# Topic 8 – Heat

Specific heat capacity (c) - E required to raise t of 1 kg substance by 1 K

Specific latent heat (L) - E required to change state of 1 kg substance at constant t

## Molecule speeds

mean of sum of squares of speeds of individual molecules

* The equation shows that for **same T**, the **average KE per molecule** is the same for any molecules (so heavier = slower)
* Potential energy changes during change of state. **T is constant** for this state
* Internal energy =
* **Rate of E transfer to surroundings** affect **T-t** curve

Why does increasing temperature increase the pressure?

1. Atoms moves faster
2. More frequent collisions
3. State variables that are unchanged
4. is greater
5. Larger force on walls

## Ideal gas equation

Internal energy of the gas:

* Use to answer MC questions

**Assumption that molecules behave as ideal gas such that:**

1. Negligible size
2. Identical
3. Exert no force on each other except during collisions
4. Random motion

* **Molecules in ideal gas has no PE**

# Topic 9 – Nuclear physics

## Particle interactions

|  |  |  |  |
| --- | --- | --- | --- |
| **Particle** | **General equation** | **Trend of prop.** | **Penetrating power** |
| Alpha |  | 1. Ionization 2. Range 3. Penetrating power | Stopped by paper |
| Beta |  | Stopped by few mm Aluminum |
| Gamma |  | Reduced by few mm Lead |

Activity - The rate of decay of (unstable) nuclei

Random decay - We cannot predict which nucleus will decay next

Half life - The average time taken for the activity to halve

Binding energy - E required to split the nucleus up into its separate nucleons

Show half-life equals…

* Read from graph at least 2 half-lives

Why can’t use activity to determine age

* Time scale too long
* Activity

### Measuring count rates

Count rates is the number of particles that reach the detector per time

* Background radiation increases reading

*Measure background radiation for subtraction before source in position for long durations of time*

* Longer time reduces uncertain of decay’s random nature

## Fusion & fission

Why does fission release energy?

* mass of products less than initial mass

Why does the fragments of a fission move away from each other?

* Initial momentum is 0
* Momentum must be conserved

### Binding energy

### Binding energy per nucleon graph

Fe is the most stable element as smallest

Why nuclear fission is only possible for massive nuclei?

* Splitting of massive nucleus
* Splitting of light nucleus requires energy as

Why does fission of massive nuclei release large amounts of energy?

* Splitting of massive nucleus
* Large number of nucleons from fragments means large overall energy release

### Fusion as power supply

**Advantages**

1. Unlimited fuel supply
2. Hardly any radioactive waste

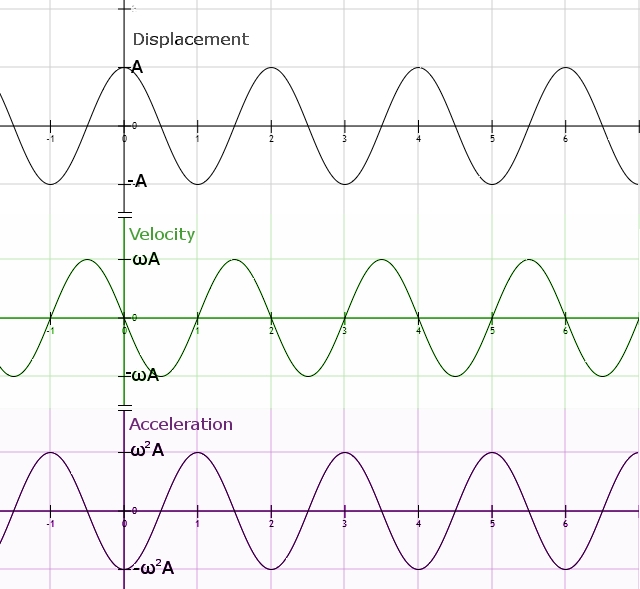
**Disadvantages / facts**

* High temperatures (essential) are needed to give nuclei enough KE to overcome the electrostatic repulsion to come near
* High densities needed to give a high enough collision rate (for continued only)
* The reaction must be contained securely along with a strong magnetic field
* If material touches container, the temperature decreases
* *Stars are ideal for fusion as great gravitational forces promote required conditions*

# Topic 10 – Simple harmonic motion (SHM)

**Conditions:**

1. A force continually trying to return object to center position
2. Fdisplacement from center position

Assuming :

### Graphs

## Conservation of energy

Free oscillations have all E conserved.

## Terminologies

### Resonance

When the frequency of the applied force to an oscillating system is equal to its natural frequency , the amplitude of the resulting oscillations increases significantly

### Damping

Reduction in energy and amplitude of oscillations due to resistive forces on the oscillating system

* Plastic materials is necessary for energy dissipation to be effective

**Types of damping:**

1. Light / under:
2. Critical:
3. Heavy / over:

# Topic 11 – Gravity and space

## Gravitational forces

Gravity is always attractive

## Starshine

Black body radiation - Object that completely absorbs all radiation that lands on it

Standard candle - Object with known luminosity

Wien’s law:

## Star classifications

**H-R diagram**

### Star formation

* Dust & gas clump together by gravityprotostar
* Star undergoes nuclear fusion
* Binding E diffrelease E as EM radiationheat star
* Gravitational collapse prevented by pressure of vibration of particles

### Star properties

* Large gravitational forces
* High densities & temperatures

### Life cycles

**Low-mass stars (~1x Sun)**

## Distance to stars

Parallax - Change in position relative to background

Inverse square law:

Determine distance by standard candle

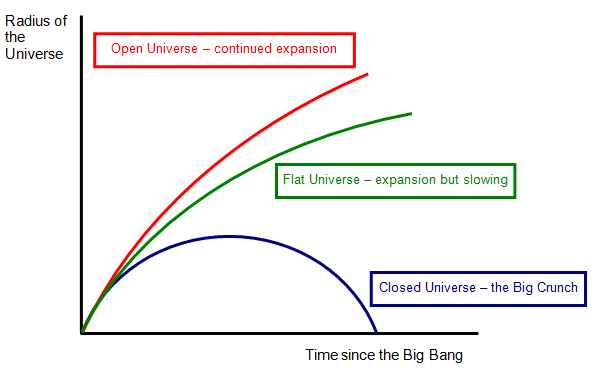
1. Standard candle – object of known luminosity
2. Identify object standard candle and measured
3. Inverse square law used

## Calculation of the age of the universe

Approaching Distancing

## Theories of the fate of everything

Critical density - Density of matter in the Universe, below which universe will expand forever



* Dark matter can’t be seen and that does not emit or absorb electromagnetic radiation.
* It explains why stars orbit galaxies even if the centripetal force by the mass of stars is lower than needed.
* Gravitational lenses verify existence of dark matter, as masses deform space-time which bends light. This bending effect is observed in photographs of deep space.