# Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hour: \_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_

# AP Chemistry: *14HW*

***Directions: Complete the following problems.***

1A. Consider the reaction 2 AB3(g) 🡨🡪 A2(g) + 3 B2(g) In a certain experiment, over a specific time period, 0.0084 mol of AB3 is consumed every second in a 3.0-L container. What are the rates of production of each product, in M/s?

1B. Over a time period t, a reaction’s rate data is as follows: –X/t = 0.0080 M/s

–Y/t = 0.0160 M/s

Z/t = 0.0200 M/s

Based on the rate data, write the balanced equation for the reaction.

2A. What are the units for each of the following?

rate of a reaction rate constant for a 1st-order rate law

rate constant for a zero-order rate law rate constant for a 3rd-order rate law

2B. CHCl3(g) + Cl2(g) 🡨🡪 CCl4(g) + HCl(g) has the rate law… rate = k [CHCl3] [Cl2]1/2

i. How was this rate law determined?

ii. What are the units for k?

ANSWERS: 1A. A2: +0.0014 M/s; B2: +0.0042 M/s 2A. M/s; Ms–1; s–1; M–2 s–1 2Bii. M–1/2 s–1

3A. For the reaction Cl2(g) + 2 NO(g) 🡨🡪 2 NOCl(g) **[Cl2]o(M) [NO]o(M) init. rate (M/s)**

data were taken as shown. 0.14 0.14 0.25

0.28 0.14 0.50

i. Write the rate law. 0.28 0.28 2.03

ii. Determine the rate constant.

3B. For the reaction S2O82– + 2 I– 🡨🡪 2 SO42– + I2 **[S2O82–]o(M) [I–]o(M) init. rate (M/s)**

data were taken as shown. 0.066 0.132 2.06 x 10–5

0.066 0.066 1.03 x 10–5

i. Write the rate law. 0.033 0.132 1.03 x 10–5

ii. Determine the rate constant.

3C. The reaction in the blood between hemoglobin (Hb) **[Hb]o(M) [CO]o(M) init. rate (M/s)**

and carbon monoxide yielded the data shown. 2.92 1.32 0.817

5.83 1.32 1.64

i. Write the rate law. 5.83 3.96 4.90

ii. Determine the initial rate of the reaction if [Hb]o = 2.82 M and [CO]o = 1.38 M.

3D. Data were take for the following reaction: 2 ClO2(aq) + 2 OH–(aq) 🡨🡪 ClO3–(aq) + ClO2–(aq) + H2O(l)

**[ClO2]o(M) [OH–]o(M) init. rate (M/s)**

0.0890 0.178 0.102

i. Write the rate law. 0.178 0.178 0.409

0.178 0.0890 0.205

ii. Determine the initial rate of reaction if [ClO2]o = 0.225 M and [OH–]o = 0.315 M.

ANSWERS: 3Aii. 91 M–2 s–1 3Bii. 2.4 x 10–3 M–1 s–1 3Cii. 0.825 M/s 3Dii. 1.15 M/s

4A. Consider the reaction yY 🡪 zZ At a certain temperature and [Y]o = 0.1340 M, concentration versus time data were collected. A plot of 1/[Y] v. t resulted in a straight line with slope +0.0723 M–1 s–1.

i. Write the rate law.

ii. Determine the rate constant.

iii. Determine the reaction’s half-life.

iv. How much time is required for [Y] to decrease to 6.50 x 10–4 M?

4B. For the decomposition of reactant D at a particular D 🡪 E + F

temperature, concentration versus time

data were collected. A plot of ln [D] v. t resulted in a straight line with slope –3.20 x 10–3 s–1.

i. Write the rate law.

ii. Determine the rate constant.

iii. Determine the reaction’s half-life.

iv. How much time is required for the first 10.% of D to decompose compared to the time required for the

second 10.% to decompose?

ANSWERS: 4Aii. 0.0723 M–1.s–1 4Aiv. 2020 s 4Biii. 217 s

4Aiii. 103 s 4Bii. 3.20 x 10–3 s–1 4Biv. 33 s versus 37 s

5A. A first-order reaction is 35% complete in 436 s. How much time is required for 75% completion?

5B. The rate law for the decomposition of reactant G is… rate = k [G]. It takes 160. s for [G] to drop from

2.50 M to 0.850 M. At the same temp., how much time is required for the drop from 3.15 M to 0.650 M?

Sketch the energy profile for each reaction. Label the key features of each profile.

6A. E = +50 kJ/mol, Ea = 75 kJ/mol 6B. E = –60 kJ/mol, Ea = 100 kJ/mol

7A. For a particular combustion reaction, the activation energy is 124 kJ/mol. The rate constant at 325 K is

2.13 x 10–4 M–1 s–1. Determine the rate constant at 395 K.

ANSWERS: 5A. 1400 s 5B. 234 s 7A. 0.725 M–1 s–1

7B. A first-order decomposition reaction has rate constants of 0.061 s–1 and 0.141 s–1 at 20.oC and 50.oC, respectively. Determine the activation energy for the reaction, in kJ/mol.

Write rate laws, based on the following elementary steps.

8A. CH3NC 🡪 CH3CN 8B. O3 + NO 🡪 O2 + NO2

O3 🡪 O2 + O O3 + O 🡪 2 O2

9A. A proposed mechanism is: C4H9Br 🡪 C4H9+ + Br– (slow)

C4H9+ + H2O 🡪 C4H9OH2+ (fast)

C4H9OH2+ + H2O 🡪 C4H9OH + H3O+ (fast)

i. What are the mechanism’s intermediates?

ii. Write the reaction’s overall balanced equation.

iii. Write the correct rate law, based on the given mechanism.

9B. A proposed mechanism is: A 🡨🡪 2 B (fast, eq)

B + C 🡪 D + E (slow)

B + E 🡪 F (fast)

i. Write the overall equation.

ii. Determine the rate law.

iii. Determine the reaction order of each reactant and the overall reaction order.

ANSWER: 7B. 22 kJ/mol

9C. A proposed mechanism for carbon monoxide reacting with nitrogen 2 NO2 🡪 NO3 + NO (slow)

dioxide to form carbon dioxide and nitrogen monoxide is: NO3 + CO 🡪 NO2 + CO2 (fast)

i. Is this mechanism even possible? Explain.

ii. Write the rate law, based on the given mechanism.

9D. A proposed mechanism is: A + B 🡨🡪 C (fast, eq)

2 C + D 🡪 E (slow)

E 🡪 C + F (fast)

Write the overall equation

and determine the rate law.

9E. The rate law rate = k [H2][NO]2 applies to the reaction 2 H2 + 2 NO 🡪 N2 + 2 H2O

The proposed mechanism: 2 NO 🡨🡪 N2O2 (1)

N2O2 + H2 🡪 N2O + H2O (2)

N2O + H2 🡪 N2 + H2O (3)

Which must be the rate-determining step in this mechanism?

10A. One mechanism for the destruction of ozone O3 + NO 🡪 NO2 + O2 (slow)

in the upper atmosphere is: NO2 + O 🡪 NO + O2 (fast)

Identify the catalyst and the intermediate.

10B. The gaseous decomposition of reactant H was studied **Surface Ea (kJ/mol)**

on two different metal surfaces. Without no catalyst Metal 1 148

at all, the activation energy is 256 kJ/mol. Metal 2 176

i. When the metals are used, is this a case of hetero- or homogeneous catalysis? Explain.

ii. Which surface acts as the better catalyst for this reaction? Explain.