

Chemistry 12
 January 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.	D	U	1	1	A1, A6	25.	B	K	1	4	K2
2.	D	K	1	1	A5, B9	26.	C	U	2	4	K8
3.	A	U	1	1	B5	27.	D	K	1	4	L1
4.	A	U	2	1	B6	28.	C	U	1	4	L11
5.	D	U	1	1	C5	29.	B	U	1	4	M4
6.	A	H	2	2	C4, D2	30.	C	U	1	4	N2
7.	D	U	1	2	D3	31.	C	U	2	4	N4
8.	D	U	2	2	D7	32.	B	K	1	4	O2
9.	B	U	1	2	E2	33.	A	U	2	4	O5
10.	C	H	1	2	E3	34.	A	H	2	4	P2
11.	D	U	1	2	F1	35.	D	K	1	4	R4
12.	A	K	1	2	F2	36.	C	K	1	4	P6
13.	D	U	1	2	F4	37.	B	K	1	4	Q3
14.	C	U	1	2	F5	38.	C	K	2	5	S1
15.	B	U	1	3	G6	39.	A	U	1	5	S2
16.	B	U	1	3	G3	40.	A	U	1	5	S2
17.	A	U	1	3	H2	41.	A	U	1	5	S2
18.	C	U	1	3	H4	42.	D	U	1	5	S6
19.	B	K	1	3	I2	43.	D	U	1	5	T1
20.	A	H	2	3	I3	44.	C	H	1	5	U9
21.	D	U	1	3	I4	45.	B	K	2	5	U3, U4
22.	C	U	2	3	I5	46.	B	U	2	5	U2
23.	B	K	1	4	J3	47.	C	U	1	5	V4
24.	B	U	1	4	J11	48.	D	U	1	5	W4

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	B3
3.	3	U	2	2	E2, E3
4.	4	U	4	2	F6
5.	5	U	3	3	H3
6.	6	U	3	3	I6
7.	7	U	4	4	J10, J11
8.	8	U	5	4	L6, L10, O3
9.	9	U	4	4	J8, M5
10.	10	K	1	4	Q1
11.	11	U	4	5	T6
12.	12	H	5	5	W2, W4

Written Response = 40 marks

Multiple Choice = 60 (48 questions)

Written Response = 40 (12 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

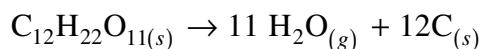
INSTRUCTIONS: You will be expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner.

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 following reaction: (3 marks)



The rate of decomposition of $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ is 0.75 mol/min .
What mass of C is produced in 10.0 seconds?

Solution:

For Example:

$$\begin{aligned} \text{Rate of C production} &= \frac{0.75 \text{ mol C}_{12}\text{H}_{22}\text{O}_{11}}{\text{min}} \times \frac{12 \text{ mol C}}{1 \text{ mol C}_{12}\text{H}_{22}\text{O}_{11}} \\ &= \frac{9.0 \text{ mol}}{\text{min}} \\ \text{Mass of C in 10 s} &= \left(\frac{9.0 \text{ mol}}{\text{min}} \right) \times \left(\frac{12.0 \text{ g}}{\text{mol}} \right) \times (10.0 \text{ s}) \times \left(\frac{1 \text{ min}}{60 \text{ s}} \right) \\ &= 18 \text{ g} \end{aligned}$$

← 3 marks

2. Define the term *activation energy*.

(2 marks)

Solution:

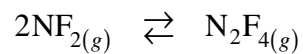
For Example:

Activation energy is the minimum amount of energy required to form the activated complex from the reactants.

} ← **2 marks**

3. Consider the following equilibrium:

(2 marks)



Equilibrium shifts to the right when volume is decreased. Describe the changes in reaction rates that cause this shift to the right.

Solution:

For Example:

Both forward and reverse rates increase as a result of increased concentration.

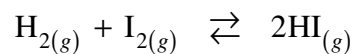
} ← **1 mark**

The forward rate increases more than the reverse rate, so the equilibrium shifts to the right.

} ← **1 mark**

4. Consider the following:

(4 marks)



Initially, 0.200 mol H_2 and 0.200 mol I_2 are added to an empty 2.00 L container.
At equilibrium, the $[\text{I}_2] = 0.020 \text{ mol/L}$. What is the value of K_{eq} ?

Solution:

For Example:

	H_2	+	I_2	\rightleftharpoons	2HI	} ← 4 marks
[I]	0.100 mol/L		0.100		0	
[C]	-0.080		-0.080		+0.160	
[E]	0.020		0.020		0.160	

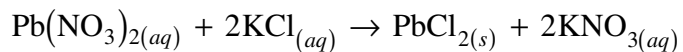
$$K_{eq} = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = \frac{(0.160)^2}{(0.020)(0.020)} = 64$$

5. When equal volumes of 0.20 M $\text{Pb}(\text{NO}_3)_2$ and 0.20 M KCl are mixed, a precipitate of PbCl_2 forms.

a) Write the formula equation for the above reaction.

(1 mark)

Solution:

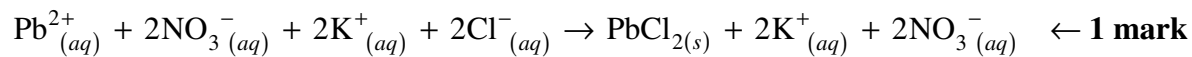


← 1 mark

b) Write the complete ionic equation for the above reaction.

(1 mark)

Solution:

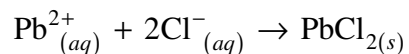


← 1 mark

c) Write the net ionic equation for the above reaction.

(1 mark)

Solution:



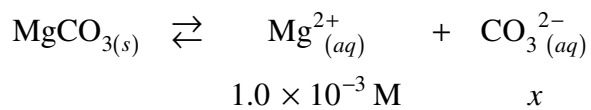
← 1 mark

6. Calculate the maximum $[\text{CO}_3^{2-}]$ that can exist in $0.0010 \text{ M Mg}(\text{NO}_3)_2$. **(3 marks)**

Solution:

For Example:

$$K_{sp} \text{ MgCO}_3 = 6.8 \times 10^{-6}$$



← 1 mark

$$[\text{CO}_3^{2-}] = \frac{K_{sp}}{[\text{Mg}^{2+}]}$$

$$= \frac{6.8 \times 10^{-6}}{1.0 \times 10^{-3}}$$

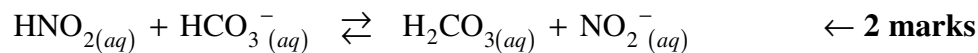
$$= 6.8 \times 10^{-3} \text{ M}$$

← 2 marks

7. The two reactants in an acid-base reaction are $\text{HNO}_{2(aq)}$ and $\text{HCO}_3^-(aq)$.

a) Write the equation for the above reaction. **(2 marks)**

Solution:



b) Define the term *conjugate acid-base pair*. **(1 mark)**

Solution:

For Example:

A conjugate acid-base pair are two species whose formulas differ by a proton. **← 1 mark**

c) Write the formulas for a conjugate acid-base pair for the above reaction. **(1 mark)**

Solution:



8. At 10.0°C, $K_w = 2.95 \times 10^{-15}$ for pure water.

a) Calculate the pH of water at 10.0°C.

(3 marks)

Solution:

For Example:

$$K_w = 2.95 \times 10^{-15} = [\text{H}_3\text{O}^+][\text{OH}^-] \quad \leftarrow \text{1 mark}$$

$$\text{Since } [\text{H}_3\text{O}^+] = [\text{OH}^-]$$

$$[\text{H}_3\text{O}^+]^2 = 2.95 \times 10^{-15}$$

$$[\text{H}_3\text{O}^+] = 5.43 \times 10^{-8} \text{ M} \quad \leftarrow \text{1 mark}$$

$$\text{pH} = 7.265 \quad \leftarrow \text{1 mark}$$

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

b) A mixture of the indicators phenolphthalein and bromcresol green is added to the water. What is the resulting colour of the mixture? Explain.

(2 marks)

Solution:

For Example:

Resulting colour:

Blue at pH = 7.265. \leftarrow 1 mark

Explanation:

Bromcresol green is blue at pH 7.265; phenolphthalein is colourless. \leftarrow 1 mark

9. At a particular temperature a 1.0 M H_2S solution has a $\text{pH} = 3.75$. Calculate the value of K_a at this temperature. **(4 marks)**

Solution:

For Example:

	H_2S	+ H_2O	\rightleftharpoons	H_3O^+	+	HS^-	
[I]	1.0			0		0	} ← 2 marks
[C]	-1.78×10^{-4}			$+1.78 \times 10^{-4}$		$+1.78 \times 10^{-4}$	
[E]	$1.0 - 1.78 \times 10^{-4}$			1.78×10^{-4}		1.78×10^{-4}	

$$\text{pH} = 3.75$$

$$[\text{H}_3\text{O}^+] = 1.78 \times 10^{-4} \text{ M}$$

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{HS}^-]}{[\text{H}_2\text{S}]} = \frac{(1.78 \times 10^{-4})^2}{1.0 - 1.78 \times 10^{-4}} = 3.2 \times 10^{-8}$$

10. What is the main function of a buffer solution?

(1 mark)

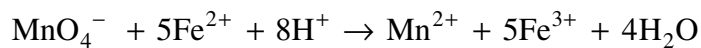
Solution:

For Example:

The main function of a buffer solution is to resist changes in pH.

} ← **1 mark**

11. A titration is performed to determine the concentration of Fe^{2+} in 25.00 mL of an FeSO_4 solution. It requires 22.52 mL of 0.015 M KMnO_4 to reach the equivalence point according to the following equation:



Calculate the $[\text{Fe}^{2+}]$.

(4 marks)

Solution:

For Example:

$$\text{mol MnO}_4^- = 0.02252 \text{ L} \times 0.015 \text{ M} = 3.38 \times 10^{-4} \text{ mol}$$

← **1 mark**

$$\text{mol Fe}^{2+} = 3.38 \times 10^{-4} \text{ mol MnO}_4^- \times \frac{5 \text{ mol Fe}^{2+}}{1 \text{ mol MnO}_4^-}$$

} ← **1½ mark**

$$= 1.69 \times 10^{-3} \text{ mol}$$

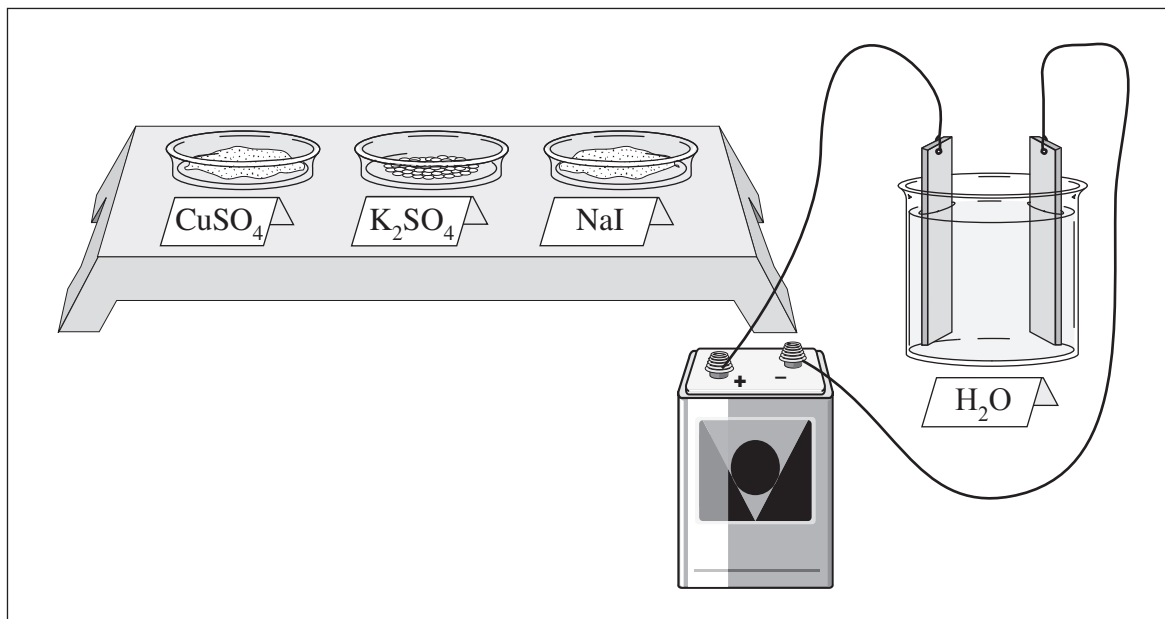
$$[\text{Fe}^{2+}] = \frac{1.69 \times 10^{-3} \text{ mol}}{0.0250 \text{ L}}$$

$$= 0.068 \text{ M}$$

} ← **1½ mark**

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

12. Consider the following diagram:



Students are asked to produce hydrogen and oxygen gas by the electrolysis of water. They are given three substances (CuSO₄, K₂SO₄ and NaI) to choose from to prepare an electrolytic solution that will only produce hydrogen and oxygen.

a) Which substance should be selected? Explain why.

(3 marks)

Solution:

For Example:

Substance: K₂SO₄ (1 mark)

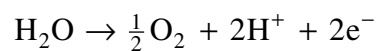
Explanation: It is the only one of the three substances that will neither oxidize (1 mark) nor reduce (1 mark) before water does.

b) Write the equation for the half-reaction that occurs at the anode in the electrolytic cell.

(1 mark)

Solution:

For Example:



← **1 mark**

c) Explain why it would **not** be acceptable to use a copper anode in this cell.

(1 mark)

Solution:

For Example:

A copper anode would oxidize.

← **1 mark**

END OF KEY