Name ______________________ Date ____________ Group Name ________

# LABORATORY REPORT

**Title:** Angle of Incidence/ Angle of Reflection Lab

**Problem:** How does the shape of a mirror affect the image seen?

**Purpose:** ____________________________________________

____________________________________________

**Hypothesis:** ____________________________________________

____________________________________________

____________________________________________

____________________________________________

**Variable:** ______________________

**Measurable Outcome:** T: ______________________
U: ______________________
T: ______________________

**Constants:**
1. ______________________
2. ______________________
3. ______________________
4. ______________________

**Materials:**

1. flashlight
2. slit card
3. mirror
4. 4 different colored pencils
5. protractor
6. procedure and data table

**Complete the chart to help organize your ideas:**

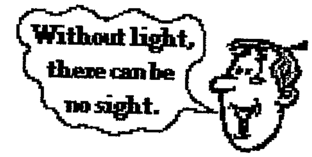
| TYPE OF MIRROR | SHAPE OF MIRROR | BEHAVIOR OF LIGHT | IMAGE PRODUCED |
|---|---|---|---|
| PLANE | | | |
| CONVEX | | | |
| CONCAVE | | | |

# Procedure:

1. Hold a plane mirror in front of you. Observe how your reflection appears.
2. Write down how your reflection appears in the plane mirror.
3. Repeat steps 1 and 2 for the concave and convex mirrors.
4. Set up the mirror, slit card, and flashlight so that the light is hitting the mirror at any angle other than 90 degrees.
5. Trace the path of light into the mirror and the path of light off the mirror with a pencil.
6. Using a protractor, draw the normal line (90 degree line).
7. Bend the mirror so that it's concave, and using a different colored pencil, trace the path of reflected light.
8. Bend the mirror so that it's convex, and using another colored pencil, trace the path of reflected light.
9. Measure the number of degrees the incoming path of light is from the normal line (this is called the angle of incidence). Record results.
10. Measure the number of degrees the reflected path of light is from the normal line (angle of reflection) for the plane mirror. Record results.
11. Measure the number of degrees the reflected path of light is from the normal line (angle of reflection) for the concave mirror. Record results.
12. Measure the number of degrees the reflected path of light is from the normal line (angle of reflection) for the convex mirror. Record results.

| Mirror | Trial 1 | | Trial 2 | | Trial 3 | |
|---|---|---|---|---|---|---|
| | I | R | I | R | I | R |
| Plane | | | | | | |
| Concave | | | | | | |
| Convex | | | | | | |

# Reflection of Light




Reflection of light occurs when the waves of light hit a surface, such as a mirror, and light waves bounce away from the surface. The simplest example of visible light reflection is the surface of a smooth pool of water, where incident light is reflected to produce a clear image of the scenery surrounding the pool (See Figure 1). Yet, throw a rock into the pool and the water forms waves, which disrupt the reflection by scattering the reflected light rays in all directions.

Reflections From the Surface of Water

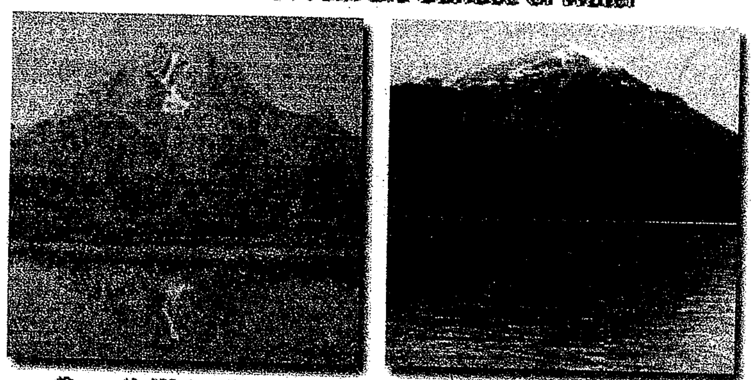



Figure 1

Some of the earliest accounts of light reflection originate from the ancient Greek mathematician Euclid, who conducted a series of experiments around 300 BC, and appears to have had a good understanding of how light is reflected. However, it wasn't until a millennium and a half later that the Arab scientist Alhazen proposed a law describing exactly what happens to a light ray when it strikes a smooth surface and then bounces off into space.

The incoming light wave is referred to as an **incident** light wave, and the wave that is bounced away from the surface is termed the **reflected** light wave. Visible white light that is directed onto the surface of a mirror at an angle (incident) is reflected back into space by the mirror surface at another angle (reflected) that is equal to the incident angle. For example, a beam of light from a flashlight that is shined at an angle onto a smooth, flat mirror (See Figure 2) is reflected in an equal opposite direction. Thus, the angle of incidence is equal to the angle of reflection for visible light. This concept is

Equal Angles of Reflection

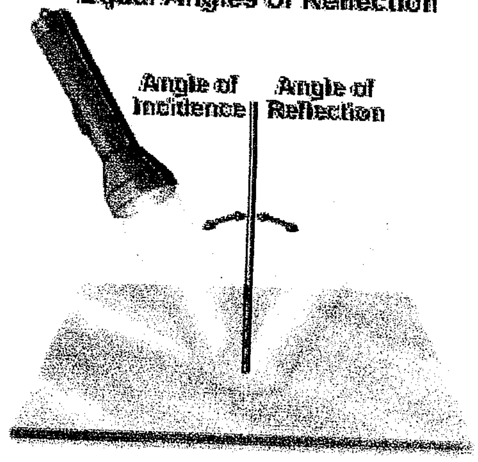



Figure 2

often termed the **Law of Reflection**. All wavelengths of light are being reflected at equal angles.

The best surfaces for reflecting light are very smooth surfaces, such as a glass mirror or polished metal, although almost all surfaces will reflect light to some degree.

The amount of light reflected by an object, and how it is reflected, depends upon the smoothness or **texture** of the surface. When the surface is very smooth, almost all of the light is reflected equally, producing a mirror image that is identical but reversed. However, in the real world most objects have uneven, rough surfaces where light is reflected in all directions.

**Concave mirrors**: This type of mirror is commonly found in shaving or cosmetic mirrors where the reflected light produces a magnified image of the face. The inside of a shiny spoon is a common example of a concave mirror surface. If the inside of the spoon is held close to the eye, a magnified upright view of the eye will be seen. If the spoon is moved farther away, an upside-down view of the whole face will be seen.

**Convex mirrors:** Another common mirror having a curved-surface is often used in buses and automobile rear-view reflectors where the curved outward mirror helps the driver to see more. This is because it produces a smaller, more panoramic view of events occurring behind the vehicle. Convex mirrors are also used as wide-angle mirrors in hallways and businesses for security and safety. The most amusing applications for curved mirrors are the mirrors found at state fairs, carnivals, and fun houses. These mirrors are often a mixture of concave and convex surfaces, to produce bizarre, distorted reflections when people observe themselves.

Reflection from Convex and Concave Surfaces

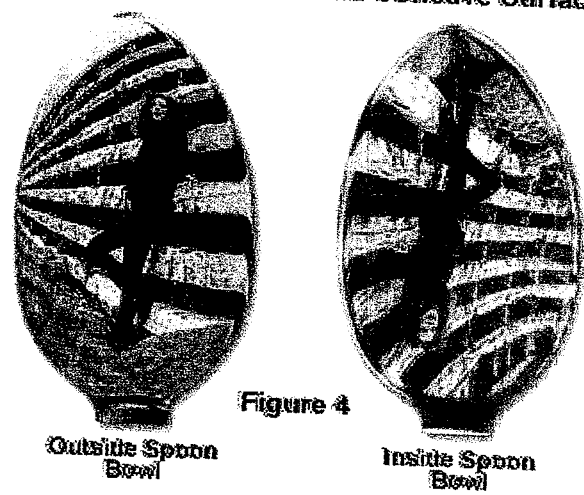



Figure 4

Spoons can be used to simulate convex and concave mirrors, as illustrated in Figure 4 for the reflection of a young woman standing beside a wooden fence. When the image of the woman and fence are reflected from the outside **bowl** surface (convex) of the spoon, the image is upright, but distorted at the edges. In contrast, when the reverse side of the spoon (the inside bowl, or concave, surface) is used to reflect the scene, the image of the woman and fence are upside-down.

Why does a diamond sparkle so? The way in which gemstones are cut is one of the more aesthetically important and pleasing applications of the principles of light reflection. Particularly in the case of diamonds, the beauty and value of an individual stone is largely determined by the geometric relationships of the external faces (or **facets**) of the gem. The facets that are cut into a diamond are planned so that most of the light that falls on the front face of the stone is reflected back toward the observer (Figure 6). A portion of the light is reflected directly from the outside upper facets, but some enters the diamond, and after internal reflection, is reflected back out of the stone from the inside surfaces of the lower facets. These internal ray paths and multiple reflections are responsible for a diamond's sparkle, often referred to as its "fire". An interesting consequence of a perfectly cut stone is that it will show brilliant reflection when viewed from the front, but will look darker or dull from the back, as illustrated in Figure 6.

Faceted Diamond Reflections

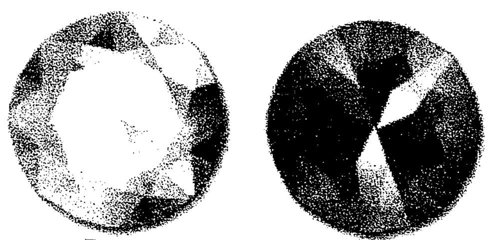



Figure 6

**Use the information from this article to answer the following questions for Conclusion #4 and 5.**

## Conclusion Part 4:

1. Explain why in all mirrors (plane, convex, and concave) a reflection is seen in reverse.
2. Choose either concave or convex, and answer the following questions:
    a. Describe the shape of the mirror you chose.
    b. How does light behave after hitting that mirror?
    c. How does this mirror affect the field of vision (area seen)?
    d. How does this mirror affect the size of the image seen?

## Conclusion Part 5:

1. Describe one example of how each mirror is used in every day life, and tell WHY you would use it for that.
2. How does the behavior of reflected light cause the "sparkle" seen from a diamond or other gem?