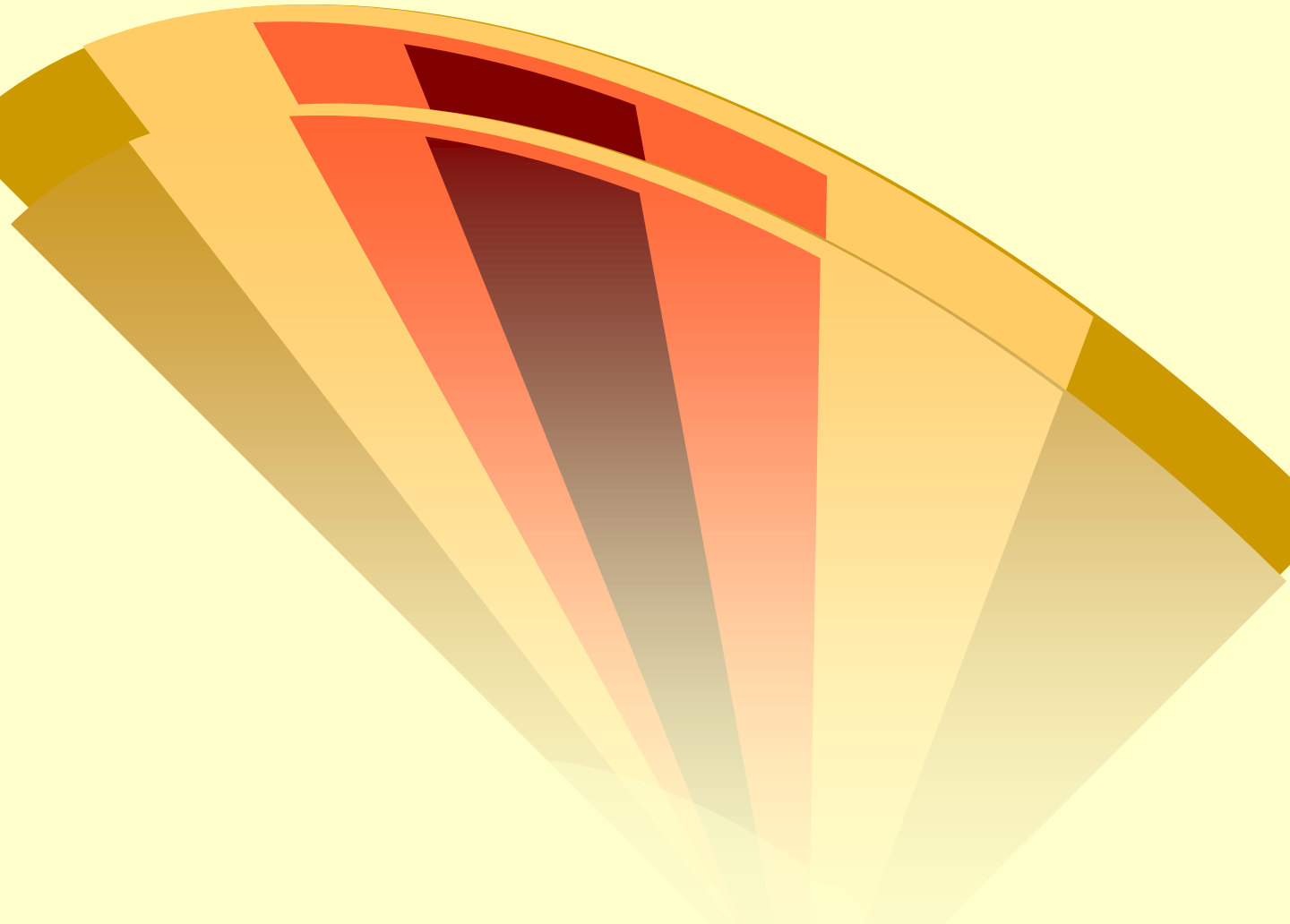

Thermal Physics

Topic 3.1 Thermal Concepts

Temperature

- At a macroscopic level, temperature is the degree of hotness or coldness of a body as measured by a thermometer
- Temperature is a property that determines the direction of thermal energy transfer between two bodies in contact
- Temperature is measured in degrees Celsius (ºC) or Kelvin (K)
  - Where Temp in K = Temp in ºC + 273
  - Temp in K is known as the absolute temperature

Thermal Equilibrium

- When 2 bodies are placed in contact
- Heat will flow from the warmer body to the colder body
- Until the two objects reach the same temperature
- They will then be in *Thermal Equilibrium*
- This is how a thermometer works

Thermometers

- A temperature scale is constructed by taking two fixed, reproducible temperatures
- The upper fixed point is the boiling point of *pure* water at *atmospheric pressure*
- The lower fixed point is the melting point of *pure* ice at *atmospheric pressure*

- These were then given the values of 100 ºC and 0 ºC respectively, and the scale between them was divided by 100 to give individual degrees

Temperature - Microscopic

- At a microscopic level, temperature is regarded as a measure of the **average kinetic energy per molecule** associated with its movement ***in the substance***

Internal Energy

- The Internal (thermal) energy of a body is the **total** energy associated with the **thermal motions** of the particles
- It can comprise of both kinetic and potential energies associated with particle motion
- Kinetic energy arises from the translational and rotational motions
- Potential energy arises from the forces between the molecules

Heat

- The term **heat** represents energy transfer due to a temperature difference
- Occurs from higher to lower temperature regions

Methods of Heat Transfer

- Heat can be transferred from one body to another by
  - Conduction
  - Convection
  - Radiation

Thermal Conduction

- The process in which a temperature difference causes the transfer of energy from the hotter region of the body to the colder region by particle collision **without** there being any **net movement** of the substance itself

- The vibration is passed from one particle to the next

Thermal Convection

- The process by which a temperature difference causes the **mass movement** of **fluid particles** from areas of high thermal energy to areas of low thermal energy (the colder region)

Thermal Radiation

- Is energy produced by a source because of its temperature that travels as **electromagnetic waves**
- It does not need the presence of matter for its transfer

How Does Conduction Happen?

- Conduction can occur in solids, liquids and gases
- In gases it is very slow as the particles are very far apart
- In Liquids the process is also very slow because the particles have a large relative mass and the increase in vibration is rather small

And in Solids

- Most solids behave in a similar way to liquids, and the increase in KE is small
- However, in solids with free electrons i.e. metals
- The electrons gain energy due to the temperature rise and their speeds increase much more than those held in the fixed positions - this is why metals are good conductors of heat

Convection?

- Particles in a region of high thermal energy are further apart (the hot area expands)
- Hence their density is lower
- The less dense region rises as they are pushed out of the way by the more dense region
- Convection currents are produced

Thermal Radiation?

- Mainly in the Infra-red region of the electromagnetic spectrum
- Dull, dark bodies are better absorbers **and** radiators than transparent or light, shiny bodies (these reflect the radiation)

Thermal Properties of Gases

- Investigations involved the measurement of
  - Pressure
  - Volume
  - Temperature
- These experiments used these macroscopic properties of a gas to formulate a number of gas laws

Physics Lab

Units

- Temperature is always measured in K
- Volume is usually in m^3
- Pressure can be different units as long as you are consistent
- But 1 atm = 1.01×10^5 Nm^{-2}
  = 101.3 kPa
  = 760 mmHg

The Mole

- The mole is the amount of substance which contains the same number of elementary entities as there are in 12 grams of carbon-12
- Experiments show that this is 6.02×10^{23} particles
- A value denoted by N_A and called the Avogadro Constant (units mol^{-1})

Molar Mass

- Molar mass is the mass of one mole of the substance
- SI units are kg mol^{-1}

Example

- Molar mass of Oxygen gas is 32×10^{-3} kg mol^{-1}
- If I have 20g of Oxygen, how many moles do I have and how many molecules?
- 20×10^{-3} kg / 32×10^{-3} kg mol^{-1}
- ∴ 0.625 mol
- ∴ 0.625 mol x 6.02×10^{23} molecules
- ∴ 3.7625×10^{23} molecules