

MIRRORS

STAGE 1_WARM-UP

THE FACE IN THE MIRROR

(...) Often, on returning home from one of those mysterious and prolonged absences (...), he himself would creep upstairs to the locked room, open the door with the key that never left him now, and stand, with a mirror, in front of the portrait that Basil Hallward had painted of him, looking now at the evil and ageing face on the canvas, and now at the fair young face that laughed back at him from the polished glass. The very sharpness of the contrast used to quicken his sense of pleasure. He grew more and more enamoured of his own beauty, more and more interested in the corruption of his soul.

from: Oscar Wilde_The Picture of Dorian Gray_Chapter 11

STAGE 2_WHAT IS A MIRROR?

STAGE 2_1_DISCUSS WITH YOUR SCHOOLMATES

1. *What is a mirror?*
2. *What are mirrors most commonly used for?*
3. *Are mirrors also used in the field of technology?*

STAGE 2_2_READ THE FOLLOWING TEXT AND CHECK IF YOU WERE RIGHT

A **mirror** is an object with a surface that has good specular reflection; that is, it is smooth enough to form an image. The most familiar type of mirror is the **plane mirror**, which has a flat surface. **Curved mirrors** are also used, to produce **magnified** or **demagnified** images or focus light or simply distort the reflected image.

Mirrors are most commonly used for personal grooming, decoration, and architecture. Mirrors are also used in scientific apparatus such as telescopes and lasers, cameras, and industrial machinery. Most mirrors are designed for visible light; however, mirrors designed for other types of **waves** or other **wavelengths** of electromagnetic radiation are also used, especially in optical instruments.

STAGE 3_BUILD YOUR OWN COPY MACHINE

1. *Think about when you look at yourself in a mirror. Do you look like a person behind a window? Do you look like a person on a photo?*
2. *Where do you think Dorian's image is? Is it in the mirror? Is it behind it?*
3. *A mirror can create a copy of a drawing or a photo. How can you obtain this copy as a real object?*

You can carry out an experiment to see how to obtain a copy of a picture by using a mirror image.

List of materials

- CD cover
- artwork
- sheet of paper
- pencils
- lamp

Description

1. Put the open CD cover on the table in an upright position (the mirror must be exactly perpendicular to the plane. Otherwise the mirror image will not be in the correct position).
2. Position the artwork on one side of the mirror and illuminate it with the lamp (the artwork should be very close to the semipermeable mirror; it must be illuminated very brightly - the blank paper should be in the darker zone).
3. Put the sheet of blank paper on the other (darker) side (artwork and paper must be in-plane).
4. Look through the CD cover and you will see the mirror image. It seems to be exactly on the blank paper (the mirror image seems to be behind the mirror and thus lies on the blank sheet of paper. If a point of the artwork is further away from the mirror, it is the same with the "mirrored" point. The initial artwork and the mirror image are of the same size).
5. Now copy the artwork on the blank paper.
6. Calculate the distance between a point of the artwork and the mirror. Do the same with its "mirrored" point.
7. Draw a line connecting the two points and measure the angle between this line and the mirror.

STAGE 4_READ THE FOLLOWING TEXT AND ANSWER THE QUESTIONS

A SHORT HISTORY OF MIRRORS

The first mirrors used by man were most likely pools of dark, still water, or water collected in a primitive vessel of some sort. The earliest manufactured mirrors were pieces of polished stone such as **obsidian**, a naturally occurring volcanic glass. Examples of obsidian mirrors found in Anatolia (modern-day Turkey) have been dated to around 6000 BC. Polished stone mirrors from central and south America date from around 2000 BC onwards.

Mirrors of **polished copper** were crafted in Mesopotamia from 4000 BC, and in ancient Egypt from around 3000 BC. The use of polished metal mirrors – **copper, tin, bronze, silver** and **gold**, and later **steel** and **pewter** – continued through the ancient Greek and Roman civilizations into the Middle Ages. In China, bronze mirrors were manufactured from around 2000 BC.

Metal-coated glass mirrors are said to have been invented in Sidon (modern-day Lebanon) in the first century AD, and glass mirrors **backed** with **gold leaf** are mentioned by the Roman author **Pliny** in his *Natural History*, written in about 77 AD. The Romans also developed a technique for creating **crude mirrors** by coating blown glass with **molten lead**.

Some time during the early Renaissance, European manufacturers perfected a superior method of coating glass with a **tin-mercury amalgam**. The exact date and location of the discovery is unknown, but in the 16th century, Venice, a city famed for its **glass-making** expertise, became a centre of mirror production using this new technique. Glass mirrors from this period were extremely expensive luxuries. The Saint-Gobain factory, founded by royal initiative in France, was an important manufacturer, and Bohemian and German glass, often rather cheaper, was also important.

The invention of the **silvered-glass mirror** is credited to German chemist **Justus von Liebig** in 1835. His process involved the deposition of a thin **layer** of metallic silver onto glass through the chemical reduction of **silver nitrate**. This silvering process was adapted for mass manufacturing and led to the greater availability of affordable mirrors. Nowadays, mirrors are often produced by the **vacuum deposition** of **aluminium** (or sometimes silver) directly onto the glass substrate.

1. *What is obsidian? What was it used for in ancient times?*
2. *Which metals were used in mirrors manufacturing?*
3. *Where were glass mirrors invented?*
4. *Which technique did Pliny mention in his Natural History?*
5. *How did the Romans help the development of mirrors manufacturing?*
6. *When and where was the tin-mercury amalgam technique perfected?*
7. *Which process led to the production of affordable mirrors?*
8. *Who invented it?*
9. *What did that process involve?*
10. *Which technique is often used nowadays?*

STAGE 5_READ THE FOLLOWING TEXT AND ANSWER THE QUESTIONS

Specular reflection

Specular reflection is the perfect, mirror-like reflection of light (or sometimes other kinds of wave) from a surface, in which light from a single incoming direction (a ray) is reflected into a single outgoing direction. Such behavior is described by the **law of reflection**, which states that the direction of incoming light (the incident ray), and the direction of outgoing light reflected (the reflected ray) make the same angle with respect to the surface normal, thus **the angle of incidence equals the angle of reflection**.

This is in contrast to **diffuse reflection**, where incoming light is reflected in a broad range of directions. The most familiar example of the distinction between specular and diffuse reflection would be glossy and matte paints. While both exhibit a combination of specular and diffuse reflection, matte paints have a higher proportion of diffuse reflection and glossy paints have a greater proportion of specular reflection. Very highly polished surfaces, such as high quality mirrors, can exhibit almost perfect specular reflection.

Even when a surface exhibits only specular reflection with no diffuse reflection, not all of the light is necessarily reflected. Some of the light may be absorbed by the materials. Additionally, depending on the type of material behind the surface, some of the light may be transmitted through the surface. For most interfaces between materials, the fraction of the light that is reflected increases with increasing angle of incidence θ_i . If the light is propagating in a material with a higher **index of refraction** than the material whose surface it strikes, then total internal reflection may occur.

Usually, the term specular reflection refers to visible light; however the term is also widely used for other electromagnetic waves. The specular reflection of non-electromagnetic waves follows basically the same laws. Acoustical mirrors—and even atomic mirrors—exist which provide the specular reflection of neutral atoms.

5_1_Say if the following statements are TRUE or FALSE. Then correct the false ones.

1. Specular reflection is the only kind of reflection existing in nature.
2. The law of reflection states that the incident ray and the reflected ray make the same angle with respect to the surface normal.
3. Diffuse reflection is related to a single outgoing ray of light.
4. High quality mirrors are characterized by a greater amount of diffuse reflection.
5. Non-electromagnetic waves follow the laws of specular reflection.

5_2_Now answer the following questions

1. What does the law of reflection state?
2. What is the difference between glossy and matte paints?
3. What can specular reflection be exhibited by?
4. Do surfaces which exhibit only specular reflection all the incoming light? Why?
5. When does total internal reflection occur?
6. Is the term specular reflection only referred to visible light?