

Data: Quick Start Guide

What's it all about then?

This experiment looks at how we manipulate data, or more specifically how we store it and transmit it from one place to another.

What you can explore through this experiment

- Visible Light is a form of energy and is a small part of the "Electromagnetic spectrum"
- Wavelengths of light
- Lasers
- Sound and vibration
- How we use light and magnetism to store information

How to present this experiment:

This is a guide suggesting how to present the experiment to the students. You do not have to follow it exactly, as long as you allow the students to explore the concepts involved.

You can expand or shorten this experiment as necessary to fill the time allocated.

The kit:

- Small house with speaker inside and laser
- MP3 player
- Baggage cart
- Track for baggage cart
- Various types of storage media
- Laptop
- Light transmitters and receivers
- Walkie-talkies
- Microscope
- Microdots



Sample images of the equipment

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Introduction

Start the experiment by saying who you are and what you do for a living. Inform students that they are going to be taking on the role of secret agents, spying on the enemy and communicating their findings with some other agents. Relate it to James Bond or similar spy themed film/TV programme.

Part 1: Spying on the enemy

1.1 House and laser-microphone setup

Discuss with the students the nature of sound being vibrations. This is the key to how the laser microphone works. Ask a student to shine the laser onto the window and move the receiver to pick-up the reflected ray. The sound inside the house can now be heard with the headphones.



Sound (vibration) from the speaker causes the window to vibrate a very small amount. This movement interferes with the path of the laser. The change in path is picked up by the detector and then converted back into sound.

Part 2 : Communicating the data

The next task is to simulate communicating the valuable intelligence to other agents. Discuss the methods we use to communicate or transport data, i.e. phone, DVDs, paper etc. In our case we need to ensure the data is safe and undetectable by basic security techniques. We have three main types of physical media to test - DVD, USB Memory stick and some microdots. Which is the best method of communicating the data?

2.1 Testing the different physical media

Setup the track with security station signs. Place the cart onto the track and ask the students to pick a type of media to test. Fix the corresponding media onto the cart and switch it on. The cart will move along and stop at each detector if the item is detected.

Why was it detected?

How does the media work?

For each media type there is a hands on model to demonstrate how it works.



The Models

Optical Media

The model consists of a spinning disc and laser setup. The disc has a series of dark patches which do not reflect the light back to the receiver. The dark patches represent the tiny pits on a CD/DVD disc. As the disc spins a kind of 'Morse Code' sound can be heard as the sound is turned on and off by the pattern of dots.



Microdots

Microdots were originally made by shrinking photos of documents. Modern microdots are made using lasers. The students can use the torch to find the microdot on the case and look at some prepared slides under the microscope.



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USB Memory stick

A memory stick or card is made from billions of tiny transistors. Each transistor can either be a 1 or a 0. Data is stored as a series of 1s and 0s similar to the tiny pits on a DVD which also represent 1s and 0s. (imagine a switch where 1 is on and 0 is off)

This model involves rolling steel balls down a chute. The balls simulate electrons flowing through the memory stick. When the electrons build up in a transistor it changes it from being a 0 to being a 1.



Place the transmitter and receiver at opposite ends of the track. The data will be transmitted and cannot be detected by any of the sensors. The problem with this setup is that it needs an unobstructed line of sight, which can be demonstrated by placing your hand in front of the beam, thereby stopping the signal. The students can investigate a similar setup with different coloured LEDs.

What's special about the white transmitter and detector? (Hint, white light and spectrum)

Radiowaves

To eliminate the 'line of sight' issue we need a technology which can penetrate through walls and transmit in all directions. Examples of this include microwaves or radiowaves. To demonstrate this we have some two-way radios. Send a student outside with one of the radios. They should be able to talk to the remaining students by pressing and holding the talk button. There is a third radio which is tuned to the same frequency. This is to show that anyone on the same frequency can listen in - so information sent in this way isn't very secure. This could lead onto a discussion about data encryption. A typical example is when bank details are encrypted when you purchase things online.

2.2 Using the Electromagnetic Spectrum

Show the students the picture of the EM spectrum and point out the different parts. We will be investigating radio, and visible light. First of all take out the LED transmitters and receivers. They are colour coded for ease of use. On the back of the transmitter is a microphone. The students can speak into the mic and a second person can hear them through the headphones attached to the receiver. NOTE: for this to work the transmitter and receiver need to be in 'line of sight' and with no obstructions in the way.



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