Energy (nrg)

How energy changes the physical state of matter & energy involved in chemical Δ

Energy

- Energy is measured in CALORIES and JOULES
- Calories(cal)
  - The amount of nrg required to raise 1.0 gram of water 1.0 ^{o}C
  - Kilocalories are often used, 1000cal = 1.0 kcal
  - kcal are use in diet, one dietary cal really is a kcal
- Joule (J)
  - is the SI unit and is based on work
  - Joule equals f x d = N m = J
  - Kilojoules (kJ) are commonly used
- Conversion factor 4.18 J = 1 cal

Energy Calculations

- As you will recall, temperature is a measure of the average kinetic energy (Maxwell distribution)
- So if temperature changes the energy must have changed.
- The amount of energy is also dependent on mass of material (more mass more energy)
- The third factor is something called specific heat. This needs its own slide to explain.

Specific Heat (C)

- Definition: the amount of heat necessary to move 1.00 gram of a substance 1.00 °C
- Unit of specific heat (C) are cal/g ^{o}C or
  J/g ^{o}C
- Like density, specific heat is an intensive physical property, every substance has a unique specific heat.
- Metals have low C and heat up quickly, water has a high C and stores energy well.

Specific heat table

Material	Specific Heat cal/g° C
Brass	0.09
Iron	0.11
Nickel	0.106
Water	1.0
Aluminum	0.217
Lead	0.0305

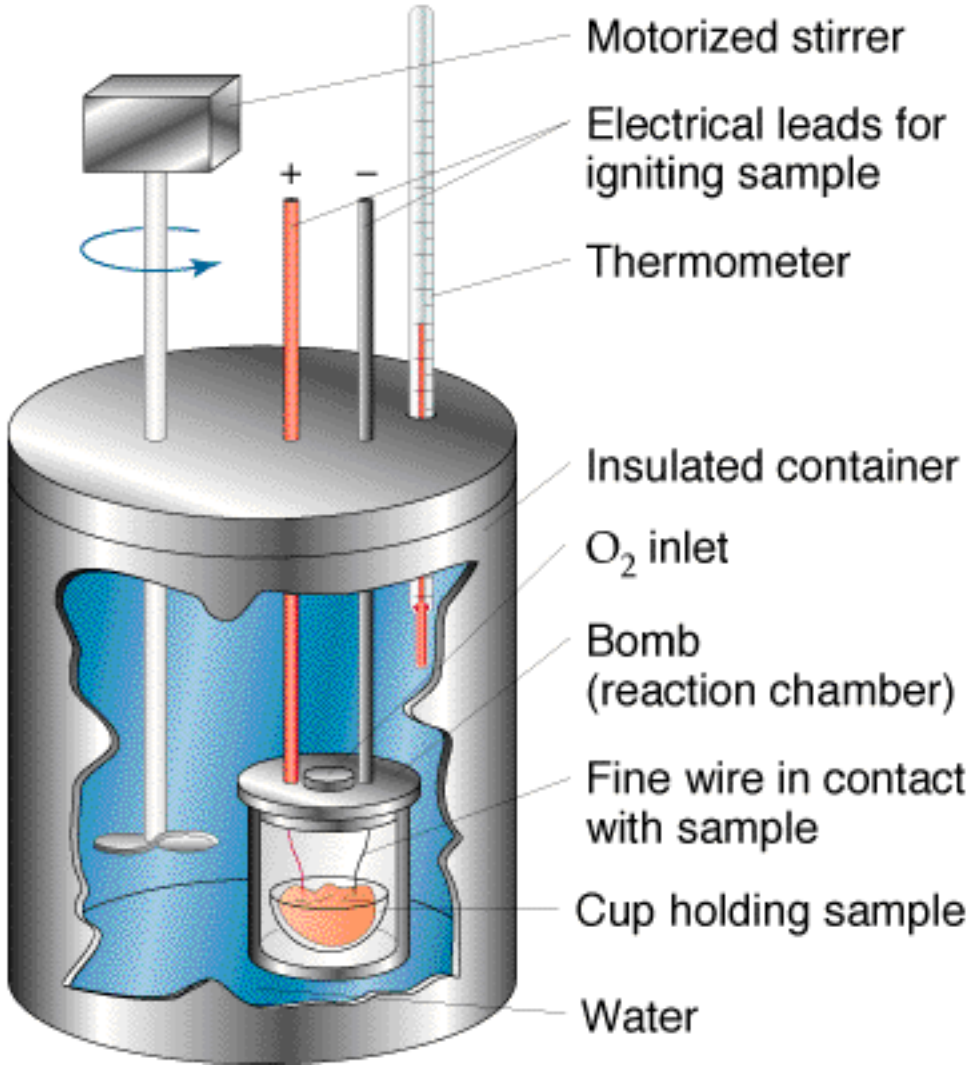
And now some MATH. This is called Calorimetry

The basic equation

$$Q = cm\Delta T$$

Q: heat added
c: specific heat
m: mass
ΔT: change in temperature

This a calorimeter use to measure energy change



$$Q = C\ m\ \Delta T$$

Units

$$Cal = \frac{cal}{g\ ^oC} \quad \frac{grams}{1} \quad \frac{^oC}{1}$$

Find the increase in energy if the temperature of 150 mL of water Is increased from 20 ^{o}C to 75 ^{o}C

$$Q = \frac{1.0\ cal}{g\ ^oC} \times \frac{150\ g}{} \times \frac{55\ ^oC}{} = 8250\ cal$$

Now some basic Thermodynamics of chemical Δ

- System
- Surroundings
- Two types of reactions
  - Exothermic, energy leaving the system
  - Endothermic, energy into the system

Homework

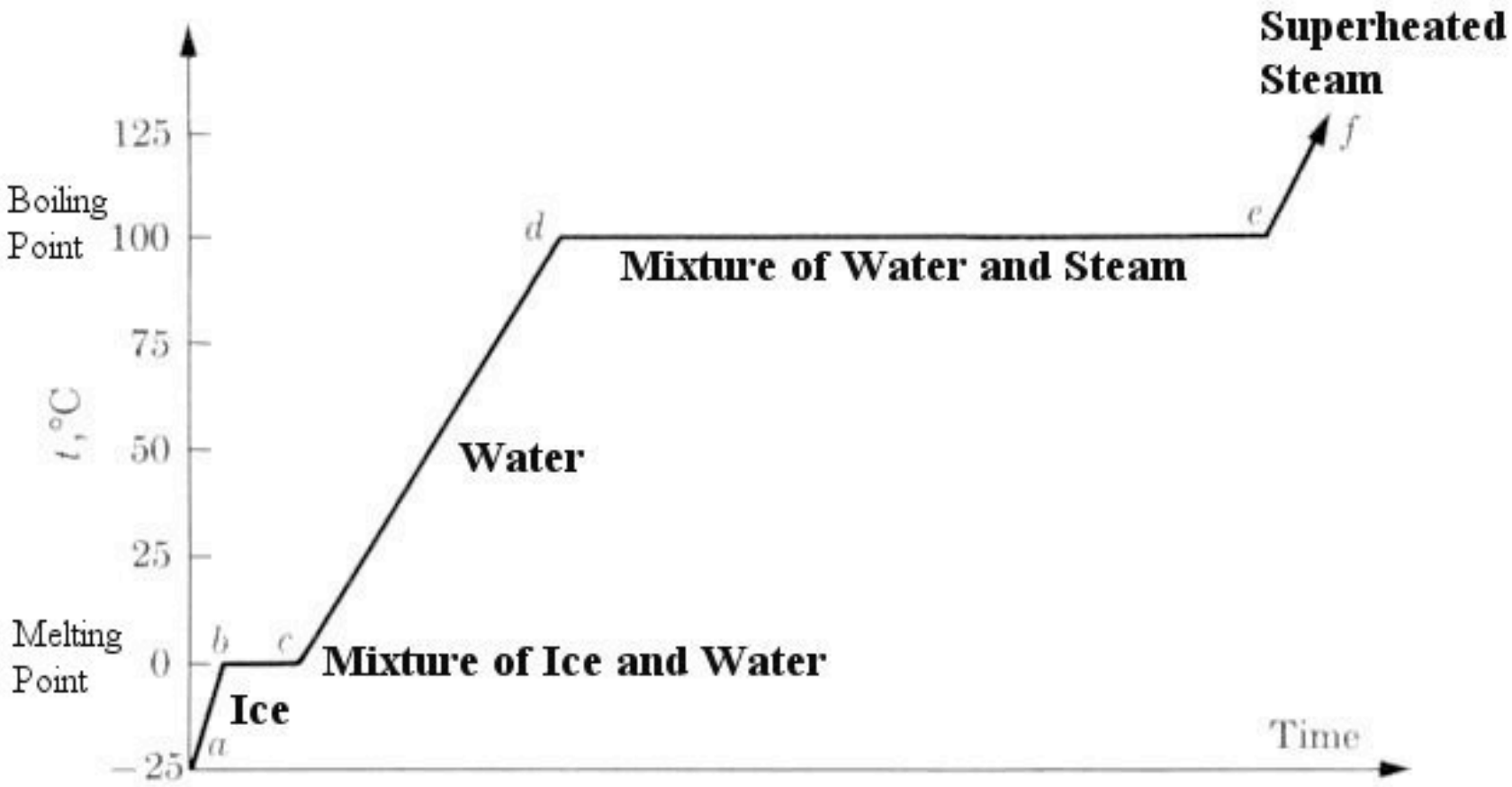
- Reading chapter 11
- Page 299 questions: 6-10

Warm-up question

- Find the change in energy if 15.5 L of water @ 40 ^{o}C drops to a temperature of 26 ^{o}C. Express your answer in kJ. Will the surroundings heat up or cool down during this temperature change?

Energy and physical Δ

- When materials change in energy temperature changes. Faster particles when heating-up, slower particles when cooling.
  - This is kinetic NRG $Q = C\ m\ \Delta T$
- When changing phase the temperature doesn't change? The energy is either lost or gained by the substance
  - This is potential NRG $\Delta H = H_f\ m$ or $\Delta H = H_v\ m$



Phase Change of H_2O

Specific heat

- For water

  C = 1.0 cal/g ^{o}C or 4.18 J/g ^{o}C

- For ice

  C = 0.5 cal/g ^{o}C or 2.1 J/g ^{o}C

- For steam

  C = 0.4 cal/g ^{o}C or 1.7 J/g ^{o}C

Heat of fusion & heat of vaporization

- Water melting or freezing (heat of fusion)

$$H_f = 80 \text{ cal/g} \quad = \quad 334.4 \text{ J/g}$$

- Water, boiling evaporation, condensation (heat of vaporization)

$$H_v = \quad 540 \text{ cal/g} \quad = \quad 2257.2 \text{ J/g}$$

Now, a problem

Find the energy needed to change 100 grams of ice @ -15.0 ^{o}C into super heated steam @120 ^{o}C.

We need 5 individual equations to find all the energy involved. This is easier to show you on the board.

Hint: solving these type of problems is more about being neat & organized, than it is about being too difficult.

- Ice $H = m\ C\ \Delta t$ 100 g 15°C .5 cal/g °C
- Melting $H = H_f\ m$
- Water $H = m\ C\ \Delta t$ 100 g 100 °C 1 cal/g °C
- Vaporization $H = H_v\ m$
- Steam $H = m\ C\ \Delta t$ 100 g 20 °C .4 cal/g °C