

Chemistry 12
June 1997 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.	U	1	D	1	I-A-2	25.	U	4	D	1	IV-B-3
2.	K	1	D	1	I-B-2	26.	U	4	A	1	IV-F-3
3.	U	1	B	1	I-D-5	27.	U	4	A	1	IV-F-7
4.	K	1	D	1	I-E-2	28.	H	4	C	1	IV-F-4, 6, H-9
5.	K	1	D	1	I-E-3	29.	H	4	A	1	IV-F-11
6.	K	2	C	1	II-A-3	30.	U	4	A	1	IV-G-3, F-9
7.	U	2	D	1	II-E-2	31.	U	4	B	1	IV-I-2
8.	H	2	D	1	II-C-4	32.	U	4	D	1	IV-J-1
9.	U	2	B	1	II-E-2	33.	U	4	C	1	IV-J-4
10.	K	2	C	1	II-G-2	34.	K	4	D	1	IV-J-5
11.	U	2	B	1	II-I-2	35.	U	4	B	1	IV-J-1, 2, K-1
12.	U	2	A	1	II-J-2	36.	K	4	C	1	IV-L-2
13.	U	2	C	1	II-J-4	37.	K	5	C	1	V-A-6
14.	K	3	C	1	III-A-1	38.	U	5	D	1	V-A-3
15.	U	3	C	1	III-B-3	39.	U	5	A	1	V-A-4
16.	H	3	B	1	III-B-7	40.	U	5	B	1	V-C-3
17.	U	3	C	1	III-A-8	41.	U	5	A	1	V-D-1
18.	U	3	B	1	III-D-2	42.	U	5	A	1	V-B-4
19.	U	3	C	1	III-D-3	43.	U	5	D	1	V-E-1
20.	U	3	D	1	III-D-4	44.	U	5	C	1	V-F-2
21.	K	4	A	1	IV-B-1	45.	U	5	C	1	V-G-4, 6
22.	U	4	B	1	IV-D-2	46.	U	5	C	1	V-G-13
23.	U	4	C	1	IV-B-2	47.	K	5	D	1	V-I-3
24.	U	4	D	1	IV-D-7	48.	U	5	A	1	V-J-3

Part B: Written Response

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

Multiple Choice = 48 (48 questions)

Written Response = 32 (11 questions)

Total = 80 marks

LEGEND:

Q = Question Number

C = Cognitive Level

T = Topic

K = Keyed Response

S = Score

CGR = Curriculum Guide Reference

B = Score Box Number

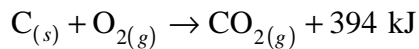
PART B: WRITTEN RESPONSE

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. The combustion of coal, C, produces carbon dioxide gas according to the following equation:



- a) What is the value of ΔH for this reaction? (1 mark)

Response:

$$\Delta H = -394 \text{ kJ/mol CO}_2 \quad \leftarrow \text{1 mark}$$

- b) Using collision theory, explain why a lump of coal does not react with oxygen at room temperature and pressure. (1 mark)

Response:

For example:

This reaction has a very high activation energy and therefore collisions will be unsuccessful. } \leftarrow 1 mark

- c) Many coal mine disasters have resulted when a spark ignites coal dust in the air. Explain, using collision theory. (2 marks)

Response:

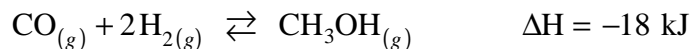
For example:

The spark provides activation energy, therefore more effective collisions occur. \leftarrow 1 mark

The large surface area provides for more collisions to occur.

← **1 mark**

2. Consider the following equilibrium:



Explain, using Le Chatelier's principle, how the following changes will affect the number of moles of CH_3OH present at equilibrium.

a) Adding a catalyst.

(1 mark)

Response:

For example:

The moles of CH_3OH will not change because the equilibrium does not shift. ← **1 mark**

b) Decreasing the volume of the system.

(1 mark)

Response:

For example:

The moles of CH_3OH will increase because the equilibrium shifts right. ← **1 mark**

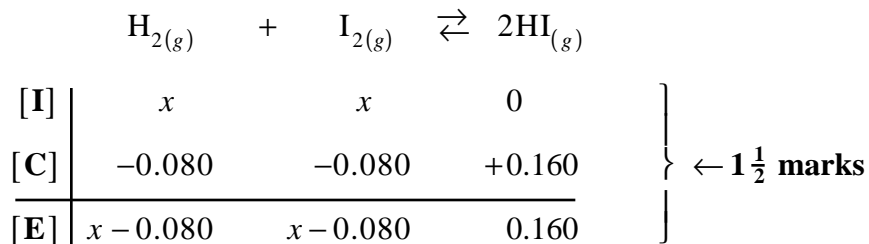
3. Consider the following equilibrium:



Equal moles of H_2 and I_2 are placed in a 1.00 L container. At equilibrium, the $[\text{HI}] = 0.160 \text{ mol/L}$. Calculate the initial $[\text{H}_2]$.

(3 marks)

Response:

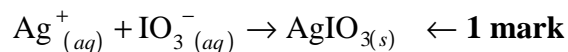


$K_{eq} = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$	}	
$64 = \frac{(0.160)^2}{(x - 0.080)^2}$		$\leftarrow 1\frac{1}{2}$ marks
$[\text{H}_2] = x = 0.10 \text{ mol/L}$		

4. a) Write the net ionic equation for the precipitation reaction that occurs when solutions of NaIO_3 and AgNO_3 are mixed.

(1 mark)

Response:



b) Using appropriate calculations, explain why a precipitate forms when 15.0 mL of 0.50 M NaIO_3 are added to 35.0 mL of 0.50 M AgNO_3 .

(3 marks)

Response:

$$[\text{IO}_3^-] = 0.50 \text{ M} \times \frac{15.0 \text{ mL}}{50.0 \text{ mL}} = 0.15 \text{ M} \quad \leftarrow \frac{1}{2} \text{ mark}$$

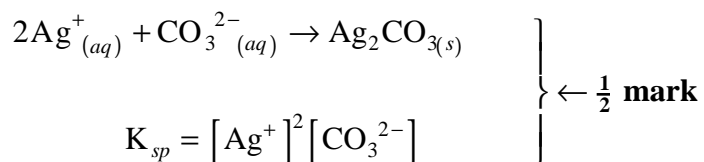
$$[\text{Ag}^+] = 0.50 \text{ M} \times \frac{35.0 \text{ mL}}{50.0 \text{ mL}} = 0.35 \text{ M} \quad \leftarrow \frac{1}{2} \text{ mark}$$

$$\left. \begin{aligned} \text{Trial } K_{sp} &= [\text{Ag}^+][\text{IO}_3^-] \\ &= 0.35 \text{ M} \times 0.15 \text{ M} \\ &= 0.052 \end{aligned} \right\} \leftarrow \text{1 mark}$$

Since $\text{Trial } K_{sp} (0.052) > K_{sp} (3.2 \times 10^{-8})$, a precipitate forms. $\leftarrow \text{1 mark}$

5. What is the maximum $[\text{CO}_3^{2-}]$ that can exist in a $1.3 \times 10^{-4} \text{ M AgNO}_3$ solution? (2 marks)

Response:



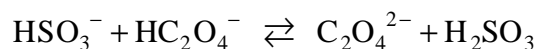
$$8.5 \times 10^{-12} = (1.3 \times 10^{-4})^2 [\text{CO}_3^{2-}] \quad \leftarrow 1 \text{ mark}$$

$$[\text{CO}_3^{2-}] = 5.0 \times 10^{-4} \text{ M} \quad \leftarrow \frac{1}{2} \text{ mark}$$

$\frac{1}{2}$ mark was deducted for incorrect significant figures

6. a) Write the net ionic equation for the predominant reaction between NaHSO_3 and NaHC_2O_4 . (2 marks)

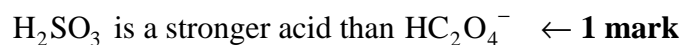
Response:



b) Explain why the reactants are favoured in the above reaction. (1 mark)

Response:

For example:



7. What is the $[\text{H}_3\text{O}^+]$ in a solution formed by adding 60.0 mL of water to 40.0 mL of 0.040 M KOH?

(2 marks)

Response:

$$\text{After dilution } [\text{KOH}] = 0.040 \text{ M} \times \frac{40.0 \text{ mL}}{100.0 \text{ mL}} \quad \leftarrow \frac{1}{2} \text{ mark}$$

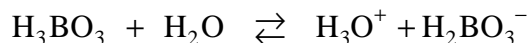
$$[\text{OH}^-] = 0.016 \text{ M} \quad \leftarrow \frac{1}{2} \text{ mark}$$

$$[\text{H}_3\text{O}^+] = \frac{1.0 \times 10^{-14}}{0.016} = 6.2 \times 10^{-13} \text{ M} \quad \leftarrow 1 \text{ mark}$$

8. Calculate the pH in 100.0 mL of 0.400 M H_3BO_3 .

(4 marks)

Response:



[I]	0.400	0	0	} $\leftarrow 1\frac{1}{2}$ marks
[C]	-x	+x	+x	
[E]	0.400 - x \approx 0.400	x	x	

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{H}_2\text{BO}_3^-]}{[\text{H}_3\text{BO}_3]}$$

$$7.3 \times 10^{-10} = \frac{x^2}{0.400} \quad \leftarrow 1\frac{1}{2} \text{ marks}$$

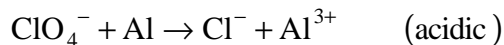
$$x = 1.7 \times 10^{-5}$$

$$[\text{H}_3\text{O}^+] = 1.7 \times 10^{-5} \text{ M}$$

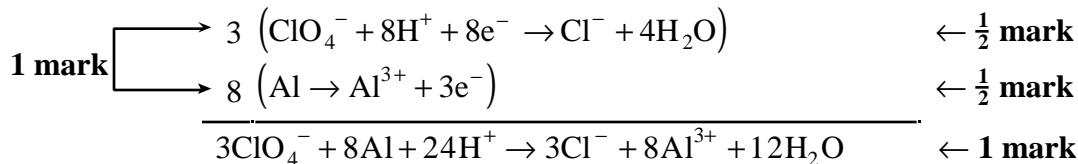
$$\text{pH} = -\log(1.7 \times 10^{-5}) = 4.77 \quad \leftarrow 1 \text{ mark}$$

9. Balance the following redox reaction:

(3 marks)

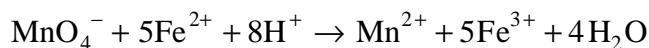


Response:



10. An impure sample of iron was dissolved in acid. The Fe^{2+} in this solution was titrated with 0.0210 M KMnO_4 . Use the following data table and redox equation to determine the moles of Fe^{2+} in the sample.

(3 marks)



TRIAL	VOLUME KMnO_4
1	37.26 mL
2	35.18 mL
3	35.22 mL

Response:

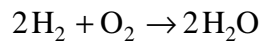
$$\text{Average volume } \text{KMnO}_4 = 35.20 \text{ mL} \quad \leftarrow 1 \text{ mark}$$

$$\text{mol } \text{KMnO}_4 = (0.03520 \text{ L})(0.0210 \text{ M}) = 7.392 \times 10^{-4} \text{ mol} \quad \leftarrow 1 \text{ mark}$$

$$\text{mol } \text{Fe}^{2+} = \left(\frac{5 \text{ mol } \text{Fe}^{2+}}{1 \text{ mol } \text{MnO}_4^-} \right) (7.39 \times 10^{-4} \text{ mol}) = 3.70 \times 10^{-3} \text{ mol} \quad \leftarrow 1 \text{ mark}$$

$\frac{1}{2}$ mark was deducted for incorrect significant figures

11. The overall reaction in a fuel cell is:

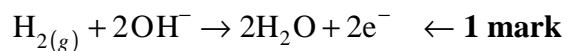


a) Write the equation for the half-reaction at the anode.

(1 mark)

Response:

For example:



b) Is the overall reaction spontaneous? Explain.

(1 mark)

Response:

Yes, the reaction is spontaneous.

For example:

- $0.82 - (-0.41) = 1.23 \text{ V}$
- Positive E° value
- Electrochemical cell

END OF KEY