



# KINETICS

## RELATIVE REACTION RATES

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[WWW.MIOY.ORG/CHEM165](http://WWW.MIOY.ORG/CHEM165)

# INTRODUCTION

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- Chemical kinetics: study of rates of reactions
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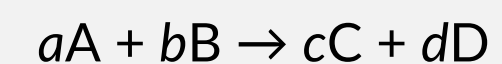
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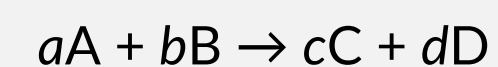
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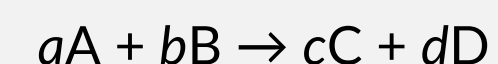
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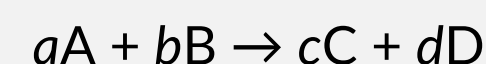
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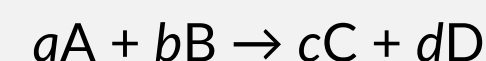
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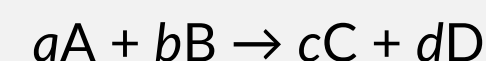
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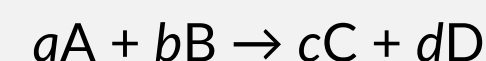
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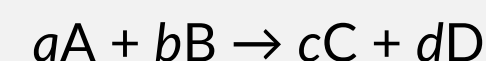
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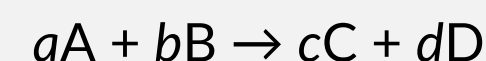
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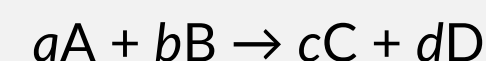
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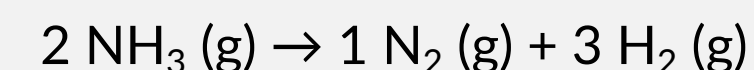
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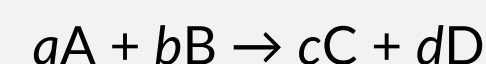
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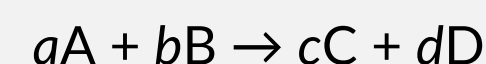
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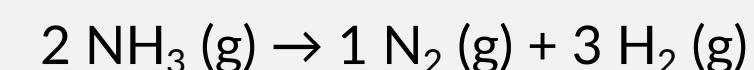
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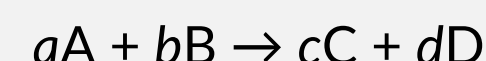
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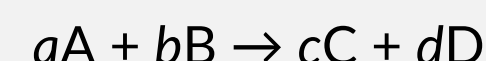
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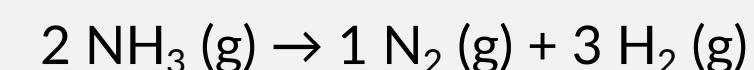
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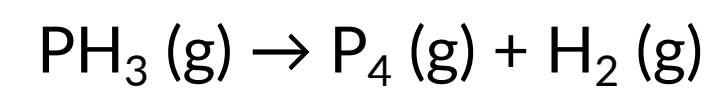
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This is how you can derive them. These are the relative reaction rates!

# PRACTICE PROBLEM 1

Consider the following unbalanced chemical equation:



If, over a specific time period, 0.0081 mol  $\text{PH}_3 (\text{g})$  are consumed in a 1.59 L container each second of the reaction, what is the rate of formation of  $\text{P}_4 (\text{g})$ ?

— *answer* —

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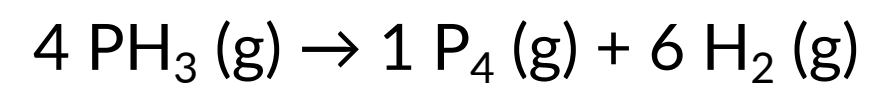
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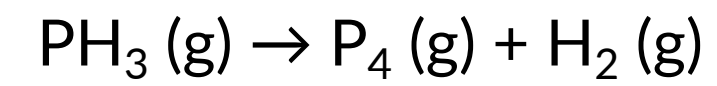
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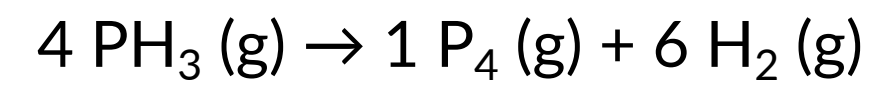
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Let's work in terms of concentration of the gas. Note that the concentration change is negative for reactants!

$$\Delta[\text{PH}_3] = \frac{-0.0081 \text{ mol PH}_3}{1.59 \text{ L}} = -0.005094 \text{ M}$$

# PRACTICE PROBLEM 1

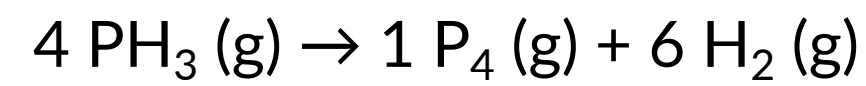
Consider the following unbalanced chemical equation:



If, over a specific time period, 0.0081 mol  $\text{PH}_3 (\text{g})$  are consumed in a 1.59 L container each second of the reaction, what is the rate of formation of  $\text{P}_4 (\text{g})$ ?

— *answer* —

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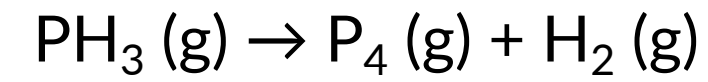
This is the change in concentration for every one second. Therefore, the rate of consumption of  $\text{PH}_3 (\text{g})$  is:

$$\frac{\Delta[\text{PH}_3]}{\Delta t} = -0.005094 \frac{\text{M}}{\text{s}}$$



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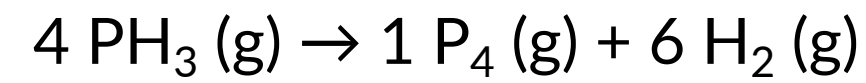
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From the balanced chemical equation, we know that for every 4 moles of  $\text{PH}_3$  consumed, 1 mole of  $\text{P}_4$  and 6 moles of  $\text{H}_2$  are produced. Therefore, the relative rates are:

$$-\frac{1}{4} \frac{\Delta[\text{PH}_3]}{\Delta t} = \frac{\Delta[\text{P}_4]}{\Delta t} = \frac{1}{6} \frac{\Delta[\text{H}_2]}{\Delta t}$$

# PRACTICE PROBLEM 1

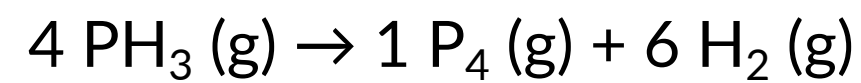
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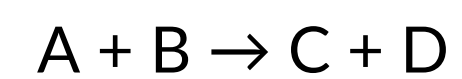
$$-\frac{1}{4} \frac{\Delta[\text{PH}_3]}{\Delta t} = \frac{\Delta[\text{P}_4]}{\Delta t} = \frac{1}{6} \frac{\Delta[\text{H}_2]}{\Delta t}$$

Now we can solve for the rate of formation of  $\text{P}_4$ :

$$\frac{\Delta[\text{P}_4]}{\Delta t} = -\frac{1}{4} \frac{\Delta[\text{PH}_3]}{\Delta t} = -\frac{1}{4} \cdot \left[ -0.005094 \frac{\text{M}}{\text{s}} \right] = 0.0013 \frac{\text{M}}{\text{s}}$$

## PRACTICE PROBLEM 2

Consider the following unbalanced chemical equation:

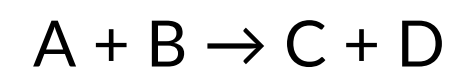


After 25 seconds, you measure the rate of formation of C to be  $2.97 \times 10^{-6}$  M/s and the rate of formation of D to be  $9.70 \times 10^{-7}$  M/s. Based on this kinetic data, what is the mole-mole ratio between the two products: C and D?

— *answer* —

## PRACTICE PROBLEM 2

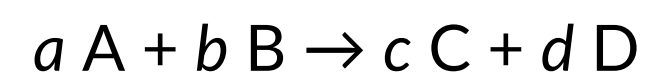
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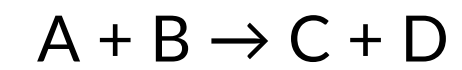
— *answer* —

First, balance the chemical equation as:



## PRACTICE PROBLEM 2

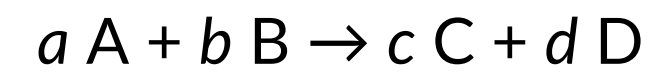
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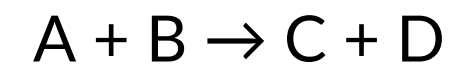


From this balanced equation, we can express the relative reaction rates as:

$$-\frac{1}{a} \frac{\Delta[A]}{\Delta t} = -\frac{1}{b} \frac{\Delta[B]}{\Delta t} = \frac{1}{c} \frac{\Delta[C]}{\Delta t} = \frac{1}{d} \frac{\Delta[D]}{\Delta t}$$

## PRACTICE PROBLEM 2

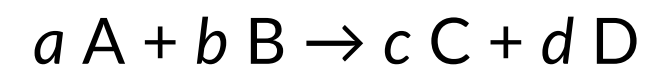
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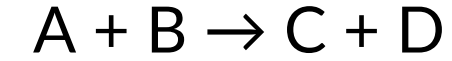
We are interested in the latter two terms, which deal with the two products formed:

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## PRACTICE PROBLEM 2

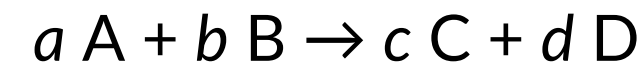
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We are interested in the latter two terms, which deal with the two products formed:

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We can rearrange this expression to find the mole-mole ratio between C and D, which is  $c/d$ :

$$\frac{c}{d} = \frac{\frac{\Delta[C]}{\Delta t}}{\frac{\Delta[D]}{\Delta t}} = \frac{2.97 \times 10^{-6} \frac{\text{M}}{\text{s}}}{9.70 \times 10^{-7} \frac{\text{M}}{\text{s}}} = 3.06 \approx 3$$