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# Training Skills to Solve Some Inorganic Chemistry Exercises by Using the Graphic Method of Calculation for Teaching Chemistry in High School

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**Abstract** This paper introduces the way to solve some inorganic chemistry exercises by using the graphic method of calculation for teaching chemistry in high school. We have divided them into 7 types of exercise involving in the use of graphs to find the solution methods. Based on these ways, the authors have built 9 Sample Problems. On that basis, the authors compiled 15 drilling exercises for Test Yourself which are used for teaching and self-studying inorganic chemistry in High School.

***Keywords:*** *inorganic chemistry, graphic method, acids / bases, gases, aqueous solution chemistry, precipitation*

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## 1. Introduction

Chemistry exercises play an important role, including content and chemistry teaching methods in high school. Training skills to solve problems is indispensable in chemistry teaching activities. Within the scope of this paper, we will introduce some types of inorganic chemistry exercises that use graphs to infer solution methods. Thereby, training and enhancing skills to solve chemistry exercises in general and inorganic chemistry in particular is very important for students [1,2,3].

## 2. Content

### 2.1. General Problem

In inorganic chemistry, a common problem is

$$\mathbf{A}(\textbf{a gas, solid or soln.}) + \mathbf{B}(\textbf{soln.}) \rightarrow \mathbf{P}\downarrow$$

(The symbol **P↓** stands for “precipitate” in solution).

The precipitate **P** can be soluble in an excess reactant of **A** or **B**. At that time the same amount of precipitate can have two different values of **A** or **B**. To solve this problems, teacher can guide students to use the graph of the relationship between the number of moles of precipitate **P** ($n_\downarrow$) and the number of moles of **A** or **B** [4,5].

### 2.2. Some Common Types

#### 2.2.1. Type 1: Bubble Slowly the Gas of $CO_2$ or $SO_2$ through Solution of $Ca(OH)_2$ or $Ba(OH)_2 \rightarrow P\downarrow \xrightarrow{CO_2\ \text{excess}}$ Soluble

In this case $CO_2$ will perform 2 tasks below.

Task 1: Increase gradually the mass of precipitate up to a maximum, according to the reaction

$$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l). \quad (1)$$

Task 2: Dissolve the precipitate, according to the reaction

$$CaCO_3(s) + CO_2(g) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq). \quad (2)$$

The relationship between the number of moles of $CO_2$ and the number of moles of precipitate is represented as the graph in Figure 1.

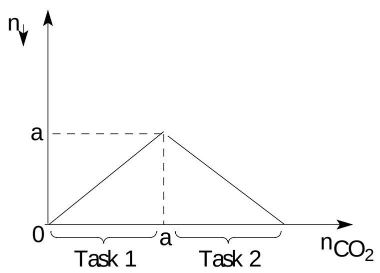



**Figure 1.**

### 2.2.2. Type 2: Bubble slowly the Gas of $CO_2$ or $SO_2$ Through the Mixture Solution of $Ca(OH)_2/Ba(OH)_2$ and NaOH/KOH $\rightarrow$ P$\downarrow$ $\xrightarrow{CO_2\ \text{excess}}$ Soluble

In this case $CO_2$ will perform 3 tasks below.

Task 1: Form the maximum mass of precipitate, according to the reaction

$$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l). \quad (1)$$

Task 2: React between acidic oxide with alkali to form the acidic salt (not neutral salt because of excess $CO_2$), according to the reaction

$$CO_2(g) + NaOH(aq) \rightarrow NaHCO_3(aq). \quad (2)$$

Task 3: Dissolve the precipitate, according to the reaction

$$CaCO_3(s) + CO_2(g) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq). \quad (3)$$

The relationship between the number of moles of $CO_2$ and the number of moles of precipitate is represented by the graph in Figure 2.

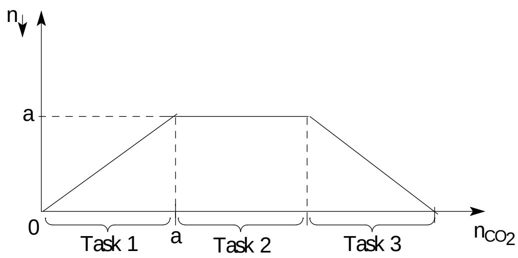



**Figure 2**.

### 2.2.3. Type 3: Add Slowly Solution of NaOH to Solution of $Al^{3+}/Zn^{2+}$ $\rightarrow$ P$\downarrow$ $\xrightarrow{\text{NaOH excess}}$ Soluble

In this case $OH^-$ will perform 2 tasks below.

Task 1: Form the maximum mass of precipitate, according to the reaction

$$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s) \quad (1)$$

Task 2: Dissolve the precipitate, according to the reaction

$$Al(OH)_3(s) + OH^-(aq) \rightarrow [Al(OH)_4]^-(aq) \quad (2)$$

The relationship between the number of moles of $OH^-$ and the number of moles of precipitate is represented by the graph in Figure 3.

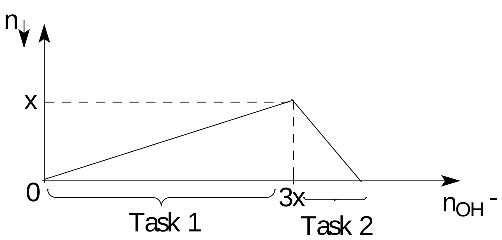



**Figure 3.**

### 2.2.4. Type 4: Add Slowly Solution of NaOH to Mixture Solution of $Al^{3+}/Zn^{2+}$ and $H^+$ $\rightarrow$ P$\downarrow$ $\xrightarrow{\text{NaOH excess}}$ Soluble

In this case $OH^-$ will perform 3 tasks below.

Task 1: Neutralize $H^+$ ion in the solution, according to the reaction

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l) \quad (1)$$

Task 2: Form the maximum mass of precipitate, according to the reaction

$$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s) \quad (2)$$

Task 3: Dissolve the precipitate, according to the reaction

$$Al(OH)_3(s) + OH^-(aq) \rightarrow [Al(OH)_4]^-(aq) \quad (3)$$

The relationship between the number of moles of $OH^-$ and the number of moles of precipitate is represented by the graph in Figure 4.

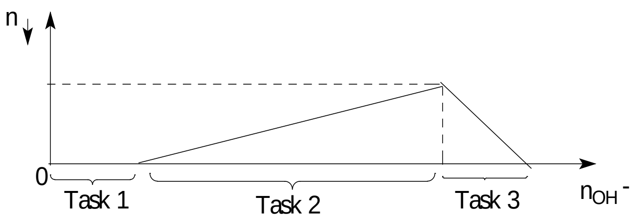



**Figure 4**.

### 2.2.5. Type 5: Add Slowly Solution of HCl to the Solution of $[Al(OH)_4]^-$ / $[Zn(OH)_4]^{2-}$ $\rightarrow$ P$\downarrow$ $\xrightarrow{\text{HCl excess}}$ Soluble

In this case $H^+$ will perform 2 tasks below

Task 1: Form the maximum mass of precipitate, according to the reaction

$$[Al(OH)_4]^-(aq) + H^+(aq) \rightarrow Al(OH)_3(s) + H_2O(l) \quad (1)$$

Task 2: Dissolve the precipitate, according to the reaction

$$Al(OH)_3(s) + 3H^+(aq) \rightarrow Al^{3+}(aq) + 3H_2O(l) \quad (2)$$

The relationship between the number of moles of $H^+$ and the number of moles of precipitate is represented by the graph in Figure 5.

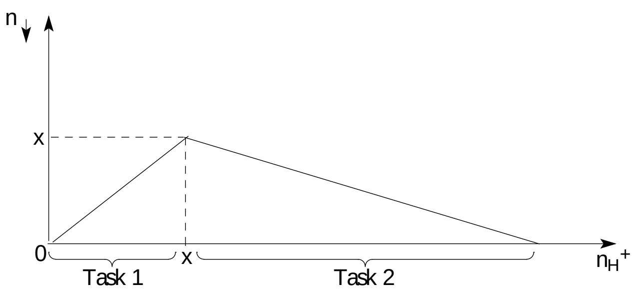



**Figure 5**.

### 2.2.6. Type 6: Add Slowly Solution of HCl to the Mixture Solution of $[Al(OH)_4]^-$ / $[Zn(OH)_4]^{2-}$ and $OH^- \rightarrow P\downarrow \xrightarrow{HCl\ excess}$ Soluble

In this case $H^+$ will perform 3 tasks below.

Task 1: Neutralize $OH^-$ ion in the solution, according to the reaction

$$OH^-(aq) + H^+(aq) \rightarrow H_2O(l) \quad (1)$$

Task 2: React between $H^+$ ion with complex ion to form the precipitate, according to the reaction

$$\left[Al(OH)_4\right]^-(aq) + H^+(aq) \rightarrow Al(OH)_3(s) + H_2O(aq) \quad (2)$$

Task 3: Dissolve the precipitate, according to the reaction

$$Al(OH)_3(s) + 3H^+(aq) \rightarrow Al^3(aq) + 3H_2O(l) \quad (3)$$

The relationship between the number of moles of $H^+$ ion and the number of moles of precipitate is represented by the graph in Figure 6.

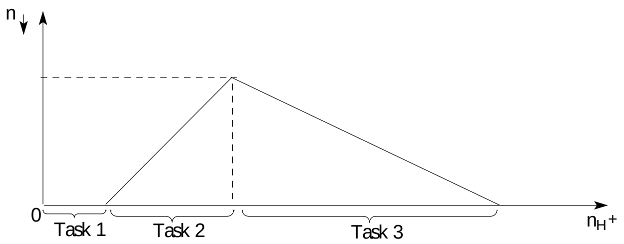



**Figure 6**.

### 2.2.7. Type 7: Add Slowly Solution of $NH_3$ to the Solution of $Cu^{2+}/Cu^{1+}/Zn^{2+}/Ag^+ \rightarrow P\downarrow \xrightarrow{NH_3\ excess}$ Soluble

In this case $NH_3$ will perform 2 tasks below.

Task 1: Form the maximum mass of precipitate, according to the reaction

$$\begin{aligned} &Cu^{2+}(aq) + 2NH_3(aq) + 2H_2O(l) \\ &\rightarrow Cu(OH)_2(s) + 2NH_4^+(aq) \end{aligned} \quad (1)$$

Task 2: Dissolve the precipitate, according to the reaction

$$\begin{aligned} &Cu(OH)_2(s) + 4NH_3(aq) \\ &\rightarrow \left[Cu(NH_3)_4\right]^{2+}(aq) + 2OH^-(aq) \end{aligned} \quad (2)$$

The relationship between the number of moles of $NH_3$ and the number of moles of precipitate $Cu(OH)_2$ is represented by the graph in Figure 7.

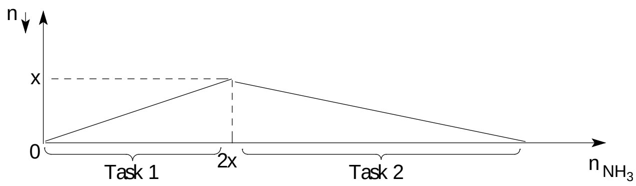
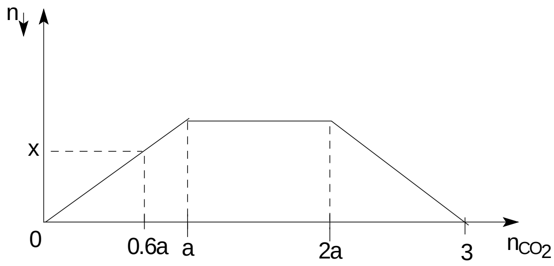



**Figure 7**.

## 2.3. Sample Problems

Based on the 7 types of common exercise above, we designed some following exercises to help students practising skills using graphs to solve the exercises of inorganic chemistry in high school.

**Example 1:** Bubble slowly the gas of $CO_2$ through mixture solution of $Ca(OH)_2$ and KOH. Observed the phenomena according to the following graph (data are calculated in units of moles).




The value of x is

A. 0.45 B. 0.42

C. 0.48 D. 0.60

*Solution:* Based on the above graph, we can see the order of tasks of $CO_2$ is

Task 1:

$$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$$

$$\Rightarrow n_{CO_2} = n_\downarrow max = a$$

Task 2:

$$CO_2(g) + KOH(aq) \rightarrow K_2CO_3(aq) \rightarrow KHCO_3(aq)$$

*(do not form the neutral salt because of the excess carbon dioxide which dissolved the precipitate)*

$$\Rightarrow n_{CO_2} = 2a - a = a$$

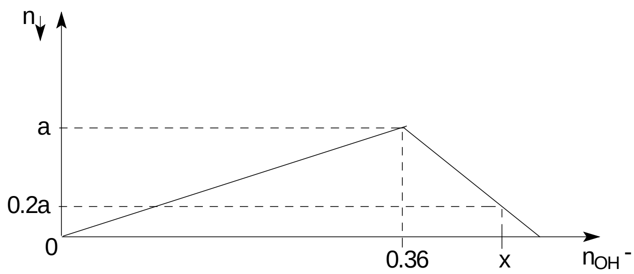
Task 3:

$$CO_2(g) + CaCO_3(s) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq)$$

$$\Rightarrow n_{CO_2} = n_\downarrow max = a$$

At the position at which $n_{CO_2} = 3 = a + a + a \rightarrow a = 1 \rightarrow x = 0.6a = 0.6 \rightarrow$ Answer D.

**Example 2:** Add slowly an excess of NaOH solution to $AlCl_3$ solution. Experimental results are shown in the following graph (data are calculated in units of moles)




The value of x is

A. 0.412 B. 0.456

C. 0.515 D. 0.546

*Solution:* From the graph, we find that

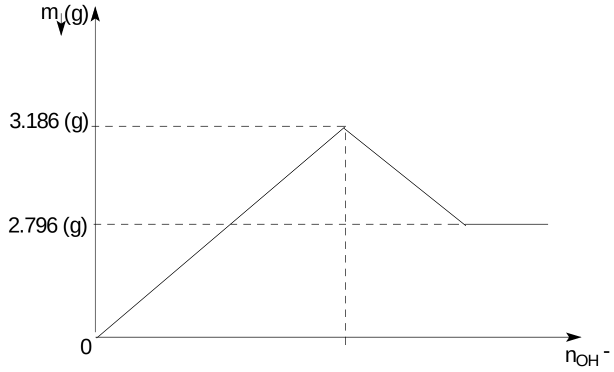
$$n_{OH^-} = 3a = 0.36 \rightarrow a = 0.12$$

At the position at which

$n_{OH^-} = x = 3a + (a - 0.2a) = 3 \times 0.12 + 0.8 \times 0.12 = 0.456$

$\rightarrow$ Answer B.

**Example 3:** Add slowly 0.2 M $Ba(OH)_2$ solution to a test tube containing V (L) of c (mol/l) $Al_2(SO_4)_3$ solution. Experimental results are shown in the following graph




When the mass of precipitate is a constant, the minimum volume of $Ba(OH)_2$ solution is required to be

A. 30 mL B. 60 mL
C. 45 mL D. 75 mL

*Solution:* From the graph, we find that $OH^-$ ion performed 2 tasks below

Task 1: Increase gradually the mass of precipitate up to a maximum.

Task 2: Dissolve the precipitate.

In which parallel segment to the axis $n_{OH^-}$ shown that $BaSO_4$ precipitate is insoluble in base.

We find that :

$$m_{BaSO_4} = 2.796 \text{ (g)}$$

and $m_{Al(OH)_3} = 3.186 - 2.796 = 0.39$ (g)

$$n_{Ba^{2+}} = n_{BaSO_4} = \frac{2.796}{233} = 0.012;$$

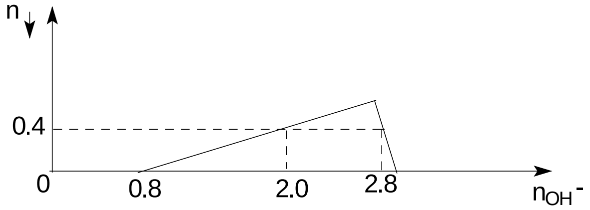
$$n_{OH^-} = 3 \times n_{Al(OH)_3}$$

$$= 3 \times \frac{0.39}{78} = 0.015$$

$$n_{Ba(OH)_2 \min} = 0.012 \rightarrow V_{Ba(OH)_2 \min} = \frac{0.012}{0.2} = 0.06 \text{ (L)}$$

$= 60$ (mL) $\rightarrow$ Answer B.

**Example 4:** Add slowly an excess of NaOH solution to the mixture of solution containing a mol HCl and b mol $AlCl_3$. Experimental results are shown in the following graph (data are calculated in units of moles)




The ratio of $\frac{a}{b}$ is

A. 4/3 B. 2/3
C. 1/1 D. 2/1

*Solution:* From the graph, we find that $OH^-$ ion performed 3 tasks below.

Task 1: Neutralize the acid in that solution

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$
$$\Rightarrow n_{OH^-} = n_{H^+} = a = 0.8$$

Task 2: Increase gradually the mass of precipitate up to a maximum

$$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$$
$$\Rightarrow n_{OH^-} = 3n_{Al^{3+}} = 3b$$

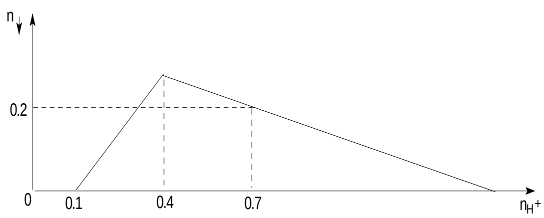
Task 3 : Dissolve the precipitate

$$Al(OH)_3(s) + OH^-(aq) \rightarrow Al(OH)_4^-(aq)$$
$$\Rightarrow n_{OH^-} = n_{\downarrow}\text{dissolved} = (b - 0.4)$$

At the position at which

$n_{OH^-} = 2.8 = \underbrace{0.8}_{Task 1} + \underbrace{3b}_{Task 2} + \underbrace{(b-0.4)}_{Task 3} \rightarrow b = 0.6 \rightarrow$ The ratio $\frac{a}{b} = \frac{4}{3} \rightarrow$ Answer A.

**Example 5:** Add slowly an excess of HCl solution to the mixture of solution containing x mol $Ba(OH)_2$ and y mol $Ba[Al(OH)_4]_2$. Experimental results are shown in the following graph (data are calculated in units of moles).




The value of x and y are

A. 0.05 and 0.15 B. 0.10 and 0.30
C. 0.10 and 0.15 D. 0.05 and 0.30

*Solution:* From the graph, we find that $H^+$ ion performed 3 tasks below.

Task 1: Neutralize the base in that solution

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$
$$\Rightarrow n_{H^+} = n_{OH^-} = 2x = 0,1 \rightarrow x = 0.05$$

Task 2: Increase gradually the mass of precipitate up to a maximum

$$[Al(OH)_4]^-(aq) + H^+(aq) \rightarrow Al(OH)_3(s) + H_2O(l)$$
$$\Rightarrow n_{H^+} = n_{\downarrow}\max = n_{[Al(OH)_4]^-} = 2y$$

Task 3 : Dissolve the precipitate

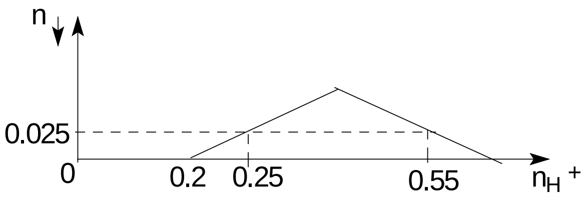
$$Al(OH)_3(s) + 3H^+(aq) \rightarrow Al^{3+}(aq) + 3H_2O(l)$$
$$\Rightarrow n_{H^+} = 3 \times n_{\downarrow}\text{dissolved} = 3(2y - 0,2)$$

At the position at which

$$n_{H^+} = 0.7 = \underbrace{0.1}_{Task 1} + \underbrace{2y}_{Task 2} + \underbrace{3(2y-0.2)}_{Task 3} \rightarrow y = 0.15$$

$\rightarrow$ Answer A.

**Example 6:** Add slowly an excess of HCl solution to the mixture of solution containing a mol KOH and b mol $K_2[Zn(OH)_4]$. Experimental results are shown in the following graph (data are calculated in units of moles).




The ratio of $\frac{a}{b}$ is

A. 1.5 B. 1.0

C. 2.0 D. 2.5

*Solution:* From the graph, we find that $H^+$ ion performed 3 tasks below.

Task 1: Neutralize the base in that solution

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$
$$\Rightarrow n_{H^+} = n_{OH^-} = a = 0.2$$

Task 2: Increase gradually the mass of precipitate up to a maximum

$$\left[Zn(OH)_4\right]^{2-}(aq) + 2H^+(aq) \rightarrow Zn(OH)_2(s) + 2H_2O(l)$$
$$\Rightarrow n_{H^+} = 2n_{[Zn(OH)_4]^{2-}} = 2\times b \text{ and } n_{\downarrow}\max = b$$

Task 3: Dissolve the precipitate

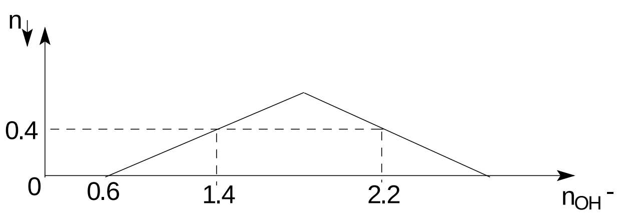
$$Zn(OH)_2(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + 2H_2O(l)$$
$$\Rightarrow n_{H^+} = 2n_{\downarrow} \text{ dissolved} = 2(b-0.025)$$

At the position at which

$$n_{H^+} = 0.55 = \underbrace{0.2}_{Task 1} + \underbrace{2b}_{Task 2} + \underbrace{2(b-0.025)}_{Task 3} \rightarrow b = 0.1 \Rightarrow \frac{a}{b}$$

$= \frac{0.2}{0.1} = 2 \rightarrow$ Answer C.

**Example 7:** Add slowly an excess of NaOH solution to the mixture of solution containing a mol HCl and b mol $ZnCl_2$. Experimental results are shown in the following graph (data are calculated in units of moles)




The total value of (a + b) is

A. 1.4 B. 1.6

C. 1.2 D. 1.3

*Solution:* From the graph, we find that $OH^-$ ion performed 3 tasks below.

Task 1: Neutralize the acid in that solution

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$
$$\Rightarrow n_{OH^-} = n_{H^+} = a = 0.6$$

Task 2: Increase gradually the mass of precipitate up to a maximum

$$Zn^{2+}(aq) + 2OH^-(aq) \rightarrow Zn(OH)_2(s)$$
$$\Rightarrow n_{OH^-} = 2n_{Zn^{2+}} = 2b \text{ and } n_{\downarrow} \max = n_{Zn^{2+}} = b$$

Task 3: Dissolve the precipitate

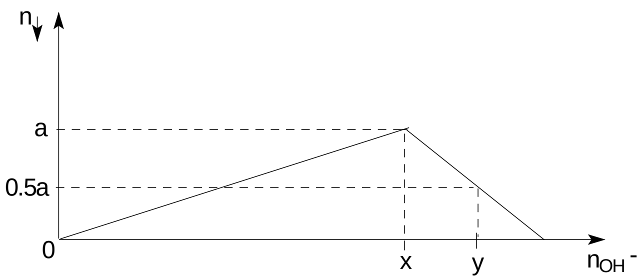
$$Zn(OH)_2(s) + 2OH^-(aq) \rightarrow \left[Zn(OH)_4\right]^{2-}(aq)$$
$$\Rightarrow n = 2\times n_{\downarrow}\text{dissolved} = 2(b-0.4)$$

At the position at which

$$n_{OH^-} = 2.2 \rightarrow 2.2 = \underbrace{0.6}_{Task 1} + \underbrace{2b}_{Task 2} + \underbrace{2(b-0.4)}_{Task 3} \rightarrow b = 0.6$$

$\rightarrow$ Answer C.

**Example 8:** Add slowly an excess of NaOH solution to $AlCl_3$ solution, experimental results are shown in the following graph (data are calculated in units of moles)




The ratio of $\frac{x}{y}$ is

A. 7/8 B. 6/7

C. 5/4 D. 4/5

*Solution:* From the graph, we find that $OH^-$ ion performed 2 tasks below.

Task 1: Increase gradually the mass of precipitate up to a maximum

$$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$$

Task 2: Dissolve the precipitate

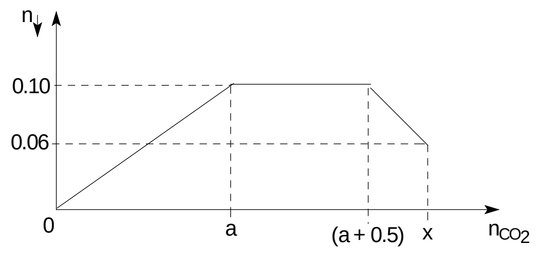
$$Al(OH)_3(s) + OH^-(aq) \rightarrow \left[Al(OH)_4\right]^-(aq)$$

From the graph, we find that

$$\begin{cases} x = 3a \\ y = \underbrace{3a}_{Task 1} + \underbrace{(a-0.5a)}_{Task 2} \rightarrow y = 3.5a \end{cases} \rightarrow \frac{x}{y} = \frac{6}{7}$$

$\rightarrow$ Answer B.

**Example 9:** Bubble slowly the gas of $CO_2$ through mixture solution of $Ca(OH)_2$ and NaOH. Experimental results are shown in the following graph (data are calculated in units of moles)




The value of x is

A. 0.64 B. 0.58

C. 0.68 D. 0.62

*Solution:* From the graph, we find that $CO_2$ performed 3 tasks below.

Task 1: Increase gradually the mass of precipitate up to a maximum

$$n_{CO_2} = n_{\downarrow}max = a = 0.1$$

Task 2: Keep the constant mass of precipitate

$$n_{CO_2} = (a + 0.5) - a = 0.5$$

Task 3: Dissolve the precipitate

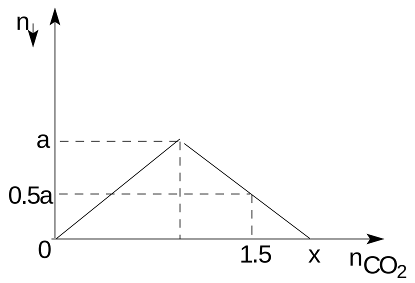
$$n_{CO_2} = n_{\downarrow}dissolved = 0.10 - 0.06 = 0.04$$

We have: $\sum n_{CO_2} = x = a + 0.5 + 0.04 = 0.64$

→ Answer A.

## 2.4. Test Yourself

**1.** Bubble slowly the gas of $CO_2$ through solution of $Ba(OH)_2$. Observed the phenomena happening according to the following graph (data are calculated in units of moles)



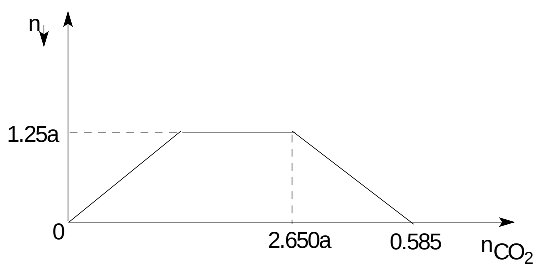

The value of x is

A. 1.8 B. 2.0

C. 2.2 D. 2.4

**Answer B**

**2.** Bubble slowly V (L) at s.t.p. of the gas of $CO_2$ through the mixture of $Ba(OH)_2$ and KOH solution. Experimental results are shown in the following graph (data are calculated in units of moles). *Hint:* 1 mole of gas at s.t.p. occupies 22.4 $dm^3$.



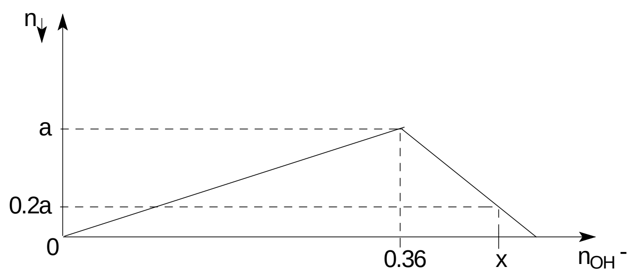

In order to obtain the maximum precipitate, the value of V is

A. 4.480 ≤ V ≤ 8.960 B. 2.240 ≤ V ≤ 6.720

C. 3.654 ≤ V ≤ 6.585 D. 4.200 ≤ V ≤ 8.904

**Answer D**

**3**. Add slowly an excess of NaOH solution to $AlCl_3$ solution. Experimental results are shown in the following graph (data are calculated in units of moles)



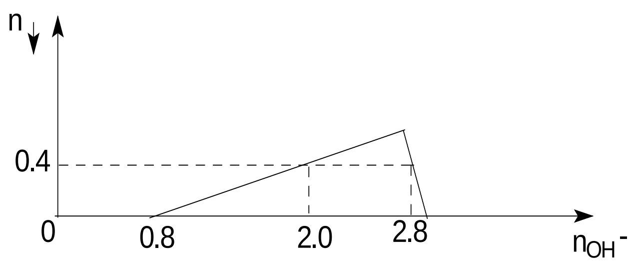

The value of x is

A. 0.412 B. 0.456

C. 0.515 D. 0.546

**Answer B**

**4**. Add slowly an excess of NaOH solution to the mixture of solution containing a mol HCl and b mol $AlCl_3$. Experimental results are shown in the following graph (data are calculated in units of moles)



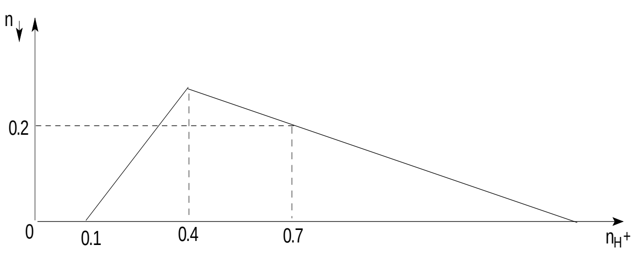

The ratio of $\frac{a}{b}$ is

A. 4/3 B. 2/3

C. 1/1 D. 2/1

**Answer A**

**5**. Add slowly an excess of HCl solution to the mixture of solution containing x mol $Ba(OH)_2$ and y mol $Ba[Al(OH)_4]_2$. Experimental results are shown in the following graph (data are calculated in units of moles)



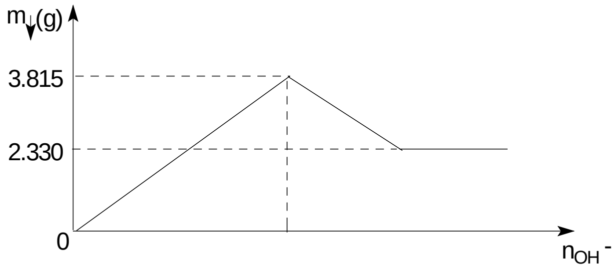

The value of x and y are

A. 0.05 và 0.15 B. 0.10 và 0.30

C. 0.10 và 0.15 D. 0.05 và 0.30

**Answer A**

**6.** Add slowly 0.2 M $Ba(OH)_2$ solution to a test tube containing V (L) of c (mol/l) $ZnSO_4$ solution. Experimental results are shown in the following graph



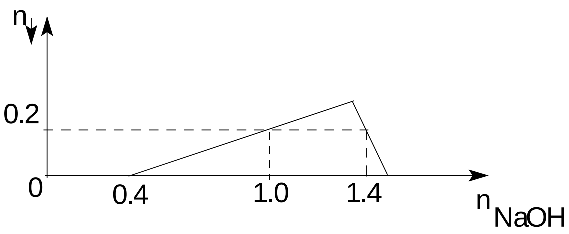

In order to constant precipitate, the volume of $Ba(OH)_2$ solution is the minimum needed

A. 50 mL B. 60 mL

C. 45 mL D. 75 mL

**Answer D**

**7.** Add slowly an excess of NaOH solution to X solution containing x mol $H_2SO_4$ and y mol $Al_2(SO_4)_3$. Experimental results are shown in the following graph (data are calculated in units of moles)



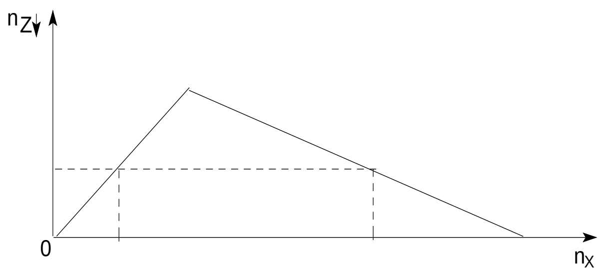

If add slowly a solution containing 0.7 mol $Ba(OH)_2$ to solution X until the reaction occurs completely, we obtain m grams of precipitate. Value of m is **closest to which of the following value**?

A. 170 B. 150

C. 180 D. 120

**Answer A**

**8.** Add slowly an excess of X solution to Y solution to form Z precipitate. Experimental results are shown in the following graph (data are calculated in units of moles)




Which result of the following experiment is shown as the above graph?

A. Add slowly an excess of HCl solution to $Na[Al(OH)_4]$ solution

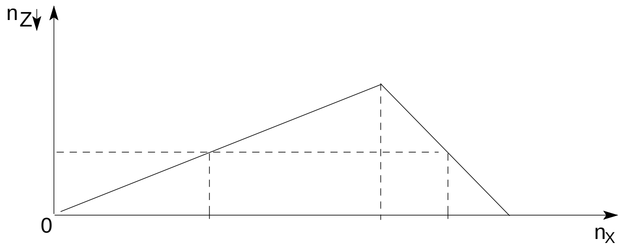
B. Add slowly an excess of NaOH solution to $AlCl_3$ solution

C. Add slowly an excess of NaOH solution to $ZnCl_2$ solution

D. Bubble slowly the gas of $CO_2$ through solution of $Ca(OH)_2$

**Answer A**

**9.** When add slowly a substance X to a substance Y to form a precipitate Z. Experimental results are shown in the following graph (data are calculated in units of moles)




Which result of the following experiment is shown as the graph above?

A. Add slowly an excess of HCl solution to $Na[Al(OH)_4]$ solution

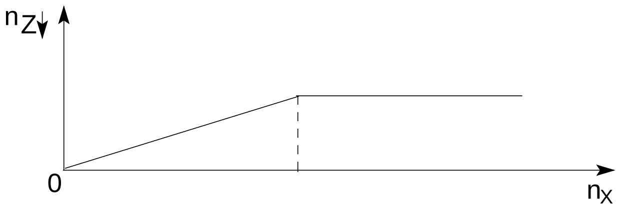
B. Add slowly an excess of NaOH solution to $AlCl_3$ solution

C. Add slowly an excess of HCl solution to $Na_2[Zn(OH)_4]$ solution

D. Bubble slowly the gas of $CO_2$ through solution of $Ca(OH)_2$

**Answer B**

**10.** Add slowly a substance X to a substance Y to form a precipitate Z. Experimental results are shown in the following graph (data are calculated in units of moles)




Which result of the following experiment is shown as the above graph?

A. Add slowly an excess of KOH solution to $ZnCl_2$ solution

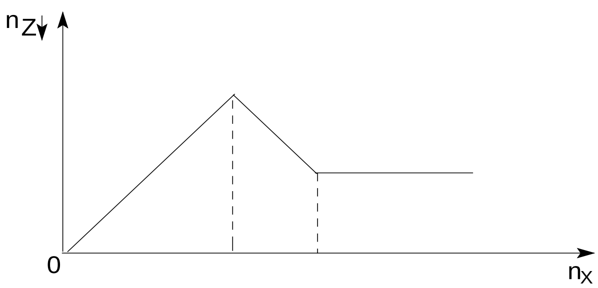
B. Bubble slowly the gas of $CO_2$ through solution of $Ca(OH)_2$

C. Bubble slowly the gas of $NH_3$ through solution of $AlCl_3$

D. Bubble slowly the gas of $NH_3$ through solution of $ZnCl_2$

**Answer C**

**11.** Add slowly an excess of X solution to Y solution to form Z precipitate. Experimental results are shown in the following graph (data are calculated in units of moles)




Which result of the following experiment is shown as the graph above?

A. Add slowly an excess of $Ba(OH)_2$ solution to $AlCl_3$ solution

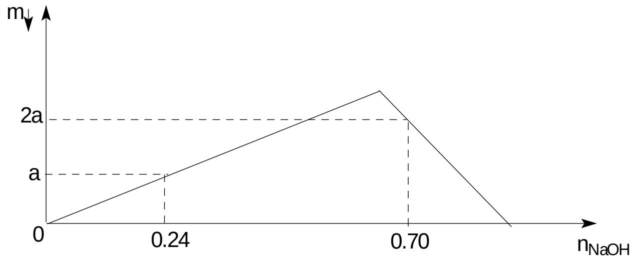
B. Add slowly an excess of $Ba(OH)_2$ solution to $Al_2(SO_4)_3$ solution

C. Add slowly an excess of $Ba(OH)_2$ solution to mixture solution of HCl and $AlCl_3$

D. Add slowly an excess of NaOH solution to $Al_2(SO_4)_3$ solution

**Answer B**

**12.** Dissolve $AlCl_3$ in water to form a solution X. Add slowly an excess of NaOH solution to X solution. Experimental results are shown in the following graph.




Based on the above graph, the maximum mass of the precipitate obtained in above experiment is

A. 12.48 grams B. 14.04 grams

C. 16.77 grams D. 23.40 grams

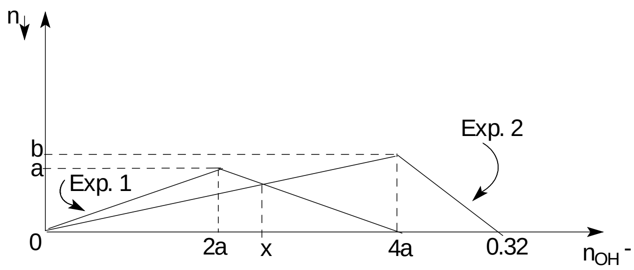
**Answer C**

**13.** A solution X contains a mol of $ZnSO_4$, a solution Y contains b mol of $AlCl_3$ and a solution Z contains c mol of KOH. Perform 2 following experiments:

Experiment 1: Add slowly to the end of an excess of the solution Z to the solution X.

Experiment 2: Add slowly to the end of an excess of the solution Z to the solution Y.

The precipitate of two experiments changed according to the following graph



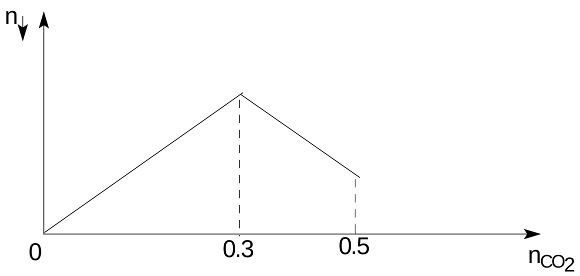

If each experiment used x mol KOH, the total mass (grams) precipitate obtained in two experiments will be **closest to which of the following value**?

A. 8.0 B. 8.5

C. 9.0 D. 9.5

**Answer B**

**14.** Bubble slowly the gas of $CO_2$ through 11 % (by mass) $Ca(OH)_2$ solution. The reaction occurs completely to form a solution X. Experimental results are shown in the following graph (data are calculated in units of moles)



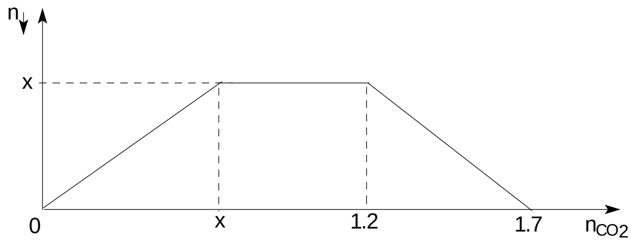

Defining concentration of solution X in terms of mass percent?

A. 16.20 % B.14.59 %

C. 15.28 % D. 16.87 %

**Answer C**

**15.** Dissolve a mixture X containing a mol K and b mol Ca in 200 mL 0.1 M $Ca(OH)_2$ solution to form the solution Y and V (L) the gas of $H_2$ (at s.t.p.). Bubble slowly an excess of $CO_2$ gas through Y solution. Experimental results are shown in the following graph (data are calculated in units of moles). Hint: 1 mol of gas at s.t.p. occupies 22.4 $dm^3$.




The value of V is

A. 14.56 B. 19.04

C. 22.40 D. 26.88

**Answer A**

## 3. Conclusions

The paper proposed identification signs of 7 types of inorganic chemistry exercises can use the graphic method to solve easily. Based on the experimental results are shown in the graph, easily infer the relationship between the number of moles of precipitate and the number of moles of reactants. Thereby, teacher will practice skills to solve chemical exercises for students based on the experimental results are illustrated by the graph. They are exciting forms of exercise for students in high school.


## Acknowledgements

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