

Chemistry 12

August 2005 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.	B	K	1	1	A2	31.	D	U	1	4	K8
2.	D	U	1	1	A2	32.	D	U	1	4	K9
3.	A	U	1	1	A5	33.	A	U	1	4	L6
4.	D	U	1	1	B2	34.	B	K	1	4	L8
5.	C	U	1	1	B6	35.	A	U	1	4	L12
6.	C	U	1	1	B7	36.	B	U	1	4	M3
7.	A	H	1	2	D2	37.	A	U	1	4	M4
8.	C	H	1	2	D4	38.	B	U	1	4	N4
9.	D	U	1	2	D7	39.	C	H	1	4	N2, P4
10.	D	U	1	2	E2	40.	A	U	1	4	O5, 6
11.	C	U	1	2	E2	41.	B	K	1	4	O2
12.	D	U	1	2	E3	42.	A	U	1	4	P2
13.	D	H	1	2	F2	43.	B	H	1	4	P6, N2
14.	C	U	1	2	F3	44.	C	U	1	4	Q2, 3
15.	D	U	1	2	F4	45.	D	U	1	4	Q2, 3
16.	B	U	1	2	F5	46.	A	U	1	4	R1
17.	B	U	1	2	F7	47.	B	U	1	5	S1
18.	A	K	1	3	G3	48.	B	U	1	5	S1
19.	A	U	1	3	G8	49.	B	U	1	5	S2
20.	B	U	1	3	H3	50.	C	H	1	5	S4
21.	C	U	1	3	H4	51.	C	U	1	5	S6
22.	D	U	1	3	H7	52.	B	U	1	5	T3
23.	A	U	1	3	I2	53.	B	U	1	5	T6
24.	C	U	1	3	I4	54.	D	U	1	5	U2
25.	D	U	1	3	I5	55.	A	U	1	5	U3, 5
26.	A	U	1	3	I6	56.	A	U	1	5	U7
27.	B	U	1	4	J8	57.	D	H	1	5	U3
28.	C	K	1	4	J9	58.	A	K	1	5	V2
29.	C	U	1	4	J11	59.	B	U	1	5	W8, 5
30.	C	H	1	4	K1	60.	C	U	1	5	W5

Multiple Choice = 60 marks

Part B: Written Response

Q	C	S	CO	PLO
1.	U	5	1	C2, 5
2.	U	3	2	F7, 8
3.	U	3	3	H3
4.	U	4	4	K12
5.	U	5	4	M6
6.	U	3	4	P4
7.	U	4	5	T2
8.	U	3	5	W5

Written Response = 30 marks

Multiple Choice = 60 (60 questions)

Written Response = 30 (8 questions)

EXAMINATION TOTAL = 90 marks

Legend:

Q = Question Number

S = Score

K = Keyed Response

CO = Curriculum Organizer

C = Cognitive Level

PLO = Prescribed Learning Outcome

PART B: WRITTEN RESPONSE

Value: 30 marks

Suggested Time: 40 minutes

INSTRUCTIONS: You are 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 mechanism:

Step 1	$\text{Cl}_2 \rightarrow 2\text{Cl}$	(fast)
Step 2	$\text{Cl} + \text{CO} \rightarrow \text{COCl}$	(slow)
Step 3	$\text{COCl} + \text{Cl}_2 \rightarrow \text{COCl}_2 + \text{Cl}$	(fast)

Identify a reaction intermediate in the reaction mechanism and write the equation for the overall reaction. Explain why increasing the $[\text{CO}]$ will increase the reaction rate, but increasing the $[\text{Cl}_2]$ will not.

(5 marks)

Solution:

For Example:

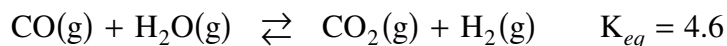
Reaction Intermediate: COCl **OR** Cl ← 1 mark

Overall Reaction Equation: $2\text{Cl}_2 + \text{CO} \rightarrow \text{COCl}_2 + 2\text{Cl}$ ← 2 marks

Explanation: The slowest step is Step 2, so increasing $[\text{CO}]$ will speed up Step 2. Increasing $[\text{Cl}_2]$ will not speed up the slowest step so does not increase the reaction rate.

} ← 2 marks

2. Consider the following equilibrium:



Initially, 0.50 mol CO, 0.50 mol H₂O, 0.62 mol CO₂ and 0.62 mol H₂ are placed in a 1.0 L container, and the reaction proceeds towards products.

Calculate the equilibrium [H₂].

(3 marks)

Solution:

For Example:

	CO(g)	+	H ₂ O(g)	\rightleftharpoons	CO ₂ (g)	+	H ₂ (g)
[I]	0.50		0.50		0.62		0.62
[C]	-x		-x		+x		+x
[E]	0.50 - x		0.50 - x		0.62 + x		0.62 + x

$$K_{eq} = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]}$$

$$\sqrt{4.6} = \sqrt{\frac{(0.62 + x)^2}{(0.50 - x)^2}}$$

$$x = 0.14$$

$$[\text{H}_2] = (0.62 + x) = 0.76 \text{ M}$$

← 3 marks

3. A solution is prepared by mixing equal moles of $\text{Ba}(\text{NO}_3)_2$, K_2SO_4 and BaS and precipitation occurs. Identify the precipitate(s) and write the net ionic equation(s) for the reaction(s).

(3 marks)

Solution:

For Example:

Precipitate: $\text{BaSO}_4(\text{s})$

← **1 mark**

Net Ionic Equation: $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$

← **2 marks**

4. Write balanced equations to show water acting as an acid with $\text{CH}_3\text{CH}_2\text{NH}_2$, then water acting as a base with H_2O_2 . **(4 marks)**

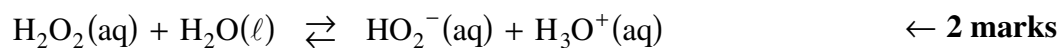
Solution:

For Example:

As an acid:



As a base:



5. Calculate the initial concentration of a solution of NH_3 which has a $\text{pH} = 11.33$ and $K_b = 1.8 \times 10^{-5}$. Begin by writing the equation for the predominant reaction.

(5 marks)

Solution:

For Example:

	$\text{NH}_3(\text{aq})$	+	$\text{H}_2\text{O}_{(\ell)}$	\rightleftharpoons	$\text{NH}_4^+(\text{aq})$	+	$\text{OH}^-(\text{aq})$	← 1 mark
I	x				0		0	
C	-2.14×10^{-3}				2.14×10^{-3}		2.14×10^{-3}	
E	$x - 2.14 \times 10^{-3}$				2.14×10^{-3}		2.14×10^{-3}	← 1 mark

$$\text{pH} = 11.33, \text{pOH} = 2.67 \therefore [\text{OH}^-] = 2.14 \times 10^{-3} \text{ M} \quad \leftarrow 1 \text{ mark}$$

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]}$$

$$1.8 \times 10^{-5} = \frac{(2.14 \times 10^{-3})(2.14 \times 10^{-3})}{(x - 2.14 \times 10^{-3})} \quad \leftarrow 1 \text{ mark}$$

$$(1.8 \times 10^{-5})x - 3.85 \times 10^{-8} = 4.58 \times 10^{-6}$$

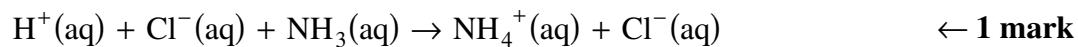
$$(1.8 \times 10^{-5})x = 4.62 \times 10^{-6}$$

$$x = [\text{NH}_3]_{\text{initial}} = 0.26 \text{ M} \quad \leftarrow 1 \text{ mark}$$

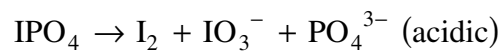
6. A sample of the strong acid $\text{HCl}(\text{aq})$ is titrated with a sample of $\text{NH}_3(\text{aq})$, a weak base. Write the formula, complete ionic and net ionic equations for the titration reaction. **(3 marks)**

Solution:

For Example:



7. In an unusual compound, IPO_4 , iodine exists as Iodine(III). The compound decomposes as follows:

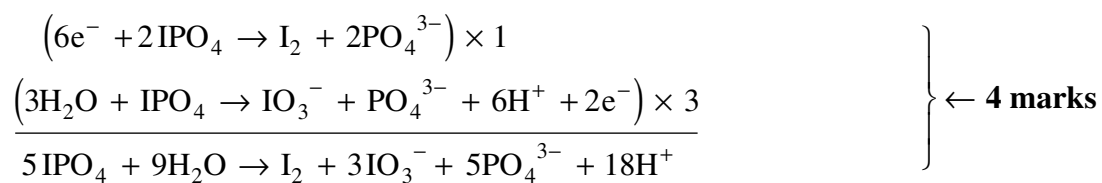


Balance this redox equation in acidic solution.

(4 marks)

Solution:

For Example:



8. In separate electrolysis experiments, 1.0M NaCl, 1.0M KNO₃, 1.0M Li₂SO₄, and 1.0M Cs₃PO₄ all produced the same gas at their cathodes. Write the equation for the formation of this gas and explain why this same reaction occurs in all four cases. **(3 marks)**

Solution:

For Example:



Explanation:

Water is more easily reduced than any of the metal ions. ← **1 mark**

END OF KEY