

1. Physical Quantities

<u>prefix</u>	<u>symbol</u>	<u>factor</u>
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}

<u>scalar</u>	<u>vector</u>
distance	displacement
speed	velocity
—	acceleration

2. Kinematics

speed: distance travelled per unit time

velocity: rate of change of displacement per unit time

↳ S.I. unit: m/s

acceleration: rate of change of velocity per unit time

↳ S.I. unit: m/s²

$$a = \frac{v-u}{t}$$

3. Force & pressure

force: push / pull that one object exerts on another

S.I. unit: newton (N)

mass: measure of the amount of matter in an object

S.I. unit: kilogram (kg)

gravitational : 10 N / kg

field strength:

weight : $W = mg$

S.I. unit: newton (N)

density: mass ÷ vol.

S.I. unit: kg / m³

pressure: force acting ⊥ to the surface per unit area

S.I. unit: pascals (Pa) or N/m²

4. Dynamics

balanced forces: $R.F = 0$

unbalanced forces: $R.F. \neq 0$

N1L: if $R.F = 0$, object will be in rest / uniform motion

∴ constant speed : zero acceleration

N2L: $F = ma$

N3L: action - reaction pair

friction

good effects:

- braking
- walking without slipping

bad effects:

- wear & tear
- unnecessary heating

reduces:

- water (lubrication)
- air
- smooth surface

5. Turning effect of forces

moment of a force = Fd

S.I. unit: Nm (newton metre)

★ principle of moments:

when a body is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anti-clockwise moments about the same pivot.

centre of gravity:

the C.G of an object is the point through which its whole weight appears to act on.

6. Energy

Energy: the capacity to do work

S.I. unit: joule (J)

energy stores

- kinetic store
- internal store
- nuclear store
- Chemical potential store
- Elastic potential store
- gravitational potential store

} can be transferred by:
- mechanically
- heating
- electrically
- propagation of waves

Kinetic store:

$$E_k = \frac{1}{2}mv^2$$

gravitational

$$E_p = mgh$$

potential store:

$$E_k = E_p$$

conservation of energy:

Energy cannot be created or destroyed, energy can be transferred from one store to another.

W.D. = force $\times$ distance

S.I. unit = joule (J)

Power = rate of work done

$$= \frac{W.D.}{t}$$

S.I. unit = watt (W)

7. Waves

Source of waves: vibration or oscillation

wave:

- disturbance that transfers energy from one place to another.
- made up of periodic motion

transverse waves:

- waves travel $\perp$ to the direction of vibration (crests or troughs)

e.g. water waves, EM waves

longitudinal waves:

- waves travel $\parallel$ to the direction of vibration (compressions & rarefactions)

e.g. sound waves

wavefront:

imaginary line joining all in a wave that are in the same phase of vibration

period:

time taken to complete a wave

S.I. unit: second (s)

frequency:

number of completed waves produced per second

S.I. unit: Hertz (Hz)

$$f = \frac{1}{T} \quad / \quad v = f\lambda$$

$\downarrow$
period,
frequency

$\downarrow$
wave
speed

wave speed:

distance travelled by a wave in one second

S.I. unit: metre per second (m/s)

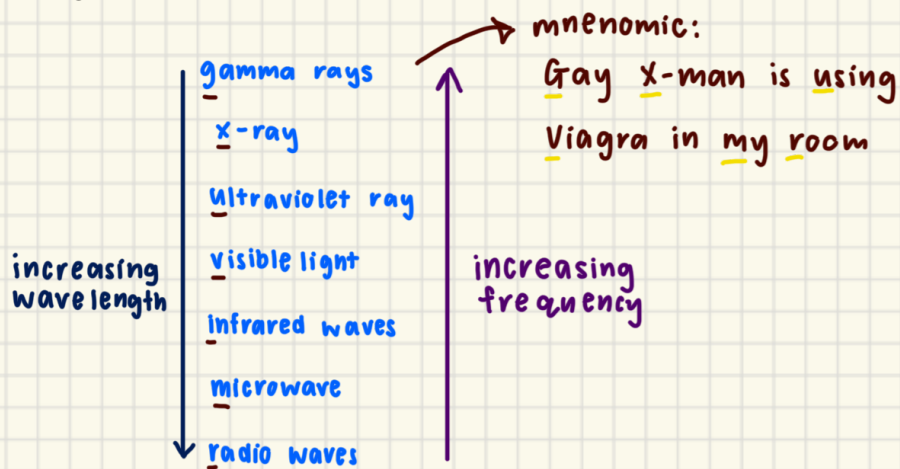
wavelength:

distance between two successive crests or troughs.

S.I. unit: λ (m)

$\rightarrow$ following one another

8. Electromagnetic Spectrum



Applications:

radiowaves:

- Communication (e.g. radio & tv)
- used in astronomy to study the composition, structure and processes of planets and other celestial objects
- reception and transmission of data between a Radio Frequency Identification (RFID) tag and a reader device

microwaves:

- heating up food
- communication
 - ↳ satellite communication and mobile phones
- used in GPS

infrared:

- infrared cooker
- thermometer (found in airports)
- remote controls

visible light:

- transmitted through optical fibres in endoscopy
- used in photography

ultraviolet:

- sterilisation of medical & lab equipment
- disinfection of water in treatment plants
- sunbeds for fake tanning

x-ray:

- imaging of bones in radiography
- cancer treatment in radiation therapy
- cabinet x-ray systems to screen luggage and carry-on items (found in airports)

Gamma ray:

- cancer treatment in radiation therapy
- sterilisation of medical equipment and elimination of microorganisms in food.

* speed of EM waves in vacuum: 3×10^8 m/s

9. Thermal Processes

- Energy transfer by heating & thermal equilibrium

- ↳ energy is transferred by heating from a region of higher temp. to a region of lower temp. until both regions have the same temp.
- ↳ bodies that are at the same temp. are in thermal equilibrium and there is no net energy transfer between the bodies
- ↳ for bodies that are at diff. temp., energy can be transferred through conduction, convection and radiation.

1. Conduction

- process of energy transfer through the passing on of vibrational motion from one particle to another.

description:

- 1)- particles at the heated end gained Ek and vibrate faster
 - they collide with the neighbouring particles and transfer energy to them.
 - this process continues from particle to particle until the energy from heated end to the cold end.
- 2)- occurs through the collisions of particles from the heated end to the cold end.
- 3)- cannot occur in vacuum
- 4)- fastest in solids
 - ↳ because particles are closely packed
 - slowest in gases
 - ↳ because particles are far apart
- 5)- metals are good thermal conductors because of free electrons
 - ↳ the free electrons can move in the spaces between of the metal atoms to collide with other atoms and electrons move quickly and transfer the energy to them.

2. Convection

- process of energy transfer by means of convection currents in a fluid (liquid or gas), due to density difference; transfer of energy through a medium via the flow of the medium itself

description:

- 1)- occurs to density changes in fluids (liquid or gases)
- 2)- cannot occur in solids and vacuum
- 3)- heating by convection (heat source at the bottom)
 - ↳ fluid at the bottom got heated up, becomes less dense and rise
 - ↳ the denser, cooler fluid at the top sinks
 - ↳ this process continues to set up a convection current to heat up all the fluid
- 4)- cooling by convection
 - ↳ the fluid at the top is cooled, becomes denser and sinks
 - ↳ the fluid at the bottom is warmer and less dense and rises
 - ↳ this process continues to set up a convection current to cool all the fluid

3. Radiation

- process of energy transfer in the form of EM waves, without the aid of a medium.
- radiation can travel through vacuum since no medium is required for the transfer of energy

description:

- 1)- does not require a material medium so it can occur in vacuum.
- 2)- black surfaces are good thermal absorbers / emitters
- 3)- rough surfaces are good thermal absorbers / emitters
- 4)- higher surface temp. will emit more energy
- 5)- larger S.A. are good thermal absorbers / emitters

10. Light

laws of reflection:

1. the incident ray, reflected ray and the normal at the point of incidence all lies in the same plane.
2. angle of incidence = angle of reflection
 $i = r$

- a real image can be formed on a screen
- a virtual image cannot be formed on a screen

characteristics of a plane mirror image:

- laterally inverted
- same size
- upright
- distance of image from mirror = distance of object from mirror

refraction:

- bending of light as it passes from one optical medium to another

Laws of refraction:

1. the incident ray, reflected ray and the normal at the point of incidence all lies in the same plane. } same as reflection
2. $\frac{\sin i}{\sin r} = \text{constant}$

The refractive index of a medium is the ratio of speed of light in the medium. ($n > 1$)

$$n = \frac{c}{v}$$

→ speed of light in vacuum
→ speed of light in medium

11. Electric charge and current of electricity

- conventional current is in the opposite direction to electron flow

$$I = \frac{Q}{t}$$

I = current;
Q = electric charge;
t = time taken

S.I. unit: ampere (A)

$$\mathcal{E} = \frac{\text{work done}}{Q}$$

$\mathcal{E}$ = e.m.f.
W = work done
Q = amount of charge

S.I. unit: volt (V)

$$V = \frac{\text{work done}}{Q}$$

$V = \text{p.d. or voltage}$
 $W = \text{work done}$
 $Q = \text{amount of charge}$

S.I. unit: volt (V)

$$V = IR$$



memorise it
as Victory = RI

$V = \text{p.d. across the component}$

$W = \text{work done}$

↳ i.e. amount of electrical energy
converted to other forms

$I = \text{current flowing (ampere, A)}$

S.I. unit: Ohm (Ω)

$$R = \rho \frac{l}{A}$$

$R = \text{resistance}$

ρ (rho) = resistivity

$l = \text{length of wire}$

$A = \text{cross-sectional area}$

S.I. unit: ohm (Ω)

12. D.C. circuits

potential difference : $V = V_1 + V_2 + \dots$
in series circuit

resistance in : $R = R_1 + R_2 + \dots$
series circuit

resistance in : $R = \left[\frac{1}{R_1} + \frac{1}{R_2} + \dots \right]^{-1}$
parallel circuit

13. Practical Electricity

$$P = VI$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

$P = \text{power}$

$V = \text{potential difference}$

$I = \text{current flowing}$

$R = \text{resistance}$

$$P = \frac{E}{t}$$

or

$$P = \frac{\text{work}}{t}$$

$E = \text{energy converted}$

$t = \text{time taken}$

$E = pt$, energy = power $\times$ time

↳ joules = watt $\times$ seconds
kwh = kilowatt $\times$ hours ↔ either or

$$E = VIt$$

$$E = I^2 R t$$

$$E = \frac{V^2}{R} t$$

$E = \text{electrical energy}$

$V = \text{potential difference}$

$I = \text{current flowing}$

$R = \text{resistance}$

$t = \text{time taken}$

Common units of : joules (J) or kilowatt-hours (kwh)
electrical energy :

Fuses and circuit breakers prevent excessive current.

Typical household fuses are rated at
1A, 2A, 3A, 5A, 10A, 13A

- * when fuse limit is reached,
the electric circuit is broken
until the fuse is replaced with
a new one.
- * when choosing a fuse, pick one
that can take a current slightly
higher than the normal circuit

<u>wire name</u>	<u>colour</u>
live wire	brown
earth wire	green and yellow
neutral wire	blue

Live wire:

- connected to a high voltage
and delivers current to the appliances

Neutral wire:

- completes the circuit by providing
a return path to the supply for
the current.
- usually at zero volt.

Earth wire:

- low-resistance wire that is usually
connected to the metal casing of appliances
and provides a path of least resistance
for current to flow when the metal
casing becomes live.

Circuit breaker:

- safety device
 - ↳ can switch off the electrical supply
in a circuit when a large current
that exceeds the rated value of the
circuit breaker flows through it.
 - ↳ connected to live wires
 - ↳ can be reset by switching them on again.

Fuse:

- safety device that is placed onto an
electrical circuit to prevent excessive
current flow

14. Magnetism

- ability to attract ferromagnetic materials
e.g. iron and steel

properties of magnets:

- attract magnetic materials
- have two poles; the magnetic effect is strongest at the particles
- a freely suspended magnet will come to rest in the north-south direction
- law of magnetism:
like poles repel & unlike poles attract

Methods to magnetise magnetic materials:

- stroking
- electrical method using DC and solenoid

methods to demagnetise magnets:

- heating
- hammering
- dropping on floor
- electrical method using AC and solenoid

soft magnetic materials (e.g. iron)
are easy to magnetise and demagnetise

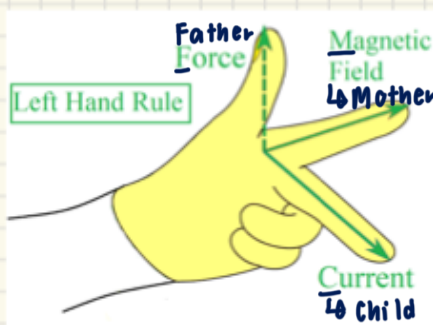
hard magnetic materials (e.g. steel,
alnico, neodymium) are difficult to
magnetise and demagnetise

15. Electromagnetism



magnetic field strength can be increased by:

- increasing current
- increasing number of turns per unit length of the solenoid
- placing a soft iron within the second.



16. Radioactivity

Atomic Structure

subatomic particle	location	mass	charge
proton	nucleus	1	+1
neutron	nucleus	1	0
electron	electron shell	$\frac{1}{1840}$ (negligible)	-1



nuclear notation

- X is the symbol of an element
 - A is the mass (nucleon) number
 - Z is the atomic (proton) number
- } protons + neutrons

nuclear decay

- random process when an unstable atomic nucleus loses its energy by emissions of electromagnetic radiation

⇒ One cannot know what nucleus will decay / when nuclear decay will occur

The diagram shows three types of nuclear decay with visual representations of parent and daughter nuclei and the emitted particles.

Alpha Decay

- A giant nucleus emits an alpha particle (Helium Nucleus, 2A, 2X)
- Alpha particles have positive charge and are relatively heavy
- Alpha particles have limited penetration abilities, stopped by a sheet of paper or human skin

Beta Decay

- Emission of a beta particle (high speed electron)
- High-energy, high-speed electrons emitted
- More penetrative than alpha particles
- Can be stopped by plastic, glass or a few millimeters of Aluminium

Gamma Decay

- Emission of a Gamma Photon, a form of high-energy electromagnetic radiation
- Electromagnetic radiation of very high frequency and energy. They are neutral and highly penetrative
- Requires dense materials such as lead or several centimeters of concrete to shield against them

Artificial/Natural sources of background radiation

Artificial sources:

- Medical X-rays
- Building materials
- Waste products from nuclear power stations

Natural sources:

- Rocks
- Radon gas in the air
- Food and drink
→ High potassium foods
e.g. bananas, carrots

S.I. unit: Becquerel (Bq)

1 Becquerel = 1 disintegration per second

Measurement of radiation is sometimes expressed as being a rate of counts per unit time, also known as the **count rate**

↓
unit: counts/min
counts/second

Half-life

- time taken for half the nuclei of that nuclide in any sample to decay
the greater the half-life, the more stable the nuclei

Hazards of radioactivity

- Radioactive isotopes can damage healthy cells
- Energy carried by radiation can kill cells, cause mutation and cancer

Protecting ourselves from radioactive materials

Limit contamination!!

If we are present at a site where there may have been a radioactive accident, we can take the following precautions.

- Leave the immediate area quickly to avoid being contaminated with radioactive materials. Follow the directions of officials to the nearest safe building or area.
- Remove the outer layer of the clothing as the radioactive materials may be on the clothing. Removing the clothing will reduce the risk of contamination.
- Wash all exposed parts of the body with soap and lukewarm water. This removes radioactive materials that may be present on the body and reduces the risk of contamination.