1A-The Scientific Endeavor

What is Science?

- Study of the natural and physical world,unconfined to laboratory
- Different from other ways of learning because of the way its done
- Relies on testing ideas with evidence gathered from natural world
- Scientific knowledge subjected to change

Positive attitudes in science

1. Curiosity–Questioning what happens around him/her
2. Integrity–Making truthful observations
3. Perseverance–Sticking to the truths and facts till discovery is proven, not giving up
4. Creativity–Thinking out of the norm, not easily influenced by others beliefs
5. Open Mindedness–Willing to accept critique,ideas from others
6. Objectivity–Following the facts, not influenced by what is widely accepted

The scientific method

- Process that acquires facts and knowledge through testing hypothesis
    - Characterised by the use of experiments to gather observations to test hypotheses

- Carrying out fair experiments help minimise bias when testing,often non linear and iterative

Stage	Process
Identify the problem	Question that can be solved through experimentation is developed
Observations, research	Preliminary info gathered through observations/research
Formulate hypothesis	Hypothesis is proposed to solve the question
Test hypothesis with experiment	Experimental procedure is developed and followed. Data collected must be reproducible by others, preferably measurable
Collect data, analyse results	Data and observations recorded, organised, usually in table. Statistical methods, graphs used to help. Results confirmed by retesting.
Draw conclusion	Statement that accepts/rejects hypothesis made, using data, analysing results to provide explanations
Report results,share findings	Submit formal reports to scientific journals. Through these publications, scientists share their experiments and findings with others, allowing them to learn from others.

Designing a fair experiment

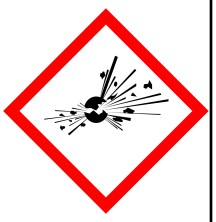
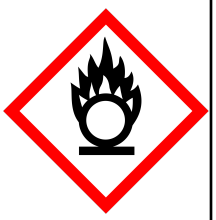
- Experiment where only independent variable is changed while keeping conditions same
- It is important to identify and control variables
  - Variables are factors which have effect on the experiment
    - Independent variable (AKA Change Variable)
    - Dependent variable (AKA Measured Variable)
    - Control variable (AKA Control Variable,or the variable that remains the same)

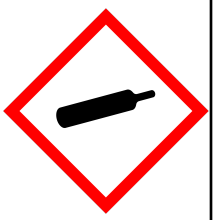
Lab safety rules

1. Students must not enter the lab unless teacher is present
2. Lab prep rooms out of bounds to students
3. Front and Back doors to be kept open
4. Know location and use of fire extinguishers,fire blankets, safety showers,eyewash devices, first aid kit
5. Do not perform unauthorised experiments

6. Do not remove anything from the labs
7. All bags to be placed in a designated area
8. Eating and Drinking is prohibited
9. Pranks and Horseplay prohibited
10. Wash all used apparatus
11. Securely replace lids,caps and stoppers
12. Do not proceed when in doubt
13. Understand all instructions
14. Read labels on reagent bottles before doing anything
15. Do not taste/smell chemicals
16. Do not touch chemicals unless told to do so
17. Do not return unused chemicals to original containers to avoid contamination
18. Wear goggles when handling chemicals
19. Keep flammable substances away from naked flames
20. Only heat up what lab procedure indicates
21. Learn how to use the bunsen burner
22. Do not point an open end of a test tube toward yourself
23. Do not reach over a bunsen burner
24. Always extinguish the flame when burner is not used
25. Report and record breakages,spillages and accidents immediately
26. Throw sharp waste objects in the correct bin
27. If chemicals get in your eye wash with lots of water
28. Treat burn with running water
29. Clean up any spill
30. Ensure all gas taps air valves and water taps turned off
31. Return apparatus to proper storage places
32. Wash hands before leaving lab
33. Dispose waste in correct bins
34. Never throw solids or corrosive liquids into the sink

Symbol	Type of hazardous substance	How to handle
	Flammable Catches fire easily Examples include kerosene and alcohol	-Wear safety goggles -Keep away from naked flames,sparks and oxidising substances

	Corrosive Substance may cause severe damage to body parts Examples include hydrochloric acid and nitric acid	-Wear gloves and safety goggles -Avoid direct skin contact as it can cause burns -Rinse with water immediately if it spills
	Acute toxicity Substance causes harmful effects when swallowed, breathed or skin contact Examples include mercury, cyanide	-Do not breath,ingest or allow to come in contact with skin or eyes -Wear gloves and safety goggles -Handle chemical in fume cupboard
	Harmful or irritant Substance causes irritation to eyes, respiratory system and skin Examples include bromine	-Do not breath,ingest or come into contact with skin/eyes -Wear gloves and safety goggles -Handle chemical in cupboard
	Explosive Substance causes explosion upon contact with heat Examples include flash powder	-Avoid ignition sources,keep your distance and wear protective gear -Illegal to carry out unauthorised experiments with these
	Oxidising substance Substance releases oxygen easily which causes fire and explosion Examples include fluorine	-Wear gloves and safety goggles -Do not breath, ingest or allow it to come into contact with skin or eyes
	Carcinogenicity/Aspiration Hazard Substance may damage organs and cause cancer and breathing difficulty Examples include uranium	-Wear gloves and safety goggles -Do not breath, ingest or allow it to come into contact with skin or eyes

	Environment toxicity Substance harmful to the environment Examples include zinc	-Do not release into environment without appropriate disposal methods
	Gas under pressure Substance may explode when heated or cause breathing difficulties when leaked in enclosed spaces Examples include hydrogen	-Avoid contact with naked flame heat sources -Ensure sufficient air ventilation

Base quantities

- Set of independent physical quantities
- SI units of base quantities are called base units
- All other physical quantities come from the multiplication/division of 2/more base quantities

Base quantity	SI unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A

Prefix	Standard form	Factor
Mega (M)	$1x10^{6}$	x1000000
Kilo (k)	$1x10^{3}$	x1000
Deci (d)	$1x10^{-1}$	Divide 10
Centi (c)	1×10^{-2}	Divide 100
Milli (m)	$1x10^{-3}$	Divide 1000

Micro (u)	$1x10^{-6}$	Divide 1000000

Mnemonic for the Above
Great **M**ighty **K**ing **D**ied **D**rinking **C**hunky **M**ilk **M**onday **N**ight
Giga, Mega, Kilo, Deca, deci, centi, milli, micro, nano

Lab apparatus

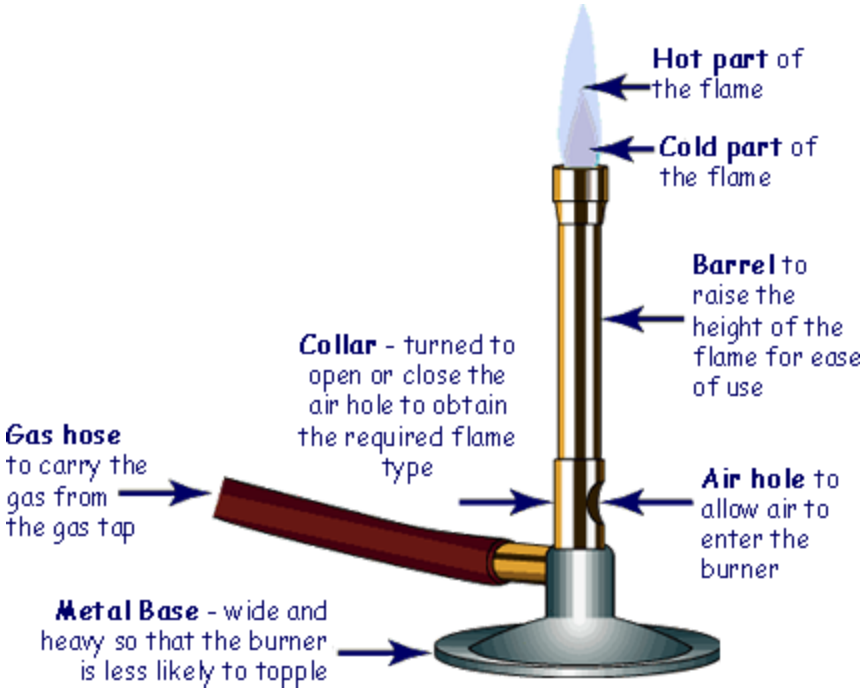
- Mass (kg)-Electronic Balance, (0.01g)
- Time (s)-Digital Stopwatch (0.01s)
- Temperature (K)-Thermometer (0.5C)
- Volume (m^3)-Beaker (approximate only), Measuring Cylinder(0.5cm^3) , Burette(0.05cm^3), Pipette(0.1cm^3)
- Volume of gases(m^3)-Gas Syringe(0.5cm^3)

Others

- Mortar and pestle-Grind solid chemicals into powder
- Gas jar-Collect gases
- Test Tube rack-Hold test tubes in upright position
- Test Tube Holder-Hold test tube while heating or pouring chemicals
- Test Tube-Contain small amounts of matter
- Round Bottomed Flask-Allow for more uniformed heating of liquid, more resistant to fracturing
- Retort Stand-Support an apparatus during an experiment
- Tripod Stand-Support apparatus during heating
- Evaporating Dish-Container for small volume of liquid to evaporate
- Filter Funnel-Hold filter paper
- Boiling Tube-Contain/heating small volumes of liquid
- Crucible–Heat solids over a flame
- Flat Bottomed Flask-Holding and mixing chemicals
- Conical Flask-Containing and mixing chemicals
- Wire Gauze-Placed on tripod stand to support apparatus and spread heat evenly during heating

Bunsen Burner

- Used for heating in science lab



- Turn collar to close air holes
- Hold lighter over top of barrel
- Turn on gas tap and click lighter
- Open air hole to obtain a steady blue to heat substances
- To turn off a bunsen burner turn off the gas tap
- With no gas supply the flame will go out immediately
- Type of flame obtained depends on airflow through the air hole
- When air hole is opened air is drawn into barrel where it mixes with natural gas,this ensures complete combustion due to excess oxygen
- Methane+O_2=CO_2+Water
- Hot and steady blue flame is produced, known as the non luminous flame
- When the air hole is closed natural gas can only mix with a limited supply of air at the mouth of the barrel
- Incomplete combustion occurs due to limited supply of oxygen to support combustion
- Methane+O_2=Carbon Monoxide+Carbon+CO_2+Soot+Water
- Yellow/Orange flame is produced, known as the luminous flame, called safety flame cause others know bunsen burner is lighted
- Yellow flame is brighter than the blue flame because the specks of soot glow when heated
- Luminous Flame is bright and visible unlike a Non Luminous Flame
- Luminous Flame is obtained when closing the air hole unlike a Non Luminous Flame
- Luminous Flame is yellow/orange in colour unlike a Non Luminous Flame which is blue

- Luminous Flame produces a lot of soot unlike a Non Luminous Flame
- Luminous Flame is flickering and unsteady unlike a Non Luminous one which burns steadily
- Luminous flame is not as hot as a Non Luminous Flame

To heat a test tube using bunsen burner

- Make sure there are no loose hair,clothes or flammable stuff nearby and wear safety goggles
- Fill test tube to about ⅓ full
- Place test tube holder about 2 cm below top of test tube
- Hold the test tube at an angle of 45 degrees.
- Make sure mouth of test tube is pointed away from people
- Heat test tube with non luminous flame
- Move test tube back and forth across the flame

To heat a liquid in a beaker

- Make sure there are no loose hair, clothes or flammable substances nearby
- Wear safety goggles
- Put wire gauze on stand
- Place the beaker on it
- Close air hole and light bunsen burner
- Open air hole to obtain the Non Luminous Flame
- Turn off bunsen burner when liquid reaches the required temperature

1B1

Why are accurate measurements important?

- 5 senses limited and unreliable
- Measuring instruments help us make accurate measurements giving us accurate results
- Technological advancements have helped man extend observations beyond 5 senses

Measurement of length

- Length is the distance between 2 specific points
- SI unit is metre

Instruments for measuring length

- Retractable Measuring Tape (measures several metres)
- Metre Rule (measures several cm)
- Flexible Measuring Tape (measures several cm)

- Digital Calipers (measures up to 15 cm)
- Digital Micrometer Screw Gauge (up to 2.5 cm)

Metre rule

- Commonly used measure length with precision of 1mm or 0.1cm
- Precision of measuring instrument is limited by the smallest division on its scale

Parallax error

- Error in a measurement due to eye not being in correct position when taking reading
- To ensure accuracy of measurement eye must be positioned vertically above the mark
- Always take reading by positioning observing eye directly above the markings on the ruler
- When measuring length using the metre rule put one end of the object at zero mark unless zero mark is blunt

Measuring tape

- Commonly used to measure large round objects eg circumference of tree or long distances eg width of a room
- Precision is 1 mm/0.1 cm
- Function of metal tip attached at 0 mark is to prevent wear and tear
- Thus the measuring tape will be more accurate when taking measurement from 0 mark

Internal callipers

- Used to measure internal diameter of circular hollow object
- Precision of internal callipers depends on type of rule used

External callipers

- Used to measure External Diameter of circular hollow object
- Precision of External Calipers depends on type of ruler used

Digital Calipers

- Very precise instrument for measuring internal and external diameters of hard object
- With jaws of instrument its useful for measuring external/internal diameter of cylindrical objects eg pipe/test tube
- Can measure to precision of 0.01 mm or 0.001 cm
- However to account for sources of error we can record measurements to 0.1cm or 0.01cm

Digital micrometre screw gauge

- Useful for measuring small lengths like diameter of ball bearings
- Measures to precision of 0.001mm
- To account for sources of error record measurement to 0.01 mm
- Turn thimble till anvil and spindle touch object
- Turn ratchet till it clicks
- Ratchet prevents tightening of object

1B2

Measuring area

- Area is the measure of the size of a surface
- SI unit is square metre
- Area of regular 2D plane surfaces calculated using formula
- l=length, b=breadth, h=height, pi=calculator pi, r=radius
- Area of square=l x l
- Area of rectangle=lxb
- Area of circle=pi x(r squared)
- Area of parallelogram=bxh
- Area of trapezium=½(a+b)x h
- Area of triangle=½ b x h

Finding area of irregular 2D plane surfaces

- Can be estimated using small unit squares of known areas and counting the units
- Place irregular plane surface eg leaf on graph paper
- Draw outline of irregular surface on graph paper
- An incomplete unit square lying in outline is counted only if ½ or more lies in outline

1B3

Measurement of volume

- Volume refers to the amount of space an object occupies
- SI unit is m^3
- Other units include ml and l
- 1l=1000ml,where 1ml=1cm^3,therefore 1l=1000cm^3

Measuring volume of liquids

- Place measuring cylinder on flat surface

- Pour liquid into measuring cylinder
- For most liquids meniscus curves down
- Place eyes as same level as bottom of meniscus, except is mercury which curves up
- Precision is half of smallest interval

Accuracy when reading volumes of liquids

- Place container on flat horizontal surface to ensure meniscus is parallel to surface
- Liquid level can be read correctly
- Position eyes perpendicular to markings of scale and read meniscus at eye level
- This ensures there is no parallax error
- There is no such thing as meniscus error

Instrument for measuring volume of liquid

- Beaker (for approximate volume only)
- Measuring cylinder (more precise than beaker)
- Burette (measures variable volumes precisely)
- Pipette (measures fixed volume precisely)

Volume of regularly shaped solid objects formula

- Cube=lxlxl
- Cylinder=pi x r^2 x h
- Cone=⅓ pi x r^2 x h
- Sphere=4/3 x pi x r^3
- Container=l x b x h

Measuring volume of small irregularly shaped solid that sinks

- When solid object is placed into measured volume of water the volume of water that rises is volume of object
- Procedure is to partially fill measuring cylinder with water
- Read initial volume v1
- Fully submerged object
- Read final volume v2
- v2-v1=vol of object

Measuring volume of large irregularly shaped solid objects that sinks

- Fill eureka can with water till excess water flows out
- Remove beaker when excess water stops flowing
- Place empty measuring cylinder below spout of displacement can
- Tie irregularly shaped object with string
- Lower it gently into displacement can till it is fully immersed in water

- When excess stops flowing into measuring cylinder, observe and record vol of water displaced by object v collected in the measuring cylinder

Measuring vol of small irregular shaped solid that floats

- Immerse sinker fully into measuring cylinder
- Read initial volume v1 of sinker
- Tie object to sinker
- Immerse sinker and object fully in water
- Read final volume v2
- v2-v1=ans

1B4

Mass

- Amount of matter in an substance
- SI unit kilogram
- Measured by comparing unknown mass to a standard mass using beam balance
- Unit tonne is used for big mass (one tonne =1000 kg)
- Gram and milligram used for smaller masses
- Can also use electronic balance

Weight

- The gravitational force acting on an object
- Acts vertically downward towards the centre of earth
- SI unit is Newton
- Measured by amount of gravitational force acting on the body
- Force metre/spring balance/compression balance can be used
- Weight of an object is dependent on its mass
- Weight=Mass x Gravitational Field Strength(GFS)
- Gravitational Field Strength(GFS) tells us how strong is the gravitational field
- GFS is 10 N kg-1 on earth

Density

- Mass per unit volume
- Density=mass divided by volume
- SI unit of density is kg/m^3
- Can also use g/cm^3
- A ship made of iron is able to float as average density of the ship also includes the air in the ship

- Ship sinks if there's a hole as water flows in and air goes out, increasing average density of the ship
- Average Density = total mass divided by total volume
- Substances with higher density sinks in fluids with lower density
- Substances with lower density floats in fluids with higher density

1B5

- Time is a dimension where events can be ordered from the past to the present to the future, measuring the duration of events and the intervals between them
- Time is a quantity with SI unit of seconds(s)
- Other units are year, month, day, hour(h), minute(min)
- All instruments use some kind of periodic motion to tell time
- Digital stopwatches show readings to two decimal places
- Can use mechanical stopwatch, electronic stopwatch for measurement of time

Pendulum

- Oscillation is a periodic to and fro movement of the pendulum bob
- Time taken for pendulum to complete one oscillation(t) is called the period (unit seconds)
- Frequency is the number of oscillations the pendulum makes per second (unit hertz)
- Amplitude is the max displacement of the bob from its resting position
- Use small angle of swing (below 10 degree) so it will not swing out of plane
- Start timing only after a few swings so the oscillations are stable
- Mass of pendulum does not affect period of oscillation
- Length of pendulum affects period of oscillation
- Gravitational Field Strength affects period of oscillation
- Period of the pendulum is T(time)=2 x pi square root length of pendulum divided by GFS
- Equation shows that period depends only length of pendulum and GFS
- Factor in Human reaction time,around 0.3-0.5 s

Rate

- Rate is a comparison between two physical quantities
- Commonly used to measure how a quantity changes over time

1B6

Distance

- Total length covered by moving object, irrespective of direction of motion
- SI unit metre (m)
- Other units are miles,yards, centimetres, kilometres and light years
- Light years is the distance taken for light to travel in a year around 9.46 x 10^{15}

Displacement

- Straight line distance covered from a point
- Direction needs to be specified
- SI unit metre (m)

Speed

- Rate of change of distance
- Measurement of how fast or slow something is moving
- SI unit metre/second (m/s)
- Another common unit is km/h
- Instantaneous speed is the speed of an object at a particular instant
- Average speed = total distance travelled divided by total time taken to travel
- Allows you to estimate how distance changes over time

Velocity

- Rate of change of displacement
- Measures speed in a specific direction
- Constant speed in same direction=constant speed
- Constant speed direction changed=velocity changed
- Average velocity is total displacement divided by total time taken

Ticker tape timer

- Electrical device that makes use of oscillations of a steel strip to mark intervals of time
- As the strip vibrates 50 times/second 50 dots are made in 1 second

2 Exploring Diversity of Matter by Physical Properties

Matter

- Anything that has mass and occupies space

- Made up of atoms which are made up of protons, electrons and neutrons
- Exists in four states, solid, liquid,gas and plasma (out of syllabus)

Classification

- A process of grouping substances based on their chemical or physical properties
- Objects are recognized and differentiated based on their properties.
- Matter used for making objects is termed as a material

Physical and Chemical properties

- All matter has their own unique properties
- Physical properties can be observed by the five senses without changing the composition of the material,Examples are volume, mass, density, melting point, boiling point
- Chemical properties describe the ability of a substance to react to form new substances,Examples are flammability and resistance to corrosion

Physical and chemical changes

- Matter constantly changes physically and chemically
- Physical change involves change in physical property but not chemical composition,Often reversible,No new product formed
- Examples are change of states, expansion and contraction
- Chemical changes involve change in the chemical property and change in chemical composition of substances,happens as two or more particles interact to form new bonds between particles, irreversible, new product(s) formed
- Examples are respiration, photosynthesis, fireworks, burning of fuels and cooking

Physical properties of materials

Density

- Density of a material is often a characteristic physical property of the material
- High density materials like lead are used to make sinkers to sink

Strength

- Ability to support a heavy load without breaking
- Steel and concrete are strong materials used for building stuff like skyscrapers

- Most pure metals are weak but can be made stronger by combining with other materials or non metals to form alloys

Hardness

- How resistant a solid matter is to various kind of permanent shape change when a force is applied

Flexibility

- Ability to bend without breaking and return to original shape and size after bending
- The larger the force needed to bend a material to a certain distance, the less flexible it is

Electrical conductivity

- Measure of how readily an electric current flows through it
- Materials that allow electricity to flow easily are electrical conductors, Examples include metals
- Materials that do not allow large currents to flow through them easily are classified as electrical insulators,Most non metals except graphite are good electrical insulators

Thermal conductivity

- How readily heat flows through a material
- Good conductors and bad conducts,like metal is a good conductor unlike wood

Melting and Boiling points

- Melting point is the temperature at which the substance changes from solid to liquid
- Boiling point is the temperature at which the substance changes from liquid to gas

	Metals	Ceramics	Glass	Plastics	Fibres
Density	Generally high	Medium	High	Generally low	Low
Ductility	Ductile	Non Ductile	Non Ductile	Non Ductile	Non Ductile
Electrical conductivity	Conductor	Insulator	Insulator	Insulator	Insulator

Flexibility	Flexible	Inflexible	Inflexible	Varied	Flexible
Hardness	Varied	Hard	Hard	Varied	soft
Malleability	Malleable	Malleable before firing	Malleable at high temp	Malleable before solidify	Non Malleable
Strength	Varied	Fairly strong	Fairly strong	Varied	Strong
Thermal conductivity	Good conductor	Poor conductor	Poor conductor	Poor conductor	Poor conductor
Melting and Boiling points	High	High	High	Varied	Cannot resist high temp

3-Exploring Diversity of Matter by its Chemical Composition

- Matter can be classified by its chemical composition
- Elements are the basic building blocks of matter
- Shows all the elements in an organised manner
- Elements classified as metals and non metals
- Elements in the same vertical columns belong in the same group and have similar chemical properties
- Elements in the same horizontal rows belong to the same period
- Elements left of the Hay-McDaniels line are metals and vice versa for the right
- Metals and nonmetals have distinct properties
- Conserve metals as they are finite

Chemical symbols of elements

- Each symbol consists of one or two letters
- Each element in the periodic table has its own symbol
- Each symbol begins with a capital letter
- If a symbol has 2 letters, the first letter is a capital letter while the second letter is a lowercase letter

Compounds

- A compound is a pure substance made of two or more elements chemically combined in a fixed ratio
- Have different properties from the elements they are formed from
- Made of either molecules or ions
- Ions are electrically charged particles, negatively or positively
- Water (H_2O) is a compound made of 2 hydrogen atoms and one oxygen atom
- Since compounds are formed by chemical reactions, it is not possible to break them down into the elements that formed them
- However they can be broken down by chemical means like light, heat or electricity

Representing Compounds with Chemical Formulae

- A compound can be represented by a chemical formula
- Formula shows the symbols of the elements present in the compound and the ratio of the different atoms present

Mixtures

- Mixture is an impure substance made up of two or more substances that are not chemically combined
- Can be mixed in any ratio
- Made up of either two or more elements,two or more compounds,or one or more elements and compounds

Classifying mixtures by how particles are distributed

- Homogeneous mixtures(particles are evenly distributed) (solutions)
- Solutions are mixtures where one substance is soluble/ can dissolve in another substance (called the solvent)
- When solute dissolves in a solvent a solution is formed
- Heterogeneous mixtures(particles are unevenly distributed) (suspensions)
- Mixture which one substance is insoluble/cannot be dissolved

Difference between solutions and suspensions

Solutions	Suspensions
Light passes through the mixture	Light largely scattered in random directions
Homogenous mixture	Heterogenous mixture

Cannot be separated by filtration	Can be separated by filtration

Describing solutions

- Can be described as dilute, concentrated or saturated depending on how much solute is dissolved in the solvent
- Limit to amount of solute that can dissolve in a fixed amount of solvent, called solubility of the solute,neg sugar(solute) is very soluble in water(solvent)
- This means solubility of sugar in water is very high, and a large amount of sugar can dissolve in a certain volume of water
- Chalk powder is only slightly soluble in water
- This means solubility of chalk powder in water is low, and only a small amount of chalk powder can dissolve in the same volume of water
- Dilute(a little solute dissolved)
- Concentrated(decent amount of solute dissolved)
- Saturated (most amount of solute dissolved)

Factors affecting solubility

- Nature of the solvent
- Nature of the solute
- Temperature

How do we measure solubility

- Measure maximum mass of solute that can be dissolved in a fixed volume of solvent at a particular temperature
- Temperature affects solubility, meaning different masses of solute can be dissolved at different temperatures
- Hence solubility curve is used to show the max mass of solute that can be dissolved at each temperature

Factors that affect rate of solubility

- Temperature,the higher the temperature, the faster a solute dissolves
- Particle size of solute,the smaller the size of solute particles, the faster the solute can dissolve because the smaller particles have a larger surface area in contact with the solvent
- Rate of stirring,the faster the rate of stirring the faster the solute can dissolve

4. Separation Techniques

- Many substances around are mixtures eg air, sea, water and petroleum
- Must separate these mixtures to make use of these substances
- Use physical separation to separate mixtures into components,no chem reactions involved
- Technique depends on physical properties of substances in mixture and substance to be obtained

Solid liquid mixture

Filtration

- Separate insoluble solid from a liquid in solid liquid mixture,based on the size of solid and liquid particles
- Solid particles bigger than holes in the filter paper and cannot pass through,while Liquid particles smaller than the holes of filter paper and pass through
- Residue is solid collected on filter paper,while filtrate is liquid that passes through filter paper
- Pass mixture through filter paper
- Insoluble solid obtained as residue while liquid is obtained as filtrate

Evaporate to dryness

- Obtain soluble solid that is thermally stable (does not decompose on heating) from solution,based on boiling point of substances of solution
- Solute has a higher boiling point than the solvent
- All of solvent would evaporate at its boiling point leaving solid solute behind
- Heat solution in evaporating dish over wire gauze and tripod stand bunsen burner till all water boil off
- Not suitable for obtaining a solid that decomposes when heated
- Sodium chloride is the common solute as it is thermally stable
- Most substances break down into simpler substances when heated strongly,eg sugar decomposes to form carbon and water when heated
- Some salts like copper (II) sulphate give off water to become a dry powder (anhydrous salt),for such substances don't use this method
- Not suitable for obtaining pure dry solid, because after evaporation any soluble impurities initially present will be present in solid residue

Crystallisation

- Obtain soluble solid that decomposes on heating from its solution
- Solubility of solid substance decreases with temperature

- When solution is heated to saturation and allowed to cool lesser solute can dissolve over time so crystals solute are formed
- Heat solution till its saturated
- Cool saturated solution allowing crystals to form
- Filter mixture to obtain crystals as residue
- Wash residue with cold distilled water
- Dry crystals with filter paper
- Tripod stand bunsen burner wire gauze for setup

Simple distillation

- Obtain pure solvent from a solution,based on boiling point of substances of the solution
- Solute has higher boiling point than solvent,Solvent made to boil leaving solute behind
- Solvent vapour escapes and passes into cooler environment of condenser,vapour loses heat and changed to pure liquid
- Bulb of thermometer is placed beside side arm of distillation flask,ensures thermometer measures boiling point of substance that enters condenser
- Cold water made to enter from bottom and leave from top of condenser,ensures temperature at bottom of condenser is coolest for efficient cooling and water jacket is filled
- Boiling chips added to ensure smooth boiling
- If distillate is volatile (with low boiling point, thus the liquid easily changes to gas at room temp), conical flask is put in large container filled with ice to prevent loss by evaporation from distillation flask

Solid solid mixture

Magnetic attraction

- Magnet can be used to separate a magnetic substance from non magnetic material,but not all metals are magnetic
- Examples of magnetic metals are iron, steel, nickel
- Example of use is salvaging iron and steel and food processing

Sublimation

- Separate mixture of solids if one of the solids sublime (process where solid goes to gas state)
- Examples are iodine, dry ice mothballs and ammonium chloride
- Based on ability of some substances to sublime
- Heat mixture in evaporating dish
- Invert filter funnel to allow gaseous iodine to solidify on cooler side of funnel

Using a suitable solvent

- Separate mixture of two solids in which only one solid is soluble
- Based on ability of a solvent to dissolve some solutes but not others
- For obtaining a thermally stable solid using example of solid salt-sand mixture
- Obtain salt add distilled water to mixture and stir to dissolve salt
- Filter mixture to obtain sand as residue and salt solution filtrate
- Heat filtrate to dryness to obtain salt crystals
- For obtaining thermally unstable solid using example of solid sand sugar mixture
- To obtain sugar add distilled water to mixture and stir to dissolve sugar
- Filter mixture to obtain sand as residue and sugar solution as filtrate
- Heat filtrate to saturation
- Allow hot saturated solution to cool for crystals to form
- Filter mixture to obtain crystals as residue
- Wash crystals with cold distilled water
- Dry crystals between sheets of filter paper

Separating liquid liquid mixtures

Using separating funnel

- Used to separate immiscible liquids
- Immiscible liquids cannot dissolve in each other,hence when present together in a mixture they separate into distinct layers
- Different immiscible liquids have different densities
- Pour mixture of oil and water into separating funnel,allowing liquids to separate completely,which may take some time
- Denser liquid will be the bottom layer
- Place clean beaker below separating funnel
- Open tap of funnel to allow bottom layer to drain into beaker
- Close tap before top layer of liquid runs out
- Open tap of funnel to allow interface layer to drain into beaker
- Close tap before top layer of liquid runs out
- Now separating funnel only contains oil while beaker only has water

Fractional Distillation

- Separates miscible liquids by boiling points.
- Fractionating column with beads condenses high boiling liquid
- Low boiling liquid vapour rises and condenses in a condenser.
- In water-ethanol mixture, water condenses, ethanol distils over.
- Ethanol's lower boiling point allows separation.
- Condenser cools and collects ethanol distillate.

Use of fractional distillation in industry

- Separate liquid air into various component gases like pure oxygen
- Separate petroleum(crude oil) into its various fractions (eg petrol,naphtha,diesel)

Paper chromatography

- Method to separate solvents in a solution,depends on their solubility
- More soluble parts move faster and farther up the paper
- Mixture drop is placed on a pencil line at paper's bottom
- Dipped into a solvent-filled tube, letting components move at different speeds and separate
- Solvent's front reaching the top yields a chromatogram
- Pencil's used for the line to avoid ink interference
- Line's above the solvent, and a small sample is used to avoid overlapping spots
- Lid prevents solvent evaporation during the process

Uses of chromatography

- Separate and identify the components presents in coloured substances and food dyes
- Separate and identify substances in drugs
- Separate and identify in blood and urine to check steroids in athletes

Using chromatograms to identify substances

- Run mixture together with known components (standards) and compare distance travelled
- Alternatively we can compare their rf values with known rf values of suspected substances using the same solvent
- Ratio between distance travelled by a given substance and distance travelled by solvent is known as retention factor (rf)
- Formula is rf=distance travelled by substance/distance travelled by solvent
- Through distance travelled by substance and solvent are affected by how long chromatogram is run rf value of a substance does not change as long as carried out under same conditions
- When chromatogram is run for colourless substance locating agent is used
- Locating agent is substance that reacts with substances on chromatogram to produce a colourless product visible to the naked eyes

How do we determine the purity of substance?

- Pure substance has fixed melting and boiling point

- Impurity will affect melting point in 2 ways
- Lowers the melting point the greater the amount of impurity the lower the melting point or the substance melts over a range of temperatures
- An impurity will affect the boiling point of a substance in 2 ways
- Increases boiling point, greater the amount of impurity the higher the boiling point
- Substance boils over a range of temperatures
- To determine purity of substance in a lab measure its melting point or boiling point
- If a substance is pure it will have a fixed boiling point and melting point,if impure it will melt and boil over a range of temperatures

5. Taxonomy

Introduction

- Living things called organisms,sharing characteristics of respiration, nutrition, metabolism, excretion, sensitivity, movement, reproduction, growth

Biodiversity

- Existence of many kinds of organisms on earth,Variety exists between organisms
- Biodiversity important for stability of systems in nature,where different organisms depend on one another
- Coral reefs support 25% of fish in the world

What is Taxonomy?

- Study of scientific identification and classification of living things
- Taxonomists study organisms and identify them based on their characteristics
- Living things with similar characteristics grouped together into categories,this is a classification system
- Classification is the method used by scientists to group organisms according to similarities and differences

Why classify?

- Study diversity of life by providing unique name for each organism
- Grouping them according to how closely related they are in a logical manner

Binomial system of nomenclature

- Originated and published by swedish biologist carl linnaeus in 1735
- Linnaeus binomial system of nomenclature was the 1st international system of classification
- In this system each organism has a scientific name consisting of 2 latinised words
- 1st word denotes genus while the second word designates species
- Species represents the 1st level of classification
- Binomial means 2 names eg Homo sapiens
- 1st letter of genus must be in uppercase and 1st letter of species in lower case
- Both generic and specific names are typed in italic/underlined in written work,eg *Homo sapiens (*typewritten) or Homo sapiens (handwritten)

Taxonomic groups

- In classification species are placed in groupings which in turn are gathered into larger groups
- This is on basis of observed,shared features
- All systems are hierarchical, with each successive group containing more and more different kinds of organisms
- General name for a classification group is a taxon (plural taxa)
- Taxa have been standardised
- This system of classification includes 7 levels
- Species, Genus, Family, Order, Class, Phylum, Kingdom
- Mnemonic King Phillip Came Over For Great Spaghetti

Kingdom

- Largest group containing many organisms with small no. of characteristics in common

Phylum (plural phyla)

- Group of organisms that have similar body plan as they developed

Class

- Taxonomic group comprising of organisms that share a common attribute,further divided into orders

Order

- Rank in classification below class,comprised of families sharing set of similar nature or character

Family

- Rank in classification between genus and order,a group of one or more genera especially sharing a common attribute

Genus (plural genera)

- A group of similar and closely related species

Species

- Small group containing fewer organisms with more characteristics in common,capable of interbreeding to produce fertile offspring,sharing similar characteristics
- Sometimes a species may have different kinds of breeds that show great variation but still in same species, eg over 400 different recognised breeds of pedigree dog

Domain Bacteria

- Contains prokaryotic bacteria with peptidoglycan cell walls (peptidoglycan is complex carbohydrates)
- Unicellular or filamentous

Domain Archaea

- While similar to domain bacteria in some aspects, this domain contains prokaryotic bacteria that lacks peptidoglycan in cell walls
- Archaea possess genes and several metabolic pathways that are more closely related to those of eukaryotes
- Thrive in broad range of habitats including harsh environments

Domain Eukarya

- Organisms here had once been divided into 4 major categories or kingdoms
- They were called protista,plantae,fungi and animalia
- Each eukaryotic cell contains a nucleus in which DNA is surrounded by a nuclear membrane

Kingdom Protista

- Known as protists
- Diverse group of organisms that don't fit into any other groups
- Anything that is not a plant,animal,fungi or prokaryote
- Commonly found in moist environments eg freshwater habitats
- A lot of important diseases caused by this eg malaria
- Examples are algae, amoebas and ciliates
- Species diversity 55000+

Kingdom Fungi

- Has protective cell wall made of chitin (complex carbohydrate)
- Lack chlorophyll and are heterotrophic
- Unicellular or multicellular
- Normally found in moist dark and warm environment which are optimum conditions for growth
- Important group of decomposers which break down dead decaying organisms
- Also used in biotechnology such as brewing and wine making
- Examples are mushrooms, toadstools, yeasts, truffles, moulds
- Species diversity 80000+

What are decomposers

- Organisms that break down complex nutrients in waste materials and dead organisms into simpler nutrients that return to environment
- Decomposition set free CO_2 which escapes into the atmosphere and mineral salts that dissolve in salt water
- Include bacteria and fungi
- Decomposers used during bioremediation to destroy contaminants in polluted soil or water

Kingdom Plantae

- Multicellular and autotrophic organisms
- Majority contain chlorophyll and are photosynthetic
- Possess cell walls made of cellulose and store are photosynthetic
- Classified into 2 main groups–non flowering and flowering plants
- Bryophytes(mosses) are small and short plants as they lack vascular tissue (phloem, xylem)
- Flowering plants important group of plants that bear fruits with seeds and associated with pollen transfer and seed dispersal
- Species diversity 260000+

Kingdom Animalia

- Multicellular and Heterotrophic organisms
- Most animals exhibit high level of tissue differentiation and have nervous system to coordinate body actions
- One of the advantages of tissues is to perform tasks more effectively than individual cells
- One group the sponges don't form the tissues
- Classified into 2 groups
- Vertebrates (animals with backbone) and Invertebrates (animals without backbone)

- Species diversity–800000+

6

Brief Intro to Cell Biology

- Robert Hooke examined thin slices of cork (dead cell walls of plant cells) under microscope
- Described them as made up of hundreds of box like structures
- In 1665 he published micrographia, a book describing the observations made with microscopes and telescopes
- 1st man to witness a live cell under a microscope is Anton van Leeuwenhoek
- In 1674 he discovered microscopic life invisible to human eyes
- Some of his discovery include bacteria,spermatozoa and the algae spirogyra

What are Cells?

- Basic building blocks of life
- Vary in shape,size and structure according to their functions
- Contain hereditary information passed from cell to cell during cell division
- Cells can exist singly as independent unicellular organism showing all characteristics of life or as part of a multicellular organism
- Such cells often differentiated for specific functions

What are Organelles?

- Specialised subunit suspended in cytoplasm of a eukaryotic cell that has a specific function
- Organelles either surrounded by membranes like nucleus or lack membrane like ribosomes

How can we use instruments to study part of the cell?

- Light microscope can be used to view overall shape and structure of cells
- Structures that can be seen include the cell membrane,nucleus,cell wall,cytoplasm,vacuole and chloroplast
- To achieve even higher magnification and resolution electron microscopes can be used
- Cameras fitted to microscope to take pictures called micrographs
- Light microscope compact and portable,unlike the electron microscope which is large and complication

- Maximum magnification x1000 to 1500x for light, electron x500000
- Illuminating source for light microscope is light,electron microscope is electrons
- Focusing screen for light microscope is human eye and film but electron microscope uses TV screen and film
- Light microscope has temporary mounts of either living or dead specimens but tissues must be dehydrated in an electron microscope
- Stains is dyes for light microscope but heavy metals are used in electron microscope
- Support for light microscope is glass slide but electron microscope uses copper grid

Structures of a cell

- Nucleus, Cytoplasm and Cell membrane of a cell make up the living material of the cell called the Protoplasm

Nucleus

- Largest organelle visible under light microscope
- Contains genetic material known as DNA (DeoxyriboNucleic Acid)
- Controls all cell activities such as cell growth and repair of worn out parts
- Essential for cell division
- DNA specially packaged with proteins to form a condensed structure called chromatin
- Chromatin winds itself to form visible structures called chromosomes
- DNA is the hereditary material in the cell passed down from 1 generation to the next
- Information stored in DNA controls characteristics of cell and referred to genetic blueprint of the cell

Structure of DNA

- DNA exists as a double stranded molecule consisting of 2 parallel strands of smaller subunits called nucleotides
- Double stranded DNA will wind up forming a double helix
- Nucleotide made of sugar called deoxyribose,a phosphate group, a nitrogenous base
- 4 types of bases, adenine (A),thymine (T),guanine (G),cytosine (C)
- 4 different bases give rise to 4 types of nucleotides, which join together forming a longer chain called polynucleotide
- The nucleotides are adenine nucleotide (name of 4 bases add the word nucleotide)
- Bases on one strand form bonds with bases on the other strand according to rule of complementary base pairing

- Rule of base pairing is adenine bonds with thymine guanine and cytosine
- Can remember using A Trait Can Grow
- If we know base sequence of 1 strand we will know the other strand
- Ratio of Adenine to Thymine a:t and Cytosine to Guanine c:g always 1:1
- 2 strands of DNA double helix held together with hydrogen bonds between nitrogenous bases contributing to overall molecule stability

What is a gene?

- DNA contains messages instructing cells to make proteins,called genes
- Gene is short segment of dna which controls the foundation of 1 protein
- Carries info determining how a protein should be made in a cell,eg genes provide instructions to produce proteins,haemoglobin found in red blood cells
- Human genome comprised of around 30000 genes

Cytoplasm

- Collective term for organelles suspended within cytosol
- Jelly like substance
- Site of many chemical reactions

Cell surface membrane

- Also known as plasma membrane or cell membrane
- Controls flow of materials in and out of the cell,like a castle wall
- Semipermeable

Vacuole

- Fluid filled organelle enclosed by a single membrane
- In animal cells numerous small and temporary
- Contains enzymes to digest complex food substances
- Think of it as temporary storage bubbles storing cell sap (water and mineral salts) and waste

Mitochondrion (plural mitochondria)

- Rod shaped double membrane organelle
- Think of it as the cell’s powerhouse that release energy in food by carrying out a reaction with oxygen

Chloroplast

- Double membrane organelle which contains green pigment called chlorophyll
- Absorbs sunlight during photosynthesis where water and co2 converted to glucose and o2

Cell wall

- Made of cellulose (type of complex sugar)
- Fully permeable,inelastic,inflexible and rigid wall
- Non living component surrounding cell membrane
- Provides mechanical support
- Gives cell regular shape
- Protect plant cell from injury

Endoplasmic reticulum

- Transport facility for the cell made of folded membranes
- 2 types of ER smooth and rough ER

Rough ER

- Covered with ribosomes on outer surface of membrane giving appearance of rough surface
- Transport proteins manufactured by ribosomes

Smooth ER

- Lacks ribosomes and more tubular
- Manufacture synthesise liquids
- Converts harmful substances into harmless materials

Ribosome

- Small round structures either free floating or attached to ER
- Manufactures/synthesise protein
- Proteins used for the cell to survive and grow

Golgi body

- Also known as golgi apparatus
- Series of stack like flattened spaces surrounded by a single membrane,like the wifi symbol
- Chemically modifies substances made by ER
- Stores and packages these substances in vesicles
- Vesicles are tiny spherical spaces enclosed by membrane

Difference between Plant and Animal cells

- Cell wall in plant cell unlike animal cells
- Cytoplasm confined to thin layer at edge of cell in plant cell but present throughout cell in animal
- Nucleus at edge of cell in plant cell but in centre of animal cell
- Chloroplast present in some plant cell unlike animal

- Vacuole is single and large in plant cell but animal cell have many small vacuoles
- Food reserve in plant cell is starch but its glycogen in animal cell

Specialised cells,tissues,organs and systems

- Multicellular organisms made up of different types of cells through differentiation and specialisation
- Differentiation is a process in which a cell becomes specialised for a specific function
- Specialisation is a maturation of cells into groups that differ greatly in size shape and function
- Adapted to perform different functions and specific roles
- All 230 cell types in a human body derived from a single zygote by differentiation, like nerve cells, xylem vessels and red blood cells

Root hair cell

- Increase surface area to volume ratio of the cell to absorb water and dissolved mineral salts (ions) at a faster rate from the soil into the plants
- Contains a long a narrow elongation

Xylem Vessels

- Carries water and dissolved mineral salts
- Provides mechanical support to plant
- Long narrow and hollow tubes extending from the roots to the leaves
- Do not have cross walls obstructing water flow through the lumen
- Do not have protoplasm offering resistance to water flow
- Walls are thickened with lignin to prevent collapse of vessel

Red blood cell

- Transports oxygen to cells and tissues
- Has biconcave shape increasing surface area
- Contains red pigment haemoglobin which binds to oxygen
- Lacks nucleus so as to allow more haemoglobin to be packed in
- Flexible cell surface membrane to allow it to squeeze thru tiny capillaries to supply o2 to tissue

Levels of organisation in multicellular organisms

- Cells organised into tissues,organs,organ systems

Tissue

- Defined as a group of similar cells working together to perform a specific function,like connective tissue,muscle tissue,xylem tissue

Organ

- Organised into functional units called organs
- Organ is defined as a structure that comprises 2 or more different types of tissues working together performing a specific function, eg stomach consists of epithelial tissues, muscle tissue, nervous tissue and connective tissue

System

- Group of organs which work together performing a specific function for the organism is called an organ system
- Many different types of organ systems in our body serving a specific function like nervous system,digestive system and cardiovascular system

Division of labour

- Carried out in cells and multicellular organisms
- Just like in production lines where workers specialise in doing different jobs leading to higher productivity

7.

Using the Particulate Nature of Matter as a Model

- Scientists believe matter is made up of very small particles
- Particulate nature of matter used as a model to explain matter
- Model is summarised as the particles are small,invisible and cannot be seen with a microscope
- The particles of matter move at different speeds in solids liquids and gases
- Particles in constant and random motion
- Spaces between particles in the matter, amount of space between particles different in solids liquids and gases

Brownian Motion

- All particles of matter constantly moving in a random manner known as Brownian Motion
- The particulate nature of matter can be used to explain this

Evidence for Brownian Motion

- Pollen grain suspended in water would appear to move on its own
- Water particles always moving randomly, however they are invisible to the naked eye
- Water particles collide with the pollen grain
- Pollen grain is visible to the naked eye
- Hence pollen grain appears to be moving on its own

Evidence for spaces between the particles

- If we mix 30cm^3 of rice and 30cm^3 of beans total volume is less than 60cm^3
- This is because there are spaces between rice grains and the beans
- On mixing the rice grains move into spaces between the beans

Evidence for different amount of space in diff states of matter

- Particles in a gas are far apart
- When we squeeze the balloon we are actually pushing the particles together
- The spaces between the particles of a solid are too small
- We cannot push the particles closer to one another and hence we cannot compress solids

Models of states of matter

- In science we make models to understand things we cannot directly observe
- As particles of matter are too small to be seen scientists have constructed a physical model to show how particles in the solid,liquid and gaseous state of a substance are arranged,called the particulate model of matter and helps us explain particulate nature of matter
- Also helps us visualise what solids liquids and gases are like on the inside
- Solids are very closely packed together in an orderly arrangement,vibrating about their fixed position,with very strong forces of attraction
- Liquids are closely packed in a disorderly arrangements,moving freely throughout the liquid,with strong forces of attraction between particles
- Gases are very far apart in a disorderly arrangement, moving freely and randomly at high speeds, with weak and even negligible forces of attraction between particles

Guidelines for drawing particles in different states

- Size of particle should be same size in diff states especially if particles in 1 state is provided
- No need to fill whole box/space but no. of particles drawn should be sufficient to illustrate the concept
- Particles must not overlap
- In liquid state space between particles should not be large enough to fit another particle
- Particles should be drawn from bottom of box
- Closely packed implies that particles touch each other
- Particulate model of matter can be used to explain physical properties of matters

Why does a solid have a fixed shape and fixed volume?

- Held together by very strong forces of attraction
- Only have enough kinetic energy to vibrate about their fixed positions
- Solid cannot be compressed since its particles are already very closely packed in an orderly arrangement to one another

Why does a liquid have a fixed volume but not a fixed shape

- Force of attraction is weaker than that in a solid
- Particles are further away from one another than the particles of a solid
- Particles of a liquid are still packed closely together
- Particles of a liquid not held in fixed positions
- Arranged in a disorderly manner and can move freely throughout the liquid

Why does a gas not have a fixed volume and fixed shape

- Particles of a gas are far apart from each other as the forces of attraction between the particles are weak
- Have a lot of kinetic energy and are not held in fixed positions
- Can move around rapidly in any direction
- Large space between particles allows gas to be easily compressed
- Particles of gas can be compressed as it has no fixed volume

Models of Expansion and Contraction

- When matter gains or loses heat particles will change in their movement and arrangement
- Gaining heat results in expansion while losing heat results in contraction

- We can better understand these 2 processes by studying their respective models

Expansion

- When matter is heated particles gain energy and vibrate more vigorously
- The particles move slightly further apart from one another and causes volume of matter to increase

Contraction

- When matter is cooled,particles lose energy and vibrate less vigorously
- Particles move closer to one another and causes volume of matter to decrease

Changes in volume

- When heated matter expands increase in volume is due to greater distance between the particles
- Size and number of particles remains unchanged whether they are heated or cooled

Conservation of mass

- During expansion and contraction distance between particles changes
- Although volume of matter changes,size and number of particles of the matter remain unchanged
- Hence mass of matter remains the same during expansion and contraction
- We can say mass of matter is conserved
- For example, in a steel lock distance between steel particles increases when they gain enough heat,however no. of steel particles does not change, hence mass of steel lock is conserved

Models of changes in state

- During heat gain or heat loss particles in matter gain or lose energy
- This causes changes in movement and arrangement of particles in matter
- According to the particulate nature of matter this can lead to a change in state
- The change in the state of matter can only occur if sufficient heat is gained or lost which depends on amt of energy that matter gains or loses

Melting

- Melting is the change of state of a substance from solid to liquid

- Melting point defined as the temperature at which a solid changes into a liquid

What happens during melting

- When solid is heated the particles gain heat energy and vibrate faster
- As temperature increases, particles have enough energy to overcome forces of attraction that hold them in their fixed positions
- Particles are now able to move freely throughout the liquid

Freezing

- Change of state of a substance from liquid to solid
- Freezing point defined as temp at which a liquid becomes a solid

What happens during freezing

- Particles in a liquid lose kinetic energy and move slower
- When temperature is low enough particles no longer have enough energy to move freely, thus start to settle into fixed positions as stronger forces of attraction are formed between them
- The liquid has now frozen into a solid and particles can now only vibrate about their fixed positions

Boiling

- Change of state of a substance from liquid to gas state
- Boiling point defined as temperature at which a liquid changes into a gas
- Occurs throughout the liquid,only at boiling point
- Fast process, with fast particle movement
- Bubbles formed

What happens during boiling

- When liquids is heated particles gain heat energy and move faster
- Particles in the liquid gain enough energy to overcome the forces of attraction holding them together
- Particles are now far apart and able to move freely in all directions at high speeds

Evaporation

- Process in which a liquid turns into a gas at a temp below its boiling point
- Occurs throughout the liquid,at any temperature
- Slow process with slow particle movement
- No bubbles formed

Condensation

- Defined as the process in which a gas changes into a liquid
- As temperature drops, gas particles lose energy and move more slowly
- Eventually movement of the particles become slow enough for the gas to change into a liquid

Sublimation

- Process in which solid turns into gas without going through the liquid phase
- Occurs because particles at the surface of the solid have enough energy to break away from the solid and escape as gas
- Examples of substances that undergo sublimation include dry ice and iodine crystals
- Useful as dry ice is used for refrigeration, especially good for refrigerating food as it keeps them very cold and changes into a gas without leaving liquid behind

Determining the physical states of a substance

- Physical state of a substance at a certain temperature can be determined by using info of its melting and boiling point
- Steps taken to determine the state of a substance
- Draw temperature number line.fill in position of melting and boiling points
- Write down states at different positions and identify position of temp required
- The area where it falls tells us the states

Heating and cooling curves

- Graph showing the changes in temp when a substance undergoes changes in states
- As a substance pass from solid,to liquid to gas state temp of that substance increases as total energy possessed by the increases
- Average kinetic energy of the particles increases with an increase in temperature
- During a state change the energy absorbed is used to help overcome the attractive forces between particles,without change to avg kinetic energy of the particles

8. Movement of Substances

Diffusion

- Net movement of particles from region of higher concentration to region of lower concentration eg down a concentration gradient
- Passive process (does not require energy) and slow process
- Concentration gradient is the difference in concentration between two regions
- Relationship of concentration gradient to diffusion
- Steeper the gradient for a substance, the faster the rate of diffusion for that substance
- Like putting a hot cup of water in a fridge and hot room,fridge will cool faster as temperature difference in the fridge(cold) to the cup (hot)
- To sum it up area a has more particles than area b so therefore particles move from a to b and become evenly spread out

Diffusion of liquids through fully permeable(can pass through) membrane

- If there is more than 1 substance dissolved in the same liquid then the particles of one substance diffuse independently of the other
- For Example, Potassium iodine particles separated from copper sulphate particles with permeable membrane
- Dissolved copper sulphate will dissolve across the membrane to the left,particles of potassium iodine will diffuse to the right
- This will eventually lead to the left side have both copper sulphate and potassium iodine particles, and there will have an equal amount of copper sulphate and potassium iodine particles on both sides

Diffusion of liquids through semi permeable membrane

- Basically osmosis but not with water

Examples of diffusion

- Air sacs
- Water come in to roots

Osmosis

- Movement of water molecules from a solution of higher water potential to a solution of lower water potential (eg down a water potential gradient) through a partially permeable membrane
- Type of diffusion
- Water potential is a measure of the tendency of water to move from one place to another

- Will stop when both sides reach same concentration
- Keep moving to create a balance bet both sides
- Constant motion by particles due to brownian motion

How does Osmosis Affect Living Organisms?

- Entry of water into plant
- Cell sap of root hair cells have lower water potential than soil water
- Water moves into large central vacuoles of root hairs by osmosis through a partially permeable cell membrane

What happens to a cell in a solution with higher water potential?

- Cell saps has a lower water potential than its surrounding solution
- Water enters cell by osmosis through partially permeable membrane
- Large central vacuole increases in size
- When cell becomes fat the cell is said to be turgid
- Cytoplasm gets pushed against cell wall, resulting in turgor pressure
- Turgor / turgidity in plant cell helps to keep stems upright and keeps leaves flat so they can better absorb sunlight

Animal Cell (same thing as above)

- Cell has a lower water potential than its surrounding solution
- Water enters cell by osmosis through partially permeable cell membrane
- Cell expands and bursts as cell membrane ruptures and absence of cell wall
- The cell has lysed, process is termed lysis

What happens to a cell in a solution with lower water potential?

- Partially permeable cell membrane pulled away from the cell wall
- Vacuole decreases in volume
- Cytoplasm pulled away from cell wall,so cell shrinks and becomes soft
- Lower water potential solution diffuses through permeable cell wall to occupy space between wall and cell membrane
- The cell is said to be plasmolysed and flaccid
- Plasmolysed cells can return to original state by placing them in solution of higher water potential
- Cell has a higher water potential than its surrounding solution
- Water leaves cell by osmosis through partially permeable cell membrane
- Cell shrinks and little spikes appear on the cell,the cell is crenated,this process is termed crenation

Active transport

- Energy consuming process where particles of a substance are transported against a concentration gradient from a region of lower concentration to a region of higher concentration
- Required energy comes from energy released (DO NOT WRITE produce) during cellular respiration in mitochondria
- Occurs only in living cell that as they respire
- For example, absorption of dissolved mineral salts by root hair cells,absorption of glucose and amino acids in small intestine into bloodstream

9. Model of Matter–Atoms and Molecules

Element and Atom

- Pure substance that cannot be broken down into simpler substances
- All matter is made up of atoms
- Smallest particles of an element that have the chemical properties of that element,too small to be seen with the naked eye and has diameter around 0.0000000000001m
- Atoms made of subatomic particles–protons,neutrons and electrons

Structure of an atom

- Each atom has a small centre called nucleus consisting of protons and neutrons
- Protons and neutrons are collectively called nucleons
- Electrons move around the nucleus in the electron shells
- Surrounding the nucleus is a cloud of electrons which move rapidly within electron shells around the nucleus
- In an atom number of protons and electrons are equal,so it is electrically neutral
- When number of protons and electrons are unequal an ion is formed
- Most of the atom is empty space

Behaviour of subatomic particles in an electric field

- Electrons deflected towards the positively charged plate while protons deflected towards the negatively charged plate
- Since opposite charges attract, electrons are negatively charged while protons are positively charged.
- Neutrons are not deflected in the electric field.
- Neutrons are neutral and have no charge.

- Electrons are deflected to a larger extent than protons.
- The mass of an electron is much smaller than that of a proton.

Representing information about the atom

- Information about an atom can be represented by its nuclide notation

Can obtain

- Number of protons – from proton number
- Number of neutrons – from mass number minus proton number
- Number of electrons – since atom is electrically neutral, no of protons = electrons
- Each element has a unique proton number
- Atoms of different elements have different proton number
- Atom is electrically neutral as it contains same no. of protons and electrons

Isotopes

- Atomic variants of the same element occur naturally
- Known as isotopes, they have the same chemical properties but different physical properties.
- Isotopes are atoms of same element with same no. of protons, but different number of neutrons
- Isotopes have similar chemical properties because their atoms have same no of valence (outermost) electrons
- Different isotopes of the same element have different physical properties as they have diff masses (due to different number of neutrons)
- This results in different physical properties such as melting and boiling points and densities

Electronic Structure of an Atom

- Electrons move around the nucleus in regions known as electron shells
- The electron shells are numbered 1, 2, 3 and so on, going outward from the nucleus
- Each electron shell can hold a maximum number of electrons
- Electrons fill the innermost shell first before moving to the next outer shell

1st shell

- Closest to the nucleus
- Holds max 2 electrons
- Always filled first
- Lowest energy level

2nd shell

- Hold max 8 electrons
- Higher energy than 1st shell

3rd shell

- Hold a max of 8 electrons (for the first 20 elements)
- Filled up after the 2nd shell

After the shells

- Arrangement of electrons in an atom is known as the electronic structure of an atom.
- Electronic configuration refers to numerical expression of no. of electrons in each shell
- For example, the electronic configuration of magnesium atom is 2.8.2 also written as 2,8,2
- The valence (outermost) electron shell is the electron shell that is farthest from nucleus,eg valence shell for potassium is the 4th shell
- Valence shell for aluminium is the 3rd shell
- Valence electrons are electrons found in the valence shell
- If you see structure draw but if you see configuration write numbers instead
- Valence electrons involved in formation of chemical bonds between atoms during a chemical reaction and determines the chemical properties of an element
- For example, sodium (2.8.1) has 1 valence electron
- Hence, the valence electrons of atoms give them their chemical properties

Molecules

- A molecule is a group of two or more atoms chemically combined together.
- Molecules of an element consist of a fixed number of one type of atom chemically combined.
- Molecules of a compound consist of a fixed number of atoms from different elements chemically combined.
- Diatomic molecules are those that are formed by the combination of two atoms.
- Triatomic molecules are those that are formed by the combination of three atoms
- Polyatomic molecules are those that contain four or more atoms

10.Ray Model of Light

Propagation of Visible Light

Visible Light as a form of energy

- Form of energy and a small part of electromagnetic (EM) spectrum,for us to see light has to enter our eyes
- Light from the sun takes 8min to travel through empty space
- Visible light,infrared radiation and UV radiation are all part of the spectrum of EM waves
- EM waves has good and bad effects
- All EM waves travel through space at the same speed (300 000 000 m/s)
- Light travels at a speed of 300 000 000 m/s in a vacuum (Nothing)
- Compared to light sound travels around 330m/s in air

Luminous and Non Luminous Objects

- Objects that make their own light are luminous objects
- Fireflies and glow worms can give out light,this ability is called bioluminescence
- Moon and planets are non luminous as they reflect light from the sun

Propagation of light

- Ray of light represented by a straight line with an arrow to indicate direction of travel
- Light travels in a straight line
- Beam of light is a bundle of light rays,eg a torch produces beams of light
- Beam of light can be parallel,convergent or divergent
- For experiment of this we can use the screens with holes then move one screen with a hole
- When one of the screens is moved, the eye cannot see the light because the light ray is blocked by the screen that is moved
- The light ray is blocked from reaching the eye

Shadows and eclipses

- Shadows are formed because light travels in straight lines and cannot bend around an opaque object and reach behind it
- Umbra is a dark and sharp shadow as no light reaching behind the object
- Penumbra is a partial shadow due to some light reaching behind the object
- Lunar eclipse is when Earth move between Sun and Moon (can only occur on night of full moon)

- A solar eclipse occurs when Moon moves between Sun and Earth
- Solar eclipse is a natural phenomenon illustrating formation of shadows

Transparent, Translucent and Opaque

- Transparent materials such as glass and diamond allow most of the light to pass through
- Translucent materials allow some light to pass through
- Opaque materials do not allow light to pass through

Reflection

- Light ray streaming the surface of an object called incident ray
- Point at which light in contact with surface called point of incidence
- Light ray bouncing off called reflected ray
- Imaginary line perpendicular to surface at point of incidence called normal (drawn by dotted line)
- Angle of incidence is angle between incident ray and normal
- Angle of reflection angle between the reflected ray and the normal

Laws of Reflection

- The angle of incidence (i) equal to angle of reflection ®
- Incident ray, reflected ray and normal at point of incidence all lie on same plane

Drawing Ray diagrams

- Always use a ruler when drawing rays of light
- This is cause light travels in straight lines

Regular and Irregular reflection

- Mirror and book are non luminous objects reflecting light into our eyes
- We can see our reflection in the mirror because the mirror has a smooth surface
- We cannot see our reflection in a book as it has a rough surface
- Plane mirror made from glass is a highly reflective flat surface
- Bronze mirrors which preceded glass mirrors produced more diffused reflections

More on Regular reflection

- When a parallel beam of light falls on a smooth surface the reflected rays are parallel
- Reflections from smooth surfaces are called regular or specular reflections

- Image formed is clear and undistorted

More on Irregular reflection

- When a parallel beam of light falls on a rough surface reflected rays are scattered in different directions
- Reflections from rough surfaces are diffused or irregular reflections
- No images or blurred images are produced

Characteristics formed by plane mirrors

- Image formed is upright
- Of the same size as the object
- Same distance behind mirror as object is in front of mirror
- Virtual (cannot be capture on a screen behind the mirror)
- Laterally inverted (left hand side of the object appears as the right hand side)

Effects and uses of reflecting surfaces

Plane mirror

- Used in homes,vehicles,on the roads,eg periscopes

Eye-Test

- Mirrors used by opticians to test eyesight.
- Illuminated letters are laterally inverted so that the patient can see the letters correctly in the mirror
- Letters appear further than they actually are so the room need not be that long

Concave and Convex Mirrors

- Concave mirrors have a surface that bends inwards and form images that are virtual,upright and magnified
- Convex mirrors have a surface that bend outwards and form images that are virtual,upright and smaller than the object
- Therefore, images shown on concave mirrors are bigger than that in a convex mirror

Drawing ray Diagrams

Step 1:

- Image distance from mirror = object distance from mirror
- Measure accurately the perpendicular distance between object O and the mirror surface,

- Mark off the same distance behind the mirror to locate image I.

Step 2:

- Draw the light rays from the image to the eye.
- Use dotted lines behind the mirror (virtual light rays).
- Use solid lines in front of the mirror surface.

Step 3:

- Draw the incident rays from object O to the point of incidence on the mirror surface.

Points to note

- Light rays can cover more than the eye itself.
- Both light rays that are reflected towards the eye must converge at the image in the mirror.
- Arrows must be drawn and pointed towards the eye.
- Draw normal as dotted lines.
- Any lines inside the mirror must be dotted
- Only the light rays are solid lines.

Mirrors parallel to each other

- An infinite number of images can be seen when plane mirrors are placed parallel to each other.
- This is due to each image being the reflection of an image on the opposite mirror and so on

Refraction

Why does the pencil bend in water?

- Light bends as it passes from one medium to another
- The bending of light when it travels from one transparent medium to another transparent medium is called refraction

What causes refraction?

- Light travels at different speed in diff media
- Change in the speed of light at the boundary of two media causes the path of light to bend resulting in refraction

Path of light

- Light can be reflected, transmitted or absorbed when it falls on an object.
- Light slows down upon entering the glass.
- It will thus bend towards the normal when it travels from air to glass

- The light ray which is refracted is called the refracted ray.
- When light emerges from the glass, it bends away from the normal because light travels faster in air
- The light ray which emerges from the glass block is called the emergent ray
- The refracted ray in the glass is on the opposite side of the normal as the incident ray.

Different phenomenon due to refraction

- Different media has different optical density (do not confuse with density of the material)
- It is optical density which affects the speed of light in different media
- Larger the optical density, slower is the speed of light

Effects of Refraction

No Bending of Light

- When the incident ray is perpendicular to the surface (travelling along the normal), light will just pass through without bending
- No refraction has taken place, even though the light slows down as it travels in the glass medium

Objects Appear Nearer to the Surface

- Light from an object bends as it comes out of the water (or an optically denser medium)
- However, our brain thinks that light has moved in a straight line
- Therefore, any object in water (or an optically denser medium) appears higher than its actual level
- This explains why a swimming pool appears shallower than it actually is

Objects Appear Nearer to the Surface

- Similarly, a fish appears higher than it actually is in the water due to refraction.
- As light travels faster in air than water, light from the fish bends away from the normal as it emerges from water into the air
- An observer on the ship will think that the fish is higher than it actually is as his brain perceives light to travel in straight lines.

Objects Appear to Bend

- The whole straw appears bent when viewed from the air due to refraction.
- The light from the straw immersed in the water bends away from the normal when it enters the air

- This causes the immersed part of the straw (A) to appear nearer to the surface (B) of the water than it actually is
- This perceived depth by the observer is known as the apparent depth
- Reflection–takes place in 1 (the same) medium
- Refraction— takes place in 2 media
- Reflection–speed of light unchanged
- Refraction–speed of light changes
- Both change the direction of light

Refractive Index

- -The refractive index is defined as the ratio of the speed of light in a vacuum to the speed of light in a medium under consideration
- n = speed of light in vacuum/speed of light in medium =c/v
- n is known as the refractive index and it has no units.
- The refractive index, n, can also be calculated using the formula
- n = real depth (RD)/apparent depth (AD)
- Real and apparent depth have to be of the same units while n has no units
- Also refractive index= sin (i) / sin (r)

To locate a refracted image

- Draw the tip end of the image vertically above the object.
- Draw lines to the tip of the image, dotted when in the water (not real)
- Refract ray onto the actual object, using the same reference point
- Draw in the normals at the points of incidence

Note:

- Image is always vertically above the object
- Light rays drawn towards the eye must always converge towards the image
- Normals must be drawn and dotted
- Only light rays are real and drawn with solid lines
- Arrows must be drawn and point towards the eye

Application of refraction

Refracting Telescope

- A telescope made with lenses is called a refracting telescope.
- A lens, just like in eyeglasses, bends light passing through it
- In eyeglasses, this makes things less blurry.
- A telescope that uses mirrors is called a reflecting telescope

Reversibility of Light

- A light ray will travel along the same path if its direction of travel is reversed.
- This principle is termed The Principle of Reversibility and applies to the reflection and refraction of light

Dispersion of Light

- Sunlight (white light) is a mixture of different colours.
- When a beam of light passes through a glass prism, the light splits up into the colours as they appear in a rainbow
- This splitting of white light is known as dispersion.
- This is a result of refraction where red light refracts the least whereas violet refracts the most when travelling into a denser medium
- Light of a different colour travels at different frequency,but this frequency remains constant as it passes through different media
- However, light of different colours slows down by different amounts,Red slows down the least while violet slows down the most
- White light is split into the seven colours:Red, Orange, Yellow, Green, Blue, Indigo and Violet (ROY GBIV),called the spectrum of white light
- When light rays emerge from the glass prism, they bend again but in a different direction
- Another glass prism can be positioned such that the faces through which the light enters and leaves are parallel to each other
- The different colours of light are recombined when they emerge from the second prism.

Colour Filter

- A colour filter only lets through a certain part of the coloured visible spectrum, while the remaining parts are absorbed
- Any plastic or glass of a specific colour is called a colour filter.
- When white light passes through a colour filter, all colours are absorbed except for the colour of the filter

Colours of Light

Primary Colours

- There are three primary colours of light: Red, Green and Blue (RGB),which can be mixed together to produce white light.
- They are called “primary colours of light” because they cannot be produced by mixing other colour lights.
- Mixing these colours two at a time with the same intensity produces the secondary colours of light

Observing Colours

- When white light shines on a non-luminous object, some of the colours in the spectrum are reflected and some are absorbed
- Only colours that are the same as the non-luminous object will be reflected
- An object which appears blue in white light will appear blue in blue light because it reflects blue light
- The blue object will appear black in green light and red light because it does not reflect green or red light
- The blue object appears blue under magenta light as it reflects the blue light and absorbs the red light (magenta is made of blue and red light)

11: Biological Molecules –Nutrients

Why do we need nutrients?

- Provide energy for vital activities
- Provide raw materials to make new protoplasm
- Help organisms stay healthy
- Nutrients are chemical substances in food that provide energy and materials needed by the body.

What are the nutrients found in food?

- Carbohydrates e.g. sugar, starch, fibre
- Proteins
- Fats
- Water
- Minerals
- Vitamins

Carbohydrates

- Carbohydrates are organic molecules made up of the elements: carbon (C), hydrogen (H), oxygen (O) in a fixed ratio
- Examples of food rich in carbohydrates: bread, rice, pasta

Functions of carbohydrates

- Source of energy
- Forms supporting structures, e.g. cellulose cell walls
- Conversion into other compounds (e.g. amino acids, fats, nucleic acids)
- Synthesise lubricants in animals and nectar in flowers

- Categorised into 3 categories, single sugars, double sugars and complex carbohydrates

Single sugars

- Include glucose and fructose
    - Glucose is a Substrate for cellular respiration which breaks down glucose to release energy.
        - Found in both plants and animals.
    - Fructose is widespread in plants, uncommon in animals.

Double sugars

- Include Maltose, sucrose
- A single molecule of maltose (malt sugar) is formed by joining two glucose molecules, with removal of 1 water molecule
    - Maltose is found in malted cereals and sprouting grains.
- A single molecule of sucrose (table sugar) is formed by joining 1 glucose molecule and 1 fructose molecule, with removal of 1 water molecule.
    - Sucrose can be found in sugarcane stems, sweet fruits and certain storage roots such as sugar beet and carrots.

Complex carbohydrates

- Include Starch, Glycogen, Cellulose
- Consists of many single sugar molecules joined together.
- Starch, Glycogen and Cellulose are complex carbohydrates, made up of many glucose molecules
- Starch is made up of many glucose molecules joined together, a storage form of carbohydrate in plants, made and stored in plants, but not animals
    - Starch is found in vegetables, cereals, potatoes etc.
- Glycogen is made up of many glucose molecules joined together, a storage form in animals and fungi, and stored mainly in liver and muscles.
    - Can be broken down to produce glucose for cellular respiration which releases energy
    - Glycogen is made up of many glucose molecules joined together
- Cellulose is made up of many glucose molecules joined together, the bonds between glucose units are different from that in starch.
    - Many straight chains of glucose molecules are found in cellulose.
    - Cellulose forms a greater part of the cell walls of plants.
    - Man cannot digest cellulose, which serves as dietary fibres that prevents constipation

Proteins

- Proteins are organic molecules made up of the elements: carbon (C), hydrogen (H), oxygen (O) and nitrogen (N).
- Some proteins may also contain sulphur (S)
- Synthesises new protoplasm (for growth and repair of worn out body cells), and enzymes
- Formation of protective proteins (known as antibodies) to combat diseases
- Excess proteins are not stored in the body and are broken down
- Basic unit of proteins is amino acids

Relationship between proteins and amino acids

- 22 types of amino acids, and they can be arranged differently to form different proteins
- Amino acids are linked by peptide bond to form polypeptide chains
- A polypeptide chain can be folded to form a more complex and three-dimensional molecule called protein

Fats (Lipids)

- Fats (or lipids) are organic molecules made up of the elements: carbon (C), hydrogen (H), oxygen (O).
- Efficient source and storage of energy
- Insulating layer beneath the skin
- Solvent for fat-soluble vitamins (e.g. vitamin A, D)
- Essential part of cell membrane
- Excess fats are stored as adipose tissues under the skin and around the heart and kidney.
- A fat molecule is made up of 1 glycerol molecule and 3 fatty acid molecules
- Fat molecule contain more energy than carbohydrate per unit mass

Food Tests

Iodine Test (Test for presence of starch)

Procedure

- Add a few drops of iodine solution on a sample to be tested.
- Observe and record changes in colour of iodine solution.

Results

- Starch present: test sample stained blue black
- Starch absent: test sample stained brown

Benedict's Test (Test for presence of reducing sugars)

What are reducing sugars?

- Any carbohydrate which is capable of being oxidised and causes the reduction of other substances without having to be hydrolysed first.
- Examples include glucose, fructose and maltose only.
- Sucrose is a non-reducing sugar.

Procedure

- To 2 cm^3 of test sample in a test-tube, add 2 cm^3 of Benedict's solution.
- Shake thoroughly to mix.
- Place the test-tube in a boiling water bath for 5 minutes.
- Remove the test-tube from the boiling water bath.
- Observe and record any colour changes.

Results

Reducing sugar present:

- Brick red colour formed if there is a large amount of reducing sugar present.
- Oranger colour formed if a moderate amount of reducing sugar is present.
- Green/Yellow formed if traces of reducing sugar are present.

Reducing sugar absent:

- Mixture remained blue

Biuret Test (Test for presence of proteins)

Procedure

- To 2 cm^3 of test sample in a test-tube, add 2 cm^3 of sodium hydroxide.
- Shake thoroughly to mix.
- Add 1% copper (II) sulphate solution drop by drop, shaking after every drop

Results

- Protein present: mixture turned violet
- Protein absent: mixture turned blue
- Observe and record any colour changes

Ethanol Emulsion Test (Test for presence of fats)

Procedure (on liquid food)

- To 2 cm^3 of test sample in a test-tube, add 2 cm^3 of ethanol.
- Shake thoroughly to mix.
- Add 2 cm^3 of water and shake thoroughly.
- Observe and record formation of white emulsion, if any

Procedure (on solid food)

- Cut solid food samples into small pieces and place them into a test tube, add 2 cm^3 of ethanol.
- Shake thoroughly to mix.
- Allow solid particles to settle
- Decant mixture into another test tube containing 2 cm^3 of water.
- Observe and record formation of white emulsion, if any.

Results

- Fats present: white emulsion is formed.
- Fats absent: test solution remains clear

12.Biological Molecules–Enzymes

What are Enzymes?

- Enzymes are biological catalysts that speed up chemical reactions in living organisms.
- Enzymes reduce the energy required to initiate chemical reactions.
- Thus, chemical reactions are able to take place at normal body temperature
- Each enzyme can usually only be the catalyst for a single reaction (e.g.enzyme amylase breaks down or digests starch to maltose).
- More than five hundred different enzymes in the cells of the body, each of them helping the body to work.
- Some enzymes work outside the cells,eg digestive system.

Properties of Enzymes

- Most enzymes are made up of proteins
    - This is one of the reasons why we need protein in our diet
- Enzymes speed up a reaction without being used up
    - This means they can be used over and over again as they remain unchanged at the end of the reaction.

- Enzyme activity is affected by temperature and pH.
- Enzymes are specific in their action e.g. maltase only acts on maltose; sucrase on sucrose

How Do Enzymes Work?

- Keywords: Enzyme, Substrate, Active site, Enzyme-substrate complex (ES complex), End products
- An enzyme is thought to have a region with a very specific three-dimensional (3-D) depression called the active site
- The substance on which the enzyme act is called substrate

Lock-and-key hypothesis

- The active site of an enzyme has a specific 3-D shape that only the substrate with a 3-D shape complementary to it can fit, just like a lock-and-key.
- The enzyme is the lock and the substrate is the key
- The substrate binds to the enzyme, forming an enzyme substrate complex
- Reaction takes place to convert the substrate to products

Factors Affecting Enzyme Activity

- High temperature, acids and alkalis can affect the shape of an enzyme and consequently its function.

Effect of temperature on rate of enzyme activity

- Enzymes are inactive at low temperatures as the kinetic energy is low.
- Increasing the temperature increases the kinetic energy of the enzyme and substrate molecules so that they move faster and are more likely to collide
- Increasing temperature increases the rate of the reaction up to a certain temperature (enzyme's optimum temperature) at which it is the most active.
- For every 10 °C rise in temperature, the rate of enzyme reaction is doubled, until optimum temperature is reached
- If the temperature is increased beyond optimum temperature, the bonds holding the enzyme molecule together in shape eventually break.
- The active site loses its original shape so that the substrate no longer fits into the active site.
- The enzyme is denatured. Most enzymes are denatured at 60 °C

Effect of pH on the rate of enzyme activity

- Enzymes have optimum pH

- Optimum pH falls between 6 and 8 for most enzymes
- Solutions that are more acidic or alkaline will slow the enzyme reaction down
- At extremes of pH the enzymes will denature and reaction will stop
- However, digestive enzymes in the stomach are designed to work best at pH2,but those in intestine have optimum pH of 8

Formats

Osmosis, Diffusion, Active Transport formats

1)Water potential/concentration higher or lower inside substance?
2)Water/Particles go in/out
3)[Process] occurs through a partially permeable membrane (if it does)
4)Flaccid/Plasmolysed

Diffusion:

1. _____ has a higher concentration of _____ than _____.
_____ particles diffused from the _____ to the _____ down a
concentration gradient. This causes the cell to _____.
2. Since _____ has the same concentration of _____ as _____, there was no
concentration gradient and no net movement of _____ molecules by diffusion.

Osmosis:

1. _____ has a higher water potential than the _____. Water molecules
move from _____ to the _____ through a partially permeable membrane
by osmosis. This causes the cell to _____.
2. Since _____ has the same water potential as _____, there was no water
potential gradient and hence, no net movement of water molecules by osmosis.

Model of Matter format

1)When [Substance] is heated/cooled,the particles gain/lose heat energy and vibrate faster/slower
2)As temperature increases/decreases,the particles have enough energy to overcome the forces of attraction that hold them in fixed positions (solids)
3)The particles are now able to move freely throughout the liquid (solid)