Name: _____ Date: _____

Chemistry 30

Rates of Reaction: Chemical Kinetics 50

I. Multiple Choice 20

1. The rate determining step for a complex reaction is the one which is

   A. fastest
   C. slowest
   B. last in the sequence
   D. first in the sequence

2. Which one of the following is **NOT** a key concept of the collision theory:

   A. particles must collide in order to react
   B. particles must move slowly when they collide, otherwise they simply “bounce off” one another
   C. particles must collide with the proper orientation
   D. particles must collide with sufficient energy to reach the activated complex in order to react

3. Which one of the following factors does ***not*** affect the rate of a chemical reaction:

   A. humidity
   C. temperature
   B. concentration
   D. nature of the reactants

4. Activation energy is the amount of energy required to

   A. break the bonds between the reacting molecules
   B. convert the reactants into the activated complex
   C. make the reacting particles collide
   D. form the bonds between the product molecules

5. The rate of a chemical reaction normally

   A. increases as temperature decreases.
   B. decreases when a catalyst is added.
   C. increases as reactant concentration increases.
   D. decreases as reactant concentration increases.

6. Crushing a solid into a powder will increase reaction rate because:

   A. the particles will collide with more energy
   B. the orientation of colliding particles will be improved
   C. the activation energy barrier will be lowered
   D. the powdered form has more surface area.

7. The series of steps that most reactions undergo, from initial reactants to final products, is called the:

A. catalytic conversion
B. entropy of reaction
C. activation energy
D. reaction mechanism

8. Reaction rates generally increase with an increase in temperature. Four suggested reasons are:

I. Molecules collide more frequently at higher temperatures.
II. As the temperature of a reaction increases, the activation energy for the reaction decreases.
III. The concentration of reactants will be greater at a higher temperature.
IV. The fraction of high energy molecules is greater at higher temperatures.

The correct statements are:

A. II and IV only
B. I and IV only
C. I, II and IV only
D. I, III, and IV only

9. A lump of ignited charcoal which is glowing in air burns more vigorously when lowered into a bottle of pure oxygen. This is due to an increase in

A. surface area
B. temperature
C. concentration
D. volume

10. What happens to a catalyst in a reaction?

A. It remains unchanged.
B. It is incorporated into the reactants.
C. It is incorporated into the products.
D. It evaporates.

11. It is generally believed that catalysts increase reaction rates by:

A. removing the activation energy barrier
B. providing an alternate activation energy barrier that is lower than the original barrier
C. lowering the activation energy barrier
D. giving the reacting particles more energy, thus there will be more successful collisions

12. Which one of the following statements concerning rates of reactions is **FALSE**?

A. The higher the activation energy barrier, the faster the reaction.
B. Increasing the concentration of a reactant may increase the rate of a reaction.
C. Adding a catalyst speeds up the rate of reaction for both the forward and reverse reactions.
D. Increasing the concentration increases the rate of a reaction, because it increases the number of collisions.

13. Which of the following reactions is likely to have the fastest reaction rate:

A. $Mg(s) + 2H^{+}(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$

B. $Zn(s) + S(s) \rightarrow ZnS(s)$

C. $2Ag^{+}(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4^{2-}(aq)$

D. $3\ Fe^{2+}(aq) + NO_3^{-}(aq) + 4\ H^{+}(aq) \rightarrow 3\ Fe^{3+}(aq) + NO(g) + 2\ H_2O(l)$

14. In general, an increase in temperature of 10°C will have what effect on reaction rate:

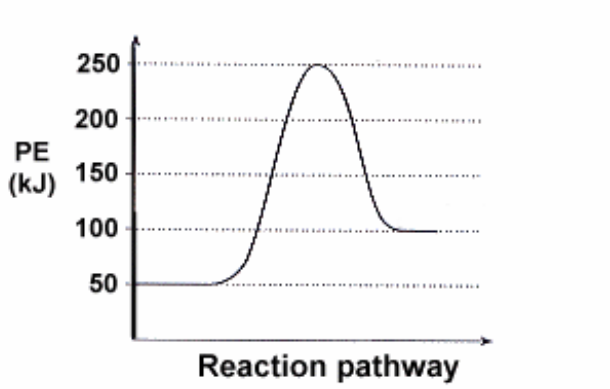
A. double the rate

B. triple the rate

C. half the rate

D. increase the rate but not by a specific amount

USE THE FOLLOWING POTENTIAL ENERGY CURVE FOR QUESTIONS 15 and 16



15. The heat of reaction, ΔH, for the forward reaction is

A. +200 kJC.

B. - 50 kJ

+150 kJ

D. + 50 kJ

16. The activation energy, E_a, for the reverse reaction is

A. + 50 kJ

B. + 200 kJ

C. -150 kJ

D. + 150 kJ

17. Which of the following substances act as catalysts in the body?

A. carbohydrates

B. lipids

C. nucleic acids

D. enzymes

18. The activation energy for the following reaction is 40.8 kcal.

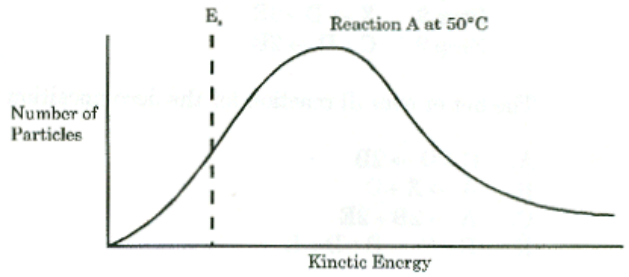
$H_2(g) + I_2(g) \rightarrow 2\ HI(g) + 3.0$ kcal

The activation energy for the reverse reaction is

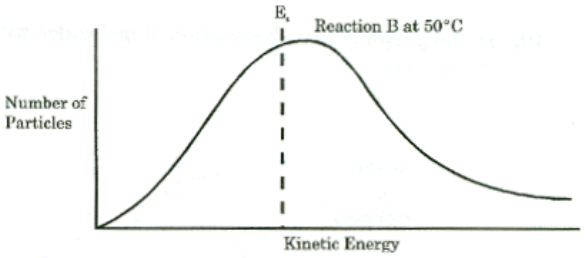
A. 43.8 kcal
B. 40.8 kcal
C. 3.0 kcal
D. 37.8 kcal

19. The following kinetic energy diagrams represent four different reactions, all carried out at 50°C, with different threshold energies (represented by the vertical dashed lines). Which reaction would likely have the fastest rate:

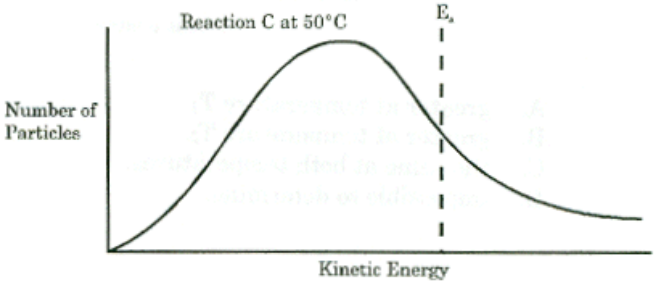
A.



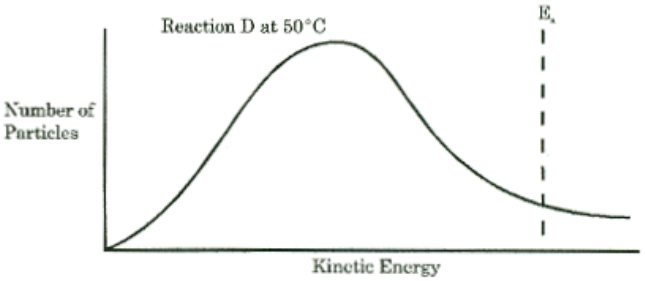
B.



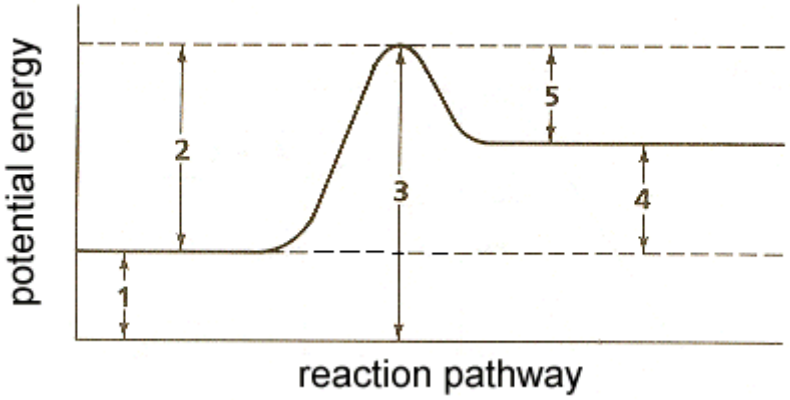
C.



D.



20. Consider the potential energy curve shown below:



The activation energy of the forward reaction is best represented by what number shown on the graph:

A. 2
B. 4
C. 5
D. 3

II. Short Answer 30

1. Use the collision theory to explain why is a lump of sugar satisfactory to use in a hot cup of tea, but granulated sugar is better to use in iced tea.

2

2. A group of educators wish to have the scientist Jane Goodall give a lecture to a group of teachers on the behavior of chimpanzees. One of the educators knows Dr. Goodall personally and goes to an adjacent office to telephone her agent in New York City. The agent has her secretary write a note to Dr. Goodall. The note is typed and faxed to Africa. The fax is placed in an envelope when it is received and given to a messenger who must travel a few kilometres by boat and a few hundred metres on foot before handing the message to Dr. Goodall. The messenger returns to the messenger office with the reply and the process is reversed. Which is the rate-determining step in this process?

2

3. The rate of disappearance of HCl was measured for the following reaction:

$$CH_3OH(aq) + HCl(aq) \rightarrow CH_3Cl(aq) + H_2O(l)$$

The following data was collected:

Time (min)	Concentration [HCl] (M)
0.00	1.85
79.0	1.67
158.0	1.52
316.0	1.30
632.0	1.00

a. Calculate the rate of the reaction for the following time periods:

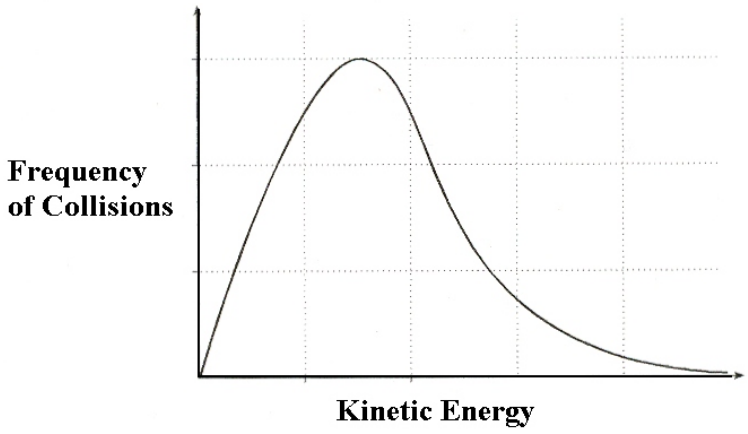
i. for the first 79.0 minutes of the reaction (from time 0.00 to 79.0) **2**

ii. for the last 316 minutes of the reaction (from time 316.0 to 632.0). **2**

b. What happened to the rate of reaction – did it speed up, slow down, or stay the same? Why?

2

4 Consider the following kinetic energy curve for a particular reaction:



On the diagram above, draw a line that would represent the same reaction carried out at a higher temperature. **2**

5. Which of the following three reactions, which one would you predict to be the fastest? Explain. **2**

a. $C_3H_8\,(g) + 5\,O_2\,(g) \rightarrow 3\,CO_2\,(g) + 4\,H_2O\,(l)$

b. $Zn^{2+}\,(aq) + S^{2-}\,(aq) \rightarrow ZnS\,(s)$

c. $Zn\,(s) + S\,(s) \rightarrow ZnS(s)$

6. Consider the following reaction: $3\,NO\,(g) \rightarrow N_2O\,(g) + NO_2\,(g)$

If the rate of production of NO_2 gas is 0.040 mol $\cdot$ $L^{-1} \cdot s^{-1}$, what would be the rate of loss of NO gas?

2

7. The following mechanisms has been proposed for the reaction between chloroform, $CHCl_3$, and chlorine.

   a. Determine the overall equation for this reaction **2**

Step 1:	Cl_2 (g)	$\rightarrow$	2 Cl (g)	**fast**
Step 2:	Cl (g) + $CHCl_3$ (g)	$\rightarrow$	HCl (g) + CCl_3 (g)	**slow**
Step 3:	Cl (g) + CCl_3 (g)	$\rightarrow$	CCl_4 (g)	**fast**
OVERALL:				

   b. Identify the reaction intermediates for the reaction (there are two) **2**

   c. Which step is the rate determining step? **1**

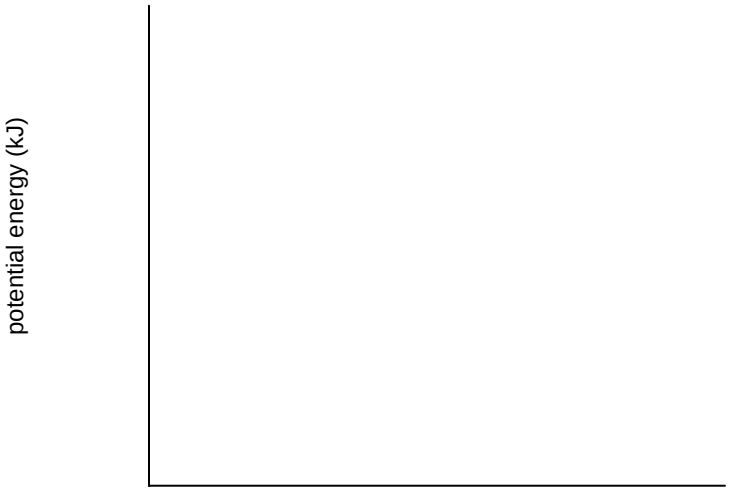
8. Consider the following reaction: **6**

   $2\ C(s) + H_2(g) + 230\ kJ \rightarrow C_2H_2(g)$ $\quad$ E_a for forward reaction = 250 kJ

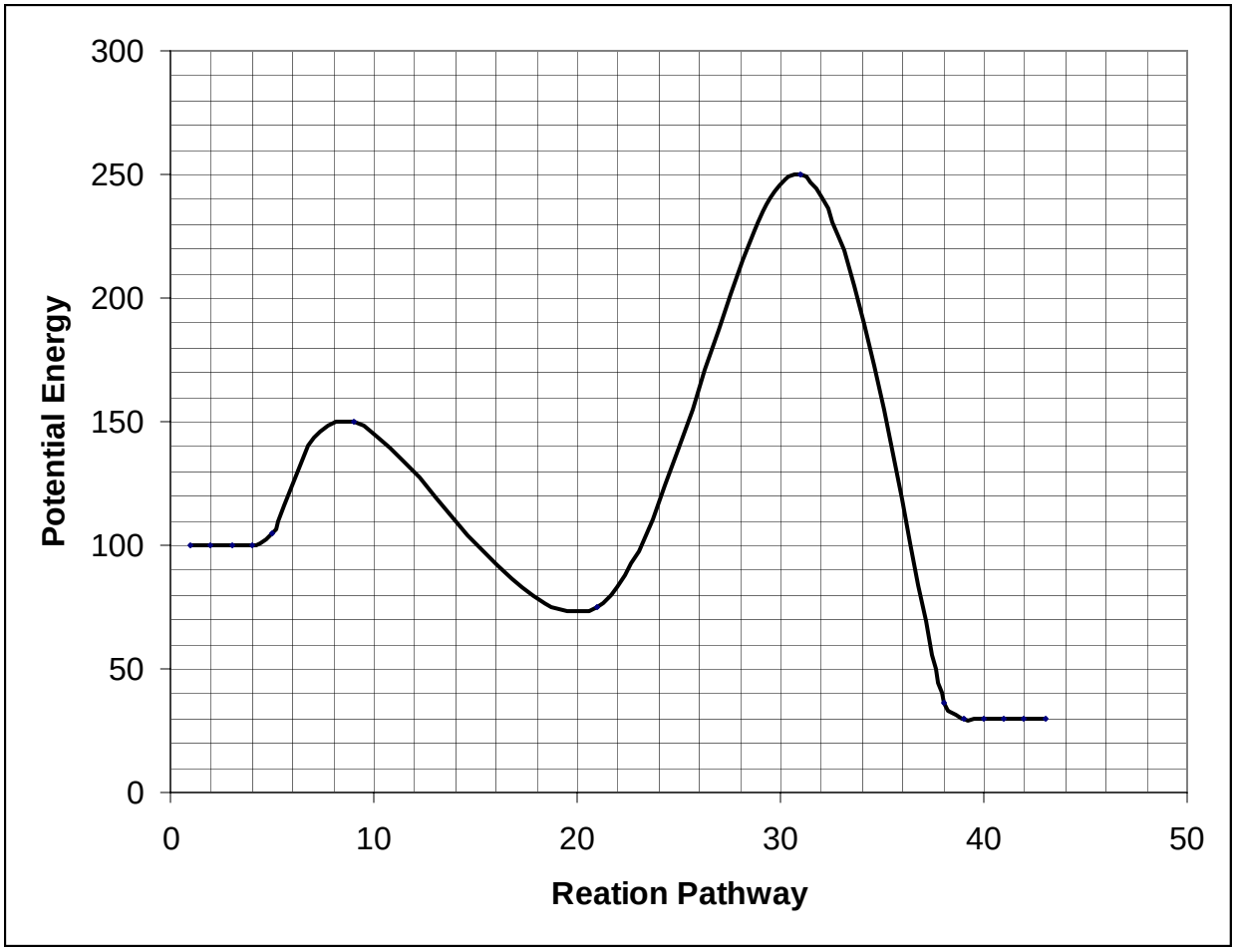
   a. Draw a potential energy curve for the reaction, clearly labeling the following:

      - Indicate a scale on the y-axis with possible values. You do not need to make your graph to scale.
      - Reactants (R), Products (P)
      - Activated Complex (AC)
      - ΔH
      - E_a for the forward reaction

   b. What is the value of E_a for the reverse reaction?



9. Consider the following potential energy curve for a two step reaction:



a. Is the overall reaction endothermic or exothermic? **1**

b. What is ΔH for the overall reaction? **1**

c. What is the activation energy for the rate-determining step for this reaction? **1**