

Chemistry 12
 August 2000 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	CO	PLO	Q	K	C	CO	PLO
1.	C	U	1	A2	25.	B	K	4	L1
2.	B	U	1	A3	26.	B	U	4	K11
3.	C	K	1	B1	27.	A	U	4	L4, 6
4.	D	U	1	B2	28.	D	U	4	L11
5.	B	U	1	B9	29.	D	K	4	L12
6.	D	K	1	C4	30.	A	K	4	M1
7.	D	K	2	D4	31.	A	H	4	M4
8.	D	H	2	D6	32.	A	U	4	M4
9.	B	U	2	D7	33.	C	U	4	N3
10.	A	U	2	E2	34.	B	U	4	O4
11.	A	U	2	F2	35.	B	U	4	P5
12.	B	U	2	F3	36.	B	K	4	R3
13.	B	U	2	F7	37.	A	K	5	S1
14.	C	K	3	G1	38.	B	U	5	S1
15.	A	U	3	G2	39.	A	U	5	S1, 2
16.	B	U	3	G7	40.	C	U	5	S3
17.	D	U	3	H1	41.	A	K	5	S6
18.	C	U	3	H2	42.	D	U	5	T3
19.	B	U	3	H5	43.	D	H	5	T5, 6
20.	C	K	3	H7	44.	D	K	5	U11
21.	B	H	3	I3	45.	B	U	5	U5
22.	C	U	3	I4	46.	C	U	5	U9
23.	A	U	4	J7	47.	D	U	5	W3, 4
24.	D	H	4	K1	48.	D	K	5	W5

Multiple Choice = 48 marks

Part B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	3	1	A3, 4
2.	2	U	3	2	E3
3.	3	U	4	2	F6
4.	4	U	3	3	H3, I6
5.	5	K	2	4	J10, 11
6.	6	U	3	4	J3, K8
7.	7	U	3	4	M3
8.	8	U	3	4	P4
9.	9	H	4	5	P4, W7
10.	10	U	4	5	T6, U11

Written Response = 32 marks

Multiple Choice = 48 (48 questions)

Written Response = 32 (10 questions)

EXAMINATION TOTAL = 80 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: 32 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.

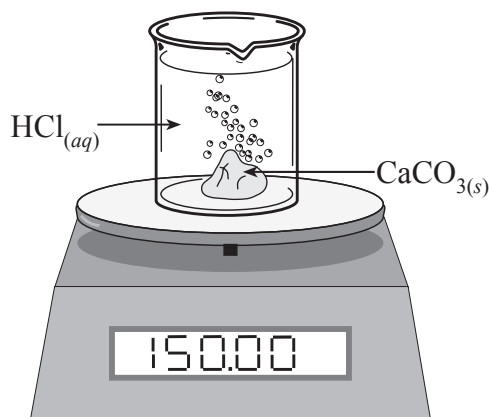
Answers must include units where appropriate and be given to the correct number of significant figures.

For questions involving calculation, full marks will NOT be given for providing only an answer.

1. Consider the following reaction:



A sample of some HCl was added to a sample of CaCO₃ in an open beaker. The total mass was monitored and the following data obtained:



Time (min)	Total mass of beaker and contents (g)
0.00	150.00
1.00	148.50
2.00	147.50
3.00	146.95
4.00	146.60
5.00	146.41
6.00	146.33
7.00	146.30
8.00	146.30

- a) Find the average rate of production of CO_2 in mol/s during the first 5 minutes. (2 marks)

Solution:

$$\frac{(150.00 \text{ g} - 146.41 \text{ g})}{5.00 \text{ min}} = 0.718 \text{ g/min}$$

} $\frac{1}{2}$ mark for subtraction
} $\frac{1}{2}$ mark for division

$$0.718 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.0 \text{ g CO}_2} = 0.0163 \text{ mol}$$

← $\frac{1}{2}$ mark

$$\text{rate in } \frac{\text{mol}}{\text{s}} = \frac{0.0163 \text{ mol}}{60 \text{ s}} = 2.72 \times 10^{-4} \frac{\text{mol}}{\text{s}}$$

← $\frac{1}{2}$ mark

- b) Give **one** reason why the rate of production of CO_2 would decrease with time.
Explain, using collision theory.

(1 mark)

Solution:

For Example:

Reason: $[\text{HCl}]$ decreases

Explanation: Less frequent collisions

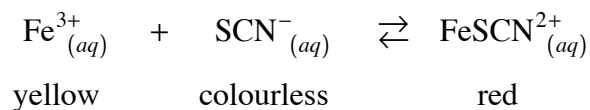
OR

Reason: Surface area of CaCO_3 decreases

Explanation: Less frequent collisions

} ← 1 mark
}

2. Consider the following reaction:



When a few drops of 6.0 M NaOH is added to 25.0 mL of the above system, a precipitate of $\text{Fe}(\text{OH})_3$ forms and the solution turns pale yellow.

a) Explain this colour change in terms of Le Châtelier's Principle. **(2 marks)**

Solution:

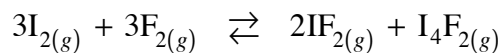
The reduced $[\text{Fe}^{3+}]$ causes a shift to the left to offset the stress. **} ← 2 marks**

b) Describe the effect on the rate of the reverse reaction as the colour change occurs. **(1 mark)**

Solution:

The rate of the reverse reaction decreases. **← 1 mark**

3. Consider the following equilibrium:



Initially, 2.00×10^{-1} mol of I_2 and 3.00×10^{-1} mol of F_2 are put into a 10.00 L flask.

At equilibrium, $[\text{I}_4\text{F}_2]$ is 2.00×10^{-3} M. Calculate the K_{eq} . **(4 marks)**

Solution:

	3I_2	+	3F_2	\rightleftharpoons	2IF_2	+	I_4F_2	}	1 mark for division by 10 1 $\frac{1}{2}$ marks for ICE table
[I]	0.0200		0.0300		0		0		
[C]	-0.0060		-0.00600		+0.00400		+0.00200		
[E]	0.0140		0.0240		0.00400		0.00200		

$$K_{eq} = \frac{(\text{IF}_2)^2(\text{I}_4\text{F}_2)}{(\text{I}_2)^3(\text{F}_2)^3}$$

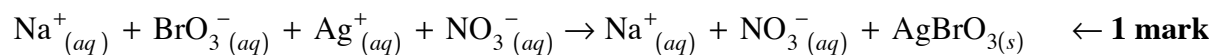
$$K_{eq} = \frac{(0.00400)^2(0.00200)}{(0.0140)^3(0.0240)^3}$$

$$= 8.44 \times 10^2$$

} ← **1 $\frac{1}{2}$ marks**

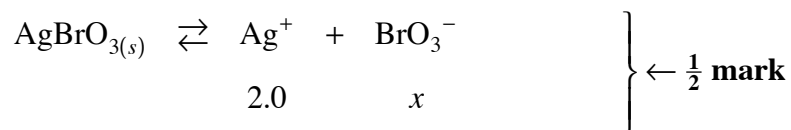
4. a) Write the complete ionic equation for the reaction between NaBrO_3 and AgNO_3 . (1 mark)

Solution:



b) What is the maximum $[\text{NaBrO}_3]$ that can exist in equilibrium with 2.0 M AgNO_3 ? (2 marks)

Solution:



$$\begin{aligned} K_{sp} &= [\text{Ag}^+][\text{BrO}_3^-] \\ 5.3 \times 10^{-5} &= (2.0)(x) \\ x = [\text{BrO}_3^-] &= [\text{NaBrO}_3] = 2.6 \times 10^{-5} \text{ M} \end{aligned} \quad \left. \vphantom{K_{sp}} \right\} \leftarrow 1\frac{1}{2} \text{ marks}$$

5. a) Define the term *Brønsted-Lowry conjugate acid-base pair*.

(1 mark)

Solution:

For Example:

A pair of chemical species which differ by the presence of a proton on the acid which is absent from the base.

} ← **1 mark**

b) Give an example of a conjugate acid-base pair.

(1 mark)

Solution:

For Example:

Acid: H_2O

Base: OH^-

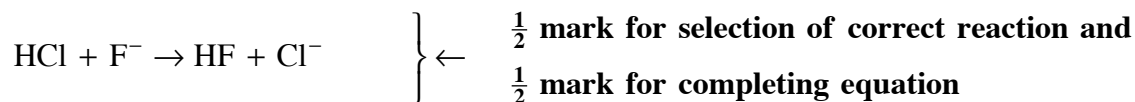
} ← **1 mark**

6. Consider the acids HCl and HF.

a) Only one of the following reactions occurs. Complete the equation for the reaction which does occur. **(1 mark)**



Solution:



b) For the reaction that occurs, are reactants or products favoured? Explain. **(1 mark)**

Solution:

For Example:

Products are favoured ($\frac{1}{2}$ mark) because HCl is stronger than HF ($\frac{1}{2}$ mark)

c) Explain why the other reaction will **not** occur. **(1 mark)**

Solution:

For Example:

Cl^- will not accept a proton.

← **1 mark**

7. Calculate the $[\text{H}_3\text{O}^+]$ of 0.10 M HNO_2 .

(3 marks)

Solution:

	HNO_2	+	H_2O	\rightleftharpoons	H_3O^+	+	NO_2^-	} ← 1½ marks
[I]	0.10 M				0		0	
[C]	-x				+x		+x	
[E]	0.10 - x				x		x	

$$K_a = 4.6 \times 10^{-4} = \frac{[\text{H}_3\text{O}^+][\text{NO}_2^-]}{[\text{HNO}_2]}$$

$$= \frac{(x)(x)}{(0.10 - x)}$$

assume $0.10 - x \approx 0.10$

$$= \frac{(x)(x)}{0.10}$$

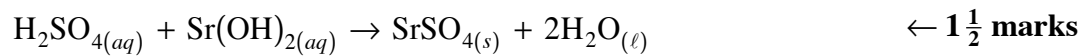
$$x = [\text{H}_3\text{O}^+] = 6.8 \times 10^{-3} \text{ M} \quad \leftarrow \frac{1}{2} \text{ mark}$$

8. Write the formula equation and the net ionic equation for the reaction between 0.10 M H_2SO_4 and 0.10 M $\text{Sr}(\text{OH})_2$.

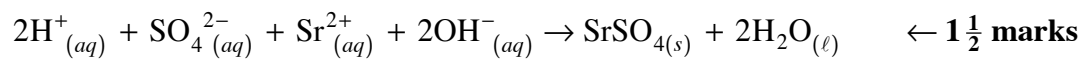
(3 marks)

Solution:

Formula equation:



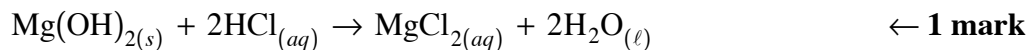
Net ionic equation:



9. During the production of magnesium metal from sea water, magnesium ions are first precipitated from sea water as magnesium hydroxide.

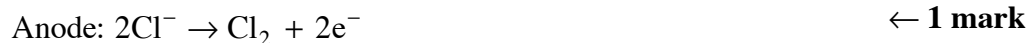
a) The magnesium hydroxide is then neutralized by hydrochloric acid, producing magnesium chloride. Write the neutralization reaction. **(1 mark)**

Solution:



b) The salt produced, magnesium chloride, is dried, melted and undergoes electrolysis. Write the reaction occurring at each electrode. **(2 marks)**

Solution:



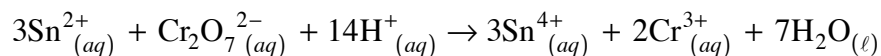
c) It is **not** possible to use electrolysis to remove Mg from a 1.0 M MgCl_2 solution. Why? **(1 mark)**

Solution:

For Example:

Water is a stronger oxidizing agent than Mg^{2+} . **$\leftarrow 1 \text{ mark}$**

10. In the process of extracting tin from a sample of ore, the tin is removed as Sn^{2+} ions. A titration requires 21.43 mL of 0.0170 M $\text{K}_2\text{Cr}_2\text{O}_7$ to reach the equivalence point with the Sn^{2+} in a 0.750 g sample of the ore.



Using the reaction, calculate the percent mass of tin in the ore sample. **(4 marks)**

Solution:

$$\text{mol Cr}_2\text{O}_7^{2-} = (0.0170 \text{ mol/L Cr}_2\text{O}_7^{2-})(0.02143 \text{ L}) = 3.643 \times 10^{-4} \text{ mol Cr}_2\text{O}_7^{2-} \quad \leftarrow \text{1 mark}$$

$$\text{mol Sn}^{2+} = 3.643 \times 10^{-4} \text{ mol Cr}_2\text{O}_7^{2-} \left(\frac{3 \text{ mol Sn}^{2+}}{1 \text{ mol Cr}_2\text{O}_7^{2-}} \right) = 1.093 \times 10^{-3} \text{ mol Sn}^{2+} \quad \leftarrow \text{1 mark}$$

$$\text{mol Sn} = \text{mol Sn}^{2+} = 1.093 \times 10^{-3} \text{ mol Sn}$$

$$\text{g Sn} = 1.093 \times 10^{-3} \text{ mol Sn} \left(\frac{118.7 \text{ g Sn}}{1 \text{ mol Sn}} \right) = 1.297 \times 10^{-1} \text{ g Sn} \quad \leftarrow \text{1 mark}$$

$$\% \text{ Sn} = \frac{1.297 \times 10^{-1} \text{ g Sn}}{0.750 \text{ g Sn ore}} \times 100\% = 17.3\% \quad \leftarrow \text{1 mark}$$

END OF KEY
