

Multiple-Choice Questions

Circle the letter for the choice that best completes the statement or answers the question.

1. Which phrase does not describe a reaction rate?
 - a) the change of the concentration of a reactant over time
 - b) the change of the number of moles of a reactant over time
 - c) the difference between the concentrations of reactants and products
 - d) the difference between the initial and final concentrations of one reactant over time
2. Which of the following criteria must be satisfied for a collision between two reactant particles to result in a reaction?
 - a) correct orientation of reactants and sufficient collision energy
 - b) sufficient collision energy
 - c) correct orientation of reactant particles
 - d) must be an exothermic reaction
3. The collision energy depends on
 - a) the potential energy stored in the reactants
 - b) the potential energy stored in the products
 - c) the kinetic energy of the reactants
 - d) the kinetic energy of the products
4. Why does a higher temperature increase reaction rate?
 - a) The reaction is more exothermic.
 - b) A larger fraction of molecules have sufficient collision energy to react.
 - c) The molecules have more potential energy.
 - d) Higher temperatures lower activation energy.
5. Why can gasoline be stored safely in a closed container without worry of combustion?
 - a) The reaction is endothermic.
 - b) The gasoline is sealed in an airtight container.
 - c) The statement is incorrect.
 - d) There is insufficient energy to supply the E_a .
6. Which statement about potential energy diagrams is **true**?
 - a) They will not have a high activation energy barrier if the reaction is slow.
 - b) They do not show the transition state.
 - c) They indicate that a reaction is exothermic if the reactants appear lower than the products.
 - d) They will have a low activation energy barrier if the reaction is fast.

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Use the following information to answer questions 7 and 8.

In an aqueous system, ΔH is -40 kJ, and the activation energy of the forward reaction is 30 kJ.

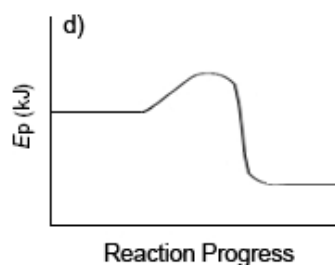
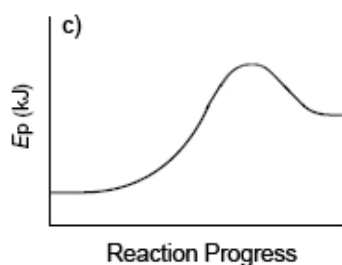
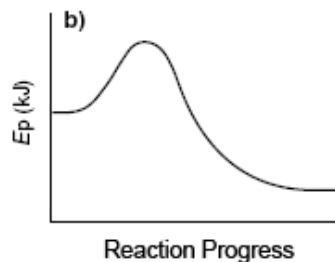
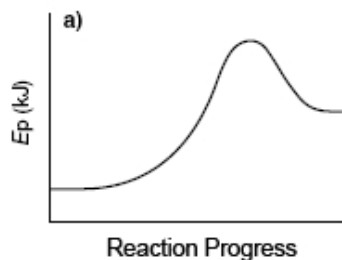
7. What is the activation energy of the reverse reaction?
 - a) 10 kJ
 - b) -10 kJ
 - c) -40 kJ
 - d) 70 kJ
8. What is the enthalpy change for the reverse reaction?
 - a) 10 kJ
 - b) -10 kJ
 - c) 40 kJ
 - d) 70 kJ
9. Which of the following statements about activation energy is **false**?
 - a) Once the activation energy has been supplied, an exothermic reaction is self-sustaining.
 - b) The higher the activation energy, the slower the reaction.
 - c) If collision energy is sufficient, activation energy is reached.
 - d) A reaction that is exothermic in the forward direction will have a smaller activation energy in the forward direction than in reverse.
10. The activated complex is formed
 - a) as reactant bonds are broken when kinetic energy is converted into potential energy
 - b) as reactant bonds are broken when potential energy is converted into kinetic energy
 - c) as product bonds are formed when kinetic energy is converted into potential energy
 - d) as product bonds are formed when potential energy is converted into kinetic energy
11. Which of the following statements about the activated complex is **true**?
 - a) It is highly stable.
 - b) It has partial bonds.
 - c) It can be isolated from a reaction.
 - d) It is the lowest energy species in a reaction.

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12. Which of the following potential energy diagrams most accurately represents a reaction where $\Delta H = 50 \text{ kJ}$ and $E_{a(\text{reverse})} = 30 \text{ kJ}$?



13. A catalyst speeds up the rate of a reaction by
- decreasing ΔH
 - increasing ΔH
 - decreasing E_a
 - increasing E_a
14. A catalyst is
- consumed in a reaction
 - produced in a reaction
 - unchanged during a reaction
 - regenerated at the end of a reaction

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Use the following information to answer question 15.

Chlorofluorocarbons, CFCs, were commonly used as aerosols and in refrigeration and are known to catalyze the decomposition of ozone in the stratosphere. Although CFCs are no longer being manufactured in North America and are being phased out worldwide, their catalytic effect is expected to continue for many years.

15. Which property of a catalyst is described in the passage above?
- Only a small amount of a catalyst is required.
 - Catalysts reduce activation energy.
 - Catalysts speed up reactions.
 - Catalysts are long-acting.
16. Which of the following emissions is not reduced by the use of a catalytic converter?
- CO(g)
 - CO₂(g)
 - NO₂(g)
 - NO(g)
17. Which of the following statements about enzymes is/are true?
- I** Enzymes can be activated and deactivated.
II Enzymes are small molecules.
III Enzymes are found in living systems.
IV Enzymes work only at high temperatures.
- III only
 - I and III only
 - I, II, and III
 - I, II, III, and IV

Numerical Response Questions

Record the answer to each numerical response question as indicated.

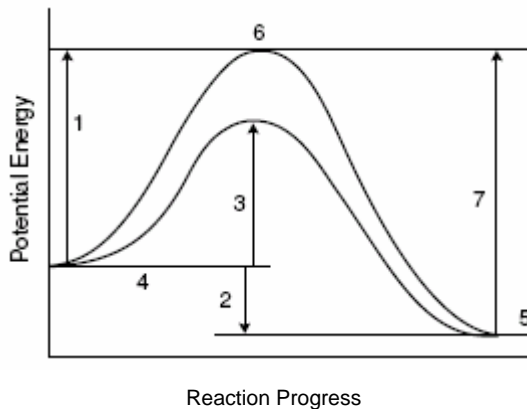
18. Insert numbers in the blanks below to indicate the order of the occurrence of the following steps in a reaction.
- ___ potential energy is converted into kinetic energy
 - ___ kinetic energy is converted into potential energy
 - ___ the activated complex is formed
 - ___ molecules collide

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Use the following diagram to answer question 19.



19. Identify the number in the diagram that indicates where the label for each of the following would be placed.

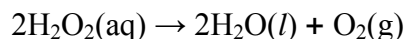
- ___ $\Delta H_{\text{forward}}$
 ___ $E_{\text{a(reverse)}}$
 ___ activated complex
 ___ $E_{\text{a(forward/catalyzed)}}$

20. If $\Delta H_{\text{forward}}$ is -230 kJ and the activation energy of the forward reaction is 150 kJ, what is the activation energy of the reverse reaction?

Written Response Questions

Answer each question in the space provided. Use complete sentences and diagrams (with labels) when necessary.

21. Catalase is an enzyme that catalyzes the decomposition of hydrogen peroxide, $\text{H}_2\text{O}_2(\text{aq})$, as shown below.



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In designing an experiment to measure the effect of temperature on catalytic action of catalase on this reaction, what variables would you control?

22. Examine the diagram below that shows the number of molecules that have energy greater than the E_a and will react at a temperature T_1 . At a higher temperature, T_2 , three times this number of molecules have an energy greater than the E_a . On this diagram, sketch the line to show the distribution of molecules at T_2 .

