1. Physical Quantities

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

scalar	vector
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/s^2

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

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 field strength: 10 N/kg
weight: $W = mg$
S.I. unit: newton (N)
density: mass ÷ vol.
S.I. unit: kg/m^3
pressure: force acting ⊥ to the surface per unit area
S.I. unit: pascals (Pa) or N/m^2

4. Dynamics

balanced forces: R.F = 0
unbalanced forces: R.F. ≠ 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 potential store:
$E_P = mgh$

$E_K = E_P$

conservation of energy:
energy cannot be created or destroyed, energy can be transferred from one store to another.

W.D. = force x 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 ⊥ to the direction of vibration (crests or troughs)
e.g. water waves, EM waves

longitudinal waves:
- waves travel // to the direction of vibration (compressions & rarefractions)
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)

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

$f = \frac{1}{T}$ → period, frequency

$v = f\lambda$ → wave speed

wave speed:
distance travelled by a wave in one second
S.I. unit: metre per second (m/s)

wavelength:
distance between two sucessive crests or troughs.

following one another

S.I. unit: λ (landa)

8. Electromagnetic Spectrum

mnenomic:

Gay X-man is using

Viagra in my room

increasing wavelength ↓

- gamma rays
- x-ray
- ultraviolet ray
- visible light
- infrared waves
- microwave
- radio waves

↑ increasing frequency

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 floors 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 E_k 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. $\frac{\sin i}{\sin r}$ = constant

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

$$n = \frac{c}{v}$$
c → speed of light in vacuum
v → 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 = p.d. or voltage
W = work done
Q = amount of charge

S.I. unit : volt (V)

$V = IR$
memorise it as victory = RI

V = p.d. across the component
W = work done
i.e. amount of electrical energy converted to other forms
I = current flowing (ampere, A)

S.I. unit: ohm (Ω)

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

R = resistance
ρ (rho) = resistivity
l = length of wire
A = cross-sectional area

S.I. unit : ohm (Ω)

12. D.C. circuits

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

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

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

13. Practical Electricity

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

P = power
V = potential difference
I = current flowing
R = resistance

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

E = energy converted
t = time taken

E = pt , energy = power x time

joules = watt x seconds
kWh = kilowatt x hours

either or

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

E = electrical energy
V = potential difference
I = current flowing
R = resistance
t = time taken

common units of electrical energy : joules (J) or kilowatt-hours (kWh)

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

wire name	colour
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

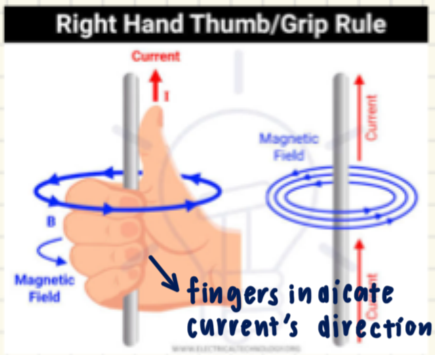
methods to magnetise magnetic materials:
- stroking
- electrical method using DC and solenoid

methods to demagnetise magnets:
- heating
- hammering
- dropping on floor
- electrical method using AC and solenoid

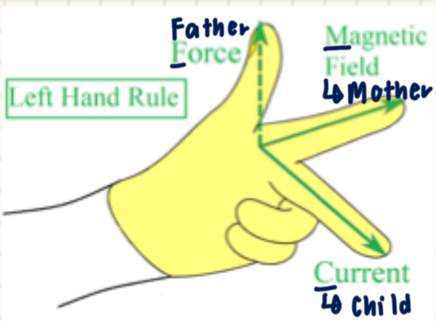
soft magnetic materials (e.g. iron) are easy to magnetise and demagnetise

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	1/1840 (negligible)	-1

$^{A}_{Z}X$ nuclear notation
- X is the symbol of an element
- A is the mass (nucleon) number } protons + neutrons
- Z is the atomic (proton) number

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

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.