

## AP Chemistry Chemical Kinetics Worksheet Answers

1.	Half lives	Reactant Fraction Remaining
	1	$\frac{1}{2}$
	2	$\frac{1}{4}$
	3	$\frac{1}{8}$
	4	$\frac{1}{16}$
	5	$\frac{1}{32}$

2. 2<sup>nd</sup> Order; 1<sup>st</sup> Order

3. a. True    b. True

c. False; As [Reactant] decreases the rate will decrease    d. True

4. a.  $-1/2 \Delta[\text{O}_3]/\Delta t = 1/3 \Delta[\text{O}_2]/\Delta t$   
b.  $-1/2 \Delta[\text{HOF}]/\Delta t = 1/2 \Delta[\text{HF}]/\Delta t = \Delta[\text{O}_2]/\Delta t$   
c.  $-\Delta[\text{N}_2]/\Delta t = -1/3 \Delta[\text{H}_2]/\Delta t = 1/2 \Delta[\text{NH}_3]/\Delta t$

5. a. rate =  $k[\text{NO}_2]^2[\text{CO}]^0$  or  $k[\text{NO}_2]^2$   
b. rate = 1/4 the original value

6. The initial rate  $R = k[\text{B}]_0^2$

7. a.  $6.0 \times 10^{-3} / 1.2 \times 10^{-2} = (0.10/0.20)^X$   
 $X = 1$  so it is 1<sup>st</sup> order with respect to A  
 $1.1 \times 10^{-1} / 1.2 \times 10^{-2} = (0.15/0.05)^X$   
 $X = 2$  so it is 2<sup>nd</sup> order with respect to B  
**Rate Law =  $k[\text{A}][\text{B}]^2$**

b. Overall it is 3<sup>rd</sup> order

c. Probably not a single step since a 3-body collision would have to occur.

8. a. half life =  $\ln(1/2) = -5.0 \times 10^{-4} \text{s}^{-1} t$   
 $-\ln(0.5) / 5.0 \times 10^{-4} \text{s}^{-1} = \mathbf{1.4 \times 10^3 \text{s}}$   
b. Assign an original value of 1.00M  
 $\ln(0.1/1.0) = -5.0 \times 10^{-4} \text{s}^{-1} t$   
 $t = -\ln(0.1) / 5.0 \times 10^{-4} \text{s}^{-1} = \mathbf{4.6 \times 10^3 \text{s}}$

9. After 30.min (one half-life)

$$P_{\text{HOF}} = \frac{1}{2} (100.\text{mmHg}) = 50.\text{mmHg}$$

$$P_{\text{HF}} = 50.\text{mmHg}$$

$$P_{\text{O}_2} = 25.\text{mmHg}$$

Calculating the rate constant  $k$ ,

$$\ln([\text{HOF}]/[\text{HOF}]_0) = -kt \qquad \ln(0.5) = -k(30.\text{min})$$

$$k = 0.023\text{min}^{-1}$$

$$\ln X = -(0.023\text{min}^{-1})(45\text{min}) = 0.35 \text{ or } 35\% \text{ (x = fraction of HOF remaining)}$$

$$P_{\text{HOF}} = 35\text{mmHg}; P_{\text{HF}} = 65\text{mmHg}; P_{\text{O}_2} = 33\text{mmHg}; P_{\text{H}_2} = 133\text{mmHg}$$

10. Reverse Reaction  $E_A >$  Forward Reaction  $E_A$  therefore the forward reaction is exothermic.
11. From the Arrhenius Equation:  
 $\ln(k_2/k_1) = -E_A/R (1/T_2 - 1/T_1)$   
 $\ln(1.5 \times 10^{-3}\text{s}^{-1}/3.46 \times 10^{-5}\text{s}^{-1}) = -E_A/8.314 \times 10^{-3}\text{kJ/molK} (1/328 - 1/298)$   
 $3.77 = -E_A/8.314 \times 10^{-3}\text{kJ/molK} (-3.07 \times 10^{-4}\text{K}^{-1})$   
 $E_A = (8.314 \times 10^{-3}\text{kJ/molK})(3.77)/(3.07 \times 10^{-4}\text{K}^{-1}) = 1.0 \times 10^2\text{kJ/mol}$
12.  $k = Ae^{(-E_A/RT)}$   
 $6.00 \times 10^{12} \text{ mol/Ls } e^{-(100.\text{kJ/mol} / (8.314 \times 10^{-3}\text{kJ/molK} * 400.\text{K}))}$   
 $k = 6.00 \times 10^{12} \text{ mol/Ls } e^{-30}$   
 $k = 0.52\text{mol/Ls}$
13. a. Step 2 is the rate determining step.  
b. Rate =  $k[\text{O}_3][\text{O}]$   
c. Step 1 is unimolecular; step 2 is bimolecular
14. a. Rate =  $k[\text{A}][\text{B}]^2$   
b.  $2.0 \times 10^{-5}\text{mol/Ls} = k(0.30)(0.30)^2$   
 **$k = 7.4 \times 10^{-4} \text{ L}^2/\text{mol}^2\text{s}$**
15. Mechanism 1 is not consistent because it is 1<sup>st</sup> order with respect to both NO and H<sub>2</sub> in the slow step  
Mechanism 2 is consistent. The net result for the slow step is 1<sup>st</sup> order with respect to H<sub>2</sub> and 2<sup>nd</sup> order with respect to NO