AP CHEMISTRY WORKSHEET ON RATE-LAW EXPRESSIONS

Name:_____Date:_____Period:_____

(1) Given the reaction: $2A_{(g)} \longrightarrow B_{(g)} + C_{(g)}$

a. Express the rate of reaction in terms of the change in concentration of each of the reactants and products.

b. When [C] is increasing at 2.0 $mol \cdot L^{-1} \cdot s^{-1}$, how fast is [A] decreasing?

(2) Given the reaction: $2D_{(g)} + 3E_{(g)} + F_{(g)} \longrightarrow 2G_{(g)} + H_{(g)}$

a. Express the rate of reaction in terms of the change in concentration of each of the reactants and products.

b. When [E] is decreasing at 0.10 $mol \cdot L^{-1} \cdot s^{-1}$, how fast is [G] increasing?

(3) Given the reaction: $A_{(g)} + 2B_{(g)} \longrightarrow C_{(g)}$

a. Express the rate of reaction in terms of the change in concentration of each of the reactants and products.

b. When [B] is decreasing at 0.50 $mol \cdot L^{-1} \cdot s^{-1}$, how fast is [A] decreasing?

(4) Given the reaction: $D_{(g)} \longrightarrow 3/2\ E_{(g)} + 5/2\ F_{(g)}$

a. Express the rate of reaction in terms of the change in concentration of each of the reactants and products.

b. When [E] is increasing at 0.25 $mol \cdot L^{-1} \cdot s^{-1}$, how fast is [F] increasing?

(5) Given the following reaction and experimental data at 25 ^{0}C:

$$A + B \longrightarrow \text{Products}$$

reaction:	[A]	[B]	Rate:
1	0.10	0.10	1.56×10^{-8} *M*/s
2	0.25	0.10	2.4375×10^{-7} *M*/s
3	0.25	0.04	3.90×10^{-8} *M*/s

a. What is the order of this reaction with respect to reactant A?

b. What is the order of this reaction with respect to reactant B?

c. What is the OVERALL reaction order?

d. What is the value of the specific rate constant (with UNITS)?

e. Write the correct RATE LAW for this reaction:

f. What would be the rate of the forward reaction if the concentration of A is changed to 1.75 *M* and the concentration of B is changed to 0.25 *M*?

g. You are a chemical manufacturer for the above product. You have only enough money to purchase additional A OR additional B. Would increasing the concentration of A to 3.0 *M* or increasing the concentration of B to 3.0 *M* cause you to produce product at a greater rate? EXPLAIN YOUR ANSWER.

(6) By what factor does the rate change in each of the following cases, assuming that temperature is held constant?

a. A reaction is first order with respect to reactant A, and [A] is doubled.

b. A reaction is second order with respect to reactant B, and [B] is halved.

c. A reaction is second order with respect to reactant C, and [C] is tripled.

(7) Given the following reaction and experimental data at 25 ^{0}C:

$$2A + B + 2C \longrightarrow D + 2E$$

reaction:	[A]	[B]	[C]	Rate:
1	0.10 *M*	0.20 *M*	0.10 *M*	5.0×10^{-4} *M*/min
2	0.20 *M*	0.20 *M*	0.30 *M*	1.5×10^{-3} *M*/min
3	0.30 *M*	0.20 *M*	0.10 *M*	5.0×10^{-4} *M*/min
4	0.40 *M*	0.60 *M*	0.30 *M*	4.5×10^{-3} *M*/min

a. What is the order of this reaction with respect to reactant A?

b. What is the order of this reaction with respect to reactant B?

c. What is the order of this reaction with respect to reactant C?

d. What is the OVERALL reaction order?

e. What is the value of the specific rate constant (with UNITS)?

f. Write the correct RATE LAW for this reaction:

g. What would happen to the rate of the reaction if the concentrations of A, B, and C were all DOUBLED?

(8) Given the following reaction and experimental data at 25 ^{0}C:

$$A + B \longrightarrow C$$

reaction:	$[A]_0$	$[B]_0$	Initial Rate of Formation of C:
1	0.10	0.10	2.0×10^{-4} *M*·s^{-1}
2	0.20	0.10	8.0×10^{-4} *M*·s^{-1}
3	0.40	0.20	2.56×10^{-2} *M*·s^{-1}

a. What is the order of this reaction with respect to reactant A?

b. What is the order of this reaction with respect to reactant B?

c. Write the correct RATE LAW for this reaction (include the specific value for the rate constant WITH correct units):

(9) Given the following reaction and experimental data at 25 ^{0}C:

$$A + B + C \longrightarrow D$$

reaction:	$[A]_0$	$[B]_0$	$[C]_0$	Initial Rate:
1	0.0500 *M*	0.0500 *M*	0.0100 *M*	6.25×10^{-3} *M*·s^{-1}
2	0.1000 *M*	0.0500 *M*	0.0100 *M*	1.25×10^{-2} *M*·s^{-1}
3	0.1000 *M*	0.1000 *M*	0.0100 *M*	5.00×10^{-2} *M*·s^{-1}
4	0.0500 *M*	0.0500 *M*	0.0200 *M*	6.25×10^{-3} *M*·s^{-1}

a. What is the order of this reaction with respect to reactant A?

b. What is the order of this reaction with respect to reactant B?

c. What is the order of this reaction with respect to reactant C?

d. What is the OVERALL reaction order?

e. What is the value of the specific rate constant (with UNITS)?

f. Write the correct RATE LAW for this reaction:

KEY: WORKSHEET ON RATE LAW EXPRESSIONS

(1) a. Rate = $\frac{-\Delta[A]}{2\Delta t} = \frac{\Delta[B]}{\Delta t} = \frac{\Delta[C]}{\Delta t}$

b. twice as fast as C increases; 4.0 $mol \cdot L^{-1} \cdot s^{-1}$

(2) a. Rate = $\frac{-\Delta[D]}{2\Delta t} = \frac{-\Delta[E]}{3\Delta t} = \frac{-\Delta[F]}{\Delta t} = \frac{\Delta[G]}{2\Delta t} = \frac{\Delta[H]}{\Delta t}$

b. 2/3 as fast as E decreases; 0.067 $mol \cdot L^{-1} \cdot s^{-1}$

(3) a. Rate = $\frac{-\Delta[A]}{\Delta t} = \frac{-\Delta[B]}{2\Delta t} = \frac{\Delta[C]}{\Delta t}$

b. half as fast as B decreases; 0.25 $mol \cdot L^{-1} \cdot s^{-1}$

(4) a. Rate = $\frac{-\Delta[D]}{\Delta t} = \frac{2\Delta[B]}{3\Delta t} = \frac{2\Delta[F]}{5\Delta t}$

b. 5/3 as fast as B increases; 0.42 $mol \cdot L^{-1} \cdot s^{-1}$

(5) a. 3rd order in reactant [A]
b. 2nd order in reactant [B]
c. 5th order overall
d. $1.56 \times 10^{-7}\ M^{-4} \cdot s^{-1}$
e. Rate = $(1.56 \times 10^{-7}\ M^{-4} \cdot s^{-1})[A]^3[B]^2$
f. $5.2 \times 10^{-8}\ M \cdot s^{-1}$
g. Increasing the concentration of A; A has a larger order in the rate law than reactant B

(6) a. doubled
b. decreased by a factor of 4
c. increased by a factor of 9

(7) a. 0th order in reactant [A]
b. 1st order in reactant [B]
c. 1st order in reactant [C]
d. 2nd order overall
e. $2.5 \times 10^{-2}\ M^{-1} \cdot min^{-1}$
f. Rate = $(2.5 \times 10^{-2}\ M^{-1} \cdot min^{-1})[B][C]$
g. rate would be increased by a factor of 4

(8) a. 2nd order in reactant [A]
b. 3rd order in reactant [B]
c. Rate = $(20.\ M^{-4} \cdot s^{-1})[A]^2[B]^3$

(9) a. 1st order in reactant [A]
b. 2nd order in reactant [B]
c. 0th order in reactant [C]
d. 3rd order overall
e. $50.\ M^{-2} \cdot s^{-1}$
f. Rate = $(50.\ M^{-2} \cdot s^{-1})[A][B]^2$