Chemistry 12

April 2002 Provincial Examination

ANSWER KEY / SCORING GUIDE

CURRICULUM:

Organizers	Sub-Organizers
1. Reaction Kinetics	A, B, C
2. Dynamic Equilibrium	D, E, F
3. Solubility Equilibria	G, H, I
4. Acids, Bases, and Salts	J, K, L, M, N, O, P, Q, R
5. Oxidation – Reduction	S, T, U, V, W

Part A: Multiple Choice

Q	K	C	S	CO	PLO	Q	K	C	S	CO	PLO
1.	C	U	1	1	A2	25.	B	U	1	4	J12
2.	D	K	1	1	A5	26.	D	U	1	4	K6
3.	D	U	1	1	B1, B5	27.	B	U	2	4	L3
4.	B	U	1	1	B6, B7, D2	28.	D	K	1	4	L5
5.	A	H	2	1	C4	29.	B	K	1	4	N1
6.	D	U	1	1	C5	30.	D	H	2	4	M1, N4
7.	B	U	1	2	D3	31.	B	U	1	4	N3
8.	C	U	2	2	D7	32.	C	H	1	4	O3
9.	D	U	1	2	E2	33.	D	U	1	4	O4
10.	B	H	1	2	E3	34.	D	K	1	4	P1
11.	A	U	1	2	F1	35.	D	U	2	4	P3
12.	B	K	1	2	F2	36.	B	U	1	4	P4
13.	D	U	1	2	F4	37.	B	K	2	4	R3
14.	A	U	2	2	F5	38.	B	K	1	5	S1
15.	C	K	1	3	G1	39.	C	U	2	5	S3
16.	B	U	1	3	G3	40.	A	U	1	5	S4
17.	D	U	1	3	G8	41.	D	K	1	5	S5
18.	A	U	1	3	H3	42.	D	U	1	5	S5
19.	B	U	2	3	H5	43.	D	K	1	5	T5
20.	A	K	1	3	I2	44.	C	H	2	5	U5
21.	A	U	1	3	I3	45.	C	U	1	5	U3
22.	C	U	2	3	I4, I6	46.	D	U	1	5	U9
23.	C	K	1	4	J2	47.	A	K	2	5	U11,V4
24.	C	U	1	4	J7	48.	B	K	1	5	W5

Multiple Choice = 60 marks (48 questions)

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	3	1	A3
2.	2	K	2	1	C2
3.	3	K	2	2	E2
4.	4	U	4	2	F6
5.	5	U	5	3	G5, I3
6.	6	U	3	4	J3, K10
7.	7	U	2	4	K12
8.	8	U	2	4	L11
9.	9	U	5	4	M3
10.	10	U	3	4	P1
11.	11	U	4	5	T1
12.	12	U	2	5	W2
13.	13	H	3	5	W7

Written Response = 40 marks

Multiple Choice = 60 (48 questions)
Written Response = 40 (13 questions)
EXAMINATION TOTAL = 100 marks

LEGEND:

Q = Question Number **K** = Keyed Response **C** = Cognitive Level
B = Score Box Number **S** = Score **CO** = Curriculum Organizer
PLO = Prescribed Learning Outcome

PART B: WRITTEN RESPONSE

Value: 40 marks **Suggested Time: 50 minutes**

INSTRUCTIONS:	You will be expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner. Your steps and assumptions leading to a solution must be written in the spaces below the questions. Answers must include units where appropriate and be given to the correct number of significant figures. **For questions involving calculations, full marks will NOT be given for providing only an answer.**

1. Consider the reaction: **(3 marks)**

$$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(g)}$$

At certain conditions, $0.15\,\text{mol}\ CO_2$ is produced in 2.0 minutes.
What is the rate of consumption of C_2H_4 in g/s ?

Solution:

For Example:

$$\text{rate of formation of } CO_2 = \frac{0.15\,\text{mol}}{2.0\,\text{min}} = 0.075\,\text{mol/min}$$ ← **1 mark**

$$\text{rate of consumption of } C_2H_4 = \frac{1}{2} \times \text{rate of formation of } CO_2 = 0.0375\,\text{mol/min}$$ ← **1 mark**

$$= \frac{0.0375\,\text{mol } C_2H_4}{60\,\text{s}} \times \frac{28.0\text{g}}{\text{mol}}$$

$$= 1.8 \times 10^{-2}\ \text{g/s}$$ ← **1 mark**

2. Define the term *reaction mechanism.* **(2 marks)**

Solution:

For Example:

A reaction mechanism is a series of steps that result in the overall reaction. } ← **2 marks**

3. State *Le Chatelier's Principle*. **(2 marks)**

Solution:

For Example:

Le Chatelier's Principle states that when a stress is placed on an equilibrium system, the system will shift to offset this stress until a new equilibrium is reached. ← **2 marks**

4. Consider the following: **(4 marks)**

$$CH_{4(g)} + H_2O_{(g)} \rightleftarrows CO_{(g)} + 3H_{2(g)}$$

Initially, $0.060\,\text{mol}\ CH_4$, $0.080\,\text{mol}\ H_2O$, $0.280\,\text{mol}\ CO$ and $0.740\,\text{mol}\ H_2$ are placed into a $4.00\,\text{L}$ container. At equilibrium, the $[H_2] = 0.200\,\text{mol/L}$. What is the value of K_{eq} ?

Solution:

For Example:

	CH_4	+	H_2O	$\rightleftarrows$	CO	+	$3H_2$
[I]	$0.015\,\text{mol/L}$		0.020		0.070		0.185
[C]	−0.005		−0.005		+0.005		+0.015
[E]	0.010		0.015		0.075		0.200

← **2 marks**

$$K_{eq} = \frac{[CO][H_2]^3}{[CH_4][H_2O]}$$

$$= \frac{(0.075)(0.200)^3}{(0.010)(0.015)}$$

$$= 4.0$$

← **2 marks**

5. A 30.00 mL sample of a saturated solution of Ag_2SO_4 was heated in an evaporating dish until all the water was evaporated. The following data were recorded:

Volume of solution	30.00 mL
Mass of evaporating dish	32.125 g
Mass of evaporating dish and solid Ag_2SO_4	32.260 g

Calculate the K_{sp} value for Ag_2SO_4 . **(5 marks)**

Solution:

For Example:

Mass of Ag_2SO_4 collected is $32.260\,g - 32.125\,g = 0.135\,g$ ← **1 mark**

$$\text{Solubility of } Ag_2SO_4 = \frac{0.135\,g\ Ag_2SO_4}{0.03000\,L} \times \frac{1\,mol}{311.9\,g}$$

$$= 0.0144\,mol/L$$

← **2 marks**

$$Ag_2SO_{4(s)} \rightleftarrows 2Ag^+_{(aq)} + SO_4{}^{2-}_{(aq)}$$

$$K_{sp} = \left[Ag^+\right]^2\left[SO_4{}^{2-}\right]$$

$$= (0.0288)^2(0.0144)$$

$$= 1.20 \times 10^{-5}$$

← **2 marks**

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

6. The ion $H_2PO_4^-$ is an amphiprotic anion.

a) Define the term *amphiprotic*. **(1 mark)**

Solution:

For Example:

Amphiprotic describes the ability to act as an acid in one reaction and as a base in a different reaction. } ← **1 mark**

b) Write the balanced equation for the reaction when $H_2PO_4^-$ reacts with HF. **(2 marks)**

Solution:

$$H_2PO_4^- + HF \rightleftarrows H_3PO_4 + F^-$$ ← **2 marks**

7. Write an equation for a reaction in which H_2O acts only as a Brønsted-Lowry base. **(2 marks)**

Solution:

For Example:

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

8. Calculate the pH of $0.25\,\text{M}\ \text{Sr(OH)}_2$. **(2 marks)**

Solution:

For Example:

$$\left[\text{OH}^-\right] = 0.50\,\text{M}$$
$$\text{pOH} = 0.30$$
$$\text{pH} = 13.70$$

} ← **2 marks**

9. Calculate the pH of 0.25 M NH_4Cl . **(5 marks)**

Solution:

For Example:

	NH_4^+	+	H_2O	$\rightleftarrows$	H_3O^+	+	NH_3
[I]	0.25				0		0
[C]	$-x$				$+x$		$+x$
[E]	$0.25 - x$				x		x

← **2 marks**

$$K_a = 5.6 \times 10^{-10} = \frac{\left[H_3O^+\right]\left[NH_3\right]}{\left[NH_4^+\right]} = \frac{(x)(x)}{0.25 - x}$$

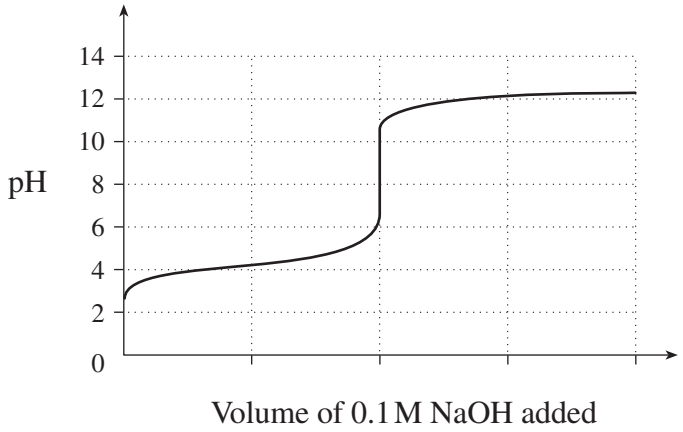
$$x = \left[H_3O^+\right] = 1.18 \times 10^{-5}\ \text{M}$$

$$\text{pH} = 4.93$$

← **3 marks**

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

10. A 0.1 M unknown acid is titrated with 0.10 M NaOH and the following titration curve results:



a) Choose a suitable indicator (other than phenolphthalein) and give a reason for your choice. **(1 mark)**

Solution:

For Example:

Suitable Indicator: Thymol blue

Reason:
- The transition point is close to the equivalence point.

} ← **1 mark**

b) Is the unknown acid weak or strong? Explain. **(2 marks)**

Solution:

For Example:

Unknown Acid: Weak ← **1 mark**

For example any* one *of the following for* 1 mark *each:

Explanation:
- the shape of the curve is characteristic of a weak acid being titrated with a strong base
- the initial pH is greater than 1.0
- the pH at the equivalence point is greater than 7.0

} ← **1 mark**

11. Balance the following redox reaction: **(4 marks)**

$$Ag_2O + Si \rightarrow Ag + SiO_3^{2-} \qquad \text{(acidic)}$$

Solution:

For Example:

$$2 \times \left(2e^- + 2H^+ + Ag_2O \rightarrow 2Ag + H_2O\right)$$

← **2 marks (1 mark for each half-reaction)**

$$1 \times \left(3H_2O + Si \rightarrow SiO_3^{2-} + 6H^+ + 4e^-\right)$$

← **1 mark for balancing electrons**

$$2Ag_2O + H_2O + Si \rightarrow 4\,Ag + SiO_3^{2-} + 2H^+$$

← **1 mark for addition**

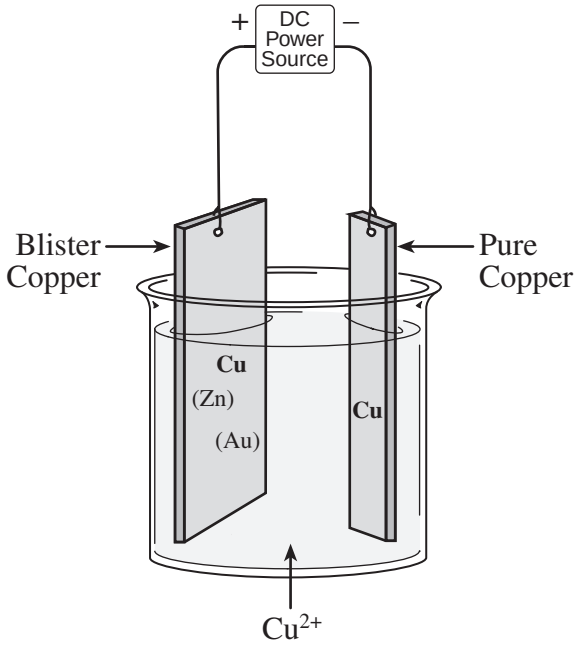
12. Sodium metal is produced commercially by the electrolysis of molten $NaCl_{(\ell)}$. Explain why sodium metal, $Na_{(s)}$, cannot be produced by electrolysis of aqueous $NaCl_{(aq)}$. **(2 marks)**

Solution:

For Example:

H_2O is more easily reduced than Na^+. ← **2 marks**

13. Blister copper is an impure sample of copper containing small amounts of zinc and gold. Blister copper is purified using electrolysis.



Sufficient voltage is supplied to oxidize copper at the anode.

a) What happens to the zinc at the anode? Explain. **(2 marks)**

Solution:

For Example:

Zn is oxidized. ← **1 mark**

It is an even stronger reducing agent than the copper. ← **1 mark**

b) Write the equation for the half-reaction that occurs at the cathode. **(1 mark)**

Solution:

$Cu^{2+} + 2e^- \rightarrow Cu$ ← **1 mark**

END OF KEY