Heat – Unit Practice Problems – Solutions

Heat and Temperature

1. Pretend you are doing a scientific study on the planet Earth.
   a. Name three things in the system you are studying. *Animals, plants, atmosphere, Earth's core, etc.*
   b. What is the surroundings? *Space outside of the Earth's atmosphere*
   c. Explain if Earth is an open system, a closed system or an isolated system. *Earth is an open system, since both matter and energy are able to pass into and out of our atmosphere.*
2. Distinguish between kinetic and potential energy in the following examples: two separated magnets *potential*; an avalanche of snow *kinetic*; temperature *kinetic*, books on library shelves *potential*; a mountain stream *kinetic*; a stock car race *kinetic*; separation of charge in a battery *potential*, chemical bonds *potential*.
3. *All of the energy that passes out of the steel enters into the water. The steel acts as the system and the water acts as the surroundings. Because the system is isolated, all of the energy is contained within the steel and water, so there is nowhere else for it to go other than between those two things.*
4. *Solid molecules are lower energy and are fixed in place, although vibrating and rotating within those confines. Liquid molecules have a higher amount of energy, are slightly further apart (although still loosely bonded), so they can move around more easily. Gas molecules are high energy and have very little interaction with each other, so they move very quickly and without restraint.*
5. *The transfer of heat (energy) is dependent on a temperature difference between two substances (between system and surroundings). Heat flows from high temperature to low temperature.*

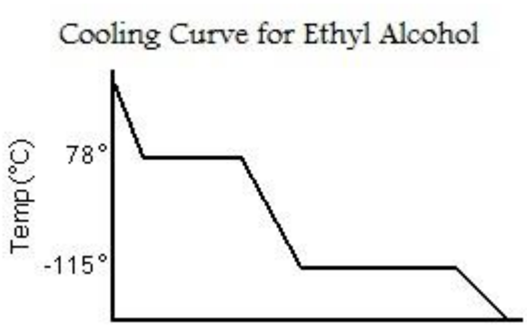
Specific Heat Capacity

6. *Another liquid could be used, but it would probably be less effective than water. The benefit of water is that it has a very high specific heat capacity, so it holds the heat longer and minimizes error in the experiment by minimizing heat loss.*
7. *Iron would feel hotter. It has a lower specific heat capacity, which means it takes less energy to heat it up. So, since we are assuming they have been in the sun for the same amount of time (and both received the same amount of solar energy), the temperature of the iron will rise more than the aluminum.*
8. *The ocean stores energy from the sun. It takes a long time for the heat to be released from the ocean, even when the sun is not shining as long during the day (in the winter). This means that it is always releasing some amount of heat, which means it never gets quite as cold.*
9. $q = 2660\ J$
10. $q = -8.30\ kJ$
11. $q = c\Delta T = 3517\ J$
12. $c = 0.71\ J/g{\cdot}°C$
13. $q = -33\ kJ$
14. $c = 0.972\ J/g{\cdot}°C$
15. $V = 28.2\ mL$
16. $T_f = 27.7°C$

Phase Changes

17. *They are breaking or forming the intermolecular bonds (spreading apart or bonding together)*
18. *The molecules are gaining or losing energy to make them move faster or slower (changing temperature = changing kinetic energy)*
19. *They are the flat lines in between the curved/sloped lines. Melting is at a lower temperature than boiling.*

20. *Graph*
    a. *I*
    b. *V*
    c. *II*
    d. *5°C*
    e. *55°C*
    f. *I, III, V*
    g. *II, IV*
    h. *-15°C*
    i. *80°C*
21. *When water is boiling, it stays at a constant temperature (100°C) until it has all evaporated, so boiling it for longer will not increase the temperature.*
22. *Cooling curve*



Latent Heat

23. *Vaporization takes more energy. This is because, when going from a liquid to a gas, all of the intermolecular bonds (bonds between molecules) must be broken. This takes significantly more energy than just allowing bonds to become more flexible, as is the case for going from a solid to a liquid.*
24. *q = 66.1 kJ*
25. *q = 67 J*
26. q_f *= 83.4 kJ* *q = 104.6 kJ* q_v *= 564.3 kJ* *total q = 752.3 kJ*
27. *copper, since it needs less energy to melt (lower* L_f*)*
28. *a. q = 647.9 kJ* b. *t = 720 s*
29. *t = 42.5 s*
30. $q_1 = -59.0$ *kJ* $q_2 = -187.0$ *kJ* $q_3 = -3.6$ *kJ* *total q = -249.6 kJ*

Thermochemical Equations and Enthalpy

31. *Balanced chemical equation, states, enthalpy change*
32. $CH_3COOH\ (aq) + 2\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 2\ H_2O\ (g)$ $\Delta H = -871$ kJ
33. $2\ Al_2O_3\ (s) \rightarrow 4\ Al\ (s) + 3\ O_2\ (g)$ $\Delta H = 332$ kJ
34. *When…*
    a. $2\ Mg\ (s) + O_2\ (g) \rightarrow MgO\ (s)$ $\Delta H = -1204$ kJ
    b. *q = -64 kJ*
    c. *m = 3.21 g*
35. *Baking soda…*
    a. *+129 kJ*
    b. *q = 7.68 kJ*

Heat of Solution

36. *When solid sodium…*
    a. $NaOH\ (s) \rightarrow Na^+\ (aq) + OH^-\ (aq)$ $\Delta H = -445$ kJ/mol

   b. $q = -334\ kJ$
37. *10.2 g of…*
   a. $KClO_3\ (s) \rightarrow K^+\ (aq) + ClO_3^-\ (aq)$ $\Delta H = 42\ kJ/mol$
   b. $q = 3.50\ kJ$
   c. $-12.9°C$
38. $T = 0.0017°C$
39. $m = 28.0\ g$
40. *a.* $\Delta H = -39.4\ kJ/mol$ *b. heat loss to environment/calorimeter, assumption that density and specific heat are the same as water (may be slightly different), assumption that solid dissolves completely, assumption that temperature is finished changing*