$\rightleftarrows$	H^+	$+$	CN^-	
I	0.10		0		0	
C	$-x$		$+x$		$+x$	← **1 $\frac{1}{2}$ marks**
E	$0.10 - x$		x		x	
	≈ 10					

$$K_a = \frac{\left[H^+\right]\left[CN^-\right]}{[HCN]}$$

$$4.8\times10^{-10} = \frac{(x)(x)}{(0.10)}$$

$$\sqrt{\left(4.8\times10^{-10}\right)\left(0.10\right)} = \sqrt{(x)^2} \quad \leftarrow \mathbf{1\,\frac{1}{2}\,marks}$$

$$\left[H^+\right] = 6.9\times10^{-6} \quad \leftarrow \mathbf{\frac{1}{2}\,mark}$$

$$pH = -\log\left(6.9\times10^{-6}\right) = 5.16 \quad \leftarrow \mathbf{\frac{1}{2}\,mark}$$

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QUESTION:

10. Balance the following redox equation in an acidic solution. **(4 marks)**

$$FeO_4^{2-} + NH_3 \longrightarrow N_2 + Fe^{3+}$$

RESPONSE:

For **each** balanced half-reaction.

$8H^+ + FeO_4^{2-} + 3e^- \rightarrow Fe^{3+} + 4H_2O \leftarrow$ **1 mark**

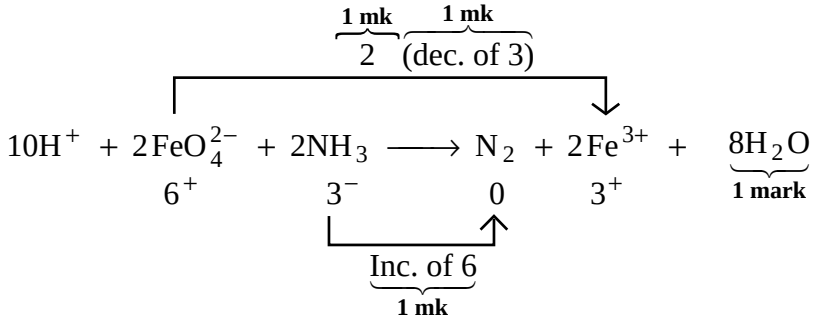
$2NH_3 \rightarrow N_2 + 6H^+ + 6e^- \leftarrow$ **1 mark**

For multiplying top equation by $2\times$ $\leftarrow$ **1 mark**

For adding and cancelling electrons and H^+ $\leftarrow$ **1 mark**

$2FeO_4^{2-} + 10H^+ + 2NH_3 \rightarrow 2Fe^{3+} + 8H_2O + N_2$

OR



QUESTION:

11. In an electrolytic cell, current is passed through molten NaCl.

a) Suggest suitable electrodes for this process. **(1 mark)**

b) Write the equation for the reaction occurring at the cathode. **(1 mark)**

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

RESPONSE:

a) Pt or carbon or other inert electrodes. ←**1 mark**

b) $Na^+ + e^- \rightarrow Na$ ←**1 mark**

c) $2NaCl \rightarrow 2Na + Cl_2$ ←**1 mark**

END OF KEY