Accuracy

how close a measurement is to the true or accepted value

precision

close measurements of the same item are to each other

accuracy is affected by systematic error, and reliability is affected by random errors.

Kinematics

Scalar quantities

Physical quantities that have magnitude only

Vector quantities

Physical quantities that have magnitude and direction.

Distance

Total length covered by a moving object regardless of the direction of motion

Displacement

The distance measured in a straight line in a specific direction

Speed

The distance moved per unit time.

Velocity

The rate of change of displacement

Acceleration

Rate of change of velocity

Uniform acceleration

constant rate of change of velocity

Terminal velocity .

When air resistance against the object is equal to the weight of the object. Velocity remains the same while acceleration is 0m/s^2. Distance continues to increase. When both objects of different mass are thrown at same height, the one wither higher mass will reach a higher terminal velocity. The object with the higher mass will have a higher weight. When it has higher weight, more air resistance needed to be equal to weight to reach terminal velocity. Hence, NET FORCE on heavier object is higher which allows it to reach a higher terminal velocity and higher acceleration.

Air resistance increases with speed of object, surface area of object and density of air

More dense air, more air resistance, slower falling of the ball since it reaches terminal velocity faster. Larger surface area, more air resistance, object reaches terminal velocity faster.

Acceleration due to gravity is constant at 10m/s^2. Since acceleration is rate of change of velocity. The acceleration when a ball is thrown up is 10m/s downwards. Why ? when the ball is thrown up, as it leaves the hand, the only force acting on the ball is weight. Weight acts downwards. Since f=ma and the resultant force on the ball is downward due to weight and no upward force. Hence, acceleration is in the same direction as the resultant force and is therefore 10m/s^2 that’s why when u throw up, it decelerates.

Forces

Contact forces include

Normal reaction force

The push exerted by a surface on an object pressing on it

Tension

The pull exerted by a stretched spring, string or rope on an object attached to it

Friction

The force that tends to oppose motion between surfaces in contact

Non contact forces

Gravitational force

The pull exerted by the earths gravity on an object.

Electric force

The attractive pull or repulsive forces between electrostatic charges

Magnetic force

The attractive pull or push between magnets

Effects of force include

A body at rest moves

A moving body increases in speed

A moving body decreases in speed

An object changes in shape

A moving body changes direction

Newtons first law of motion

An object will continue in its continuous state of rest or movement in a single line unless a resultant force acts on it

Newtons second law of motion f=ma

When a resultant force acts on an object of a constant mass, the object will accelerate in the direction of the resultant force. The product of the mass of the object and the acceleration is the resultant force

Net force causes it to accelerate. For terminal velocity questions, when comparing two objects falling in the air, say that the heavier object will have higher terminal velocity since more air resistance needed to be equal to weight. Hence, the net force for heavier object allows it to accelerate and have a higher velocity.

Newtons third law of motion

When body A exerts a force on body B, body B will exert a opposite and equal force on body A. this tells us that forces always occur in pairs and they are made up of action and reaction. They are equal, act in opposite directions and act on mutually opposite bodies. Form an action reaction pair.

Friction can be reduced by using wheels, ball bearings, lubricants and polished surfaces and air cushion

A **wheel reduces friction** by allowing the contacting surfaces to roll rather than to drag or slide over each other. By **reducing friction**, a **wheel** can enable you to use less force to move an object. The less force you use to move an object, the easier your work becomes.

**Bearings reduce friction** by means of this rolling motion. The "rolling **bearing**", with its rolling motion, **reduces friction** more than the "plain **bearing**" with its sliding motion, allowing for a greater **decrease** in the amount of energy consumption during rotation

**Lubrication reduces** the heat generated when two surfaces are in motion. It smoothes the process by forming a film between two surfaces that **reduces friction** and thus improves performance and efficiency.

polished surfaces reduce friction by removing surface irregularities. This allows the surfaces to slide over one another reducing friction

air cushion reduces friction as it glides over a smooth surface which is air instead of being in contact with another object. Reduces friction which is the force that tends to oppose motion.

Friction can be enhanced by

Treads which channel the excess water out from under the tire. In this way, the rubber can get in better contact with the wet pavement surface, thus greatly increasing friction and traction.

Parachutes

Increases surface area which increases air resistance. Air resistance exerts a force on the parachute, slowing down the freefall of a man

Chalk

Absorbs precipitation from the hands which decreases its compliance and hence reducing the coefficient of friction.

Free body diagrams

Tip to tail and parallelogram diagrams

Addition of parallel vectors

Free body diagrams

Tip to tail is used for things that are in equilibrium parallelogram used for resultant force. Eg bow and arrow.

Mass weight density

Mass

 the amount of matter in a body

Weight

 the gravitational force acting on an object

Gravitational field

The region in which a mass experiences a force due to gravitational attraction

Gravitational field strength

The gravitational force acting per unit mass

Inertia

The reluctance of an object to change its state of rest or motion due to its mass. An object of larger mass will be have more inertia and more reluctant to change its state of rest or motion.

Density

the mass per unit volume of an object

instruments use to measure weight and mass

mass

beam balance or electronic balance

weight

spring balance

turning effect of forces

the moment of a force

 the product of the force applied and the perpendicular distance from the line of action of the force applied to the pivot

the principle of moments

when an object is in equilibrium, the sum of anti clockwise moments is equal to the sum of clockwise moments about the same pivot.

In exam, do say sum of anticlockwise moment due to weight or whatever force applied that causes the moment DUE TO WEIGHT DUE TO WEIGHT DUE TO WEIGHT

Conditions for equilibrium

The resultant force is zero e.g. normal reaction force of the balance is equal to the weight of the object

The resultant moment on the object is equal to zero

Center of gravity

The center of gravity of an object is a point where all the weight of the object appears to act

For an object of regular shape and uniform density, the center of gravity is at its geometrical center

Stability

The stability of an object is the measure of its ability to return to its original position after it Is slightly displaced

Different types of equilibrium

Stable eqm

When it is slightly tilted, the center of gravity rises before moving back to its original center of gravity. The line of action of force remains within the base of the object. The moment of its weight causes it to return to its original position.

Unstable eqm

When slightly tilted the center of gravity drops, line of action of force lies outside of the objects base, the moment due to its weight causes the object to topple

Neutral eqm

When slightly displaced, the center of gravity remains at the same height. The line of action of the force and the normal reaction force coincide, the moment due to its weight about the objects pivot is zero.

Energy work and power

Energy

the capacity to do work

the principle of conservation of energy

energy cannot be created nor destroyed. It can only be transferred from one form to another. The total energy in an isolated system is constant

efficiency

 the ratio of useful energy output over the total energy input as a percentage. In real life, not all the energy input is converted to useful energy. Some of the energy is converted into non useful forms of energy like thermal and sound energy due to friction or air resistance

work

work done by a constant force on an object is the product of the force and the distance moved by the object in the direction of the force.

Power

The rate of work done.

types of energy

kinetic energy

1/2mv^2 \, mass velocity

The energy of a body due to its motion

gravitational potential energy

mgh

energy stored in a body due to its height from the ground

electrical energy

the energy of an electric charge due to its motion and position

chemical potential energy

the energy stored in a substance due to the position of the atoms or electrons in the substance

elastic potential energy

energy stored in a body due to its stretched deformation

light

electromagnetic waves that are visible to the eyes

thermal energy

energy stored in a body due to its temperature

nuclear energy

energy released during a nuclear reaction

there is a question where they ask about the men pulling up and anchor on a boat. at first, the men are producing a certain amount of power. after that they pull the anchor up to the same height but they do it at a faster rate, producing more power. why is it so

as the anchor is pulled up to the same height, the total work done remains constant. however, power is rate of work done. since they are pulling the anchor up at a faster rate, it means that less time in seconds is required to pull the anchor up to the same height. hence, p = w/t, less t for same w= more p.

this shows that it is not because more work is done but its just same amount of work done but in a shorter time thats why p increases.

pressure

pressure

F/A

force acting per unit area.

pressure in liquids

hpg, height density gravitational field strength

the deeper an object, the more pressure it experiences. This is because there is more water above the object. Hence, more force.

Pascal law

pressure applied to an enclosed fluid will be transmitted without a change in magnitude to every point of the fluid and to the walls of the container. The pressure at any point in the fluid is equal in all directions.

Atmospheric pressure

the force exerted on a surface by the air above it as gravity pulls it to Earth. Atmospheric pressure is 1.013x10^5 Pa or 1 atm.

Instruments used to measure pressure

Barometer measures atmospheric pressure. It is the atmospheric pressure that pushes the water up the evacuated tube. The higher the atmospheric pressure, the more water gets pushed and in turn the mercury at the surface decreases. If there is air in the evacuated tube then the surface wont decrease as the pressure exerted by the air in the evacuated column is sufficient to equalise atmospheric pressure.

Manometer measures differences in pressure of gases and liquids. Pressure from gas supply = pressure of atmosphere + pressure from mercury (hpg)

Liquid used is usually mercury which has a density of 13600kg/m^3.

Applications of pressure in liquids

Hydraulic press

In a hydraulic press, the pressure applied at one point is equal to the pressure applied at another point due to pascals law. A larger base will exert a larger force while a smaller base exerts a smaller force. Due to this reason, the point of contact for humans has a small base while the point of contact for the object of heavier weight has a larger surface area. The princicple of conservation of energy can be applied in this concept as work done equal to force x distance in the direction of the force. Hence, Fx X Dx = Fy X Dy

Applications of atmospheric pressure

Drinking with straw

When we suck, lesser pressure in straw. Hence atmospheric pressure pushes on the surface of the cup and forces liquid into the straw

Filling a syringe

Pulling the plunger lowers pressure in the barrel. Due to the difference in pressure, atm pressure pushes on surface of liquid and forces liquid into the syringe.

Suction cup

When it is pressed against a smooth surface, it forces air out. This lower pressure in the suction cup. Due to difference in air pressure, the atmospheric pressure presses on the surface of the suction cup, allowing it to be sucked onto the surface. With a rough surface, it will not stick as there are irregularities in the surface which allow air to enter and equalize pressure. Hence, air does not press on the suction cup.

Temperature

Temperature

How hot or cold an object is

Ice point

The temperature of pure melting ice at one atmospheric pressure.

Thermometric property

A property that increases linearly and continuously to the increase in temperature.

Determining ice point

Immerse bulb in lower part of thermometer into funnel containing crushed pure melting ice. When mercury level remains steady, mark that point as l0 on the thermometer.

Steam point

The temperature of steam from pure water boiling at one atmospheric pressure

Determining steam point

Immerse bulb slightly above boiling water. When mercury level steadies, mark the point on the thermometer as l100.

Use manometer to ensure pressure is 1atm to prevent water from boiling at lower temperature. Also use a substance with good thermometric properties so that the readings vary linearly and continuously with temperature.

Resistance thermometer

Consists of a platinum wire coiled around a piece of mica in a silica tube. The resistance of  a fixed length of wire varies continuously and linearly with a range of temperature values. ( good thermometric material )

X=Rx-R0 / R100 – R0

Thermocouple

Consist of two type of wires made of different material. The end of wires ( junctions ) produce a small electromotive force when there is temperature difference. One junction is placed at ice point while the other at random temperature.

Connect more voltmeters in series to make thermocouple more sensitive. This allows the thermocouple to show a greater change in output for every degree Celsius change in temperature.

What makes a good thermometer

vary uniquely with different temperature

increases lineraly and continuously with increase in temperature

easily reproducable and accurately measured over wide range of temperatures

Safe to use

Sensitive to small temperature changes

Fixed point is a temperature that is easily and precisely reproducable and where all thermometers show the same reading under same conditions

Kinetic model of matter

Formulas to note:

P1v1=p2v2

Derived from p is inversely proportional to volume. Hence, p=1/v and pv=1. When that is so, just equate both 1 to get p1v1=p2v2

P1v1/t=p2v2/t

Pressure is proportional to temperature. When temperature increases, the pressure increases. P=t. when temperature increases, the volume increases as particles gain more kinetic energy. Vibrate more vigoursly and move faster. Higher frequency of collisions with the walls of container, exert a higher average force on the walls of the container. Since pressure is equal to force per unit area, more higher pressure exerted. In order to for pressure in container to be equal to pressure in surroundings of 1x10^5 pa , the volume has to increase since volume inversely proportional to pressure. This decreases pressure in container to be equal to atm.

Kinetic model of matter

Tiny particles that make up matter are always in continuous random motion

Brownian motion

The observed random movement of particles in a fluid

Solids

Closely packed together in an orderly manner

Particles vibrate about fixed positions

Held by very strong forces of attraction

Least distance between particles

Liquids

Closely packed in a disorderly manner

Particles slide over one another freely

Held by strong forces of attraction

Particles are further apart from each other compared to solids but closer compared to gas

Gas

Randomly arranged and very far apart from one another

Little forces of attraction

Move in random directions at very high speeds.

Most distance between particles

Pressure in gases

In a enclosed environment, air molecules collide with the walls that surround the air particles. This exerts a force on the wall. Due to newtons third law of motion, the air bounces back as the wall exerts an equal and opposite force. Reaction force and force of particle on wall forms an action reaction pair.

Pressure temperature relationship

The pressure of a fixed mass of gas is directly proportional to the temperature of gas. If temperature increase, pressure increase. But temperature is not equal to pressure

This is because when temperature increase, particles increase in kinetic energy and move faster. They collide more often with the wall. Hence there is more average force exerted on the walls. When there is more force exerted while area is constant, pressure increases.

Pressure volume relationship

The pressure of a fixed mass of gas is inversely proportional to its volume provided temperature is constant

When there is more volume, the gases collide with the walls less often as it is a bigger volume for it to move around. When there is less volume, the gases collide more often as they are packed more closely.

Volume temperature relationship of a gas

Volume is directly proportional to the temperature of gas

when the temperature increases, the particles gain more kinetic energy and can move around faster. Hence, they collide with more force. This causes the cntainter to expand which increases volume. However when volume increase the pressure decrease. This allows pressure to stay constant.

compressed cylinder

when the cylinder is compressed, work is done on the piston. work is done since the piston moves in the direction of the force applied. by principle of conservation of energy, the work done on the piston is converted to kinetic energy of the particles. this is because the particles gain momentum from the force exerted by the piston, and increase in ke. as a result of the increase in ke, there is an increase in temperature.

Transfer of thermal energy

transfer of thermal energy

Thermal energy always flows from a region of higher temperature to a region of lower temperature. Net flow of thermal energy occurs only when there is a difference in temperature.

Conduction

Transfer of thermal energy through a medium without any flow of the medium

When an object is heated, the internal energy increases. This is because the particles gain energy, and increase in kinetic energy and vibrate more vigorously. The kinetic energy of the vibrating particles are transferred to neighbouring particles which increases the kinetic energy of the other particles. Hence when internal energy increases, it gets hotter. (non-metal). Thermal energy is transferred via the motion of free electrons/ movement of particles.

When metal is heated, the internal energy increases. . This is because the particles increase in kinetic energy and vibrate more vigorously. The kinetic energy of the vibrating particles are transferred to neighbouring particles which increases the kinetic energy of the other particles. Furthermore, the free moving electrons absorb thermal energy and gain kinetic energy. They move faster and move to cooler regions.

Conduction does not mainly occur in liquid and gas as the particles are too far apart for efficient transfer of kinetic energy.

Convection

The transfer of thermal energy by means of convection current in a fluid where there is a bulk movement of the fluid due to difference in density.

When a fluid is heated, the particles at the bottom increase in kinetic energy and expand. Hence their density decreases. When the density decreases, these hotter particles rise while the colder more dense particles sink to the bottom. This creates a convection current where the particles move in large numbers.

Radiation

Transfer of thermal energy in the form of electromagnetic waves such as infared radiation without the aid of a medium.

Colour and texture of surface, surface temperature and surface area

Dull and black surfaces are able to absorb radiation of all frequencies. Hence they can absorb the most amount of heat. Silver and shiny surfaces mostly reflect light which is a form of radiation. However they cannot reflect xray as it is of higher frequency

Surface temperature

The higher the surface temperature, the more infared emissions. This is because more atomic motions disturb electrons. Electrons are in high energy state and they don’t like it. Hence, they will fall back to low energy state by emitting radiation.

Surface area

More surface area, more area in contact with surroundings, more emission

Thermal properties of matter

Internal energy is the measure of energy within a system

Internal energy is the motion of particles in the form of kinetic energy and the forces of attraction and distance between the particles in the form of potential energy per molcule

Types of internal energy

Internal kinetic energy is due to the motion of the particles. ( transitional, rotational and vibrational motion of particles). Higher temperature allows it to vibrate more vigorously and have more internal kinetic energy. Kinetic energy increases when temperature increases while thermal energy supplied also is continuous. The increase in kinetic energy = increase in temperature.

Internal potential energy

Internal potential energy is due to the intermolecular forces of attraction and the distance between the molecules. Molecules with more potential energy are further apart from one another. Internal potential energy only increases when temperature remains constant but thermal energy is still supplied. Thermal energy used to weaken or break intermolecular forces of attraction depending on state.  (melting bonds are weakened, boiling bonds broken, condensation or freezing bonds are strengthened. )

Heat capacity

The amount of thermal energy required to raise the temperature of a substance by 1 kelvin or degree Celsius

Solids have lower heat capacity because of the distance between the particles. It is closer in solids than in liquids. Hence, heat is able to be transferred faster. Better heat conductivity in solids than liquids.

Specific heat capacity

defined as the amount of thermal energy required to raise the temperature of a unit mass of a substance by 1 degree Celsius or 1 degree.

Q=mc change theta

Latent heat of fusion

Is the amount of thermal energy required to change a substance from solid state to liquid state, without a change in temperature.

Specific latent heat of fusion

Is the amount of thermal energy required to change a substance per unit mass from Solid to liquid state without change in temperature.

Latent heat of vaporisation

The amount of thermal energy required to change a substance from liquid state to gaseous state, without a change in temperature

Specific latent heat of vaporisation

The amount of thermal required to change a substance per unit mass from liquid to gaseous state without a change in temperature.

Energy increase, total internal energy increase, thermal energy is absorbed

Fusion, vaporisation

Energy decrease, total internal energy decrease, thermal energy is given out

Condensation, solidification

Evaporation water gain heat from surroundings to change from liquid to gaseous at any temperature below 100 degrees Celsius.

Evaporation is affected by

temperature, (warmer the surroundings, more thermal energy supplied, particles absorb more thermal in same period of time, evaporate faster)

 boiling points of the liquid, more volatile evaporate faster alcohol

exposed surface area of the liquid,

humidity of surrounding air, (diffusion theory) plus the water molecules in form of water vapour will push the water vapour evaporated back into the liquid

air pressure (air molecules exert force on liquid, higher air pressure, water vapour get pushed down)

 movement of air on the surface of the liquid. (diffusion theory)

Light

Type of light rays

Convergent

Originate from multiple points and converge to join at one point focal point

Divergent

Originate from one point and diverge to other points

diverging lens is used in spectacles. in people with myopia, the change in shape of eyeball results in light rays being converged at a point before the retina. diverging lens helps to diverge the light rays such that it enters the eye at a LARGER ANGLE OF INCIDENCE. Therefore converging at a further focal point which is on the retina, forming a clear image.

Parallel

Light rays are parallel to each other and never meet

First Law of reflection

The incident ray, the reflected ray and the normal all lie on the same plane

Second law of reflection

The angle of incidence is equal to the angle of reflection

Point of incidence

Point at which light ray hits the reflecting surface

Normal

The perpendicular to the reflecting surface at the point of incidence

Incident ray

The ray that hits the reflecting surface

Reflected ray

The ray that is reflected by the reflecting surface

types of reflection

regular reflection

occurs on smooth surfaces where the normal at all points are parallel to one another and the rays are all parallel to one another

diffuse reflection

occurs on rough surfaces where the normal at all points are reflected in different directions and the rays are reflected in all directions

characteristics of light on a plane mirror image

same size as the object

laterally inverted

upright

virtual, light rays cannot meet at the image position

distance from mirror is equal to the distance of the object from the mirror

right angled mirrors:

For image number 3 it is a special case

All image presented must be equidistant from the object and the angle of incidence and angle of reflection must be equal. This object will be seen as normal and not inverted as the image viewed by the eye is a double reflection. Hence, it is flipped and inverted and then inverted again.

The image is seen at D as object O will form a image that is equidistant from o when the upper mirror is extended. When the ray is reflected to the second mirror below, the image at the first mirror is now the “object’ and when the mirror is extended, D will be equidistant to the new “object” and the image is seen at d

refraction

the bending of light as light passes through mediums of different optical densities.,

as light passes from an optically less dense to more dense medium,  it bends towards the normal

as light passes from more dense to less dense, it bends away from the normal.

Hence, objects look closer when view from above the pool/ water body

law of reflections

first law of refraction

 the refracted ray all lie in the same plane

second law of refraction / snell law

constant equal to sini/sinr

the constant remains the same even though the angle of incidence changes

the ratio of sin of angle of incidence to the sin of angle of refraction is constant

refractive index

= sin I / sin r or speed of light in vacuum / speed of light in medium

Value of sin I must always be the angle of incidence of light in air or vacuum

Speed of light in vacuum / air

3.00x10^8 or 2.99x10^8 for air

Total internal reflection

the complete reflection of a light ray in an optically denser medium at the boundary of an optically less dense medium where the angle of incidence is more than critical angle. When angle of incidence is more than critical angle, then light ray is reflected internally. When angle of incidence is equal to critical angle, the light ray cannot be seen. When angle of incidence is less than critical angle, it gets refracted.

critical angle

angle of incidence of a light ray travelling from an optically denser to an optically less dense medium at the boundary between the two medium where ligh is refracted at 90 degrees. Sinc=1/n

in an optically denser medium for which the angle of refraction in the optically less dense medium is 90 degrees. Sinc=1/n

optic fiber cables have a coating which has a lower refractive index. While the core has a high refractive index. Total internal reflection can only occur when light passes from a medium of higher optical density to a medium of lower optical density. Hence, when light touches the coating it is passing through a more dense medium while touchng the boundary of a less dense medium. Hence, total internal reflection can occur.

Converging lens

Causes light rays to converge at one point, represented by two arrows connected by a line

Rays that pass through optical centre do not bend, rays that are parallel to principal axis converge after the lens at the focal point and ray passing through focal point before lens will be parallel to principal axis.

Diverging lens

Causes light rays to diverge from a point

Principal axis

The horizontal line passing through the optical centre

Optical centre c

Midpoint between the surfaces of the lens

Focal point

The point at which all rays parallel to principal axis converge

Focal plane

The plane that passes through focal point F and perpendicular to the principal axis

Focal length

distance between optical centre and focal point

type of lenses

object > 2f image is between is f and 2f image smaller

if object is between f and 2f, image is magnified, more than 2f

object is 2f, image is 2f

object less than f, magnifying glass, image virtual

object is at f image is infinitely large, as you move object which is less than f closer to f, the image which is virtual will be bigger and bigger.

How to tell if the image formed is real. The image is on the opposite side of the lens as the object.

telescope lens

the object distance is infinite, and the image distance is equal to the focal point. Image formed is inverted, real and diminished and on the opposite side of lens

camera,eye lens

the object distance is more than twice the focal length and the image distance is between the first focal point and second focal point. Image formed is inverted real diminished and formed on opposite side of lens

photocopier lens

object distance is equal to 2 focal length and the image distance is equal to two focal length. The image formed is real inverted same size and on the opposite side of the lens

projecter, photograph enlarger

object distance is between one to two focal length and the image formed is more than 2 focal length. Image formed is real inverted and magnified and on the opposite side of the lens

eyepiece lens of telescope

object distance equal to focal length and image formed is at infinity. Image formed is virtual upright and magnified and same side of lens

magnifying glass

object distance is less than focal length and image formed is behind the object. The image is virtual, upright and magnified and same side of lens

if the refractive index of a converging lens increases, then light will be refraacted more. This will cause the focal length to be shorter which results in the image whether virtual or real to be larger than the original image.

sound

wave

periodic motion that transfers energy from one point to another without the movement of the medium

wavespeed

distance travelled by wave per second

frequency

number of complete ocsillations per unit time

wavelength

distance between two consective points in a phase.

Period

Time taken for one complete oscillation

Amplitude

Maximum displacement of a particle from rest position

Wavefront

Imaginary line that is joins all adjacent points that are in phase

Transverse waves

Direction of vibration of particles is perpendicular to the wave motion

Kinetic energy is transferred from source transferred to the particles. Perpendicular vibration of particles to the wave motion transfers energy from the source to the point.

Longitudinal waves

Waves that vibrate parallel to the wave motion. Kinetic energy from source is transferred to particles via a wave. The particles in the air are displaced forwards and backwards transferring kinetic and sound energy as the longitudinal waves pass throufh them. Particle remain at their rest positions after one complete oscillation

For wave questions where two wave graphs are shown, usually they are consecutive such that they are overlapping.

Em waves

Em waves are Transverse waves that transfer energy without aid of medium. Travel at a speed of 3.0x10^8 m/s in vacuum. When travels through different medium, speed and wavelength changes but frequency remains constant. obeys laws of reflection and refraction. If it travels in more dense medium, it will  refract. Vice versa.

Radiowaves

Radio and television communication, longest wave length, lowest wave frequency

Microwaves

Satellite gps microwave oven

Infrared waves

Remote controllers and intruder alarms

Visible light

Optic fibre cables and telecommunications

Ultraviolet rays

Sunbed, sterilization of hospital equipment

Xrays

Radiation therapy to treat cancer, imaging x ray scans

Gamma rays

Gamma knife radio surgery

Ionizing radiation

Ionizing radiation has enough to remove electrons from atoms to make them ions.

Causes damage to biological molecules which can lead to abnormal cell divison and cancer

Infrared radiation

Feel warm

Sound

A form of energy that is transferred by longitudinal waves which is the transfer of energy due to the vibration of particles parallel to the direction of wave motion. Requires a medium and is produced by vibrating sources which causes layers of air particles to shift.

Travels faster in solids than gases and liquids as the particles in a solid are more closely packed together. When this happens, the particles are displaced forwards and backwards at a shorter distance.

When whistle is blown, causes air particles to vibrate parallel to the direction of motion of the wave at the same frequency. When whistle is blown, it forms a series of compressions and rarefactions in the air and transfers kinetic energy from one particle to one another as the particles collide with one another. The sound energy is carried as a longitudinal wave to the person 10m away. Allowing person to hear the whistle.

Speed in air of 300m/s

Affected by humidity. Higher humidity, more closely packed air particles are, higher speed due to above reason.

Obey laws of reflection and refraction

Echo is the repition of a sound due to the reflection of sound.

Ultrasound is sound that is above 20000hz and above human audible range.

Used in prenatal scanning, detection of cracks in buildings and qualirt control

Infrasound is sound that is below 20hz and below human audible range.

Pitch is related to frequency.

High frequency, high pitch.

Frequency is the number of complete ocsillations of a wave per unit time

Loudness related to the amplitude

Larger the aplitude, louder the sound

 V= f lumbda

Static electricity

keyword in this chapter: INDUCED CHARGE

Law of electrostatics

Electric force attractive or repulsive force that electric charges exert on one another. Like charges repel, unlike charges attract

Electric field

Region in which an electric charge experiences an electric force

Unit coulombs C

 Electron has -1.6x10^-19c. IT IS NEGATIVE CHARGE NOT POSITIVE CAUSE ELECTRONS

6.25x10^18  number of electrons is contained in 1 charge

 two types of materials

conductors and non conductors/insulators.

conductors allow charges to flow freely throughout them

insulators do not allow charges to flow free throughout them but only can be chared at the surface without flow of charges.

Types of charging

Induction used for conductors( between two conductors)

Friction used for insulators (non conductors of electricity )

contact use in electroprecipitators (between conductor and non conductor charging )

Induction

Charging a conductor without contact between the conductor and charging body

To charge two objects

Place the two conductors touching each other on an insulating stand to prevent the electrons from earth to earth the object.

Place a positive charged rod near the left side of the conductors

the positive charged rod will attract the electrons in both objects towards the left side.

This causes the right side to be positively charged as there are more positive charges than electrons.

Separate the two objects while holding the rod near to the object on the left. The opposite charges electric forces of attraction too strong for the electrons to move so the electrons remain on the left object.

Remove the positive charged rod.

Over time negative and positive charges on the objects will redistribute. Left object will have a overall negative charge. While right object has overall positive charge.

To charge object by earthing

Placed a positive charged rod near the object which is placed on an insulating stand.

The electrons on the left side will move towards the right side of the object.

Earth the object by putting your finger or attaching earth connection to the object.

Remove the earth connection from the object

Remove charged rod from the object

Negative charges redistribute, net charge of negative

Discharged by earthing

Charging by friction

Only occurs because charges at surface transfer to one another. When try to earth the part where it is not connected to remove the charge, the charge will not be removed since there are no mobile negative charges in an insulator. Hence, no flow of mobile charges.

Discharge insulators of electricity

Heating strongly which ionizes surrounding air particles. Ions will neutralize the charges on the surface of the object.

In the case of a charged sphere, there would be a spark due to discharge of charges.

High humidity a lot of water molecules in the air. Excess electrons are transferred to or from the water molecules to neutralize the object as water is a conductor of electricity.

when two copper spheres are placed far from one another, but a copper wire is connecting them. one copper sphere being positively charged and the other being neutral or negatively charged, there will be a potential difference between them since the positive charged sphere is like the positive terminal and the other sphere will be the negative terminal, like a battery in a circuit. due to the pd difference, there will be flow of charged from the positive sphere to the negative or neutral sphere. in the case of neutral sphere, both the spheres will become positive charged. for the negative sphere, they will become neutral. however, this depends on the number of charges on each sphere. both spheres will only be neutral if the number of positive charges equal number of negative charges.

when a copper wire is connected to a positively charged metal sphere to a negative charged plastic ball, only the part where the connection is will there be a flow of charges from the metal sphere. this is because charges are unable to move freely in non conductors of electricity.

this flow of electrons/ pd difference thing only applies if the thing connecting them is a conductor of electricity. paint is not a conductor of electricity.

Electric field

Negative charges go towards the negative charge

Positive charges go away from the positive charge

The direction of the electric field shows the direction of force acting on a small unit positive charge.

Lightning

Underside of the thunderclouds become negatively charged due to charging by friction from water droplets. The electrons at the bottom of the thundercloud repel the electrons on the surface of the earth. Surface of earth become positively charge. Accumulation of electrons on underside of thundercloud ionizes the air provides a conducting path for electrons to flow to the earth. Electrons on underside attracted to positive charges on surface of earth. This causes a lightning strike.

Unconconvetional is negative charges flow from surface of earth to the cloud

Electrostatic charges

Due to friction sudden discharge causes spark and ignite flammables

Anti static packinging or earth connection provide earthing for electrons to flow.

Photocopiers

Metal drum is positive charged using highly charged wire. An intense light beam shot at image which passes through image and on drum. Darker areas will not be conducting while lgihters areas will be conducting and be earthed. This makes the darker areas still be psoitivtley charged and when a negative charged ink is sprayed, it causes it to be attracted since opposite charges attract. Presses and fuses permemnantky

The powder spreads out evenly since negative charges repel each other they then attracted to positive charges since unlike charges attract

Electrostatic precipitation

Fly ash pass through negative charged wire. This causes the ash particles to be negatively charged by contact. When passed through positive charged metal plates, it is attracted to positive charges on metal plate since unlike charges attract. As a result, ash is collected in the metal tray below the metal plate.

even if the charged metal plates were earthed, the smoke particles will still be collected. this is because the negatively charged smoke particles will induce a positive charge on the metal plates since metal is a conductor of and electrons can move freely in the object. since opposite charged attractt, the negative charged particles willl be attracted to the metal plate. however, at the metal plate, due to earth connection it will be discharged due to flow of electrons. this causes it to fall.

Magnetism

keyword : INDUCED MAGNET

Magnetic materials are materials that can be attracted to a magnet

Soft vs hard magnetic materials

soft magnetic materials are magnetic materials that are easily magnetized and demagnetized. They only able to temporary retain magnetism. It is easier for a soft magnetic material to be the stronger induced magnet.

Eg soft iron

Hard magnetic materials are magnetic materials that are hard to magnetise and demagnetize. They make good permanent magnets as they are able to retain magnetism.

Eg steel

hence, in electrical circuits like fire alarm, soft magnetic materials are usually used. for example, iron is used instead of steel because when the current is large enough, the steel iron will retain that magnetism, attracting the rod which will result in open circuit. also hard to demagnetise the steel magnet as it is hard.

Non-magnetic materials are materials that cannot be attracted to a magnet

Eg wood copper aluminium

Although copper not a magnetic material, a magnetic field around it can be produced through electromagnetic induction.

Magnets have two poles north and south pole. The magnetic field lines around magnets are as such



In exam, required to draw 3 sets of lines. One pair for top and bottom.

When magnets are freely suspended, the north pole will point towards the geographical north and geographical south of the earth

Like poles repel, unlike poles attract.

When two like poles are placed close to one another, they will repel. This is because the magnetic force of attraction between the north of the magnet and the south of the other magnet is weaker than the magnetic force of repulsion between the north poles. This is due to the fact that the north poles are closer to one another than the north-south poles of two magnets. Hence, net force of repulsion.

When two unlike poles are placed closed to one another, they will attract. This is because the north and south poles of the two separate magnets are closer to one another then the north and north pole of the two separate magnets. Hence, the force of attraction between the two separate magnet is greater than the force of repulsion between the two separate magnet.

Magnetic induction

Process whereby an object made of a magnetic material becomes an INDUCED magnet when in contact or close to a magnet. For example the north pole of a bar magnet will induce the a south pole on a magnetic material brought close to it and then the further end of the magnetic material will be the opposite pole. This is due to the magnet temporarily aligning the magnetic domains in the magnetic material, making them point in one direction from being randomly aligned. This produces a net magnetization.

Methods of magnetization

Stroking

Use only one pole, stroke one direction, lift high enough at the end. Repeat several times

Electrical method using a dc

Large direct current flows through a solenoid. Produces a large enough magnetic field to align the magnetic domains in the steel bar.

Methods of demagnetizing all of these methods must take place in east west direction so magnetic domains do not realign again

Hammering

Hammer until it alters arrangement of domains

Strong heating

Strongly heat and let it cool in east west direction, vibrate vigorously and lose alignment

Alternating current

Place magnet in solenoid in east west direction. connect to alternating current while it is still on, and slowly withdraw it from solenoid until far away.

Must not switch off as there is a chance that magnetic domains will realign because it has not been disrupted enough. Aka not fucked up enough

A magnetic field is a region surrounding a magnet which a body of magntic material experiences a magnetic force.





Magnetic shielding

To prevent surrounding magnetic fields from reaching the sensitive areas of equipment that uses magnetic fields.

The use of soft iron in magnetic shield is able to prevent magnetic field from reaching as the magnetic field lines would rather take the path in the soft iron since soft iron is a more permeable material than air. Hence, no magnetic field lines in air, unable to reach the sensitive areas. Similarly, if there is a piece of magnetic object underneath a magnet, the aread under the magnetic object will not experience any magnetic field as it is shielded by the magnetic object.

Electromagnetism

Current carrying conductor produces a magnetic field around it. a charged particle only experiences a magnetic force when it is moving in an EXTERNAL magnetic field (motor effect). If it is stationary, the force it experience is an electric force provided it is placed in an electric field near an electric charge. TYS 2014 qn27 p1

According to right hand grip rule, the direction of current will either produce a anticlockwise or clockwise magnetic field around the current. Hence, the direction of current will affect the magnetic field.

Additionally, the strength of magnetic field is affected by the current in wire. Recall, current is affected by resistance, emf, voltage, temperature. Resistance is affected by the the cross sectional area of wire and the length of wire. This affects the strength of magnetic field.

Number of coils around the solenoid also affects magnetic field. More coils means more small magnetic field of the electric charges. This increase the overall magnetic field of the solenoid.

The use of soft iron core also increases magnetic field strength since it is more permeable to magnetic field than air and therefore more magnetic field lines pass through the iron core, making it a higher concentration of magnetic field lines and stronger overall magnetic field since the lines are closer together.



Right hand grip rule related. When two parallel current carrying conductors are placed parallel to one another, the combined magnetic field inside is stronger than the outside. This results in a force acting away from the middle of the two parallel wires which gives rise to repulsive force since the stronger combined magnetic field act towards the weaker magnetic field.

Vice versa, when two current carrying conductors are placed parallel to one another in the same direction, the middle magnetic fields cancel each other out and results in the outer magnetic fields being stronger. The out magnetic field act towards the magnetic field inside which gives rise to attractive forces.

basically like currents in same direction attract, unlike currents in different direction repel. simple.

Use of magnetic field by current in real life

Circuit breaker only ( makes use of magnetic field produced by current )

When switch is on, current flows from t1 to t2 through solenoid and stationary contact. However, when the current is below limit, the magnetic field produced is not strong enough to attract the iron plate. Hence, the circuit is closed. When the current surges above the limit of 20A, the magnetic field produced around the solenoid is strong enough to attract the iron plate. This causes iron plate to be attracted and then the compressed spring to be released which forms open circuit.

Fleming left hand rule need to state which finger is what.  Current is represented by the middle finger, external magnetic field represented by the index finger and the magnetic force exerted on the moving charge in external magnetic field is represented by the thumb. They are all mutually perpendicular. Since the forces are mutually perpendicular to one another, the magnetic force is …..

When moving charged particle is in external magnetic field between two unlike poles, a magnetic force is produced since the side of magnetic field of charged particle in same direction as the magnetic force from north to south pole will combine magnetic fields and have a stronger magnetic field and act towards the weaker magnetic field. The weaker magnetic field is due to opposite direction magnetic fields between the two poles and the moving charged particle.

The charge of the particle, the direction of current and the direction of external magnetic field affects the magnetic force produced on the charged particle.

Positive vs negative charge is opposite direction in magnetic force

Real life application include the use of dc motor

In dc motor there is a dc supply, potential divider, switch, carbom brushes, rectangular coil and permanent magnets.

Rectangular coil is mounted over the axle and each end of the rectangular coil is connected to one part of the split ring commutator. The split ring commutator is lightly touching the carbon brushes.

When switch is closed, current flows in the circuit. Due to fleming left hand rule, an upwards magnetic force is exerted on the right side of the rectangular coil. A downwards magnetic force is exerted on the left side of the rectangular coil. As the rectangular coil is horizontal, it experiences maximum moment about the axle. This causes it to rotate in an anticlockwise direction about the axle. As it reaches vertical position, the split-ring commutator is no longer in contact with the carbon brushes. This forms open circuit. However, due to momentum of the rectangular coil, the rectangular coil continuously rotates anticlockwise. As the carbon brushes touch the split ring commutator again, the current is reversed by the split ring commutator. The split ring commutator reverses the current every half a revolution when rectangular coil is vertical. This ensures the current always flows in same direction through the side of the coil near the north pole and downward force is always acting on the north pole. Hence, allowing the rectangular coil to rotate continuously.

When rectangular coil is vertical, the moment is 0 due to fleming left hand rule. Take ur hand and see lol. Hence, if no split ring commutator it will just oscillate about the vertical plane and eventually rest in vertical position.

The speed of coil rotating can be alterd by increasing current through several factors see above. Rheostat also used to adjust the current flowing in circuit.

now what happens if you do not have the split ring commutator. instead you have a complete ring. well recall what a split ring commutator does, it reverses the direction of the current every half a revolution. this allows a continuous clockwise or anticlockwise moment to be produced on the coil, allowing it to move in single direction continuously. if you have no split ring, the coil will just remain vertical. this is because at vertical, there is current still flowing through the coil. hence, there is still two forces of equal magnitude acting in opposite direction. this means tha the coil will remain in eqm. hence, remaining vertical.

Electricity

Current

Rate of flow of charge

Unit ampere: A

Formula A=Q/t, where q is charge in coulombs and t is time in seconds

Also I = v/R

Conventional vs electron flow

Conventional current is the flow of positive charges from the positive terminal to the negative terminal.

Electron flow is the flow of electrons from the negative terminal to positive terminal

In series, current is constant throughout the circuit

In parallel, current splits into two depending on resistance and recombines at the end of two parallel connections

Electromotive force

Amount of work done by a source to drive a unit charge around the circuit

Unit voltage V

Formula V=j/c or V=RI

when asking to relate two units for voltage, use joules and coloumb not resistance and current because this is ohms law. not everything obeys v=ri but everything obeys j/c.

In series, the electromotive force in circuit will be the total potential difference of components added together

In parallel, the voltage of each component is equal to the electromotive force

Potential difference

Amount of work done to drive a unit charge across a component

Unit: V=RI or V=J/C

Difference between electromotive force and potential difference lies in the definition of both.

In series, the sum of potential difference is equal to the electromotive force

In parallel, the voltage is equal to electromotive force

In circuits with the Vout, to find vout simply take the R/r1+r2 multiplied by the emf of circuit

Potential difference created allows current to flow. Can be applied in two charged spheres in contact. So long as there is potential difference, there is current.

Resistance

Resistance is the ratio of potential difference to current flowing in a component.

Unit ohms

Formula r=v/I or r=v^2/p or r=pl/a

In series, the total resistance in circuit is the sum of the each resistor placed in series to one another

In parallel, the effective resistance is 1/rt=1/r1 +1/r2……

Ohms law states that current passing through a metallic conductor is directly proportional to the potential difference across it, provided physical conditions remain constant. this means that the current will be linear to the potential difference. this law neglects temperature and simply assumes temperature remains constant since the heating effect of current will always cause temperature to increase which would result in increase in temperature

Non-ohmic conductors are not linearly related. When the temperature increases, resistance increases, this gives an exponential graph. Non-ohmic conductors include filament lamp and semiconductor diode(only allows current to flow in one direction). anything that gives out light or heat is considered non ohmic since when current increases, device will generate heat due to heating effect of current. This would result in increase in temperature which would cause resistance to increase, leading to an exponential graph

Symbols of things in a circuit (test yourself)

Switch

Cell

Battery

Dc supply

Ac supply

Light bulb current flows both ways

Potentiometer vary voltage

Rheostat vary current

Fixed Resistor

Light dependent resistor current both direction

Thermistor current flows both direction

Semiconductor diode allows current to flow in one direction only

Light emitting diode allows current to flow in one direction only

Semiconductor diode device that only allows current to flow in one direction. hence, very little current or negligible current flows when current in another direction is used. It is considered a non-ohmic conductor.

Potentiometer is basically a line of resistors. Slide the contact to vary resistance.

Explanation in exam : when contact slides, resistance wire increases which increases resistance in circuit, decreasing flow of current in circuit since current is inversely proportional to the resistance. Its always first connected to the battery or the cell to vary the total voltage in circuit. Potentiometer can be used as a rheostat since it is used to vary the voltage in circuit. So if the voltage In the circuit is 0, that means no work done to drive a unit charge round the circuit. hence, no current flow since there is no charge that flows.

Rheostat is used to vary the current. When using rheostat, the current can still flow is just how much. This means that a device attached to it is never completely turned off but rather in lower power mode since smaller current is flowing into it.

Input transducers convert non electrical energy to electrical energy. They include the use of thermistors and light dependent resistors

Output transducers convert electrical energy to non electrical energy. Light emitting diode

Dangers of electricity

Damaged insulation

Insulating materials can become worn with time and expose conducting wires. These conducting wires are then intact with metal external casing which can cause electrical shocks.

Overheating of cables

Overloaded power sockets causes unusually large current to flow. Due to the heating effect of current, there is an increase in heat which can lead to electrical fire. Power sockets usually in parallel to one another. This means that the current going into power sockets are high. Due to heating effect of current blah blah overheat and start electrical fire. Main thing is Heating effect of current.

Why parallel current so high. Simply put it. each device attached to the circuit means that the voltage will be equal to the electromotive force. Hence, more devices, higher voltage. Since voltage is proportional to current, increase in voltage in parallel means increase in current

Inappropriate wires

Resistance is inversely proportional to flow of current. The thickness of wire needs to be carefully measured to prevent overheating. When resistance increase, current decrease. When resistance decrease, current increase. The surge In current means overheat

damp environments

water with uninsulated wires provide conducting path. Large current flows through path of less resistance which is the water which can cause electric shock to person.

Solutions

Double insulation

Electric cables are insulated from internal components of appliance, internal components are insulated from external casing. If insulation of electric wires become faulty, the conducting wires will not be exposed since the electric wires will touch the other layer of insulation. Used if there Is no three pin plug.

Circuit breaker

Switch off circuit when current surges. If current exceeds the rating, the circuit will trip. This is applied in magnetism in terms of electromagnetism. When current surges above the circuit rating, the magnetic field produced by the solenoid will be large enough to attract the iron core. And then refer to magnetism for more

Earthwire

Provides a path of LEAST resistance for electric current to flow. This causes a short circuit since the circuit has such low resistance suddenly. Since current is inversely proportional to resistance, the current will surge. This will either blow the fuse in the pin or cause a trip in circuit breaker.

Fuse

Must be replaced after it blows. Short piece of wire than is thin so when a large current flows, it melts due to heating effect of current. Rated value must be slightly above the normal operating current. Ratings are whole number 1.0 2.0 3.0 12.0 A

Switches break or complete circuit, connected to live wire