Secondary: Glass in Technology

Lesson: Glass in Technology	
Age Group (Grade): Yr: 7-12	Lesson duration: 1 hour

Aim: Glass has amazing properties when it comes to its ability to manipulate light, forming the backbone of many of our advances in science and technology. Students will explore what glass is, how it is made and how it can be structured to move information from one point to another.

Safety considerations: Glass and mirrors are used in this activity. It is recommended that teachers undertake a Curriculum Activity Risk Assessment (CARA) process.
It is recommended that students are briefed as to the risks of low light and cuts from broken mirror or materials, and the use of gloves when handling materials should be considered. It is recommended to conduct the activity in smaller groups where appropriate.

Links with Curriculum (KLAs):
Y9: All matter is made of atoms that are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (ACSSU177)
Y9: Energy transfer through different mediums can be explained using wave and particle models (ACSSU182)
Y10: Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries (ACSHE192)
Y9/10: Investigate and make judgements on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043)

Key Vocabulary:
Reflection
Refraction
Light
Optical Fibres
Recycle
Communication

Content	Resources
Focus Questions: • What technology uses glass? • How does glass help us communicate? • What are optical fibers and how do they work? • What is the difference between reflection and refraction? • How does glass create a reflection? • How is light refracted? • How are materials recycled? • What are the challenges of recycling?	• Targets x 3 (see over) • Coloured markers x 3 • A large dark space (i.e. an empty room with curtains) • Torches x 3 • Hand-held mirrors • Lenses of concave and convex shape • Internet access • Recycling activity sheets (see over)

Activity

Introduction
Ask Students
- Where do we see glass in our technology?
- Where do you think we would be as a civilization without glass?

Introduce Topic
This lesson will aim to identify the importance of glass in our modern technology and specifically address how it is used in communication and resource recovery. Points of interest include the use of optical fibers in communication, how light can travel through these fibers, and how optical sorters are used in Material Recycling Facilities.
Safety
Inform students of the risks associated with light and glass. Advise students to avoid looking

into the light and to inform an adult of any mirror breakages. Ensure that students know not to touch any broken glass.

Main Lesson

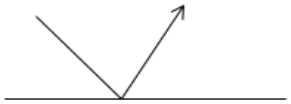
What technology uses glass? Glass is used in communication and to display information.

How does glass help us communicate? Glass, in the form of optical fibers, transfers information as light across far distances. Bundles of fiber optic cables transmit light signals which re decoded as 'data'.

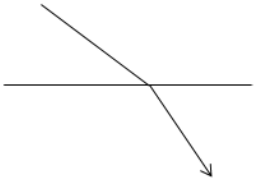
What are optical fibers and how do they work? Optical fibers are small, hair-line cables made of glass that transport light over long distances through reflection and refraction. Light travels down the core of the optical fiber (the glass structure). Light is kept inside the cable through use of cladding, which is another layer of glass wrapped around the core. There are two main types of optical fibers. The most commonly used is Single Mode, which is a very thin core in which light signals (photons) travel through without bouncing off the edges. These are typically used for long distances and are what gives you internet and telephone apps. Multimode fiber is the other type of optical fiber. It is approx. 10x larger than a single mode and allows light to follow a variety of different paths. These are only able to send data over short distances.

What happens when light travels through glass? When light travels through the air and into glass, it is both reflected and refracted.

What is reflection? Reflection is the reason we can see anything. It is light 'bouncing' off an object and back into our eyes. There are two main types of reflection: specular and diffuse. Specular reflection happens when you have a very smooth surface to reflect light upon, reflecting back a well-defined beam of light (e.g. glass, a mirror, or a polished spoon). Diffuse occurs when there is a rough surface, scattering light all over the place (e.g. light on a dusty or bumpy surface does not show your reflection). When the light particles (photons) hit the sides of the glass core at an angle less than 45 degrees, it achieves total internal reflection, which means no light is lost in refraction.



What is refraction? Refraction is light changing directions / bending when it comes into contact with a new medium (e.g. when a pencil sits half in water and half in air it appears to bend in the liquid). This occurs because of a change in speed due to the density of a medium's electrons. This can be compared to us running through air versus water – we have to move more electrons out of the way when moving through water as it is denser than air, making us slower. The cladding of optical fibers has a lower refractive index than the core, causing the light to bend within the cable.



Optical sorting in recycling. Optical sorters are used at material recycling facilities (MRFs) to identify and separate different material types. A conveyor belt moves materials under a bright light. Some of the light is absorbed by recyclable items whereas other light waves are reflected. Camera lenses record the unique light signatures of the different material types. The materials are identified based on their light signature, which are read with a spectrometer. The optical sorted is predominantly used to identify different 'types' of plastics (i.e. PET, HDPE, PVC, PP, etc.). When the specific material type is identified by the spectrometer, a jet of air is used to separate the item from the stream.

Activity One: Light Race/Light Obstacle Course

Activity One will see students moving light from one location to another to mimic the movement of information through an optic cable. Students will need to make their own or

utilise convex and concave lenses and use mirrors to move light from its source to a nominated end point.

Begin by creating three obstacle courses for the students to reflect a light throughout. Mark the end of the course with a target (see page 5) attached to a wall. Position a torch at the beginning of each course. The first course can be a straight line with no obstructions. The second may have to travel around a corner. The third course may have a few obstacles that the students need to reflect the light around/under or a few corners to navigate. The aim is to reflect the light off each mirror and attempt to line the light up with the target.

1. Students are to be divided into three (3) groups.
2. Assign a hand mirror to each student.
3. Delegate a coloured marker to each group leader and direct each group to a course.
4. When each group is within their designated course, begin the ten (10) minute timer.
5. Direct students to line their mirrors up with the light one by one until the light has reflected against all mirrors.
6. Encourage students to direct the light towards the target.
7. The team leader will use the coloured marker to mark the spot in which the light is reflected onto the wall. Do not mark the light unless all mirrors have been reflected against.
8. At the end of the ten-minute timer, rotate each group to the following course.
9. Repeat steps 5-9 until each group has attempted all courses.
10. Gather students and collect all mirrors and coloured markers.

Announce the winners of each course by measurement of closest mark to the target.

Activity Two: Research Using Glass to Recycle Glass

Activity Two will be a research project for students to seek out how glass can be recycled, and the processes involved. Is glass the answer to all of our problems or does it present with further challenges?

This is an independent research activity for the students to conduct on their own. Students will refer to the activity sheet provided and answer the questions to the best of their ability.

Introduce glass recycling through questions such as “Do you know how glass is recycled? What can glass be turned into? Are all materials recyclable?”

One of the key components in this activity is to explore how information is transferred in glass recycling processes using an Optical Sorter.

Evaluation

- Students can identify how glass has shaped technology.
- Students can explain how optic fibres are used in communication.
- The process of glass recycling can be detailed with an understanding of the pros and cons of glass as a material.

Additional suggested activities and support

- Students design an obstacle course to challenge the opposing team in the light race.
- Students can research further into the future of glass technology and create a futuristic design that uses glass. (e.g. glasses you can watch videos on, holographic projections)

Glass Recycling Process Questions

Question One: How is glass collected for recycling in your area?

Do you have a yellow lid recycling bin? Can you take glass somewhere else away from home to be recycled?

Question Two: How is glass separated at a Materials Recovery Facility?

What is a Materials Recovery Facility? Is there one near you? How is glass separated from other recyclables?

Question Three: What is a glass beneficiation plant?

What is an optical sorter and how does it sort glass?

Question Four: What technology is used in an optical sorter?

Are there glass components in an optical sorter? How does it focus light and collect information?

Question Five: What technology is used when re-manufacturing glass?

How is glass remanufactured? What proportion of glass bottles are made from recycled glass? Does recycled glass lose its quality over time?

Target