

**Chemistry 12**  
 April 2004 Provincial Examination  
**ANSWER KEY / SCORING GUIDE**

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**CURRICULUM:**

<b>Organizers</b>	<b>Sub-Organizers</b>
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**

<b>Q</b>	<b>K</b>	<b>C</b>	<b>S</b>	<b>CO</b>	<b>PLO</b>	<b>Q</b>	<b>K</b>	<b>C</b>	<b>S</b>	<b>CO</b>	<b>PLO</b>
1.	D	U	1	1	A3	31.	B	H	1	4	K9
2.	A	K	1	1	A4	32.	D	U	1	4	K12, K6
3.	B	K	1	1	B1	33.	D	K	1	4	L4
4.	B	U	1	1	B1	34.	B	U	1	4	L7
5.	A	U	1	1	B4	35.	D	H	1	4	M1, N2, N4
6.	C	U	1	1	C4	36.	B	K	1	4	M2
7.	A	U	1	1	C4	37.	C	U	1	4	N2
8.	C	U	1	1	C5	38.	D	U	1	4	N4
9.	A	U	1	2	D2	39.	B	H	1	4	O3
10.	D	U	1	2	D3	40.	D	U	1	4	O4
11.	B	U	1	2	D9	41.	C	K	1	4	P1
12.	A	U	1	2	D7	42.	B	U	1	4	P4
13.	D	K	1	2	E4	43.	B	U	1	4	P5
14.	B	U	1	2	E2	44.	B	U	1	4	Q1
15.	D	U	1	2	F4	45.	A	H	1	4	Q4
16.	C	U	1	2	F6	46.	D	K	1	4	R5
17.	A	U	1	2	F8	47.	D	U	1	5	S1
18.	A	U	1	3	G2	48.	B	U	1	5	S1
19.	A	U	1	3	G6, 7	49.	D	U	1	5	S2
20.	C	U	1	3	H1	50.	B	U	1	5	S4
21.	A	U	1	3	H4	51.	C	U	1	5	T1
22.	C	U	1	3	H5	52.	C	U	1	5	T6
23.	D	U	1	3	I1	53.	A	U	1	5	U10
24.	B	U	1	3	I2	54.	A	U	1	5	U2
25.	D	U	1	3	I4	55.	A	U	1	5	U4
26.	D	H	1	3	I6	56.	A	H	1	5	U7
27.	B	U	1	4	J3	57.	D	U	1	5	W4
28.	A	K	1	4	J4	58.	C	U	1	5	W3, 4
29.	C	U	1	4	J11	59.	C	U	1	5	W5
30.	B	U	1	4	K4	60.	D	U	1	5	W7

**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/H	4	2	E2, 3
2.	2	U	4	2	F4, 5
3.	3	U	4	3	I6
4.	4	U	3	4	J3, 5, 11
5.	5	U	3	4	L12, G8
6.	6	U	5	4	M3
7.	7	U	4	5	T2
8.	8	U	3	5	O3, W4

**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. Consider the following equilibrium:



- a) Some  $\text{HCl}_{(aq)}$  is added to the equilibrium. What happens to the amount of solid  $\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3$ ? Explain. (2 marks)

**Solution:**

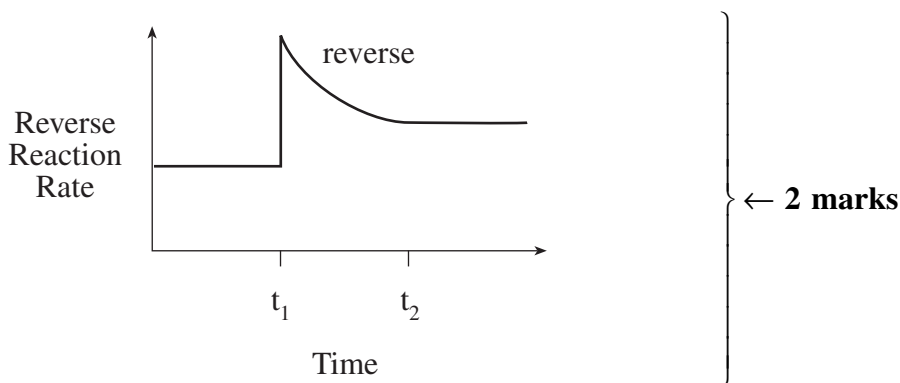
*For Example:*

The amount of solid decreases because the equilibrium shifts left. ← 2 marks

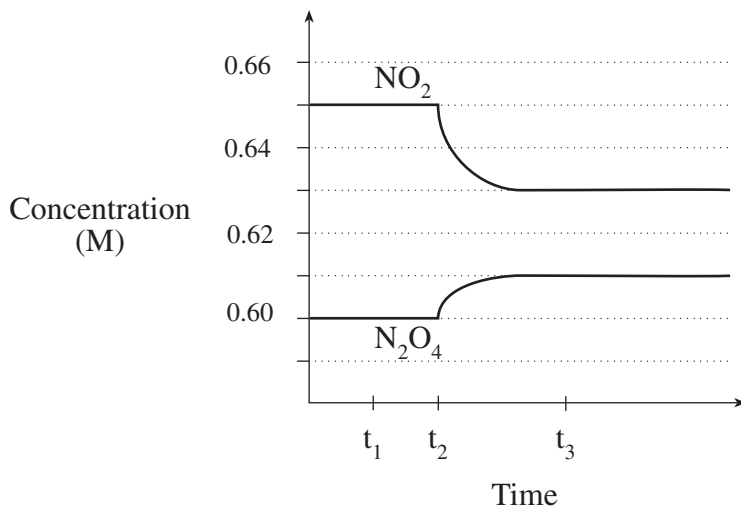
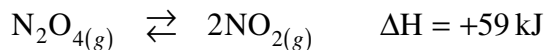
- b) The  $\text{HCl}$  is added at time  $t_1$  and equilibrium is re-established at time  $t_2$ . On the axis below, sketch what happens to the reverse reaction rate. (2 marks)

**Solution:**

*For Example:*



2. Consider the following diagram for the equilibrium:



a) Calculate the value of  $K_{eq}$  at  $t_1$ .

(1 mark)

**Solution:**

*For Example:*

$$K_{eq} = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} = \frac{(0.65)^2}{0.60} = 0.70 \quad \left. \vphantom{\frac{(0.65)^2}{0.60}} \right\} \leftarrow 1 \text{ mark}$$

b) Calculate the value of  $K_{eq}$  at  $t_3$ .

(1 mark)

**Solution:**

*For Example:*

$$K_{eq} = \frac{(0.63)^2}{0.61} = 0.65 \quad \left. \vphantom{\frac{(0.63)^2}{0.61}} \right\} \leftarrow 1 \text{ mark}$$

c) What stress was applied at time  $t_2$  ? Explain.

(2 marks)

**Solution:**

*For Example:*

Stress: Temperature was decreased

$\leftarrow$  1 mark

Explanation: because  $K_{eq}$  decreased.

$\leftarrow$  1 mark

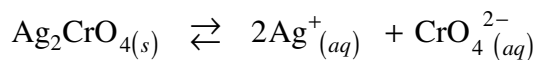
The appearance of the graph is consistent with a temperature shift.

3. Calculate the mass of solid  $\text{AgNO}_3$  that can be added to 2.0 L of a 0.10 M  $\text{K}_2\text{CrO}_4$  solution in order to just start precipitation.

(4 marks)

**Solution:**

*For Example:*



$$K_{sp} = [\text{Ag}^+]^2 [\text{CrO}_4^{2-}] = 1.1 \times 10^{-12}$$

← 1 mark

$$[\text{CrO}_4^{2-}] = 0.10 \text{ M}$$

$$[\text{Ag}^+]^2 = \frac{1.1 \times 10^{-12}}{0.10}$$

← 1 mark

$$[\text{Ag}^+] = 3.3 \times 10^{-6} \text{ M}$$

$$\text{Mass of AgNO}_3 = 3.3 \times 10^{-6} \frac{\text{mol}}{\text{L}} \times 2.0 \text{ L} \times \frac{169.9 \text{ g}}{1 \text{ mol}}$$

← 1 mark

$$= 1.1 \times 10^{-3} \text{ g}$$

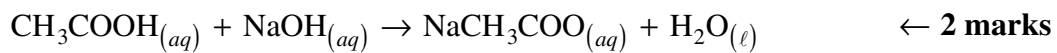
← 1 mark

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

4. a) Write the formula equation to represent the complete neutralization reaction between household vinegar (acetic acid) and drain cleaner (sodium hydroxide). **(2 marks)**

**Solution:**

*For Example:*



- b) Write the formula for the conjugate base of the reactant acid. **(1 mark)**

**Solution:**

*For Example:*



5. A sample of pure  $\text{NaOH}_{(s)}$  is dissolved in water to make 10.0L of solution and a  $\text{pH} = 10.75$  results. Calculate the mass of pure NaOH that was dissolved. **(3 marks)**

**Solution:**

*For Example:*

$$\text{pH} = 10.75$$

$$\text{pOH} = 14.00 - 10.75 = 3.25 \quad \leftarrow \frac{1}{2} \text{ mark}$$

$$[\text{OH}^-] = 5.6 \times 10^{-4} \text{ M} \quad \leftarrow \mathbf{1 \text{ mark}}$$

$$\text{mass NaOH} = 5.6 \times 10^{-4} \frac{\text{mol}}{\text{L}} \times 10.0\text{L} \times \frac{40.0\text{g}}{\text{mol}} = 0.22\text{g}$$

$\uparrow \quad \uparrow$   
 $\frac{1}{2} \text{ mark} \quad \mathbf{1 \text{ mark}}$

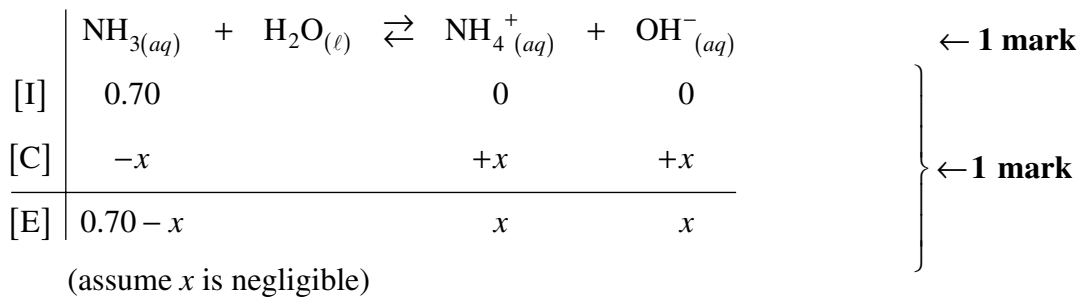
(Deduct  $\frac{1}{2}$  **mark** for incorrect significant figures.)

6. Calculate the pH of 0.70 M  $\text{NH}_3$ . Start by writing the equation for the predominant equilibrium reaction.

(5 marks)

**Solution:**

*For Example:*



$$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.8 \times 10^{-5} \quad \leftarrow 1 \text{ mark}$$

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

$$1.8 \times 10^{-5} = \frac{(x)(x)}{0.70} \quad \leftarrow 1 \text{ mark}$$

$$x = [\text{OH}^-] = 3.5 \times 10^{-3} \text{ M}$$

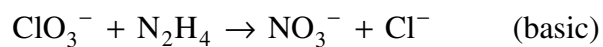
$$\text{pOH} = 2.45$$

$$\text{pH} = 11.55 \quad \leftarrow 1 \text{ mark}$$



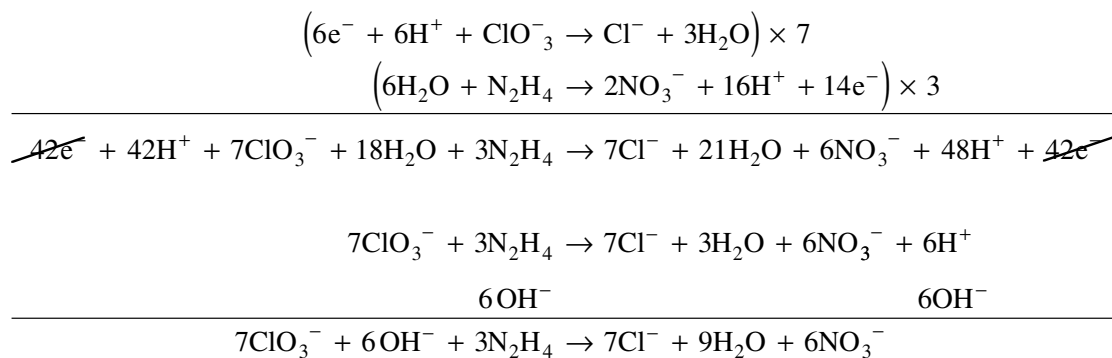
7. Balance the following redox reaction in basic solution:

(4 marks)



**Solution:**

*For Example:*



← 4 marks

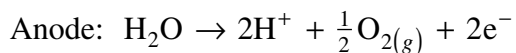
8. A 1.0M solution of  $\text{CoSO}_4$  is electrolyzed using inert electrodes.

a) Write the anode and cathode half-reactions that would occur.

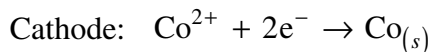
**(2 marks)**

**Solution:**

*For Example:*



← 1 mark



← 1 mark

b) What is observed when bromthymol blue is added to the solution around the anode?

**(1 mark)**

**Solution:**

*For Example:*

Bromthymol blue will turn yellow.

← 1 mark

**NOTE: Some students may note that cobalt solutions are red and therefore may indicate that the colour around the anode will be orange.**

**END OF KEY**