.6) Energy and changes: (some silly energy trivia)

- **Energy**: Ability to produce heat or do work. Potential (stored) vs. Kinetic (motion)
  Energy SI derived unit Joule $kg \cdot m^2 / s^2$
  Energy = force x distance (Newton x meter), N·m or
  Newton is defined as mass x acceleration ($kg \cdot m/s^2$)
  Acceleration = m/s^2
- **Measurement Units:** *metric*: 1 calorie = *SI*: 4.184 Joule
  Often kJ is used.
  It requires 4.18J to raise the temperature of 1 gram of water 1ºC
  BTU (British Thermal Unit): Heat required to raise 1 lbs. H_2O 1ºF at water's greatest density (39ºF or 4ºC)
  ~ 1055 J
- **Energy as an extensive property.**
  Energy is conserved in transfers as it converts forms. Energy is transferred in all changes. That is it is either released (Exothermic, negative (-) heat lost) or absorbed (Endothermic (+) heat gained by system.
  Exothermic vs. Endothermic Ex/'s
  Demo: Combustion of gummy-bear (as demo with $KClO_3$)
  Demo: Combustion of ethanol with tesla coil
  Drying clothes in gas dryer
  Melting ice
  Freezing of water
  Burning Coal
  Photosynthesis / cellular respiration
  Other physical or chemical changes

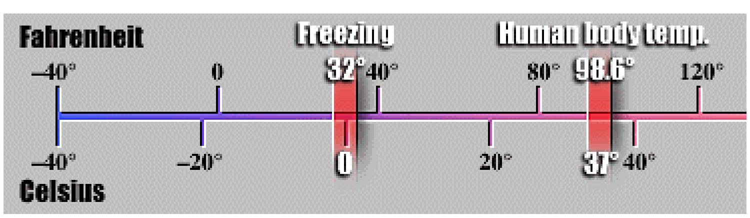
Temperature:
Measure of the average kinetic energy of particles.
At the same temperature all substances have the same average kinetic energy.

Temperature Scale:
No temperature can exist below absolute zero.
Kelvin, absolute zero, all particle motion (kinetic energy) stops.
(note degree symbol missing when stating a Kelvin temperature.)
Celsius 0°C is at 273K where the freezing point of pure water is set. (K=°C + 273)

Temperature	K	ºC	ºF
B.P. H_2O (1 atm)	373.15	100.	212.
F.P. H_2O	273.15	0.	32
Absolute Zero	0	-273.15	-459.67

Note: Kelvin / Celsius scale: same size of temperature change but the zero reference is set differently.

0 K = -273.15 ºC = -459.67°F
or K = ºC = 273 (Kelvin can never be negative!)
and ºC = K – 273
Since 1Δ degree ºC ≠ 1 Δ degree ºF
A change in temperature from B.P. to F.P. in Fahrenheit is 212 – 32 = 180º
A change in temperature from B.P. to F.P. in Celsius is100 - 0 = 100º
Scale differs by 180/100 or 9/5ths
and doesn't share the same 0 reference point, less 32.
Then: degrees F = degrees C x (9/5) + 32.
Degrees C = (degrees F - 32.) x (5/9)

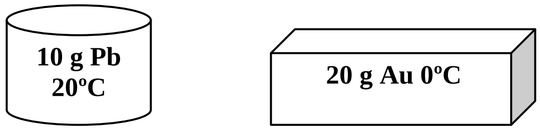


*Note that -40ºF = -40ºC
* The U.S. is the only country that continues to use Fahrenheit.

Perform some practice conversions: Ex. 185 K = _______ºC = _______ ºF

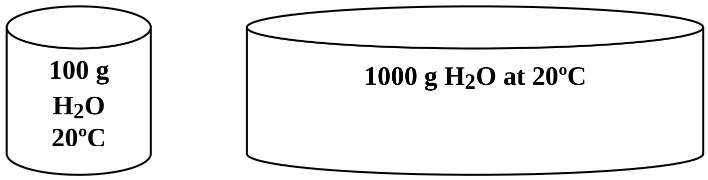
Compare heat and temperature.

Predict the direction of heat transfer with situation below:



Heat transfers due to difference in temperature. High to low. (High K.E. to low K.E.). In this case the heat transfers from the lead to the gold.

Demo: Place 100g of water and 1000g of water on bench.



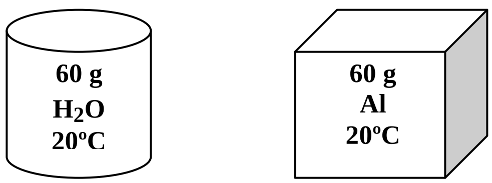
Q1: If each are at same temperature which has the greater kinetic energy? (Both same, all substances at the same temperature have the same average kinetic energy).

Q2: Now, Each drops to 0ºC, whish (gains / releases) more heat? 1000 gram H_2O releases more heat.

Q3: At both 0ºC which has the greater average kinetic energy? (both same)

Heat is energy measured in Joules, temperature is the average kinetic energy measured in ºC (other).

Demo: Equal masses at same temperature of aluminum and water are placed on lab bench.



Q4: Which has the greater average kinetic energy? (both same)

Q5: If each absorbs 1kJ of heat, which has the higher final temperature? (the Al, lower heat capacity)

Specific Heat Capacity (C_p) is defined as the amount of heat energy (Joules) required to raise 1 gram of substance by 1ºC.

Typically metals have (high / low) specific heat capacities? (low)

C_p water = 4.18 Joules/g·ºC = 1 calorie (lower case (c), Note that 1 Food Calorie(C) is equivalent to 4.184 kJ of heat energy)

What factors determine the amount of heat (Q) that is either gained or lost by a substance?

Amount of material	Mass in grams (g)
Type of material	Specific Heat (C_p), Amount of heat required to raise 1g by 1°C
	Cp $H_2O_{(l)}$ = 4.184 J/g·°C (See p.72, Table 3.2)
	Compare ΔT with substances Cp (same mass)
Change in temperature	Change in °C or Kelvin (ΔT), In problems set so that the ΔT will give a positive value.

Derive heat equation, Q:

$$Q = C_p \times m \times \Delta T$$

Units: J = J/g·°C x g x °C

Sample problems: Emphasis on units and sorting data.

Determine amount of heat, change/final temperature, specific heat, or mass in word problem.