Change of State Calculations

Earlier in this unit, we learned that when you have a change in temperature you can calculate the heat absorbed or released using the equation $q = mcΔT$. ($q$=heat in joules, $m$=mass in grams, $c$=specific heat of the object in J/g•°C, and $T$=temperature in °C).

You can also calculate the heat absorbed or released when a phase change occurs. For a change from solid to liquid, heat can be calculated using $q = nΔH_f$ (n = number of moles and $ΔH_f$ = heat of fusion in kj/mol). For a change from liquid to gas, heat can be calculated using $q = nΔH_v$ (n = number of moles and $ΔH_v$ = heat of vaporization in kj/mol).

| The specific heat of liquid water is 4.184 J/g•°C. The specific heat of solid ice is 2.09 J/g•°C. The specific heat of steam is 1.84 J/g•°C. The heat of fusion of water is 6.01 kJ/mol. The heat of vaporization of water is 40.67 kJ/mol. |

1. How many joules are required to heat 250 grams of liquid water from 0°C to 100°C?

2. How many joules are required to melt 100 g of water? How many joules are required to boil 150 grams of water?

3. How many joules are required to heat 200 grams of water from 25°C to 125°C?

4. How many joules are given off when 120 grams of water are cooled from 25°C to -25°C?

5. How many joules are required to heat 75 grams of water from -85°C to 185?

6. How many joules are released when 450 grams of water are cooled from $4 \times 10^{7}$° (the hottest temperature ever achieved by humans) to $1 \times 10^{9}$°C (the coldest temperature ever achieved).
7. How many joules are required to raise the temperature of 100 grams of water from -269°C (the current temperature of space) to 1.6 x 10^{15}°C (the estimated temperature of space immediately after the big bang)?

8. Calculate the heat needed to change 3.00 x 10^2 grams of water at 25.0°C to steam at 100.0°C.

9. Calculate the heat needed to change 75.0 grams of ice at -40.0°C to water at 20.0°C.

10. Calculate the heat released when 454 grams of steam at 100.0°C condenses and then cools to water at 30.0°C.

11. Calculate the heat needed to change 475 grams of water at 40.0°C to steam at 100.0°C.

12. Calculate the heat needed to change 2.50 x 10^2 of ice at 0.0°C to steam at 100.0°C.

13. How much heat is needed to change 3.00 x 10^2 g of ice at -30.0°C to steam at 130.0°C?

14. How much heat is removed from 60.0 g of steam at 100.0°C to change it to 60.0 g of water at 20.0°C?