

Invisibility (Light refraction) Worksheet

Learning outcomes

In this activity you will learn about light, how it travels through different mediums and the science of light refraction. You will also learn how this science is being used in the world of work.

Introduction

Light is a type of electromagnetic radiation (energy that is all around us). Light is the fastest thing in the universe and moves in straight lines. If we moved at the same speed as light, we could travel round Earth's equator approximately seven times in one second. Light from the Sun takes roughly eight minutes to reach Earth. When light hits an object, its energy can either be absorbed (changed to heat), reflected (bounced off the object) or refracted (bent away). We can see the moon because it reflects the light of the sun. Refraction is the change in direction of a light wave as it moves from one medium to another caused by the change in speed. The change in speed and direction can be measured by the Refractive Index.

Activity

Try at home - Invisibility

You will need:

- ★ Vegetable oil
- ★ Collection of different sized Pyrex (heatproof) glassware – test tubes for example can be ordered online
- ★ Rubber gloves
- ★ Basin or wipeable tablecloth
- ★ Kitchen roll to wipe up any spillages

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An adult should help with this activity – they'll find it fun too! You can also watch a short [video here](#) (1) to help you with the experiment.

1. Fill up the largest Pyrex item with vegetable oil and allow it settle
2. Place one of the test tubes in the oil – can you see the test tube?
3. Submerge the test tube and allow it to fill with vegetable oil – can you see it now?

We can only see an object if it reflects or refracts light. We see the object when the light bounces off it and enters our eyes. Once the light enters our eyes, signals are sent to the brain. Take a glass for example. The glass is clear but since light travels at different speeds through the air and the glass some of the light will be reflected and some will be refracted. You are not seeing the glass itself, but light bouncing off or being bent from other objects around it.

When Pyrex glass is placed in vegetable oil things get interesting. Light travels at the same speed through the Pyrex glass and the vegetable oil. The light isn't reflected or refracted, it passes straight through. Since the glass and the vegetable oil have similar refractive indexes the Pyrex glass appears invisible.

Scientists such as physicists came up with the term Refraction, to describe the bending of light waves as they move from one medium to another. We know about light and its properties due to scientist's studies over the years. Physics will always be an interesting area of science with many potential careers in the future. Learn more about the role here:

[Physicist](#) (2)

The Pyrex glass used in the experiment is made by chemical and materials engineers. They use their knowledge of materials and elements to create safe products for use in our homes, as well as industry. These items must also be quality tested before mass production for sale. Check out these job profiles – are there any skills they share?

[Chemical engineer](#) (3)

[Materials engineer](#) (4)

[Quality manager](#) (5)

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Real world examples

If you would like to learn more about refraction and how it can be used in modern day technologies, see the information and links below to some companies using invisibility as part of their technology.

[Hyperstealth Biotechnology](#) (6) supplies camouflage clothing and technologies to military applications around the world. They have developed their own brand of “invisibility cloak” called Quantum Stealth. This material makes an object appear invisible by bending light waves around it. As well as Material and Chemical engineers, [Biotechnologists](#) (7), [Design engineers](#) (8) and [Garment technologists](#) (9) would have been involved in the development of this stealth technology.

BAE systems in Sweden have produced a vehicle camouflaging system called ADAPTIV. This technology can hide a vehicle from thermal sensory detection. Read about the system [here](#) (10). ADAPTIV is being tested on land-based vehicles for now with future applications in development for ocean based and air vehicles. A project team with expertise and skills in problem solving, sensors, software, electronics and design developed this unique system.

[Electronics engineer](#) (11) [CAD technician](#) (12) [Aerospace engineer](#) (13)

Other types of optical camouflage systems and technologies using carbon nanotubes or metamaterials for example have already been designed. These are currently on a much smaller scale in laboratories, but the technology is always developing. Perhaps an invisibility cloak may be a part of our wardrobes in the future!

[Product designer](#) (14)

You’ve learnt about some job roles related to refraction in this activity. If you would like to explore more, you can do this at [My World of Work](#) (15)

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Website references

1. Invisibility activity guide video <https://bit.ly/3fwsAnN>
2. Physicist <https://bit.ly/2XgpAo2>
3. Chemical engineer <https://bit.ly/2XkUhZe>
4. Materials engineer <https://bit.ly/3cPfG3g>
5. Quality manager <https://bit.ly/3bQjMHb>
6. Hyper stealth Biotechnology <https://www.hyperstealth.net/>
7. Biotechnologist <https://bit.ly/2LMn4ka>
8. Design engineer <https://bit.ly/3bOd9VZ>
9. Garment technologist <https://bit.ly/2ToEJm4>
10. Vehicle Camouflaging System
www.baesystems.com/en/feature/adativ-cloak-of-invisibility
11. Electronics engineer <https://bit.ly/3g3H3ZD>
12. CAD technician <https://bit.ly/2AFT7jl>
13. Aerospace engineer <https://bit.ly/2WO5Dpu>
14. Product designer <https://bit.ly/3bJmDBz>
15. My World of Work
www.myworldofwork.co.uk/my-career-options/job-categories