Name: Date:

Chemistry 12: Reaction Kinetics – Lesson 1 – Measuring reaction rates

LT 1-3: analyze data to calculate & graph rate
LT 1-4: state different ways to monitor rate

Reaction Kinetics – the study of reactions and the factors which affect the rates

In general:

$$\text{reaction (rxn) rate} = \frac{\Delta \text{amount}}{\Delta \text{time}}$$

"Δ" = change in (final − initial)

But there are many ways we can find the Δamount.

[ ] = concentration

Example: Given the following reaction, what are some ways we could measure reaction rate?

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + ZnCl_{2(aq)}$$

$$r = \frac{\Delta \text{mass of Zn}}{\Delta \text{time}} \qquad r = \frac{\Delta [HCl]}{\Delta \text{time}} \qquad r = \frac{\Delta [ZnCl_2]}{\Delta \text{time}}$$

$$r = \frac{\Delta \text{volume gas}}{\Delta \text{time}}$$

Note – writing reactions in their ionic form can show that some ions don't change in concentration. You CANNOT use spectator ions to measure reaction rates

Example:

$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_{2(aq)}$$

Ionic Form: $Mg_{(s)} + 2H^+_{(aq)} + \cancel{2Cl^-_{(aq)}} \rightarrow H_{2(g)} + Mg^{2+}_{(aq)} + \cancel{2Cl^-_{(aq)}}$

Net ionic: $Mg_{(s)} + 2H^+_{(aq)} \rightarrow H_{2(g)} + Mg^{2+}_{(aq)}$

How could we express rate for this reaction?

$$r = \frac{\Delta \text{mass Mg}}{\Delta \text{time}} \qquad r = \frac{\Delta \text{volume of } H_2}{\Delta \text{time}} \qquad r = \frac{P_{H_2}}{\Delta \text{time}}$$

$$r = \frac{\Delta [H^+]}{\Delta \text{time}} \text{ (pH)}$$

Calculations Involving Reaction Rates

ALWAYS use conversion factors to cancel units you don't want and replace them with ones you do want!

Example $\frac{0.020\text{mol}}{\text{min}} = \frac{?\text{mol}}{\text{s}}$ 1min = 60s

Solution: $\frac{0.020\text{mol}}{\text{min}} \times \frac{1\text{ min}}{60\text{ s}} = 3.3\times10^{-4}\text{ mol/s}$

The 60 in 60 s/1min is an exact number by definition. Therefore, we don't consider it using significant digits. The 0.020 has 2 sig. digs., therefore the

You also must use molar mass to go grams ⇆ moles.

Example: 0.26 mol Zn / min = ? g of Zn/sec

$\frac{x\text{ g Zn}}{\text{s}} = 0.26\frac{\text{mol Zn}}{\text{min}} \times \frac{65.4\text{ g}}{1\text{ mol Zn}} \times \frac{1\text{ min}}{60\text{ s}} = 0.28\text{ g Zn/s}$

You Try ☺

The rate of a reaction is 0.034 g of Mg per second. Calculate the number of moles of Mg used up in 6.0 minutes.

$x\text{ mol Mg} = 0.034\frac{\text{g Mg}}{\text{s}} \times \frac{1\text{ mol}}{24.3\text{ g}} \times \frac{60\text{ s}}{1\text{ min}} \times 6\text{ min} = 0.50\text{ mol}$ Mg used in 6 min.

Comparing rates using balanced equations

When needed use coefficient ratios to compare → Stoichiometry!

Example:

If ethane is consumed at a rate of 0.066 mol/s. calculate the rate of consumption of O_2 in mol/s.

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

$\frac{x\text{ mol }O_2}{\text{s}} = 0.066\frac{\text{mol }C_2H_6}{\text{s}} \times \frac{7\ O_2}{2\ C_2H_6} = 0.23\text{ mol }O_2\text{/s}$

You may need to use the ‘mole bridge’ when other units are used.

Example:

If 67.5 g of Al are consumed per second calculate the rate of consumption of Br_2 in g/s.

$$2Al + 3Br_2 \rightarrow 2AlBr_3$$

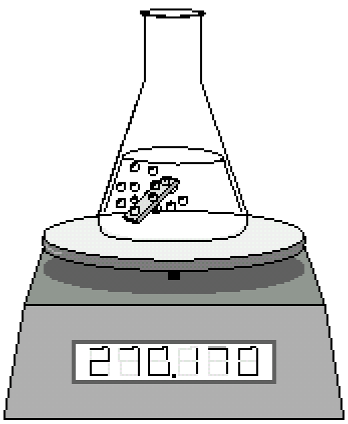
79.9 × 2

$$\frac{x\,g\,Br_2}{s} = \frac{67.5\,g\,Al}{s} \times \frac{1\,mol\,Al}{27.0\,g\,Al} \times \frac{3\,Br_2}{2\,Al} \times \frac{159.8\,g}{1\,Br_2} = 599\,g\,Br_2/s$$

You Try ☺

An experiment is done to determine the rate of the following reaction:

$$2Al_{(s)} + 6\,HCl_{(aq)} \rightarrow 3\,H_{2(g)} + 2\,AlCl_{3\,(aq)}$$



It is found that the rate of production of $H_{2(g)}$ is 0.060 g/s.

Calculate the mass of Aluminum reacted in 3.0 minutes.

$$x\,g\,Al = \frac{0.060\,g\,H_2}{s} \times \frac{1\,mol}{2\,g\,H_2} \times \frac{2\,Al}{3\,H_2} \times \frac{27.0\,g\,Al}{1\,mol\,Al} \times \frac{60\,s}{1\,min} \times 3\,min$$

$= 97.2\,g$

$= 97\,g$

Practice: pg. 2-3 #1-6