Grade 10 Science

Light and Geometric Optics

Class 10

Overall Expectations

- Evaluate the effectiveness of technological devices and procedures designed to make use of light, and assess their social benefits
- Investigate, through inquiry, the properties of light, and predict its behavior, particularly with respect to reflection in plane and curved mirrors and refraction in converging lenses
- Demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses

Light

- Light is an electromagnetic wave – has both electric and magnetic parts and does not require a medium
  - Medium – any physical substance through which energy can be transferred

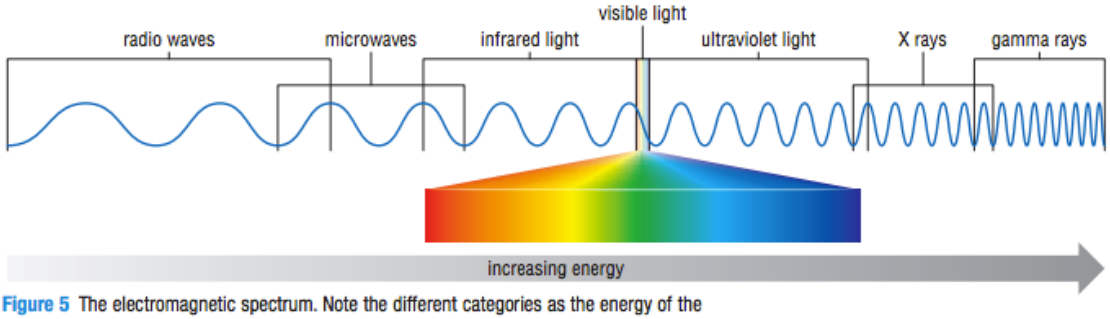
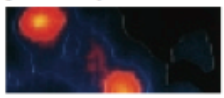


Figure 5 The electromagnetic spectrum. Note the different categories as the energy of the electromagnetic wave increases.

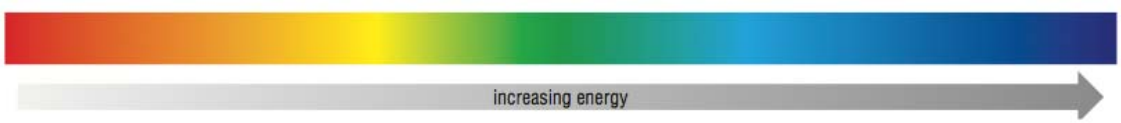
Table 1 The Many Uses of Electromagnetic Waves

Type of electromagnetic wave	Use/phenomena
radio waves 	• AM/FM radio • TV signals • cellphone communication • radar • astronomy (for example, discovery of pulsars)
microwaves 	• telecommunications • microwave ovens • astronomy (for example, background radiation associated with the Big Bang)
infrared light 	• remote controls (for example, DVD players and game controllers) • lasers • heat detection (for example, leakage from windows, roofs) and remote sensing • keeps food warm (in fast-food restaurants) • astronomy (for example, discovering the chemical composition of celestial bodies) • physical therapy

visible light 	• human vision • theatre/concert lighting • rainbows • visible lasers • astronomy (for example, optical telescopes, discovering the chemical composition of celestial bodies)
ultraviolet light 	• causes skin to tan and sunburn • increases risk of developing skin cancer • stimulates production of vitamin D • kills bacteria in food and water (sterilization) • "black" lights • ultraviolet lasers • astronomy (for example, discovering the chemical composition of celestial bodies)
X-rays 	• medical imaging (for example, of teeth and broken bones) • security equipment (for example, scanning of luggage at airports) • cancer treatment • astronomy (for example, study of binary star systems, black holes, the centres of galaxies)
gamma rays 	• cancer treatment • astronomy (for example, study of nuclear processes in the universe) • product of some nuclear decay

Visible Light

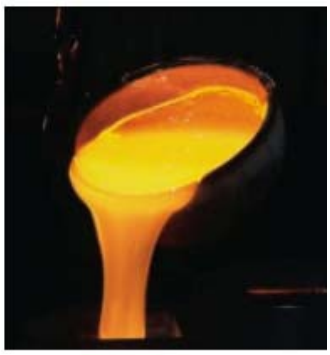
- White visible light is composed of a continuous sequence of colours called the visible spectrum (ROYGBIV)
- Visible spectrum was discovered by Sir Isaac Newton who used a prism to separate the colours



Luminous/Non-Luminous

- **Luminous** – produces its own light (ex: Sun, lightbulb, lit match, flashlight, etc.)
- **Non-luminous** – does not produce its own light and can only be seen by using reflected light (ex: tree, moon, pencil, etc.)

Incandescence



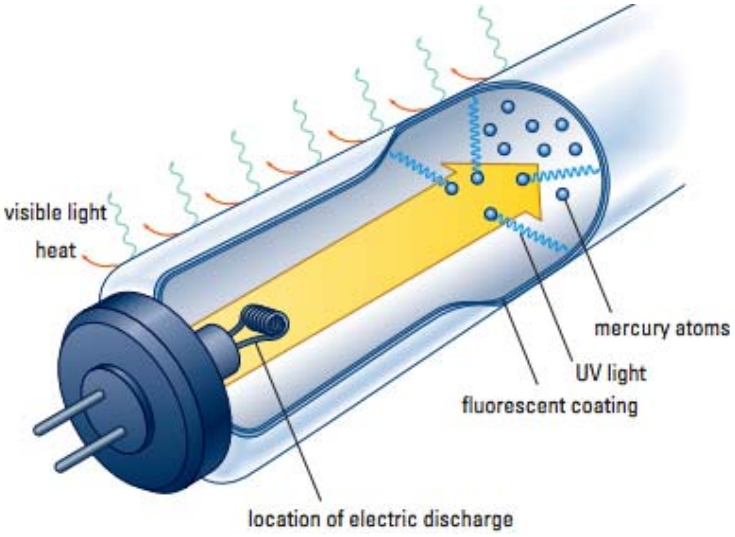
- Producing light as a result of high temperature
- Any object as it gets hotter and hotter will eventually produce light
- Ex: Incandescent lightbulbs contains a thin wire filament that glows as it gets hot
  - 5-10% of the electricity is converted into visible light
  - The rest of the energy is converted to infrared light that you feel as heat.

Electric Discharge

- Light that comes from an electric current passing through a gas (ex: Neon lights)
- Lightning is the light you see when an electric current passes through air

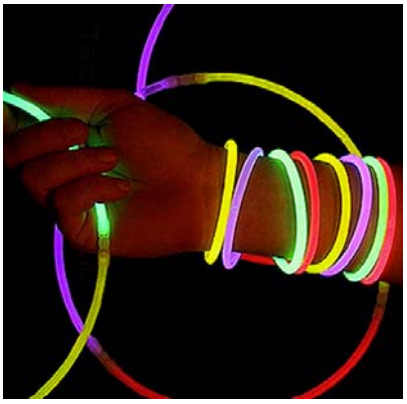

Phosphorescence/Fluorescence

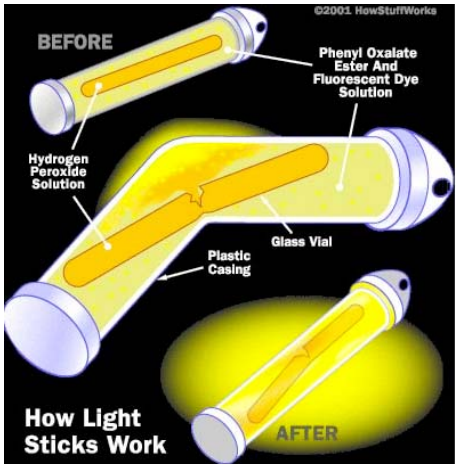
- **Phosphorescence** – glow-in-the-dark objects are coated with phosphors, which absorb light and releases energy slowly
- **Fluorescence** – objects that absorb light and release the energy immediately
  - Highlighters contain a fluorescent dye that causes the ink to glow in the presence of UV light
  - Fluorescent lights – electric charge causes the mercury vapour to emit UV lights which strike the fluorescent material and emits light



Chemiluminescence

- Production of light as a byproduct of a chemical reaction with little or no heat produced (ex: glowsticks)





Bioluminescence

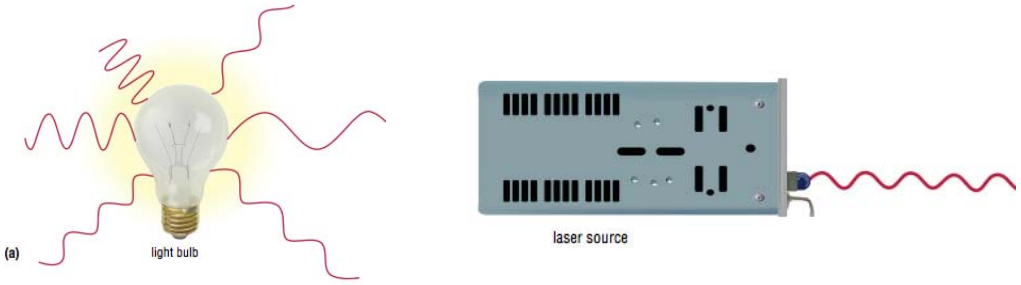
- Production of light in living organisms as a result of a chemical reaction with little or no heat produced (ex: fireflies)

Triboluminescence

- Production of light from friction as a result of scratching, crushing or rubbing certain crystals

Lasers

- Emits electromagnetic waves of exactly the same energy level resulting in a pure colour
- Laser lights is also very intense and concentrated in one narrow beam because it travel is one direction

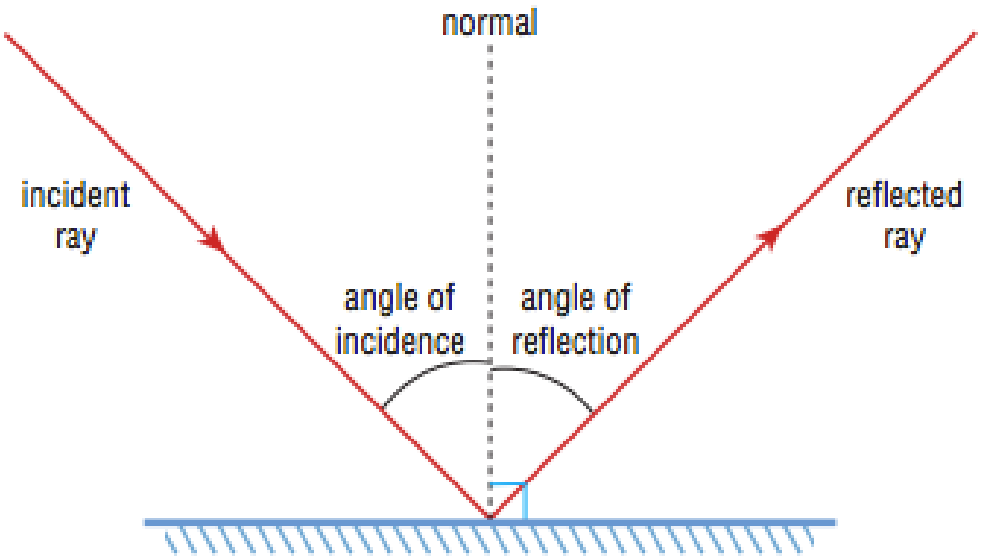


Ray Model of Light

- **Light Ray** – a line on a diagram representing the direction and path that light is traveling
- **Incident Ray** – Light emitted from a source that strikes an object
- Objects can be classified into 3 categories:
  - **Transparent** – lets light pass through easily
  - **Translucent** – allows some light to pass through
  - **Opaque** – allows no light to pass through

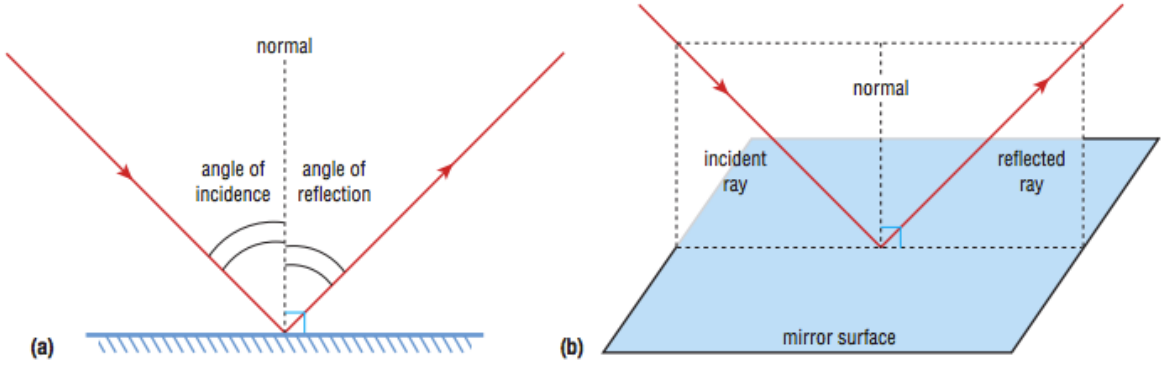
Mirrors

- **Mirror** – any polished surface that exhibits reflection
- **Image** – the reproduction of an original object that is produced through the use of light
- **Reflection** – the bouncing back of light from any surface



Laws of Reflection

- The angle of incidence equals the angle of reflection
- The incident ray, the reflected ray and the normal all lie in the same plane



Types of Reflection

- Specular Reflection – reflection off a smooth surface
- Diffuse Reflection – reflection off an irregular or dull surface

Writing Reflectively

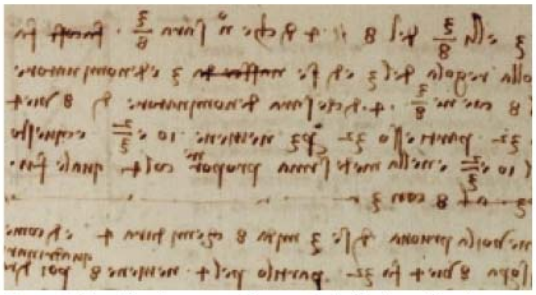


Figure 1 A section from one of Leonardo da Vinci's notebooks showing his backwards writing

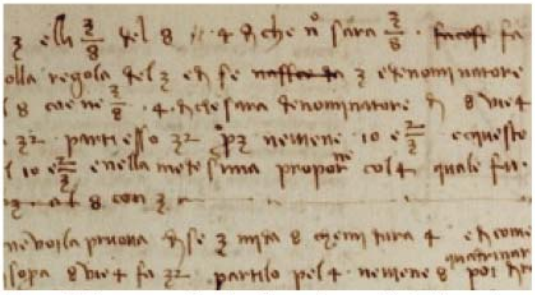
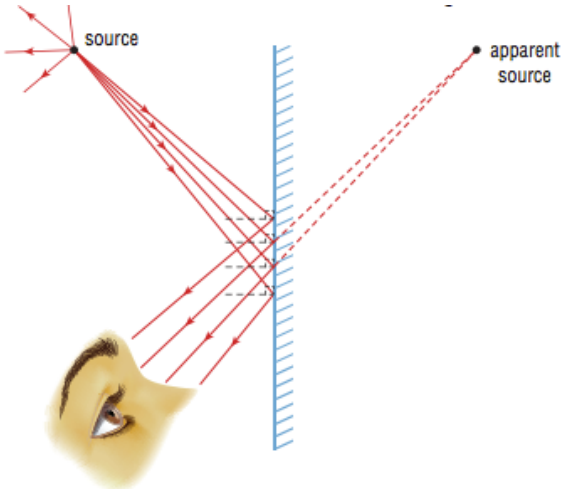


Figure 2 The same section from Figure 1 now reflected in a mirror. Note that the numbers are now readable.

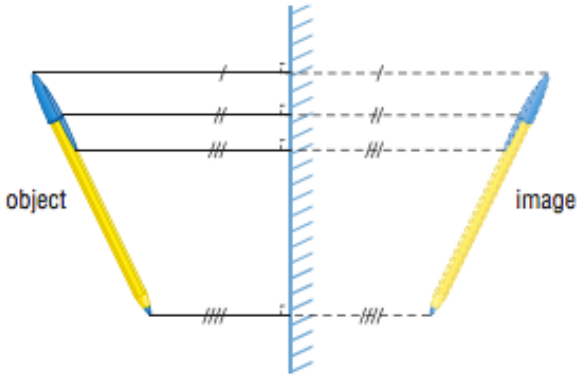
- Leonardo Da Vinci often mirror wrote in his notes unless it was intended for other people to read

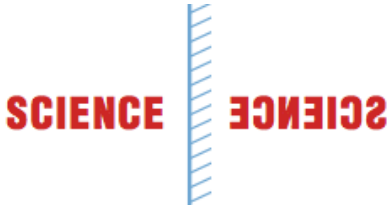
Images in Plane Mirrors



- Virtual Image – an image formed by light coming from an apparent light source; light is not coming from the actual image location

- Distance from the object to the mirror is exactly the same as the image to the mirror
- The object-image line is perpendicular to the mirror surface
- Images are upright but flipped horizontally; lateral inversion





SALT

- S = size of image compared to the object
- A = attitude of image; upright/inverted
- L = location of image
- T = type of image; real or virtual