① Speed, velocity & acceleration

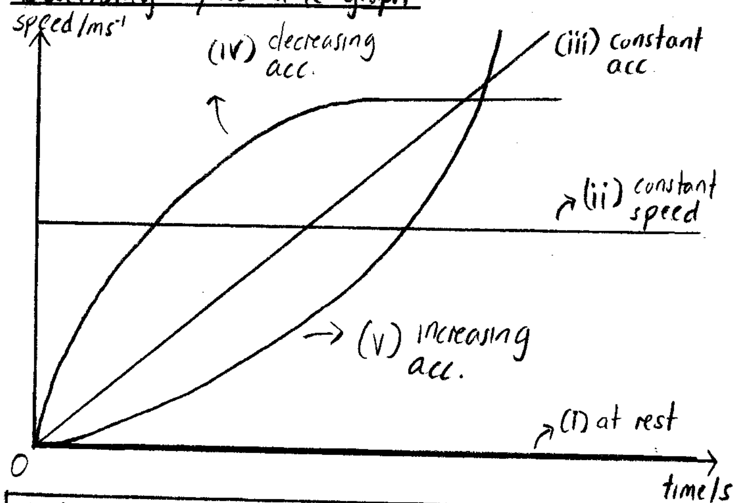
- speed is defined as rate of change of dist.

$$\boxed{\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}}$$

- velocity is defined as rate of change of displacement.
- acc. is defined as rate of change of velocity.

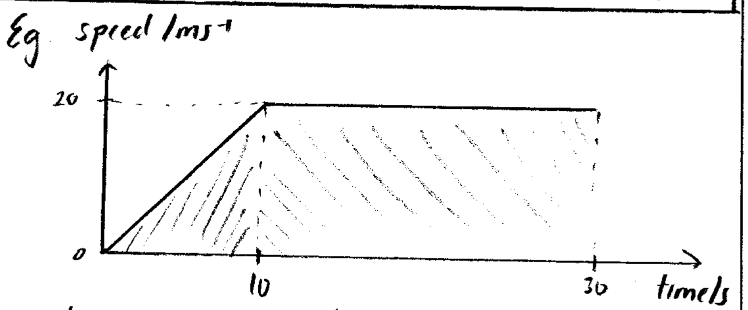
$$\boxed{acc = \frac{\text{final speed} - \text{initial speed}}{t} = \frac{v-u}{t}}$$

- Describing Speed-time graph



- $\boxed{\text{Distance travelled} = \text{Area under speed-time graph}}$

Eg



Distance travelled $= \frac{1}{2} \times 10 \times 20 + (30-10) \times 20$

$= 100 + 400$

$= 500$ m.

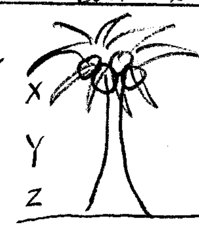
- Acceleration of free fall on Earth is $10\ m/s^2$

Eg. When a coconut falls,

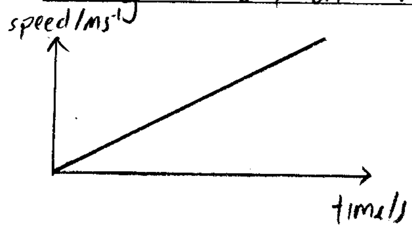
acc at X = $10 m/s^2$

" " Y = $10 m/s^2$

" " Z = $10 m/s^2$

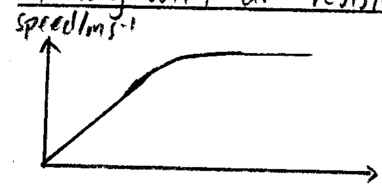


- Falling without air resistance



only force experienced is weight, hence constant acc.

- Falling with air resistance



air resistance slowly increases to overcome weight

Weight.

② Mass, Weight & Density

- Mass is the amount of particles in a body & it is measured in <u>kg</u>.
- Weight is the gravitational force & it is measured in <u>Newtons</u> (N)

$$\boxed{\begin{array}{l} \text{Weight} = \text{mass} \times \text{gravitational field strength} \\ \quad\quad \text{or} \\ W = mg \quad \Big\} \ g \text{ on Earth} = 10 m/s^2 \text{ or } 10 N/kg \end{array}}$$

- Mass is a property that resists change in motion.

Eg. It is more difficult to move a stationary bus (larger mass) than a car (smaller mass)

- Density is defined as the mass per unit volume. The unit is kg/m^3 or g/cm^3

$$\boxed{\text{Density} = \frac{\text{mass}}{\text{volume}}}$$

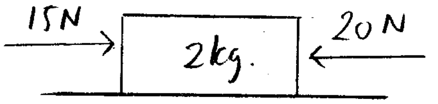
- Finding density of a regularly shaped obj
  a) Use a beam balance to measure mass.
  b) Use a ruler to measure the sides & calculate volume using formula.
  c) Calculate density by $d = \frac{m}{V}$
- Finding density of an irregular shaped obj.
  a) Use beam balance to measure mass
  b) Lower the object into a half-filled measuring cylinder & record the volume as the increse in water level
  c) Calculate the density by $d = \frac{m}{V}$.

③ Forces.

- When there is a resultant force, there will be an acceleration and vice versa

$$\boxed{\text{Force} = \text{mass} \times \text{acc or } F = ma}$$

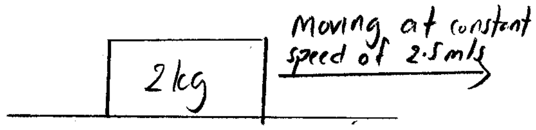
Eg.



Resultant force $= 20 - 15$
$= 5N$ (left)

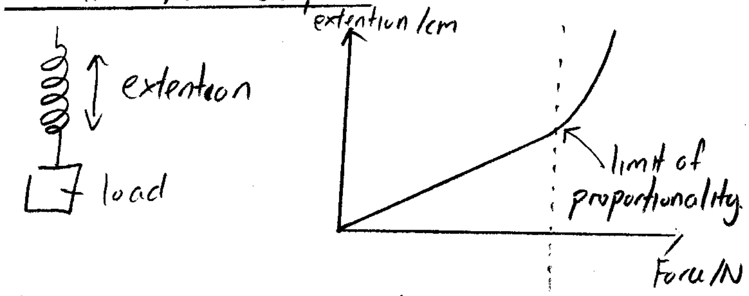
Acceleration $= \frac{F}{m}$
$= \frac{5}{2}$
$= 2.5\ m/s^2$

- When obj is moving at constant speed, there is NO acc & hence NO resultant force



constant speed ⇒ acc = 0 ⇒ Fresultant = 0N.

- Extention - Load Graph



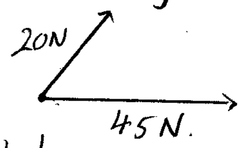
When limit of proportionality is not reached, the Force is proportional to the extention of the spring.

- Scalars & Vectors

Scalars ⇒ quantities with magnitudes only
Eg length, time, mass, current, temp

Vectors ⇒ quantities with magnitudes & directions
Eg Force, velocity, acceleration

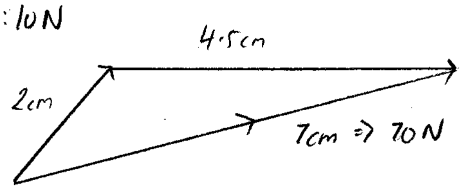
- Determining resultant of non parallel vectors



Not drawn to scale.
Find resultant force.

Working

Scale 1cm : 10N

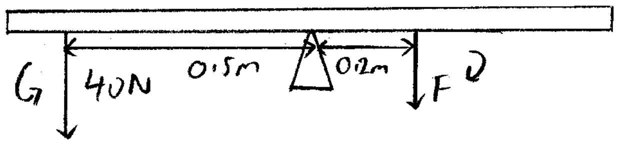


Resultant force = 70N.

④ Moments

- $\boxed{\text{Moments (Nm)} = \text{Force (N)} \times \text{dist}_{\perp} \text{ (m)}}$

Eg If system is in equilibrium, find F



a) Total clockwise moments = F × 0.2
= 0.2F Nm

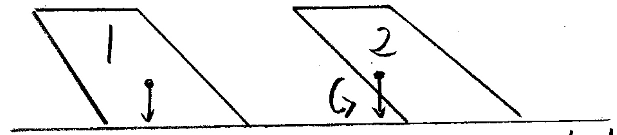
b) Total anticlockwise moments = 40 × 0.5
= 20 Nm.

c) Total CW moments = Total ACW moments

d)
$$0.2F = 20$$
$$F = \frac{20}{0.2}$$
$$= \underline{\underline{100N}}$$

- For an object to be stable,
  a) Centre of mass must be as low as possible
  b) Centre of mass must be with the base of obj.

Eg.



Object 1 will not topple.

Obj 2 is not stable as its centre of mass is out of the base.

⑤ Work, Energy, Power

- $\boxed{\text{Work (J)} = \overrightarrow{\text{Force}} \text{ (N)} \times \overrightarrow{\text{dist}} \text{ (m)}}$

- K.E. (J) $= \frac{1}{2}mv^2$ where $m \Rightarrow$ mass in kg, $v \Rightarrow$ speed in ms^{-1}

- G.P.E. (J) $= mgh$ where
  - $m \Rightarrow$ mass in kg
  - $g \Rightarrow$ gravitational field strength (ms^{-2} / kg/N)
  - $h \Rightarrow$ height in (m)

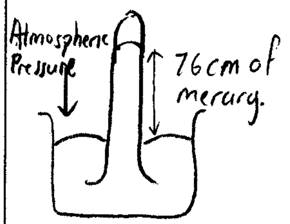
- $\text{Power (W)} = \dfrac{\text{Energy (J) or WD(J)}}{\text{time (s)}}$

⑥ Pressure

- $\text{Pressure of solid (Pa)} = \dfrac{\text{Force (N)}}{\text{Area} (m^2)}$

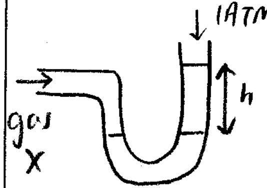
- Pressure of liquid $= h\rho g$
  - h = height (m)
  - ρ = density of liquid (kg/m^3)
  - g = gravitational field strength

Barometer ⇒ to measure atmospheric pressure



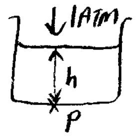
Pressure by 76cm of mercury column = 1 ATM

Manometer ⇒ To find pressure of gas X



Pressure of gas X = 1ATM + hρg

Pressure underneath liquid surface

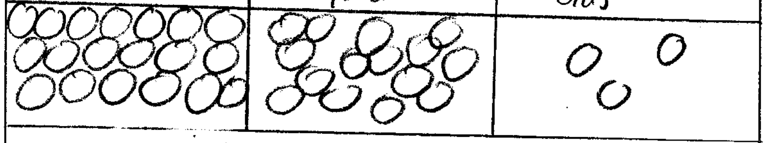


Pressure at point P = 1ATM + hρg

- Under const temperature,
  $\boxed{P_1 V_1 = P_2 V_2}$

⑦ Kinetic model of matter

Solid	Liquid	Gas



close together — distance between molecules → far apart

strongest — Forces between molecules ← weakest

- Temperature of gas ↑, speed of molecules ↑
- Pressure of gas is due to bombardment of gas particle on the container wall.
- Temperature of gas ↑, pressure ↑
  At higher temp, particles move faster & the force of bombardment ↑
- Brownian motion shows the random motion of air particles. Bright specks seen is smoke particles.

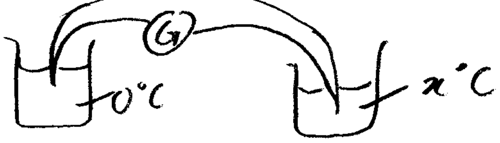
- Evaporation is the escape of the more-energetic molecules from the surface of a liquid

↑ Temperature
↑ Surface Area
↑ draught over surface
} ↑ evaporation

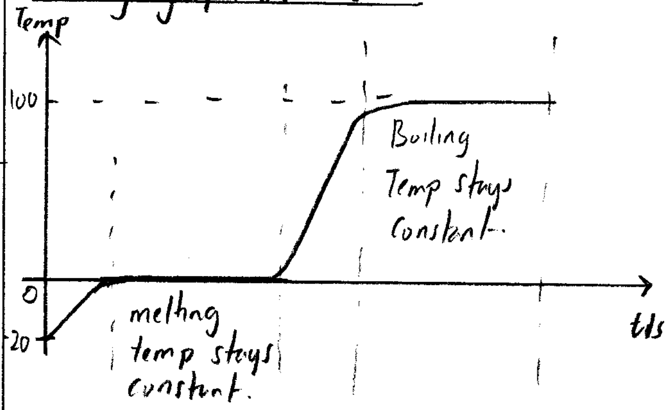
⑧ Thermal properties of matter

- Solid → Liquid → Gas
  expands the least … expands the most

- Advantages of using thermocouple
  ⇒ measuring high temperature
  ⇒ measuring rapid changing temperature



- Heating graph of water



- Boiling is a process whereby liquid changes to gas without a change in temperature.
- Melting is a process whereby solid changes to liquid without a change in temperature.

- Condensation is the process whereby gas changes to liquid without a change in temperature.
- Solidification is the process whereby liquid changes to solid without a change in temperature.

Energy change due to change in temp

$E = mc\theta$
- E - energy (J)
- m - mass (kg)
- c - specific heat capacity (J/kg/°C)

Energy change due to change in state

Melting / freezing

$E = ml_f$
- E - energy (J)
- m - mass (kg)
- l_f - latent heat of fusion (J / kg)

boiling / condensation

$E = ml_v$
- E - energy (J)
- m - mass (kg)
- l_v - latent heat of vaporisation.

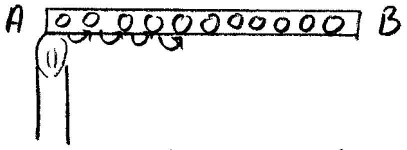
- Differences between boiling & evaporation

Boiling	Evaporation
fast process	slow process
bubbes seen	no bubbles seen
Occurs throughout liquid	Occurs on the surface
heat source provided	heat from surrounding
occurs at fixed temp	Occurs over a range of temp

⑨ Transfer of Thermal Energy

- Conduction (mainly for solids)

→ due to molecular vibration



Particle at A absorbs heat energy & vibrate fasters. The particles collides with the neighbouring particles & pass the heat energy to B.

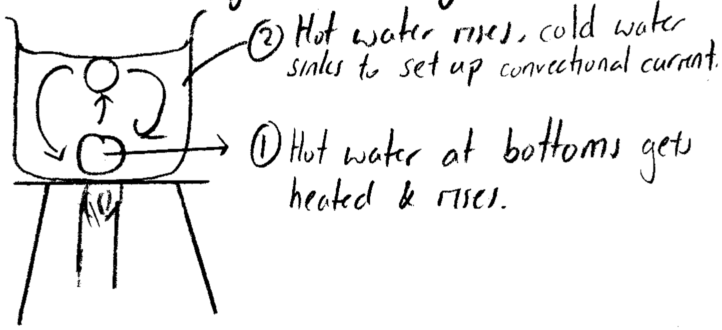
Examples of:

Good Conductors => metals.

Bad Conductors => plastic, rubber, glass etc

- Convection (mainly for liquid & gas)

→ due to change in density



- Radiation (for all matters)

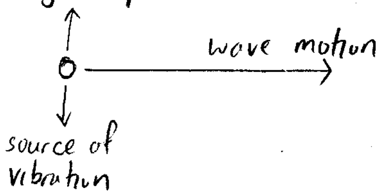
→ Due to infra-red radiation.

	Good Absorber & Emitter	Bad Absorber & Emitter
Black & dull surface	✓	
White & shiny surface.		✓

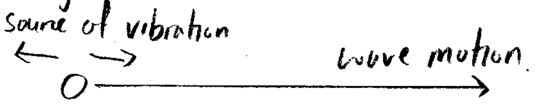
(10) General Wave Properties

- $v = f\lambda$ } v - speed (ms^{-1}), f - frequency (Hz), λ - wavelength (m)

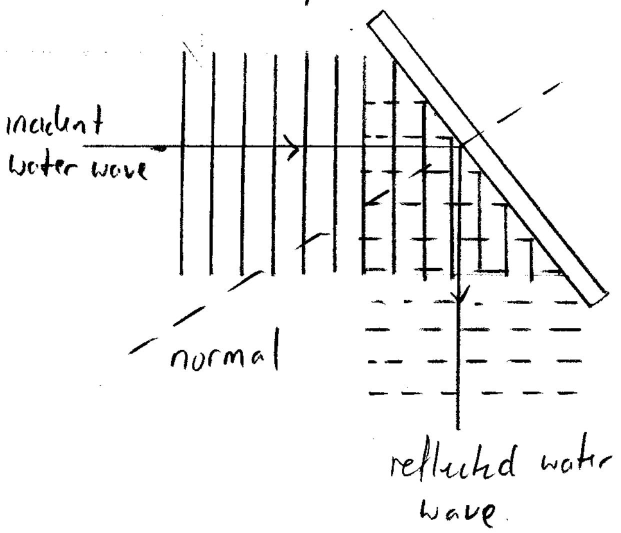
- Transverse wave is a wave whereby the source of vibration is perpendicular to the wave motion
  Eg. rope wave, water wave, light.



- Longitudinal wave is a wave whereby the source of vibration is parallel to the wave motion.
  Eg Sound wave

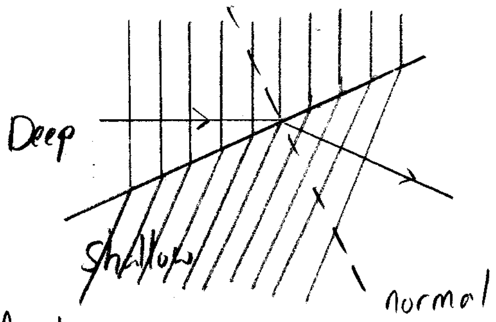


Reflection at a plane surface



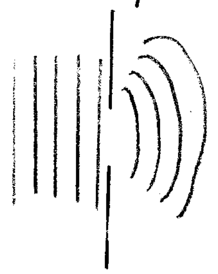
Refraction due to change in speed

Deep to shallow
⇒ faster to slower (bends towards normal)

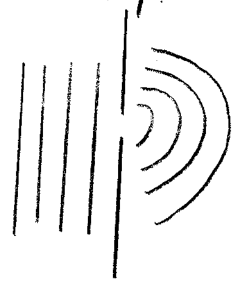


Diffraction

Wide Gap



Narrow Gap

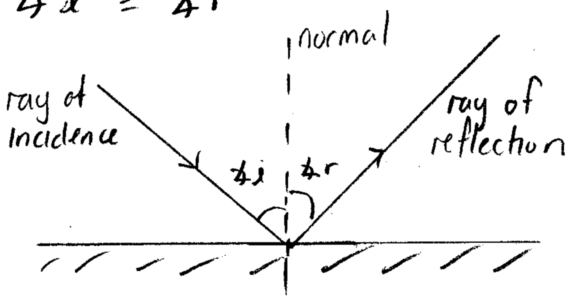


(11) Light

Reflection

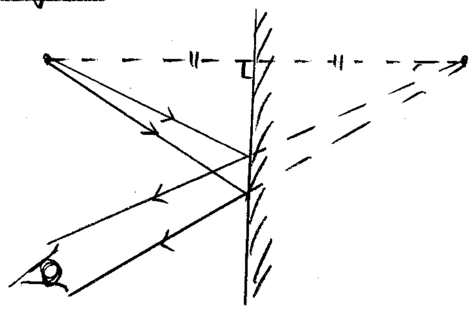
- Characteristics of plane mirror image
  → upright
  → virtual
  → laterally inverted
  → obj dist = image dist
  → obj size = image size

- $\angle i = \angle r$

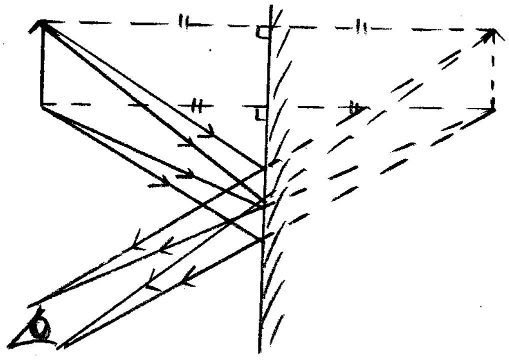


Construction of Ray Diagram

Point Object



Extended object



Refraction

$n = \dfrac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$

$n = \dfrac{\sin i}{\sin r}$ (from less dense to denser medium)

n - refractive index (no unit)
i - ∠ of incidence
r - ∠ of refraction

$n = \dfrac{1}{\sin c}$, c - critical angle

Thin Converging Lens

- Construct ray diagram for real & virtual images.

12 Electromagnetic Spectrum

- Transverse waves that travel at the speed of light ($3 \times 10^8\ ms^{-1}$)

Rome's	Radio wave	increasing wavelength ↑	decreasing frequency ↓
Mother	Microwave		
Is	Infra-red		
Very	Visible light		
Ugly,	Ultraviolet		
eXclaimed	X-ray		
Grandma	Gamma ray		

13 Sound

- Sound is an example of longitudinal wave
- Range of audible frequency
  => 20Hz to 20kHz.
- Higher amplitude => Louder sound
  Higher frequency => higher pitch.
- Speed of sound travels fastest through solid, followed by liquid then gas.

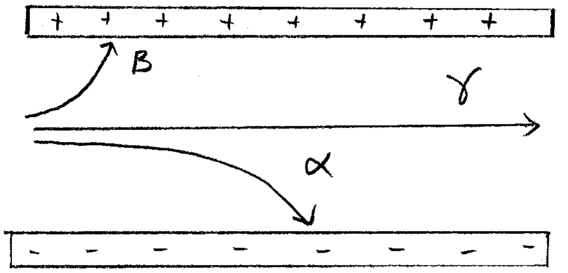
(14) Atomic Physics

- Radioactive emission occur randomly over time & space.

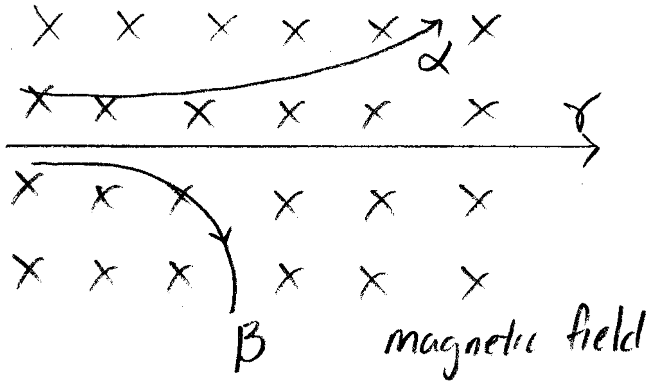
Characteristics of Alpha, Beta, Gamma Emission

	Alpha (α)	Beta (β)	Gamma (γ)
Nature	fast moving helium atom	fast moving electrons	Highly energetic waves
Ionising effect	Very strong ionising power	More than β. Less than γ	Least ionising power
Penetrating power	Least Penetrative Stopped by a sheet of paper	Stopped by Aluminium of 0.5cm thick	Most Penetrative Stopped by few cm thick of lead
Charge	+ve	-ve	neutral

Deflection in E-field



Deflection in Magnetic field



Structure of an Atom

$^{23}_{11}Na$

nucleon number => number of protons + neutrons

proton number

Na atom has:

11 protons

$23 - 11 = 12$ neutrons

11 electrons (number of protons = electrons)

Decay by Alpha Emission

$$^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He + \text{energy}$$

parent nuclide, daughter nuclide, alpha particle

Eg

$$^{226}_{88}Ra \rightarrow {}^{222}_{84}Rn + {}^{4}_{2}He$$

Decay by Beta Emission

$$^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \text{energy}$$

parent nuclide, daughter nuclide, beta particle

$$^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e$$

β particle

Decay by Gamma Emission

$$^{A}_{Z}X^{*} \rightarrow {}^{A}_{Z}X + \gamma\text{-rays}$$

parent nuclide, daughter nuclide, gamma rays.

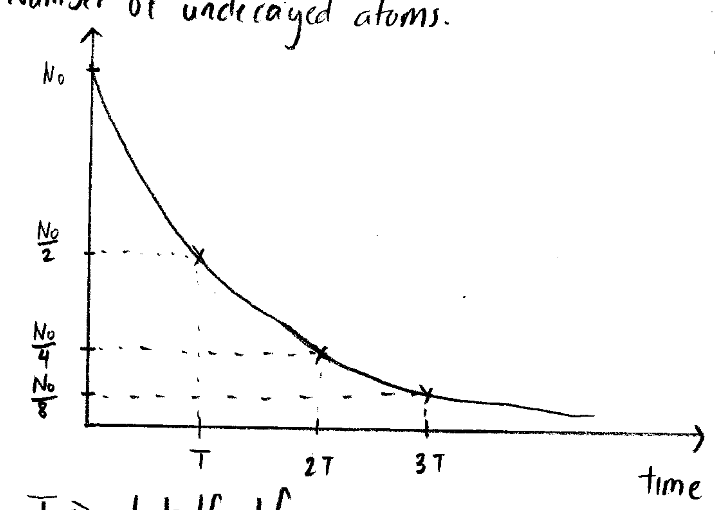
* means excited state.

Half - Life

The half-life of a sample of radioactive element is defined as the time taken for half of the unstable nuclei to decay.

$$N = N_0 \left(\tfrac{1}{2}\right)^n$$

N: no. of undecay nuclei
N_0: initial no. of undecayed nuclei
n : number of half-lifes



T ⇒ 1 half-life

After time of 1 half-life, number of undecayed atoms will be halved