

# Chemistry 12

June 2002 Provincial Examination

## ANSWER KEY / SCORING GUIDE

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### CURRICULUM:

#### Organizers

1. Reaction Kinetics
2. Dynamic Equilibrium
3. Solubility Equilibria
4. Acids, Bases, and Salts
5. Oxidation – Reduction

#### Sub-Organizers

- A, B, C  
D, E, F  
G, H, I  
J, K, L, M, N, O, P, Q, R  
S, T, U, V, W

### Part A: Multiple Choice

Q	K	C	S	CO	PLO	Q	K	C	S	CO	PLO
1.	A	U	1	1	A1	25.	B	K	1	4	K1
2.	C	K	1	1	A6	26.	A	U	2	4	K8
3.	C	U	1	1	B5	27.	A	K	1	4	L2
4.	B	U	1	1	B6	28.	D	U	2	4	L12
5.	B	U	1	1	C5	29.	D	K	1	4	M2
6.	C	H	2	1	C4, D2	30.	A	K	1	4	N1
7.	A	U	1	2	D3	31.	B	U	1	4	N3
8.	D	U	1	2	E2	32.	B	H	2	4	O3
9.	B	H	1	2	E3	33.	B	U	1	4	O4
10.	D	U	2	2	D7	34.	C	H	1	4	P1
11.	D	U	1	2	F1	35.	D	U	2	4	P3
12.	B	K	1	2	F2	36.	D	K	1	4	Q2
13.	C	U	1	2	F4	37.	C	K	1	4	R1
14.	A	U	2	2	F5	38.	D	K	1	5	S5
15.	B	K	1	3	G2	39.	D	U	2	5	S2
16.	B	U	1	3	G8	40.	C	U	1	5	S6
17.	B	U	2	3	H1	41.	C	U	1	5	S6, U9
18.	C	U	1	3	H3	42.	B	K	1	5	U3
19.	C	U	1	3	H7	43.	C	H	2	5	U5
20.	B	K	1	3	I2	44.	D	U	1	5	T1, U2
21.	B	U	2	3	I3	45.	D	U	1	5	U2
22.	C	U	1	3	I6	46.	A	H	1	5	U9
23.	B	K	1	4	J4	47.	A	U	2	5	U10
24.	C	U	1	4	J11	48.	A	U	1	5	W4

**Multiple Choice = 60 marks (48 questions)**

**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	3	1	A3
2.	2	K	2	1	B9
3.	3	K	2	2	D7
4.	4	U	4	2	F7
5.	5	U	3	3	E2, H5
6.	6	U	3	3	I4
7.	7	U	4	4	J8, K8
8.	8	U	2	4	L1
9.	9	U	5	4	M3
10.	10	U	3	4	Q5
11.	11	U	4	5	T2
12.	12	U	3	5	W1, W7
13.	13	H	2	5	S6, U9

**Written Response = 40 marks**

Multiple Choice = 60 (48 questions)

Written Response = 40 (13 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**

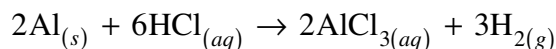
**INSTRUCTIONS:** You will be expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner.

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 reaction: **(3 marks)**



A 10.0 g sample of Al reacts completely in excess HCl in 300.0 s.  
What is the rate of production of H<sub>2</sub> in mol/s ?

**Solution:**

*For Example:*

$$\text{mol Al} = 10.0 \text{ g} \times \frac{1 \text{ mol}}{27.0 \text{ g}} = 0.370 \text{ mol Al}$$

$$\text{mol H}_2 = 0.370 \text{ mol Al} \times \frac{3 \text{ mol H}_2}{2 \text{ mol Al}}$$

$$= 0.556 \text{ mol H}_2$$

$$\text{rate} = \frac{\text{change in moles}}{\text{time}}$$

$$= \frac{0.556 \text{ mol H}_2}{300.0 \text{ s}}$$

$$= 1.85 \times 10^{-3} \frac{\text{mol H}_2}{\text{s}}$$

} ← **3 marks**

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

2. Using collision theory, give **two** reasons why reactions occur more rapidly at a higher temperature.

**(2 marks)**

**Solution:**

*For Example:*

There is a greater fraction of collisions with sufficient energy.

There are more frequent collisions.

} ← **2 marks**  
}

3. Chemical reactions tend toward a position of minimum enthalpy and maximum entropy.

a) What is meant by the term *enthalpy*?

**(1 mark)**

**Solution:**

***For Example:***

Enthalpy is a measure of heat content.

← **1 mark**

b) What is meant by the term *entropy*?

**(1 mark)**

**Solution:**

***For Example:***

Entropy is a measure of randomness.

← **1 mark**

4. Consider the following:

(4 marks)



Initially, 0.080 mol  $\text{H}_2$  and 0.080 mol  $\text{Br}_2$  are placed into a 4.00 L container.  
What is the  $[\text{HBr}]$  at equilibrium?

**Solution:**

*For Example:*

	$\text{H}_2$	+	$\text{Br}_2$	$\rightleftharpoons$	$2\text{HBr}$
[I]	0.020		0.020		0
[C]	$-x$		$-x$		$+2x$
[E]	$0.020 - x$		$0.020 - x$		$2x$

$$K_{eq} = \frac{[\text{HBr}]^2}{[\text{H}_2][\text{Br}_2]} = \frac{(2x)^2}{(0.020 - x)^2} = 12.0$$

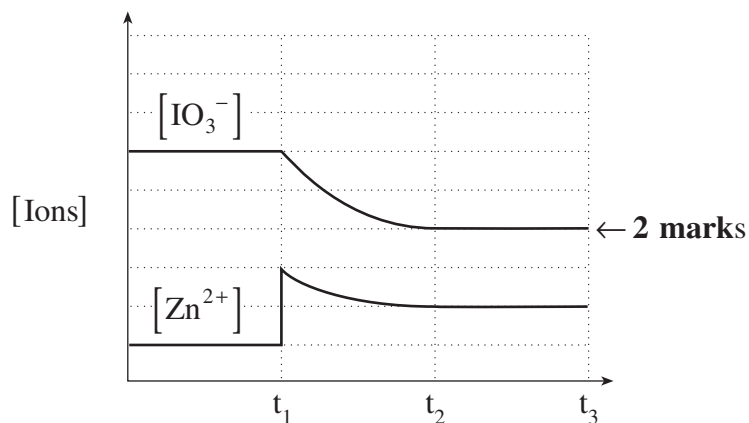
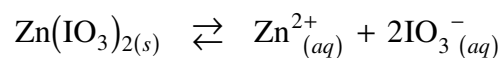
$$\sqrt{\frac{(2x)^2}{(0.020 - x)^2}} = \sqrt{12.0}$$

$$x = 0.0127$$

$$[\text{HBr}] = 2x = 0.025 \text{ M}$$

← 4 marks

5. Consider the following equilibrium and accompanying graph:



a) Identify the stress applied at  $t_1$  .

(1 mark)

**Solution:**

*For Example:*

More  $\text{Zn}^{2+}_{(aq)}$  has been added.

← 1 mark

b) Complete the above graph from  $t_1$  to  $t_3$  for the  $[\text{IO}_3^-]$  .

(2 marks)

**Solution:**

*For Example:*

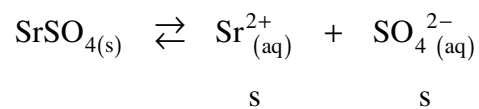
See graph above.

6. Calculate the solubility of  $\text{SrSO}_4$  in grams per litre.

(3 marks)

**Solution:**

*For Example:*



$$K_{sp} = [\text{Sr}^{2+}][\text{SO}_4^{2-}] = 3.4 \times 10^{-7}$$

$$s^2 = 3.4 \times 10^{-7}$$

$$\text{Solubility} = s = 5.8 \times 10^{-4} \text{ M}$$

$$\begin{aligned} \text{Solubility in g/L} &= 5.8 \times 10^{-4} \text{ mol/L} \times \frac{183.7 \text{ g}}{\text{mol}} \\ &= 0.11 \text{ g/L} \end{aligned}$$

} ← 3 marks

7. The cyanide ion,  $\text{CN}^-$ , is a Brønsted-Lowry base.

a) Define *Brønsted-Lowry base*.

(1 mark)

**Solution:**

*For Example:*

A Brønsted-Lowry base is a proton acceptor.

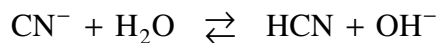
← 1 mark

b) Write the equation representing the reaction of  $\text{CN}^-$  with water.

(2 marks)

**Solution:**

*For Example:*



← 2 marks

c) Identify a conjugate pair in b) above.

(1 mark)

**Solution:**

*For Example:*

$\text{CN}^-$  and  $\text{HCN}$  **OR**  $\text{H}_2\text{O}$  and  $\text{OH}^-$

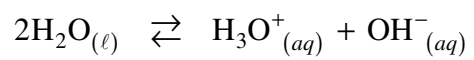
← 1 mark

8. Write an equation to show the ionization of water.

**(2 marks)**

**Solution:**

***For Example:***



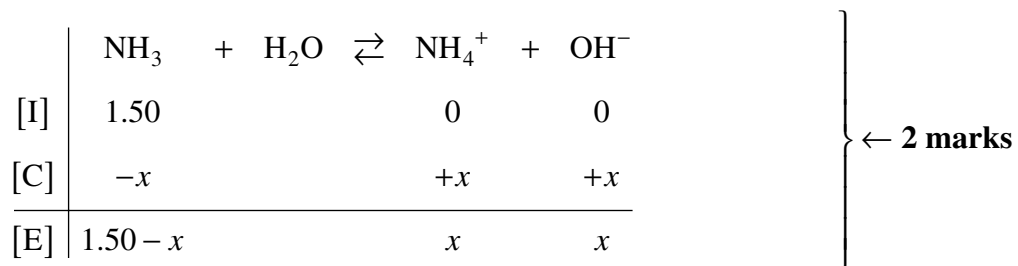
**← 2 marks**

9. Calculate the pH of 1.50 M  $\text{NH}_3$  .

(5 marks)

**Solution:**

*For Example:*



$$K_b = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.79 \times 10^{-5}$$

} ← 1 mark

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

$$= \frac{x^2}{1.50 - x}$$

$$x = [\text{OH}^-] = 5.18 \times 10^{-3}$$

$$\text{pOH} = 2.29$$

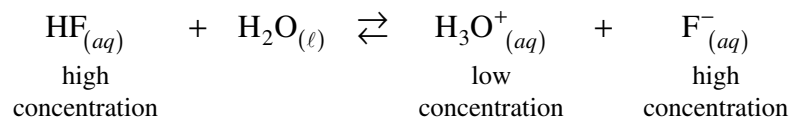
$$\text{pH} = 11.71$$

} ← 2 marks

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

10. Consider the following buffer equilibrium:

(3 marks)



Using Le Châtelier's Principle, explain what happens to the pH of the buffer solution when a small amount of NaOH is added.

**Solution:**

*For Example:*

NaOH causes  $[\text{H}_3\text{O}^+]$  to decrease. ← 1 mark

The equilibrium shifts right. ← 1 mark

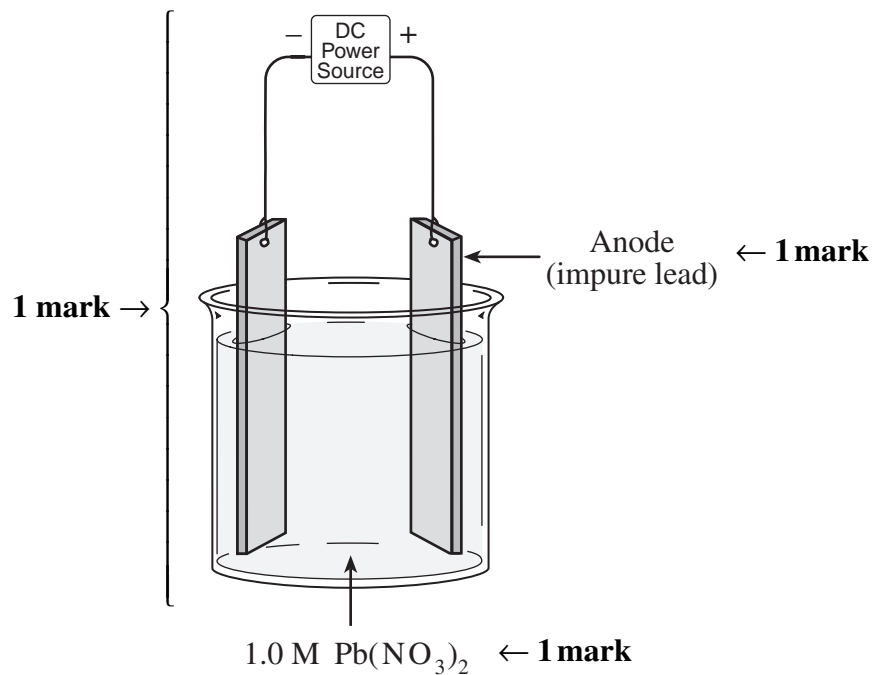
The pH almost returns to the former value. ← 1 mark



12. Draw a diagram of an operating electrolytic cell used to extract pure lead from an impure lead sample. Identify the electrolyte and the material used for the anode. (3 marks)

**Solution:**

*For Example:*



13. A sample of copper is placed in  $\text{HNO}_{3(aq)}$  and another sample of copper is placed in  $\text{HCl}_{(aq)}$ .

a) In which acid does the copper react?

$(\frac{1}{2} \text{ mark})$

**Solution:**

*For Example:*

Copper reacts in  $\text{HNO}_{3(aq)}$  .

←  $\frac{1}{2}$  mark

b) Calculate  $E^\circ$  for the reaction that occurs.

$(1\frac{1}{2} \text{ marks})$

**Solution:**

*For Example:*

$E^\circ$  is +0.62 volts

←  $1\frac{1}{2}$  marks

END OF KEY