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

PART B: WRITTEN-RESPONSE

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

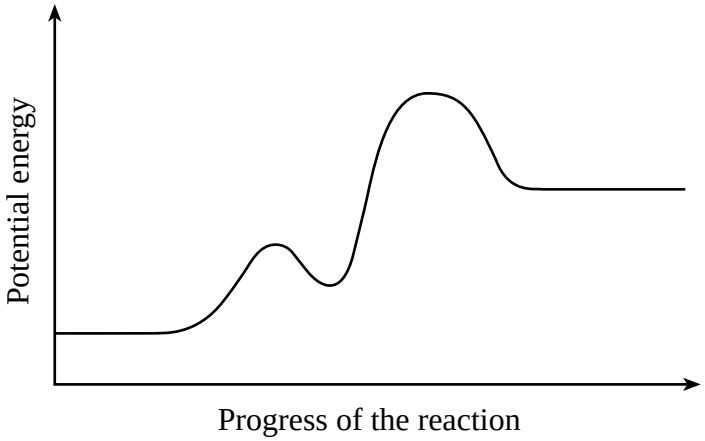
Multiple-choice = 48 (48 questions)
Written-response = 32 (11 questions)
Total = 80 marks

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

Use the following diagram to answer question 1.



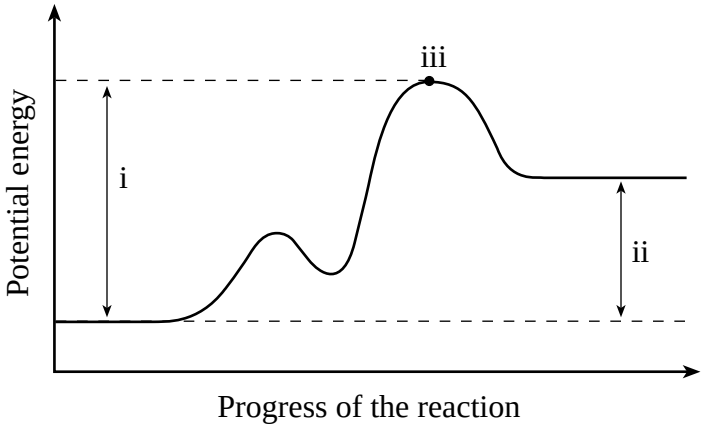
1. a) On the potential energy diagram above, **clearly** label the

   i) activation energy for the forward reaction. **(1 mark)**

   ii) heat of reaction, ΔH. **(1 mark)**

   iii) energy of the activated complex in the rate determining step. **(1 mark)**

Response:



b) Is the reaction endothermic or exothermic in the forward direction? **(1 mark)**

Response:

The reaction is endothermic in the forward direction.

2. Consider the following equilibrium:

$$N_2H_{4(g)} + 2O_{2(g)} \rightleftarrows 2NO_{(g)} + 2H_2O_{(g)}$$

More oxygen is added to the above equilibrium. After the system re-establishes equilibrium, identify the substance(s), if any, that have a net **(2 marks)**

a) increase in concentration.

Response:

NO, H_2O, O_2 $\leftarrow$ **$\frac{1}{2}$ mark each**

b) decrease in concentration.

Response:

N_2H_4 $\leftarrow$ **$\frac{1}{2}$ mark**

3. Given the following equilibrium:

$$H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)}$$

Initially, 0.200 mol H_2 and 0.200 mol I_2 were placed into a 1.0 L container. At equilibrium, the $[I_2]$ is 0.040 mol/L. Calculate the K_{eq}. **(3 marks)**

Response:

	H_2	+	I_2	$\rightleftarrows$	$2HI$
$[I]$	$0.200\,M$		0.200		0
$[C]$	-0.160		-0.160		$+0.320$
$[E]$	0.040		0.040		0.320

← **1 ½ marks**

$$K_{eq} = \frac{[HI]^2}{[H_2][I_2]}$$

$$= \frac{(0.320)^2}{(0.040)(0.040)}$$

$$= 64$$

← **1 ½ marks**

4. Define *solubility*. **(2 marks)**

Response:

For example:

The maximum amount of solute that will dissolve in a given amount of solvent.

or

The concentration of a saturated solution.

5. Will a precipitate form if 30.0 mL of 0.054 M $Ca(NO_3)_2$ is mixed with 60.0 mL of 8.1×10^{-4} M Na_2SO_4 ? **(4 marks)**

Response:

$$\left[Ca^{2+}\right] = 0.054\ \text{M} \times 30.0\ \text{mL} / 90.0\ \text{mL}$$

$$= 0.018\ \text{M} \qquad \leftarrow \textbf{1 mark}$$

$$\left[SO_4{}^{2-}\right] = 8.1\times10^{-4}\ \text{M} \times 60.0\ \text{mL} / 90.0\ \text{mL}$$

$$= 5.4\times10^{-4}\ \text{M} \qquad \leftarrow \textbf{1 mark}$$

$$\text{TIP} = \left[Ca^{2+}\right]\left[SO_4{}^{2-}\right]$$

$$= (0.018)\left(5.4\times10^{-4}\right)$$

$$= 9.7\times10^{-6} \qquad \leftarrow \textbf{1 mark}$$

Since trial ion product $< K_{sp}$, $\left(7.1\times10^{-5}\right)$, no precipitate will form. $\leftarrow$ **1 mark**

6. A weak acid, $H_2C_6H_6O_6$, is dissolved in water. Write a chemical equation to represent this system. **(2 marks)**

Response:

$$H_2C_6H_6O_6 \rightleftarrows H^+ + HC_6H_6O_6^- \quad \leftarrow \textbf{2 marks}$$

or

$$H_2C_6H_6O_6 + H_2O \rightleftarrows H_3O^+ + HC_6H_6O_6^- \quad \leftarrow \textbf{2 marks}$$

7. A chemist pipettes 25.00 mL of 0.15 M HCl into a 100.0 mL volumetric flask. Then she adds water to the mark. Calculate the pH of this solution. **(2 marks)**

Response:

For example:

$$[\mathrm{HCl}] = \frac{0.15\ \mathrm{M} \times 25.00\ \mathrm{mL}}{100.0\ \mathrm{mL}}$$

$$\left[\mathrm{H_3O^+}\right] = 0.0375\ \mathrm{M} \qquad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned} \mathrm{pH} &= -\log\left[\mathrm{H_3O^+}\right] \\ &= 1.43 \end{aligned}\right\} \leftarrow \textbf{1 mark}$$

(Subtract $\frac{1}{2}$ **mark** for incorrect significant figures.)

8. a) Write a chemical equation representing the hydrolysis of sodium acetate. **(1 mark)**

Response:

$$CH_3COO^-_{(aq)} + H_2O_{(l)} \rightleftarrows CH_3COOH_{(aq)} + OH^-_{(aq)}$$

b) Calculate the K_b value for the hydrolysis in part (a) above. **(1 mark)**

Response:

$$K_b = \frac{K_w}{K_a}$$

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

$$= 5.6 \times 10^{-10}$$

9. An acid is known to be either iodic, nitrous, ethanoic (acetic) or benzoic. A 0.200 M solution of this acid is found to have a pH of 2.44. Using this data and appropriate calculations, identify this acid. **(4 marks)**

Response:

$\left[H^+\right] = 0.0036 \text{ mol/L}$ ← **½ mark**

The acid is monoprotic and can be represented by HX.

	HX	$\rightleftarrows$	H^+	$+$	X^-
$[I]$	$0.200\,M$		0		0
$[C]$	-0.0036		$+0.0036$		$+0.0036$
$[E]$	0.1964		0.0036		0.0036

← **1 ½ marks**

$$K_a = \frac{\left[H^+\right]\left[X^-\right]}{\left[HX\right]}$$

$$= \frac{(0.0036)^2}{0.1964}$$

$$= 6.6 \times 10^{-5}$$

← **1 ½ marks**

The acid must be benzoic acid because the K_a values match. ← **½ mark**

10. Balance the following equation. **(4 marks)**

$$ClO_3^- + N_2H_4 \rightarrow NO + Cl^-$$

Response:

For example:

$4\left(ClO_3^- + 6H^+ + 6e^- \rightarrow Cl^- + 3H_2O\right)$ ← **1 mark** for each half-reaction

$3\left(N_2H_4 + 2H_2O \rightarrow 2NO + 8H^+ + 8e^-\right)$ ← **1 mark** for balancing electrons

$4ClO_3^- + 3N_2H_4 \rightarrow 4Cl^- + 6NO + 6H_2O$ ← **1 mark**

11. A student wishes to electroplate a coin with copper.

a) Identify a suitable anode. **(1 mark)**

Response:

For example:

Copper metal or Cu
Carbon or C
Platinum or Pt

b) Identify an appropriate electrolyte. **(1 mark)**

Response:

For example:

Copper(II) nitrate or $Cu(NO_3)_2$

Copper(II) chloride or $CuCl_2$

Copper(II) sulphate or $CuSO_4$

c) To which battery terminal (positive or negative) should the coin be connected? **(1 mark)**

Response:

To the negative terminal.

END OF KEY