

# Chemistry 12

June 2004 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.	<b>D</b>	<b>E</b>	<b>L</b>	<b>E</b>	<b>T</b>	<b>E</b>	<b>D</b>
2.	B	U	1	1	A5	32.	D	U	1	4	K11		
3.	D	H	1	1	B2, B5	33.	C	U	1	4	L3		
4.	D	U	1	1	B6	34.	C	K	1	4	L8		
5.	D	K	1	1	C3, 6	35.	A	U	1	4	L11		
6.	A	U	1	2	D2	36.	C	U	1	4	M1		
7.	D	U	1	2	D3	37.	A	U	1	4	M4		
8.	A	U	1	2	D6	38.	C	U	1	4	N2		
9.	C	U	1	2	D9	39.	C	U	1	4	N4		
10.	A	U	1	2	D9	40.	B	K	1	4	O2		
11.	A	H	1	2	E2	41.	A	U	1	4	O5		
12.	<b>D</b>	<b>E</b>	<b>L</b>	<b>E</b>	<b>T</b>	<b>E</b>	<b>D</b>	42.	A	H	1	4	P2
13.	C	U	1	2	E5	43.	D	U	1	4	P4		
14.	C	U	1	2	F1	44.	B	U	1	4	P6		
15.	D	K	1	2	F3	45.	B	K	1	4	Q1		
16.	B	U	1	2	F5	46.	C	U	1	4	R2		
17.	D	U	1	2	F6	47.	B	K	1	5	S1		
18.	C	H	1	3	G1, K1	48.	A	K	1	5	S1, S2		
19.	A	U	1	3	G4	49.	B	U	1	5	S2		
20.	D	U	1	3	G8	50.	C	U	1	5	S6		
21.	D	U	1	3	H2	51.	D	U	1	5	T1		
22.	C	U	1	3	H7	52.	B	U	1	5	T2		
23.	B	U	1	3	I2	53.	B	U	1	5	U1		
24.	A	U	1	3	I3	54.	A	U	1	5	U2		
25.	D	U	1	3	I4	55.	B	U	1	5	U5		
26.	A	U	1	3	I6	56.	C	U	1	5	U9		
27.	A	K	1	4	J2	57.	B	U	1	5	U6		
28.	D	K	1	4	J5	58.	B	U	1	5	W5		
29.	C	U	1	4	J7	59.	C	U	1	5	W4, 5		
30.	C	U	1	4	K2	60.	D	U	1	5	W4, 8		

**Multiple Choice = 60 marks**

**Part B: Written Response**

<b>Q</b>	<b>B</b>	<b>C</b>	<b>S</b>	<b>CO</b>	<b>PLO</b>
1.	1	U	4	1	A4, B4
2.	2	U	4	2	F7
3.	3	U	3	3	G2, 6
4.	4	U	4	4	K1
5.	5	U	3	4	L1, 6
6.	6	U	5	4	M3, N2
7.	7	U	4	5	T6
8.	8	U	3	5	V2

**Written Response = 30 marks**

Multiple Choice = 60 (60 questions)

Written Response = 30 (8 questions)

**EXAMINATION TOTAL = 90 marks**

**LEGEND:**

**Q** = Question Number

**K** = Keyed Response

**C** = Cognitive Level

**B** = Score Box Number

**S** = Score

**CO** = Curriculum Organizer

**PLO** = Prescribed Learning Outcome

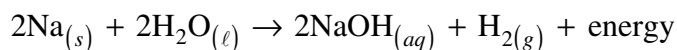
## PART B: WRITTEN RESPONSE

Value: 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. When solid sodium is placed in water at room temperature, an immediate, violent reaction occurs:



- a) Describe two methods that could be used to experimentally determine the rate of reaction. (2 marks)

Method 1: \_\_\_\_\_

Method 2: \_\_\_\_\_

**Solution:**

*For Example:*

**Any two of the following per unit time:**

- $\Delta$  mass Na
- $\Delta$  volume  $\text{H}_2$
- $\Delta$  temperature
- $\Delta$  pH
- $\Delta$  pressure

} ← 2 marks

- b) Would you expect the activation energy of this reaction to be high or low? Explain, using collision theory. (2 marks)

**Solution:**

*For Example:*

The reaction is very fast so many collisions at room temperature would have the needed energy to be successful. The activation energy of this reaction would be low.

} ← 2 marks

2. Consider the following equilibrium:



Initially, 0.15 mol  $\text{N}_2$  and 0.15 mol  $\text{O}_2$  were placed in a 1.0L container.  
Calculate the concentration of all species at equilibrium.

**(4 marks)**

**Solution:**

*For Example:*

	$\text{N}_2$	+	$\text{O}_2$	$\rightleftharpoons$	$2\text{NO}$	
[I]	0.15		0.15		0	}
[C]	$-x$		$-x$		$+2x$	
[E]	$0.15 - x$		$0.15 - x$		$2x$	

← 1 mark

$$K_{eq} = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]}$$

$$0.0095 = \frac{(2x)^2}{(0.15 - x)^2}$$

← 1 mark

$$\sqrt{0.0095} = \sqrt{\frac{(2x)^2}{(0.15 - x)^2}}$$

← 1 mark

$$x = 6.97 \times 10^{-3}$$

$$[\text{N}_2] = [\text{O}_2] = 0.15 - x = 0.14 \text{ M}$$

$$[\text{NO}] = 2(x) = 0.014 \text{ M}$$

← 1 mark

3. a) How would a saturated solution be prepared at room temperature?

(1 mark)

**Solution:**

*For Example:*

Add solute to solvent until no more solute dissolves.

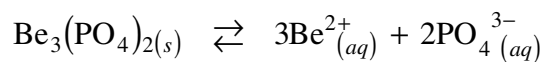
← 1 mark

b) Write a chemical equation to illustrate the equilibrium that exists in a saturated solution of  $\text{Be}_3(\text{PO}_4)_2$ .

(2 marks)

**Solution:**

*For Example:*



← 2 marks

4. Using calculations, show why the electrical conductivity of 1.0 M  $\text{H}_2\text{CO}_3$  will be less than that for 0.10 M HCl. (4 marks)

**Solution:**

*For Example:*

For 0.10 M HCl, a strong acid:  $\text{HCl}_{(aq)} + \text{H}_2\text{O}_{(\ell)} \rightarrow \text{H}_3\text{O}^+_{(aq)} + \text{Cl}^-_{(aq)}$

← 1 mark

total ion concentration = 0.10 M + 0.10 M = 0.20 M

For 1.0 M  $\text{H}_2\text{CO}_3$ , a weak acid:

	$\text{H}_2\text{CO}_{3(aq)} + \text{H}_2\text{O}_{(\ell)} \rightleftharpoons \text{HCO}_3^-_{(aq)} + \text{H}_3\text{O}^+_{(aq)}$	
[I]	1.0	0
[C]	-x	+x
[E]	1.0 - x	x

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]} = 4.3 \times 10^{-7}$$

$$\frac{(x)(x)}{1.0 - x} = 4.3 \times 10^{-7}$$

$$x = 6.6 \times 10^{-4} \text{ M} = [\text{H}_3\text{O}^+] = [\text{HCO}_3^-]$$

Total ion concentration =  $6.6 \times 10^{-4} \text{ M} + 6.6 \times 10^{-4} \text{ M} = 1.3 \times 10^{-3} \text{ M}$

Therefore, smaller ion concentration, lower conductivity.

← 2½ marks

← ½ mark

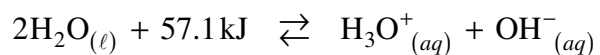
5. Water, at 60°C, has a  $K_w = 9.55 \times 10^{-14}$ .

a) Write an equation representing the ionization of water. Include the heat of reaction (57.1 kJ) in the equation.

(2 marks)

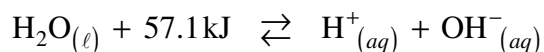
**Solution:**

*For Example:*



← 2 marks

**OR**



**Note:** Endothermic can be deduced from the data provided.

1 mark for the equation.

1 mark for determining endothermic.

b) If a small amount of NaOH is added to water, what happens to the value of  $K_w$  ?

(1 mark)

**Solution:**

*For Example:*

$K_w$  remains unchanged.

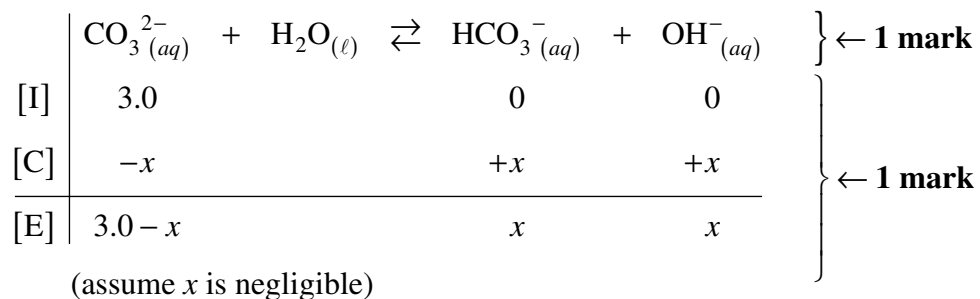
← 1 mark

6. Calculate the pH of 3.0M  $\text{Na}_2\text{CO}_3$ . Start by writing the equation for the predominant equilibrium reaction.

(5 marks)

**Solution:**

*For Example:*



$$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-11}} = 1.79 \times 10^{-4} \quad \left. \vphantom{K_b} \right\} \leftarrow 1 \text{ mark}$$

$$= \frac{[\text{HCO}_3^-][\text{OH}^-]}{[\text{CO}_3^{2-}]}$$

$$1.79 \times 10^{-4} = \frac{(x)(x)}{(3.0)} \quad \left. \vphantom{1.79} \right\} \leftarrow 1 \text{ mark}$$

$$x = [\text{OH}^-] = 0.0232 \text{ M}$$

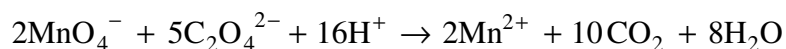
$$\text{pOH} = 1.64$$

$$\text{pH} = 12.36 \quad \left. \vphantom{\text{pH}} \right\} \leftarrow 1 \text{ mark}$$

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



7. An impure sample of  $\text{CaC}_2\text{O}_4$  weighing 0.803 g is titrated with 15.70 mL of 0.101M  $\text{KMnO}_4$ . The net reaction is



What is the percent by mass of the  $\text{CaC}_2\text{O}_4$  in the original sample?

**(4 marks)**

**Solution:**

*For Example:*

$$\text{Moles of } \text{MnO}_4^- = 0.01570\text{L} \times 0.101\text{ mol/L} = 1.5857 \times 10^{-3}\text{ mol}$$

$$\text{Moles of } \text{C}_2\text{O}_4^{2-} = 1.5857 \times 10^{-3}\text{ mol MnO}_4^- \times \frac{5\text{ mol C}_2\text{O}_4^{2-}}{2\text{ mol MnO}_4^-} = 3.9643 \times 10^{-3}\text{ mol}$$

$$\text{Moles CaC}_2\text{O}_4 = \text{Moles C}_2\text{O}_4^{2-}$$

$$\text{Mass of CaC}_2\text{O}_4 = 3.9643 \times 10^{-3}\text{ mol} \times \frac{128.1\text{g}}{1\text{ mol}} = 5.0782 \times 10^{-1}\text{ g CaC}_2\text{O}_4$$

$$\% \text{ CaC}_2\text{O}_4 = \frac{0.50782\text{g}}{0.803\text{g}} \times 100\% = 63.2\%$$

← **4 marks**

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

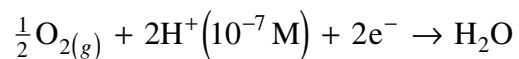
8. A sample of Zn corrodes in moist air.

a) Write the reduction half-reaction.

(1 mark)

**Solution:**

*For Example:*



← 1 mark

b) What metal could be attached to the sample to prevent the corrosion of the zinc?  
Explain.

(2 marks)

**Solution:**

*For Example:*

**Metal:** Magnesium (Mg)

**Explanation:** The magnesium is more easily oxidized than the zinc.

} ← 2 marks

END OF KEY