Unit 7: Work, Energy and Power

8 – Thermal Energy

Thermal Energy vs. Temperature

Thermal energy (Q): The total amount of Kinetic and potential energy of the particles in an object.

Temperature: The average Kinetic energy of the particles in an object.

Example: which contains more heat – a pot of boiling water or an iceberg?

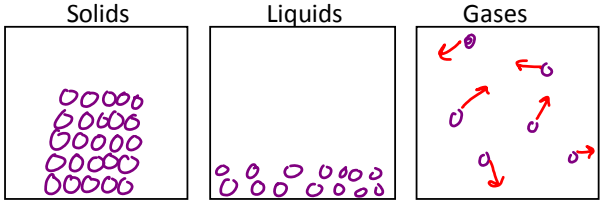
The iceberg!

Why?

So many more particles....

Atoms and molecules are in constant motion:

Solids | Liquids | Gases

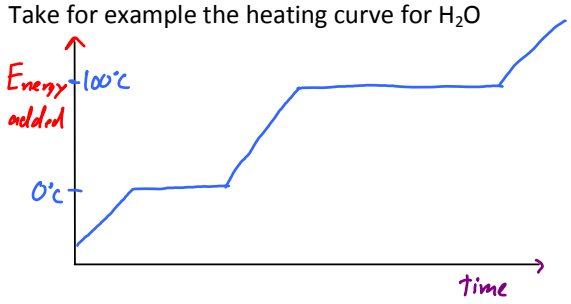


When a material is heated the molecules move faster and as a result it will (generally) expand

If an object is heated it will either

1) Increase Temperature 2) Change state

Take for example the heating curve for H_2O



Heat will always flow from high to low concentration by either

1) Conduction (contact)
2) Convection (movement of fluid)
3) Radiation (no medium required)

Until thermal equilibrium is achieved.

The amount of heat transferred to an object is found with:

$$Q = mc\Delta T$$

Where:

Q = heat (J)

m = mass (kg)

c = Specific heat capacity (J/kg·°C)

ΔT = change in temperature (°C)

Specific Heat Capacity	
Water	4180
Carbon	720
Iron	460
Copper	390
Lead	130

Example:

Mr. Trask makes a cup of coffee by boiling 250 g of water that is initially at 15° C. How much heat is needed?

$Q = mc\Delta T$

$= (0.25\,kg)(4180\,J/kg°C)(100°C - 15°C)$

$= 89\,000\,J$

Example:

A 35 kg child goes down a 3.2 m high slide. The child is initially at rest and moving at 1.8 m/s at the bottom of the slide. If the slide is made of 12 kg of iron and all the heat is transferred into the slide, by how much does the temperature of the slide increase?

$E_{ki}^{0} + E_{pi} = E_{kf} + E_{pf}^{0} + Q$

$E_{pi} = E_{kf} + Q$

$Q = E_{pi} - E_{kf}$

$= mgh_i - \frac{1}{2}mv_f^2$

$= (35\,kg)(9.8\,m/s^2)(3.2\,m) - \frac{1}{2}(35\,kg)(1.8\,m/s)^2$

$= 1041\,J$

$Q = mc\Delta T$

$\Delta T = \frac{Q}{mc}$

$= \frac{1041\,J}{(12\,kg)(460\,J/kg°C)}$

$= 0.19°C$