Chapter 5: Optical systems make use of mirrors and lenses
Chapter 5.1
The Ray Model of Light
For the study of optics, scientists use a simplified model called a:

- **Ray Model of Light**: light is represented as a straight line or ray that shows the direction the light wave is traveling.

*Figure 5.2*  A ray is an imaginary line showing the direction in which light is travelling.
Light and Matter:

- **Transparent**: Allows light to pass through freely. (window)
- **Translucent**: Most rays get through but are scattered in all directions. (wax paper)
- **Opaque**: Prevents any light from passing through. (wall)

Figure 5.4 These candleholders have different light-transmitting properties.

Figure 5.5 Light travels in straight lines until it strikes something.
Reflection:

“The angle of reflection equals the angle of incidence.”

- The incoming ray is called the incident ray. The ray that bounces off the barrier is called reflected ray. The normal is an imaginary line that is perpendicular to the barrier.

- The angle formed by the incidence beam and the normal is the angle of incidence ($i$). The angle formed by the reflected beam and the normal is the angle of reflection ($r$).

- Draw & Label Diagram ----→

Figure 5.9 Light reflected from any surface follows the law of reflection.
**Refraction:**

- When light rays pass through *transparent* or *translucent* material it slows down and changes direction because the material is more dense than air. When the light rays leave the material and enter the air again they change direction because they can move faster through the air.

- The **angle of refraction** is the angle of a ray of light emerging from the boundary between two materials such as air and glass.

- Draw & Label Diagram ----→

![Diagram](Figure 5.11A) When light rays travel from air to water, they slow down and bend toward normal. $R$ is the angle of refraction.

![Diagram](Figure 5.11B) When light rays travel from water to air, they speed up and bend away from normal.
Check Your Understanding:

CH 5.1 Questions:

Page 181 #1-7 + 9.
Chapter 5.2
Using Mirrors to Form Images
- **Plane mirror**—is flat and smooth. Light bounces off at the angles it hits. (Normal reflection)
**Concave Mirrors:**

- **A concave mirror curves inwards.** Concave mirrors, like plane mirrors, reflect light rays to form images. Concave mirrors reflect light rays in a unique way.

*Figure 5.17* Light rays collected by a concave mirror converge on a focal point before spreading out again.
Concave Continued:

- Parallel light rays bounce off the curved surface and meet at single point called the focal point. Light rays that are coming together at a focal point are described as converging.

- If a distant object is reflected in a concave mirror, its image will be small and upside down. As the image is moved closer to the focal point, it stays inverted but gets larger.

- Enlarges reflection (magnifies).
**Convex Mirrors:**

- A **convex mirror** curves outwards.
- A convex mirror reflects the parallel light rays as if they came from a **virtual focal point behind the mirror**. Light rays that spread apart after reflecting are described as **diverging**.
- Increases field of view.

*Figure 5.20* The reflected rays from a convex mirror diverge and do not meet.
Check Your Understanding:

**CH 5.2 Questions:**

*Page 189: # 1 - 9.*
Chapter 5.3

Using Lenses to Form Images

**Lens**: A curved piece of transparent material.
Concave Lenses:

- **Concave lenses** are thinner in the middle than at the **edge**. As light rays pass through the concave lens they are:
  - refracted outward. (**diverge**)
  - never meet at a focal point. (**have virtual focal point**)
Convex Lenses:

- **CONVEX LENSES** are thicker in the middle than the edges.
- When light rays pass through, they **CONVERGE** (COME TOGETHER).
- Light rays form a **FOCAL POINT** (where light rays pass through one point).

**Figure 5.24**  Light rays converge when they pass through a convex lens.
The distance from the centre of the lens or mirror to the focal point is called the **focal length**.

**Figure 5.26** The focal length of a convex lens
Check Your Understanding:

CH 5.3 Questions:

- Answer page 197: #1 - 11
Chapter Review:

Page: #198-199

Checking Concepts: #1-7

Understanding Key Ideas: #8-10, 12-14 & 18