heating + ~~cooling~~ PROCESSES

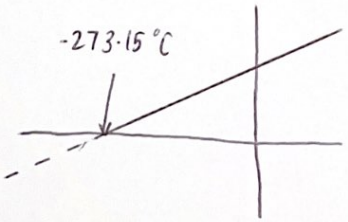
KINETIC PARTICLE MODEL
- particles are in constant motion

SOLIDS
- in a solid, particles must be exerting attractive + repulsive forces/bonds on each other
- the particles are held in fixed positions
- the particles aren't still, they are vibrating around average positions

LIQUIDS
- particles have more freedom to move around
- particles collide but remain attracted to each other; the liquid remains within a fixed volume but with no fixed shape

GASES
- particles are in constant, random motion
- move rapidly in all directions, filling the volume of the container
- the speed of the particles is high enough that when they collide, the attractive forces aren't strong enough to hold them together

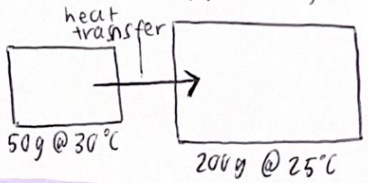
ABSOLUTE ZERO (0K)



- where objects have no kinetic energy
- all gases' temps. will converge at this point

HEAT vs INTERNAL ENERGY vs THERMAL ENERGY

HEAT
- the transfer of energy from one object to another because of a difference in temperature
- it flows from hot → cold
- SI unit: Joules (J)
- it is NOT the energy an object contains



INTERNAL ENERGY
- the sum total of all the kinetic and potential energy of all the particles in an object
- in a gas, the particles are so far apart that the energy is only kinetic (no potential)

THERMAL ENERGY
- the proportion of the internal energy of a system that is responsible for the temperature of the system

TEMPERATURE
- the measure of the degree of hotness of a substance
- the average kinetic energy of the particles

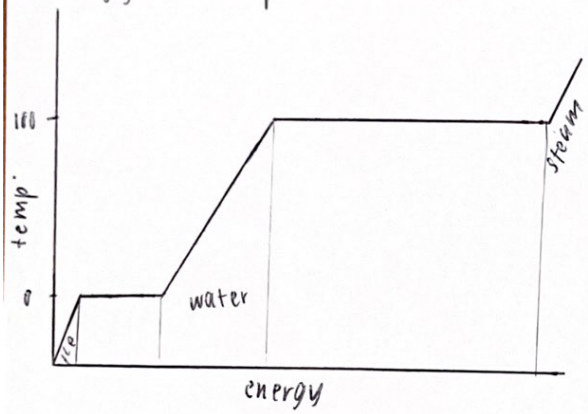
THERMAL EQUILIBRIUM
- 2 objects are said to be in thermal equilibrium when there is no net transfer of heat energy between them
- only occurs when the objects are at the same temperature

KELVIN SCALE - CONVERTING
°C → K -273.15

K → °C +273.15

THE EFFECT OF HEATING A SUBSTANCE

- particles gain kinetic energy & move away from their equilibrium positions
- as particles move apart to change state, the speed of the particles does not change
- there is an increase in potential energy of the particles



SPECIFIC HEAT CAPACITY

- the amount of energy required to increase the temperature of 1kg by one degree celcius (1°C) without change of phase

$$\Delta Q = mc\Delta T$$

- ΔQ: heat energy transferred (J)
- m: mass (kg)
- c: specific heat capacity (J/kg/K)
- ΔT: change in temp. (°C or °K)

the heat lost by the hotter material = the heat gained by the cooler one

assumption: 1L of water = 1kg

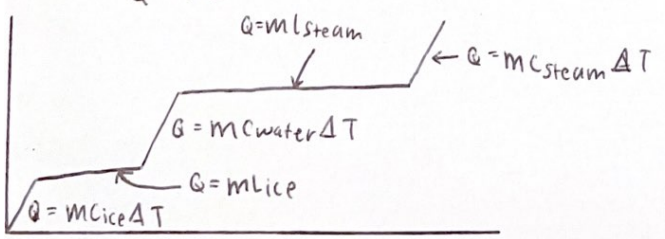
LATENT HEAT

- the energy required to change the state of 1kg of a substance
- symbol: L

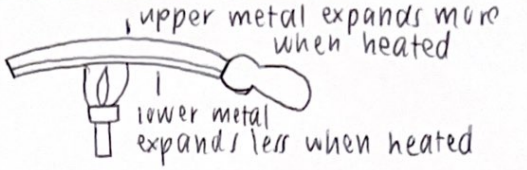
L_f = fusion (melting)

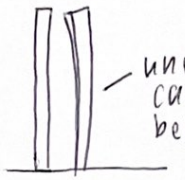
L_v = vaporisation

$$Q = mL$$



THERMAL EXPANSION - THERMOSTATS





SUBSTANCES THAT EXPAND ON FREEZING

- silicon, germanium, water, sterling silver alloys and lead-tin-antimony alloys

CONDUCTORS + INSULATORS OF HEAT

MOLECULAR COLLISIONS

- as one end of a material is heated, the particles move faster + faster
- the particles collide with others and transfer kinetic energy to them
- this makes a 'chain reaction' of collisions
- molecular collisions alone = poor conductors

FREE ELECTRONS

- electrons have a tiny mass compared to atoms
- small energy gain = large gain in velocity
- ∴ heat is transferred very quickly
- in metals, free electrons are mainly responsible for conduction = good conductors

THERMAL CONDUCTORS

- how much energy per second can flow through 1 metre of a material to raise it's temperature by 1K
- solids are better conductors than liquids or gases

THERMAL INSULATORS

- almost all non-metal materials + gases are insulators
- they don't have delocalised electrons

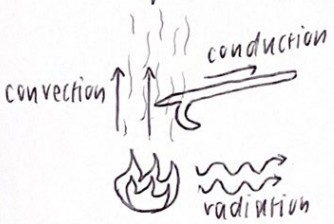
heating & ~~cooling~~ PROCESSES

CONDUCTION, CONVECTION, RADIATION

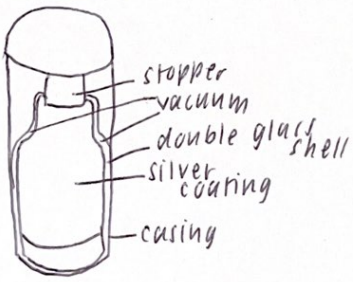
CONDUCTION
- the transfer of energy through a substance by particle collision with no net movement of particles

CONVECTION
- transfer of energy by bulk movement of particles
- the flow of particles away from a warmer to a cooler region produces a convection current
- only occur in fluids (liquid or gas)

RADIATION
- the transfer of energy without a medium
- doesn't involve particles
- all objects emit electromagnetic radiation



DEWAR FLASK



CAR COOLING SYSTEM

liquid cooling:
- circulates a fluid through pipes + passageways in the engine
- as the liquid passes through the hot engine, it absorbs heat + cools the engine
- the fluid then enters a heat exchanger (radiator) which transfers the heat from the fluid to the air blowing through it

air cooling:
- instead of circulating fluid through the engine, the engine block is covered in aluminium fins that conduct the heat away
- a fan forces air over these fins, transferring the heat to the air

car coolant:
- freezes @ well below normal water and stays liquid above 38°
- it has the capacity to hold a lot of heat
- car cooling uses pressure to further raise the boiling point of the coolant

REFRIDGERATORS + AIR CONDITIONERS

- energy is pumped from the cool space to the outside air