Physics 0625 IGCSE 2010 Formula Sheet Pg 1/9

① Speed, velocity & acceleration

- speed is defined as rate of change of dist.
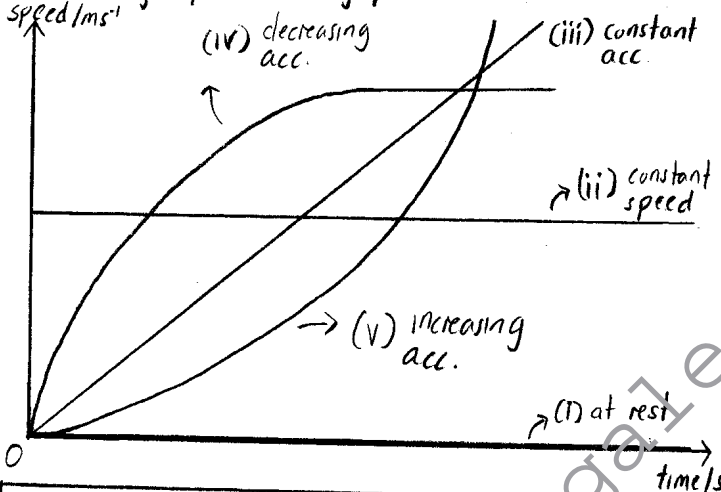
Average speed = $\dfrac{\text{Total distance}}{\text{Total time}}$

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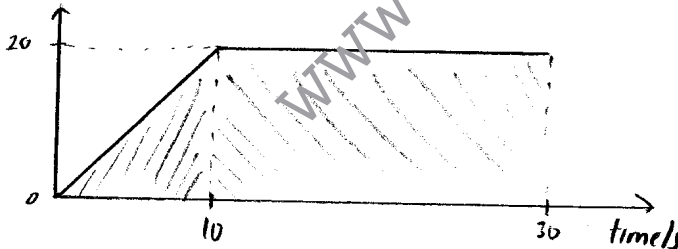- acc. is defined as rate of change of velocity.

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

- Describing Speed-time graph

- Distance travelled = Area under speed-time graph

Distance travelled = $\frac{1}{2} \times 10 \times 20 + (30-10) \times 20$
= 100 + 400
= 500 m.
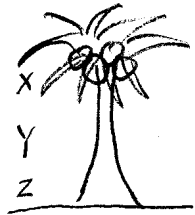
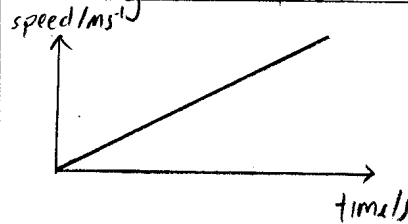- Acceleration of free fall on Earth is 10 m/s²

Eg. When a coconut falls,
acc at x = 10m/s²
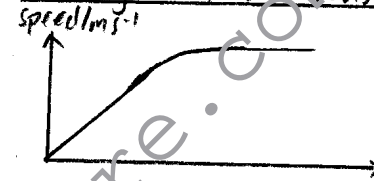" " Y = 10m/s²
" " Z = 10m/s²

- 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 __kg__.
- Weight is the gravitational force & it is measured in __Newtons (N)__

Weight = mass × gravitational field strength
or
$W = mg$ } g on Earth = 10m/s² or 10 N/kg

- Mass is a property that resists change in motion.
Eg. It is more difficult to move a stationary bus (larger mass) than a can (smaller mass)

<u>Physics 0625 IGCSE 2010 Formula Sheet</u> Pg 2/9

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

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

- <u>Finding density of a regularly shaped obj</u>

a) Use a beam balance to measure mass.

b) Use a ruler to measure the sides & calculate volume using formula.

c) Calculate density by $d = \frac{m}{V}$
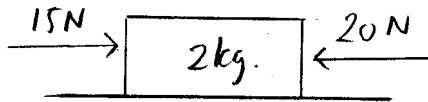
- <u>Finding density of an irregular shaped obj</u>

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 <u>Forces.</u>

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

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

Eg.

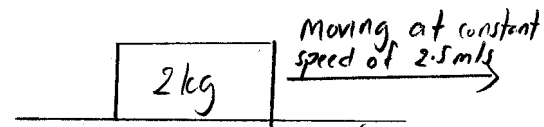15N → $\boxed{2kg.}$ ← 20 N

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

$\boxed{2kg}$ → Moving at constant speed of 2.5m/s

constant speed ⟹ acc = 0 ⟹ $F_{resultant} = 0N$.

- <u>Extention - Load Graph</u>

extention /cm

limit of proportionality
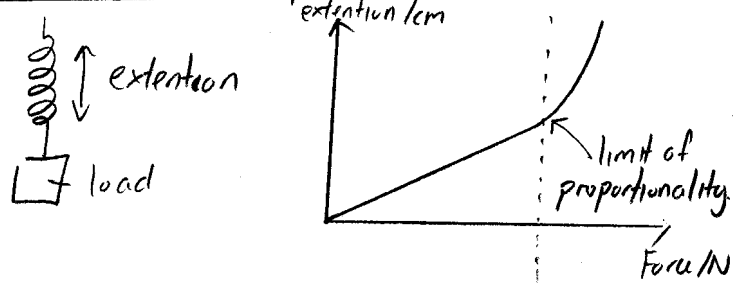
Force /N

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

- <u>Scalars & Vectors</u>

Scalars ⟹ quantities with magnitudes only
Eg length, time, mass, current, temp
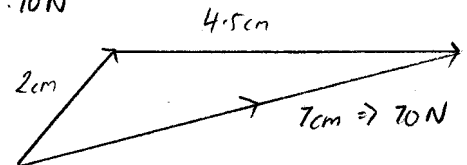
Vectors ⟹ quantities with magnitudes & directions
Eg Force, velocity, acceleration

- <u>Determining resultant of non parallel vectors</u>

20N
45N.
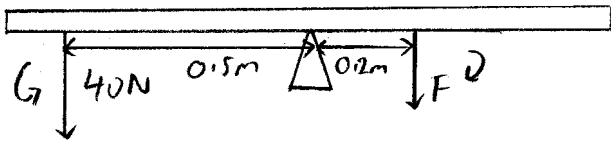} Not drawn to scale.
Find resultant force.

Working.
Scale 1cm : 10N
4.5cm
2cm
7cm ⟹ 70N

Resultant force = 70N.

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④ Moments

$$\boxed{\begin{array}{ccc} \text{Moments} &=& \text{Force} \times \text{dist}\perp \\ (Nm) & & (N) \quad (m) \end{array}}$$

Eg If system is in equilibrium, find F

G | 40N ← 0.5m → △ ← 0.2m → | 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)
$$0.2F = 20$$
$$F = \frac{20}{0.2}$$
$$= \underline{100N}$$

- 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
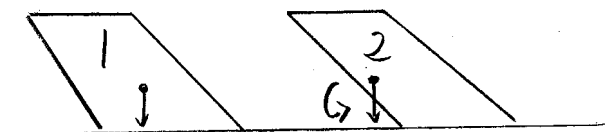
Object 1 will not topple.

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

⑤ Work, Energy, Power

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

$$\boxed{\underset{(J)}{K.E.} = \tfrac{1}{2}mv^2 \text{ where } \begin{array}{l} m \Rightarrow \text{mass in kg} \\ v \Rightarrow \text{speed in } ms^{-1} \end{array}}$$

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

$$\boxed{\underset{(W)}{\text{Power}} = \frac{\text{Energy (J) or WD(J)}}{\text{time (s)}}}$$

⑥ Pressure

$$\boxed{\underset{(Pa)}{\text{Pressure of solid}} = \frac{\text{Force (N)}}{\text{Area} (m^2)}}$$

$$\boxed{\begin{array}{l} \text{Pressure of liquid} = h\, e\, g \\ h = \text{height (m)} \\ e = \text{density of liquid } (kg/m^3) \\ g = \text{gravitational field strength} \end{array}}$$
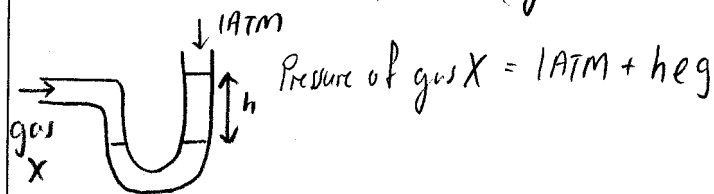
Barometer ⇒ to measure atmospheric pressure

Atmospheric Pressure ↕ 76cm of mercury.
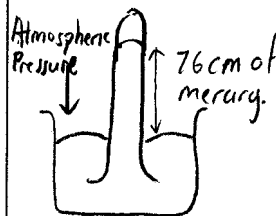
Pressure by 76cm of mercury = 1 ATM column

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<u>Manometer</u> ⇒ To find pressure of gas X

Pressure of gas X = 1ATM + heg

<u>Pressure underneath liquid surface</u>

Pressure at point P = 1ATM + heg
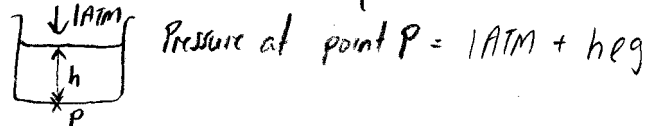
- Under const temperature,
$$P_1 V_1 = P_2 V_2$$

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 speckles seen is smoke particles.
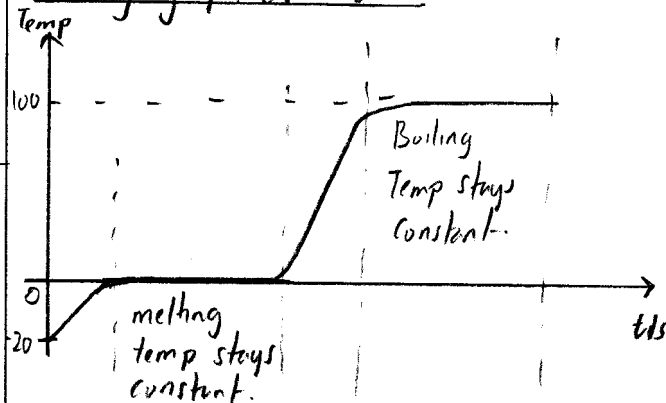

- Evaporation is the escape of the more energetic molecules from the surface of a liquid

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

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.
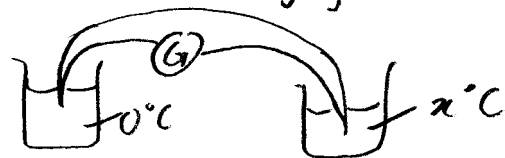
- Heating graph of water

- 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.

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- 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

$$E = mc\theta$$

$\begin{cases} E - \text{energy (J)} \\ m - \text{mass (kg)} \\ c - \text{specific heat capacity (J/kg/°C)} \end{cases}$

Energy change due to change in state

melting / freezing
$$E = ml_f$$
$\begin{cases} E - \text{energy (J)} \\ m - \text{mass (kg)} \\ l_f - \text{latent heat of fusion (J/kg)} \end{cases}$

boiling / condensation
$$E = ml_v$$
$\begin{cases} E - \text{energy (J)} \\ m - \text{mass (kg)} \\ l_v - \text{latent heat of vaporisation} \end{cases}$

- Differences between boiling & evaporation

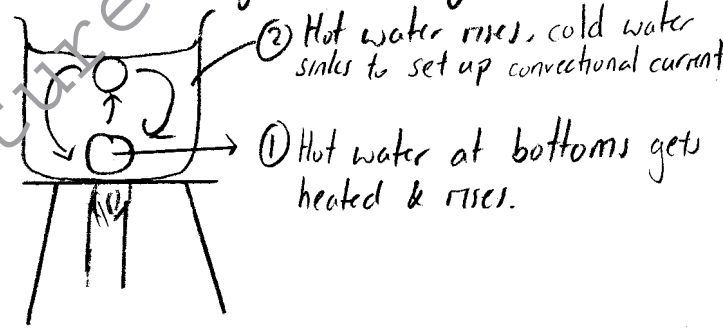| Boiling	Evaporation
fast process	slow process
bubbles seen	no bubbles seen
Occurs throughout liquid	Occurs on the surface
heat source provided	heat from surrounding
occurs at fixed temp	Occurs over a range of temp

④ Transfer of Thermal Energy

- Conduction (mainly for solids)
→ due to molecular vibration
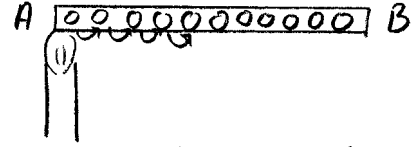
Particle at A absorbs heat energy & vibrate faster. The particles collides with the neighbouring particles & pass the heat energy to B.

Examples of:
Good Conductors ⇒ metals.
Bad Conductors ⇒ plastic, rubber, glass etc

- Convection (mainly for liquid & gas)
→ due to change in density

② Hot water rises, cold water sinks to set up convectional current.

① Hot water at bottoms gets heated & rises.

- Radiation (for all matters)
→ Due to infra-red radiation.

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

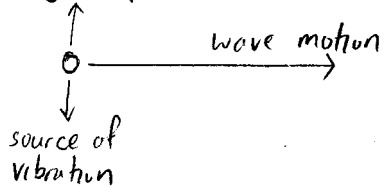Prepared by Mr Roland

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(10) General Wave Properties

$$V = f\lambda \quad \begin{cases} V - \text{speed } (ms^{-1}) \\ f - \text{frequency } (Hz) \\ \lambda - \text{wavelength } (m) \end{cases}$$
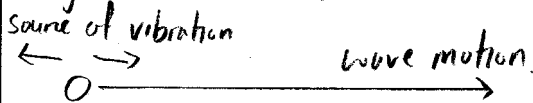
- Transverse wave is a wave whereby the source of vibration is perpendicular to the wave motion
Eg. rope wave, water wave, light.

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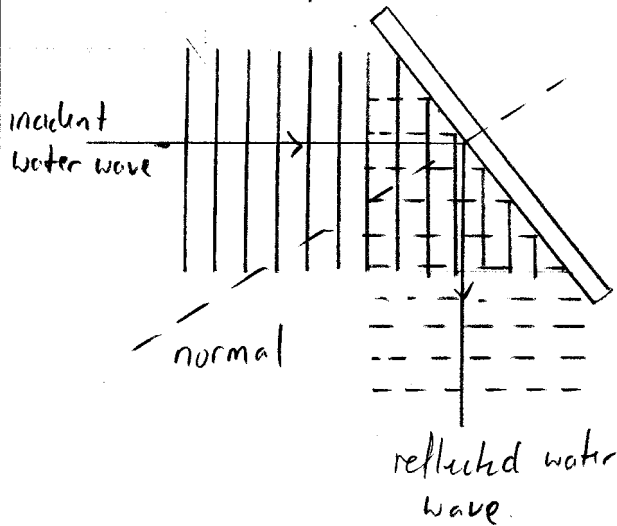
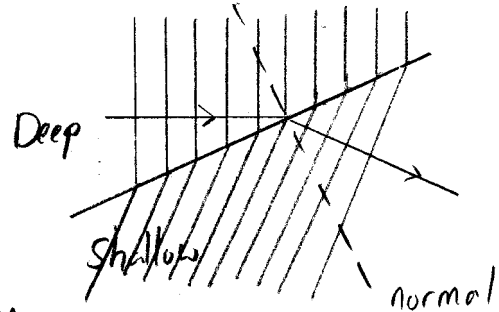- Longitudinal wave is a wave whereby the source of vibration is parallel to the wave motion
Eg Sound wave

Reflection at a plane surface

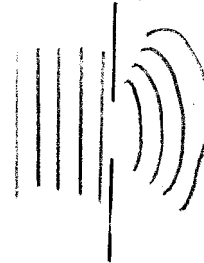incident water wave

normal

reflected water wave.

Refraction due to change in speed

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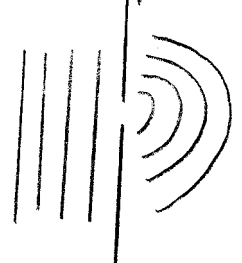
Deep
Shallow
normal

Diffraction

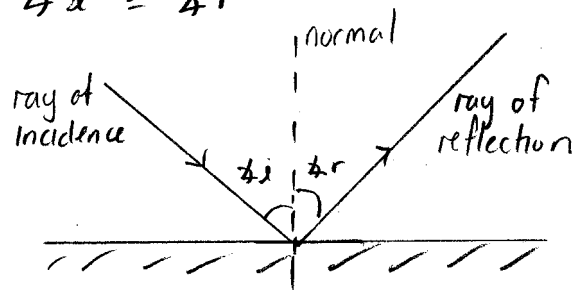Wide Gap   Narrow Gap

(11) Light
Reflection

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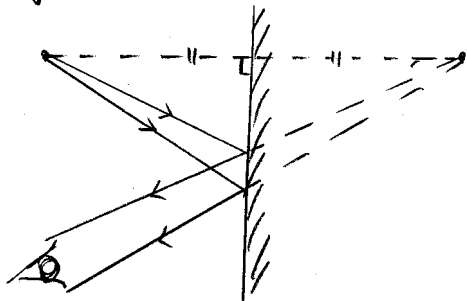 → obj dist = image dist
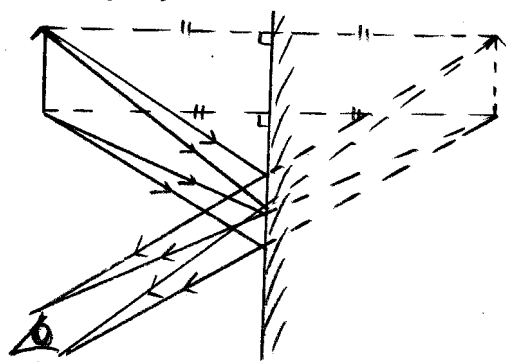 → obj size = image size.

- $\angle i = \angle r$

ray of incidence   normal   ray of reflection

$\angle i$ $\angle r$

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Construction of Ray Diagram

Point Object

Extended object

Refraction

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

$$n = \frac{\sin i}{\sin j} \quad \left(\begin{array}{l}\text{from less dense to denser} \\ \text{medium}\end{array}\right)$$

n - refractive index (& no unit)

i - ∡ of incidence

r - ∡ of refraction

$$n = \frac{1}{\sin c}, \quad c - \text{critical angle}$$

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	↑
Mother	Microwave	
Is	Infra-red	increasing wavelength / decreasing frequency
Very	Visible light	
Ugly,	Ultraviolet	
eXclaimed	X-ray	
Grandma	Gamma ray	↓

⑬ Sound

- Sound is an example of longitudinal wave
- Range of audible frequency
  ⇒ 20 Hz to 20 kHz.

- Higher amplitude ⇒ Louder sound
  Higher frequency ⇒ higher pitch.

- Speed of sound travels fastest through Solid, followed by liquid then gas.

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## Physics 0625 IGCSE 2010 Formula Sheet Pg 8/9

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
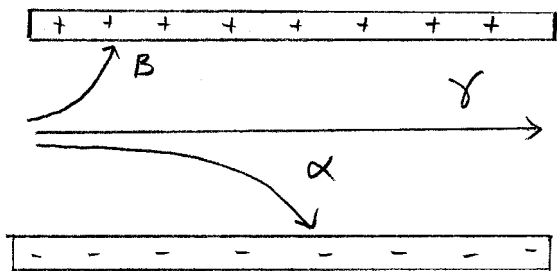
Deflection in Magnetic field

magnetic field
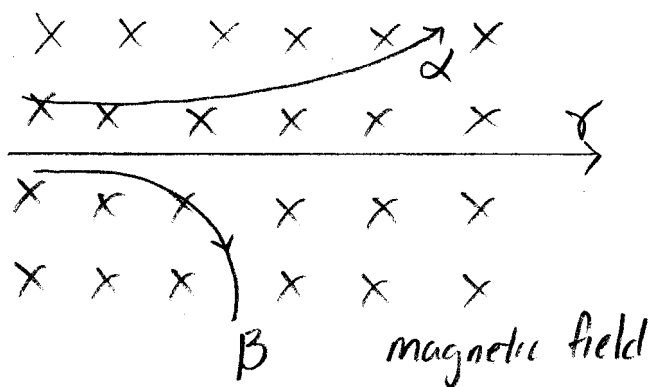
Structure of an Atom

$$^{23}_{11}Na$$

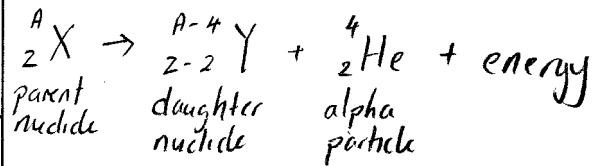nucleon number ⇒ number of protons + neutrons

proton number
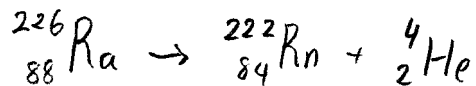
Na atom has:

11 protons

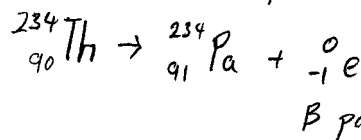23 - 11 = 12 neutrons

11 electrons (number of protons = electrons)

Decay by Alpha Emission

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

parent nuclide   daughter nuclide   alpha particle

Eg.

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

Decay by Beta Emission

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

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.

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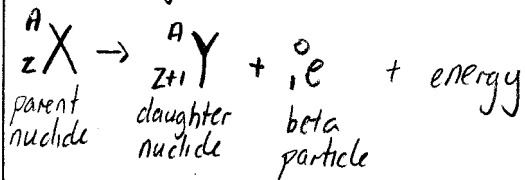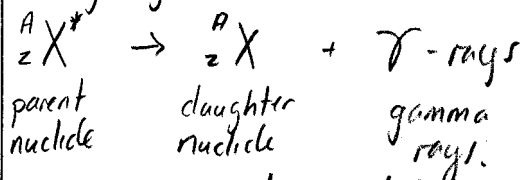
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Half - Life

The half-life of a sample of radioactive element is defined as the time taken for half of the unstable nuclei to decay
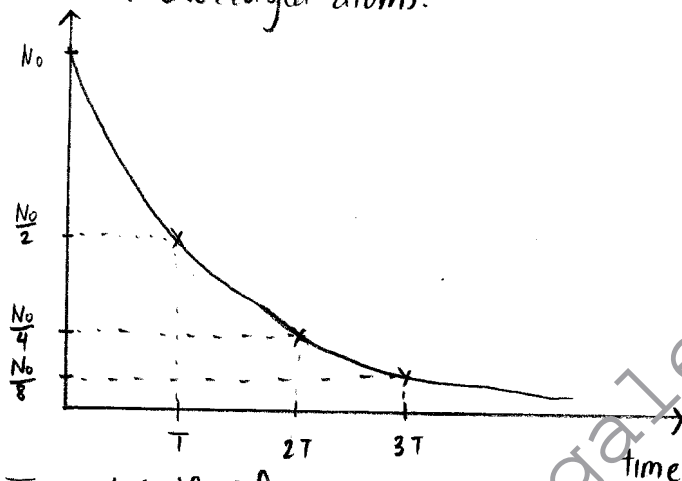
$$N = N_0 \left(\frac{1}{2}\right)^n$$

N: no. of undecay nuclei

N_0: initial no. of undecayed nuclei

n: number of half-lifes

Number of undecayed atoms.

T ⇒ 1 half-life.

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

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