

1. Heat flows from the paraffin to the surroundings. The change is exothermic.
2. Heat is flows from the surroundings to the chemicals, which are absorbing heat. Then change is endothermic.
5. Heat always flows from higher temperature to lower temperature between two objects.
6. Endothermic processes absorb heat from the surroundings, exothermic processes release heat to the surroundings.
7. The joule or the calorie.
42. 1 Calorie is 1,000 calories, or 1 Calorie is a kilocalorie.
47. a. condensing steam – exothermic                      b. evaporating alcohol – endothermic  
c. burning alcohol – exothermic                      d. baking a potato - endothermic
62. Substance B has the higher specific heat. Substances with higher specific heats change temperature the least when energy is absorbed.
  
3. +2.0 J/g°C
4. +1,800 J or 430 cal
9. +1,760 cal or +7,360 J
11. +280 kJ
13. -146 J
77. a. -150 kJ      b. +150 kJ      c. no heat was lost to the surroundings, that you had a perfectly closed system.
  
14. +6.63 kJ      15. -89.4 kJ      19. -372 kJ      73. -238 kJ
18.  $2 \text{ Mg}_{(s)} + \text{O}_{2(g)} \text{ ----> } 2 \text{ MgO}_{(s)} + 1204 \text{ kJ}$
21. +3.34 kJ      22. 1.20 grams ice      23. +1.44 kJ      24. +0.19 kJ
71. +23.6 kJ
  
25. -301 kJ      26. 3.42 mol  $\text{NH}_4\text{NO}_{3(s)}$       55. c. -556 kJ
35. -845.6 kJ      59. +30.2 kJ      66. -749.8 kJ      74. +180 kJ
81. -1207 kJ      84. -137 kJ
  
32. a. -30.91 kJ      b. +178.4 kJ      c. -113.0 kJ      37. -196.0 kJ
67. a. -890.24 kJ      b. -556.0 kJ      69. c. -904.6 kJ
  
2. Temperature, concentration, particle size, and catalysts.
4. No, the particles involved in the collision have to have the right orientation and enough energy for an effective collision.
5. The low temperature in the refrigerator slows down the decomposition of the food by bacteria.
44. Reactant particles have to have enough energy to reach activation energy (get over the wall) before the products of a reaction can be formed.
45. The rate of a reaction is increased by a catalyst. Catalysts lower activation energy, making it easier for reactants to have an effective collision or providing another reaction mechanism.
70. Activation energy for the reverse reaction is +25 kJ. ( $\Delta H$  for reverse reaction is +20 kJ)

1. -40 kJ. Exothermic
2. +20 kJ
3.  $A + B \rightarrow X + Y + 40 \text{ kJ}$
4.  $+40 \text{ kJ } X + Y + 40 \text{ kJ} \rightarrow A + B$
5. +60 kJ
6. Unstable, high energy intermediate formed in a chemical reaction.
7. There are more collision, and more collisions means a faster reaction.
8. Increases reaction rate, particles are moving faster, there are more and more energetic collisions.
9. Coal dust burns faster because there is more surface area.
10. a. The second reaction is faster because there are just a few weak ionic bonds to break. The first reaction has a lot of strong covalent bonds to break.  
b. No, even simple reactions occur in more than one step.
11. Catalysts lower activation energy.
12. Catalysts have no effect on heat of reaction.
13. Catalysts speed up a reaction.
  
30. An increase entropy favors a spontaneous process, a decrease entropy does not favor a spontaneous process.
31. The energy (enthalpy) change (First Law) and the entropy change (Second Law) together determine whether a change is spontaneous.
32. Negative  $\Delta G$
33. Released free energy is released to the environment in the form of heat. Lost heat hardly ever serves a useful function. (Exception – heating buildings)
34. Unfavorable
35. A certain temperature can make a nonspontaneous process become spontaneous. (Pressure can also have an effect but we did not consider this)
60. a. 50 mL of ice has lower entropy  
b. 10 g of NaCl crystals has lower entropy
62. No. Endothermic process can be spontaneous if there is a favorable (positive) entropy change and high temperatures.
63. The change in energy is favorable enough to make this spontaneous as long as the temperature is low enough (below the boiling point)
64. The change in energy (enthalpy) ( $\Delta H$ ) and the change in entropy ( $\Delta S$ ).
69. a. can't tell from this information alone  
b. can't tell from this information alone  
c. this means a  $-\Delta G$  and a spontaneous process