
Exploring diversity of matter using separation techniques

- How to choose the appropriate separation technique(s)
Applications:
 - Evaporation is used to extend the shelf life of food such as *ikan bilis* and reduce food wastage
 - Chromatography is used in food testing to ensure that food does not contain harmful substances and is safe for consumption
 - In Singapore, filtration and evaporation are used in the recycling of used water to obtain potable water
- The different constituents of mixtures retain their physical properties
- The differences between these physical properties allows us to choose the separation technique(s) for separating the constituents of the mixtures
- Other factors that should be considered when choosing a separation technique includes:
 - Cost
 - Reliability
 - Environmental impact
 - Example: Reverse osmosis helps us to obtain potable water in Singapore, however it is costly, therefore it may not be possible to use only reverse osmosis to obtain potable water
- Separating a mixture of magnetic and non-magnetic substances
 - Magnetic substances such as iron and steel are attracted to a magnet.
 - Steel is a mixture of iron and other elements
 - Other substances such as plastic and paper are non-magnetic
 - Magnets can be used to separate magnetic substances from non-magnetic substances (Example: When a magnet is placed near a mix of iron filings and sulphur, only the iron filings are attracted, the non-magnetic sulphur is left behind)
 - Magnetic attraction is used to separate magnetic and non-magnetic substances (Example: In Singapore, scrap metal is a waste material generated. Scrap metal contains a mixture of metals such as aluminium, copper and iron. Iron, being magnetic, can be removed from the mixture by passing a strong magnet over the scrap metal, the iron can then be reused or recycled, helping to reduce waste)
 - Separating a mixture of particles

Ray Model of Light

- Used to explain why and how we are able to see things
- Luminous objects emit light in all directions
- The light rays travel in straight lines from the objects to our eyes, allowing us to see the object
- Light from a light source can bounce off an object and enter our eyes

Reflection

- The bouncing of light is called reflection
- Light travels in straight lines even when bouncing off objects (no matter what)
- Incident ray: Ray that hits the reflecting surface
- Angle of incidence (i) is the angle between the normal and incident ray
- Normal: The line perpendicular to the surface at the point of incidence
- Point of incidence: Point where the incident ray, normal and angle of reflection meet
- Angle of reflection (r): Angle between the reflected ray and normal
- Reflected ray: Light ray travelling away from the reflecting surface after bouncing off the surface
- Angle of incidence (i) and the angle of reflection (r) are and will always be equal
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- Mirrors:
 - o Plane mirrors (Flat mirror):
 - o Properties
 - Virtual
 - Upright
 - laterally inverted
 - image is same distance from the mirror as the object is from the mirror
 - o Applications:
 - Bathroom mirror
 - periscope
 - o Convex mirror (Curved outwards):
 - o Properties
 - Shows more things
 - decreases the size of objects reflected in them
 - o Applications:
 - Funhouse mirror
 - road corners
 - rear-view mirrors

- side-view mirrors
- Concave mirror (Curved inwards):
 - Properties
 - Shows less things
 - increases the size of objects
 - Applications:
 - Vanity mirror
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 - dentist mirror
 - car headlights (reflect light to form strong beams of light)
 - microscope

Refraction

- A clear image can only be formed if the reflecting surface is smooth
- When parallel rays of light on a rough surface, each ray is reflected in a different direction
- Reflection is the bending of light at the boundary as it passes from one medium to the other => due to change of speed as it passes through 1 medium to another
- Optical mediums have a property called optical density that affects the speed that light travels at through the medium
- Light travels faster in air than in glass
 - when a ray of light travels from air (optically less dense substance) into the glass block (optically less dense substance) => it slows down and bends towards the normal
 - when the ray of light is exiting the glass block => gains speed and bends away from the normal
- Refraction also makes things appear shallower than they actually are (like in a swimming pool)
- White light is made up of a spectrum of the 7 primary colours => namely:
 - Red
 - Orange
 - Yellow
 - Green
 - Blue
 - Violet
 - ROYGBIV
- Light bend when it travels from air to water due to its decrease in speed, after rain => moisture in the air => sunlight crosses the air-water boundary to enter each raindrop => light of each colour bends at different angles, violet rays bending the most and red rays bending the least => sunlight get separated into the seven colours of the spectrum => this is known as dispersion
- Dispersion also occurs when white light passes through a glass prism

Impact of Radiation Applications

- We can only see electromagnetic (EM) radiation
- We cannot see some electromagnetic (EM) radiation such as:
infrared and ultraviolet (UV) radiation
- Infrared light:
 - o Applications
 - Infrared technology can be used in healthcare
 - In airports, public spaces to screen people for fever
 - Detects infrared radiation emitted by a person to form an image of their body temperature
 - o Harmful effects:
 - Overexposure can harm us
 - Commonly used in welding, cutting and brazing operations as well as in furnaces and molten metal production in industries
 - Workers exposed to prolonged exposure to infrared radiation have to wear goggles to protect their eyes
 - Infrared radiation also contributes to climate change, temperatures on earth have also increased and weather patterns have changed in ways that could harm living things
- Ultraviolet (UV) radiation:
 - o Applications
 - Exposure to a small amount => increases the production of vitamin D in the body
 - Used in medical treatments for skin diseases like psoriasis
 - Reproduces action of sunlight in a scientific and controlled manner
 - UV light sterilisation is an environmentally friendlier method of disinfecting medical equipment, food and water without using harmful chemicals or releasing harmful by-products
 - o Harmful effects:
 - Overexposure can harm eyes and cause skin cancer
 - Encouraged to put on sunscreen => helps filter out UV radiation
- Visible light:
 - o Applications
 - During the day, plants need the energy provided by visible light to make sugars using carbon dioxide and water using photosynthesis
 - Allows us to carry out our daily activities
 - o Harmful effects:
 - Causes chemical changes in some materials => deterioration of their quality
 - In museums, care is taken to protect very old documents, photographs and paintings => photography

is not allowed, some objects are stored in the dark to prevent discolouration by light

- Too much light => light pollution => negatively impacts animals that depend on the cycle of night and day to survive (migration, reproduction, searching for food, sleeping, escaping from predators)
- Also uses a lot of electricity (wasteful)
- Can avoid this with prudent use of energy-efficient lighting technology such as LEDs and compact fluorescents (CFLs), can reduce light pollution and energy usage