Chemical Kinetics Problem Set

1. Which of the following factors never affects the rate of chemical reactions?

    a. the physical form of the reactant molecules
    b. the presence of a catalyst
    c. irradiation with X-rays
    d. none of the above

2. Which of the following is a *homogeneous* reaction?

    a. $4NH_3$ (g) + $5O_2$ (g) ⟶ $4NO$ (g) + $6H_2O$ (g)

    b. H_2O (g) ⟶ H_2O (l)

    c. Ca (l) + H_2 (g) ⟶ CaH_2 (s)

    d. C (s) + H_2O (g) ⟶ CO (g) + H_2 (g)

3. If the reaction rate is quadrupled by doubling the concentration of a reactant, the order of the reaction with respect to that reactant is:

    a. 1
    b. 2
    c. 4
    d. could not be determined except by experiment

4. In the presence of a catalyst:

    I.   Effective collisions among reactant molecules are more easily attained.
    II. Chemical equilibrium will shift toward the products.
    III. The activation energy for the reaction is lowered.

    a. I
    b. I and III
    c. II and III
    d. I, II, and III

5. Which of the following would be the correct rate expression for this reaction?

    $$2MgO + Si \longrightarrow 2Mg + SiO_2$$

    a. rate = k [MgO] [Si]

    b. rate = k $[MgO]^2$ [Si]

    c. rate = $2k$ [MgO][Si]

    d. impossible to detemine from given information

6. Examine the data table below for the reaction:

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

Trial #	Initial [A]	Initial [B]	Initial Formation Rate of C
1	$2.0 \times 10^{-4}\ M$	$1.0 \times 10^{-2}\ M$	$8.0 \times 10^{-5}\ M\ sec^{-1}$
2	$4.0 \times 10^{-4}\ M$	$2.0 \times 10^{-2}\ M$	$6.4 \times 10^{-4}\ M\ sec^{-1}$
3	$2.0 \times 10^{-4}\ M$	$3.0 \times 10^{-2}\ M$	$2.4 \times 10^{-4}\ M\ sec^{-1}$

Which of the following is the correct rate equation for the reaction?

a. rate $= k\,[A]^2\,[B]^2$

b. rate $= k\,[A][B]$

c. rate $= k\,[A]^2\,[B]$

d. rate $= k\,[A]^2\,[B]^3$

7. The decomposition of N_2O_5 in carbon tetrachloride can be represented:

$$N_2O_5 \longrightarrow 4NO_2 + O_2$$

The reaction rate equation was found to be:

$$(6.9 \times 10^{-4}\ M\ s^{-1})\,[N_2O_5]$$

If we begin with 30 g of N_2O_5 in solution, approximately how much time elapses before only 1 g remains?

a. 5.0×10^3 s
b. 4.0×10^4 s
c. 2.0×10^4 s
d. cannot be determined from given information

8. In general the rate constant is *not* a function of:

a. the activation energy of the reaction
b. reaction temperature
c. concentration of reactants
d. none of the above

The following passage pertains to questions 9-12

Reaction of an alkyl halide with base can proceed by either a substitution or an elimination pathway. The substitution that *tert*-butyl bromide can undergo with base is represented.

$$(CH_3)_3Br + OH^- \longrightarrow (CH_3)_3OH + Br^-$$
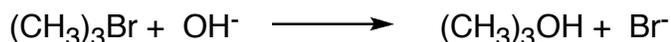
It has been found that the rate of the substitution reaction by which *tert*-butyl bromide is converted to *tert*-butyl alcohol varies directly with the concentration of alkyl halide but does not depend upon the concentration of base.   The rate equation for the reaction is as follows:

$$rate = k\,[(CH_3)_3Br]$$

At right is the energy diagram representing the reaction mechanism. The energy of the stages from from **A** (reactants) to **E** (products) is shown.
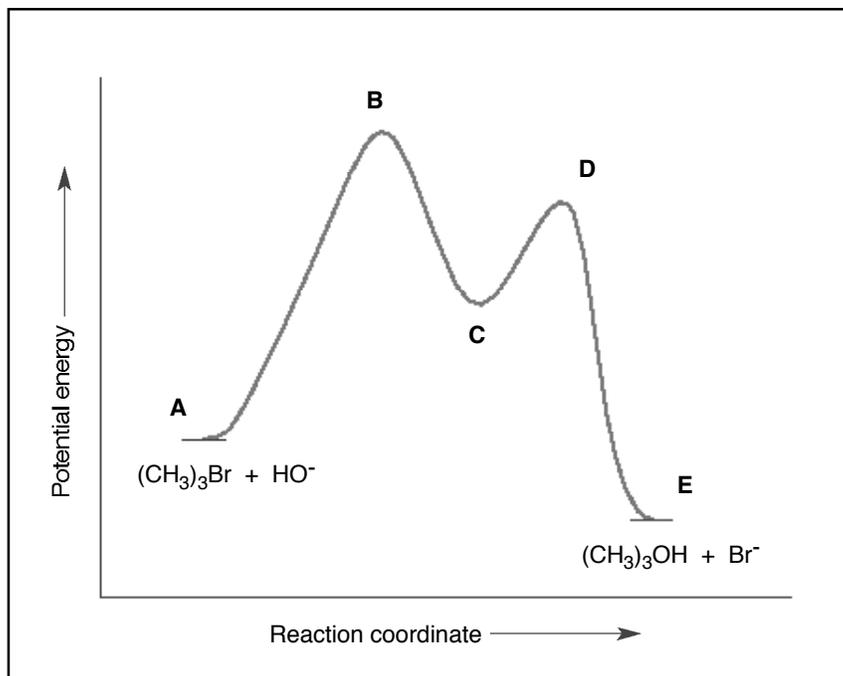
9. Which of the following best describes the reaction of *tert*-butyl bromide to form *tert*-butyl alcohol?

    a. endothermic unimolecular
    b. exothermic unimolecular
    c. endothermic bimolecular
    d. exothermic bimolecular

10. The energy difference between points **A** and **B** represents:

    a. the enthalpy change of the reaction
    b. the activation energy of the reaction
    c. the enthalpy of the intermediate carbocation
    d. more than one of the above

11. Which of the following is the rate determining step in the reaction of *tert*-butyl bromide to form *tert*-butyl alcohol?

    a. formation of the carbocation intermediate
    b. capture of the carbocation intermediate by hydroxide ion
    c. backside displacement of bromide by hydroxide ion
    d. direct displacement of bromide by hydroxide ion

12. If instead of weak base, a strong base is used in reaction with *tert*-butyl bromide, which of the following will occur?

    a. the yield of *tert*-butyl alcohol will decrease
    b. the reaction rate will increase
    c. the reaction rate will decrease
    d. none of the above