Preface and acknowledgements.

There are 24 experiments in this volume, they are arranged as teacher's notes followed by the student's worksheet. The students and teachers notes can be photocopied for use within the purchasing institution. The accompanying CD includes setup files referred to in the student's notes and will automatically install the worksheets into the **EASY**SENSE software. Once installed the worksheet can be opened using the Open worksheet route from the **EASY**SENSE Homepage. The student will see an onscreen version of the student's worksheet, slightly reworded from the printed notes, and an option to Launch. Launching will use a setup file to configure the logger and open **EASY**SENSE ready for the student to start collecting data. The student can, at any time, swap between the experiment and worksheet. This facility needs Acrobat reader to be installed.

It is hoped the experiments will make it easier for teachers to introduce data logging to students in a meaningful manner. They have been organised into topic areas, where possible. Within each topic area, higher numbered experiments usually indicate a more complex or challenging experiment. Experiments with a following a, b or c are variations of the same experiment using different apparatus.

These experiments have come from many sources. It is not the intention to suggest that they are original, they are experiments that users have asked for, or have told us are useful for the teaching of science and introducing students to data logging. They have all been tested by Data Harvest before inclusion and come form classroom experience.

Teachers conducting the experiments should carry out a correct assessment of the safety risks associated with the experiment. The inclusion or exclusion of safety information is not an indication of responsibility by the publisher. Teachers must follow local safety regulations and advice to ensure the safety of the teacher and students is maintained. Disposal and use of chemicals associated with the experiments should follow local regulations.

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Student's instructions

Teachers notes

Sensors required for each experiment

Students instructions	Sensors	Page
01 Reflectivity	Light	01 -.1
02 How does the intensity of light change with the distance form the light?	Light	02 -.1
03 Polarised sunglasses	Light	03 - 1
04 Investigating interference: Single slit diffraction	Light, Rotary Motion and Linear rack	04 - 1
05 Investigating interference: Young's double slit experiment	Light, Rotary Motion and Linear rack	05 - 1
06 Infra red in the spectrum	Infra Red, Light	06 - 1
07 An experimental estimation of Planck's constant	Voltage, Current	06a - 1
08 Fast light	Light	08 - 1
09 The Biq squeeze	Pressure	09 - 1
10 How does pressure change with height?	Pressure	10 - 1
11a How does pressure change with depth and density (Meters)?	Pressure	11a - 1
11b How does pressure change with depth and density (Snapshot)?	Pressure	11b - 1
11c How does pressure change with depth and density (Snapshot and Asks function)?	Pressure	11c - 1
12 Pressure and heat	Pressure, Temperature	12 - 1
13 What happens to the temperature of a gas if the pressure is changed?	Pressure, Fast Temperature	13 - 1
14 Boyles law (P+V)	Pressure, Fast Temperature	14 – 1
15 Temperature volume relationship in a gas	Pressure, Temperature	15 - 1
16 Pressure temperature relationship of a gas – estimating absolute zero	Pressure, Fast Temeperature	16 - 1
17 Dalton's law of partial pressures	Pressure	17 - 1
18 Determination of R, the gas constant	Pressure	18 - 1
19 Speed of sound in air(by time difference between two sensors)	Sound	19 - 1
19a Speed of sound in a solid (by time difference between two sensors)	Sound	19a - 1
19b Speed of sound in air (by reflection / echo)	Sound	19b - 1
19c Speed of sound in air (by timing)?	Motion	19c - 1

Sensors: Light
Loggers: Any **EASY**SENSE

Logging time: Snapshot

Teacher's notes

01 Reflectivity

Read

In this investigation a 'reflection index' is created for different materials against a shiny piece of aluminum foil which will be used as the 'best' reflector and will become the standard.

The practical will reveal the need for an empirical standard when describing phenomena in the natural world. There will almost certainly be some difference in the students visual impression of "brightness".

The index created will allow the interchange of data. Physics prides itself on having standards of "measure" and the method of measurement that make the interchange of information possible, and unambiguous.

The human visual system does see colour with differing intensities. There are many reasons why this should be so – the most commonly accepted is that it is a reference back to our tree dwelling ancestors and the need to differentiate between foliage and food. In our present position of development cultural references are very important. The human visual system has eye responsible for reception of the light and sensing of the light and the Higher brain centres that are responsible for perception of the image and colour information. The eye, for example simply sees red when the correct cells are activated. The brain however indicates the shade of red, gives it the name red and adds information such as red for danger, sexy red etc. The sensor however only tells you what is there, it is a dispassionate observer and recorder of the physical world.

Apparatus.

1. An **EASY**SENSE logger
2. A Smart Q Light Level sensor 0 to 1,000 Lux.
3. A piece of aluminum foil mounted on card with the shiny surface up most
4. Pieces of different colour or type of paper (the same size as the aluminum) of different perceived brightness
5. Constant light source e.g. a desk lamp.
6. Alternative light sources e.g. Led lamp, fluorescent lamp, halogen lamp.
7. Retort stand, boss and clamp

Set up of software.

The investigation only requires **Snapshot** to be started, There is no further setting up required.

Notes.

When paper is manufactured and coloured the "brightness" of the paper can be exaggerated by the use of fluorescers in the paper finish. These are agents that absorb ultraviolet light and re transmit a bright coloured light (high visibility work wear is good example of this technology). It would be an idea to have a "viewing area" created that gave a constant light for the students visual test, they could then repeat the assessment in an area of different light. Bright sunlight will activate the fluorescence well, in part this explains why it can be difficult to read a book in bright sunlight.

A4 copy paper can provide a good range of colours for the paper samples. You could even use sheets of different white paper (e.g. white for photocopying, colour printing etc.).

To create a standard measurement you may wish the students to make a frame on the work area to place the paper into the same position relative to the sensor, this can be something as simple as a chalked mark on a bench to a picture frame.

It could be useful to a have spectrum of visible light with the wavelength of the colours available.

Results and analysis.

Students are required to produce a reflection index value, this is a simple percentage of the value for the highly reflective aluminium.

You may require the students to put the results into a table form as shown below.

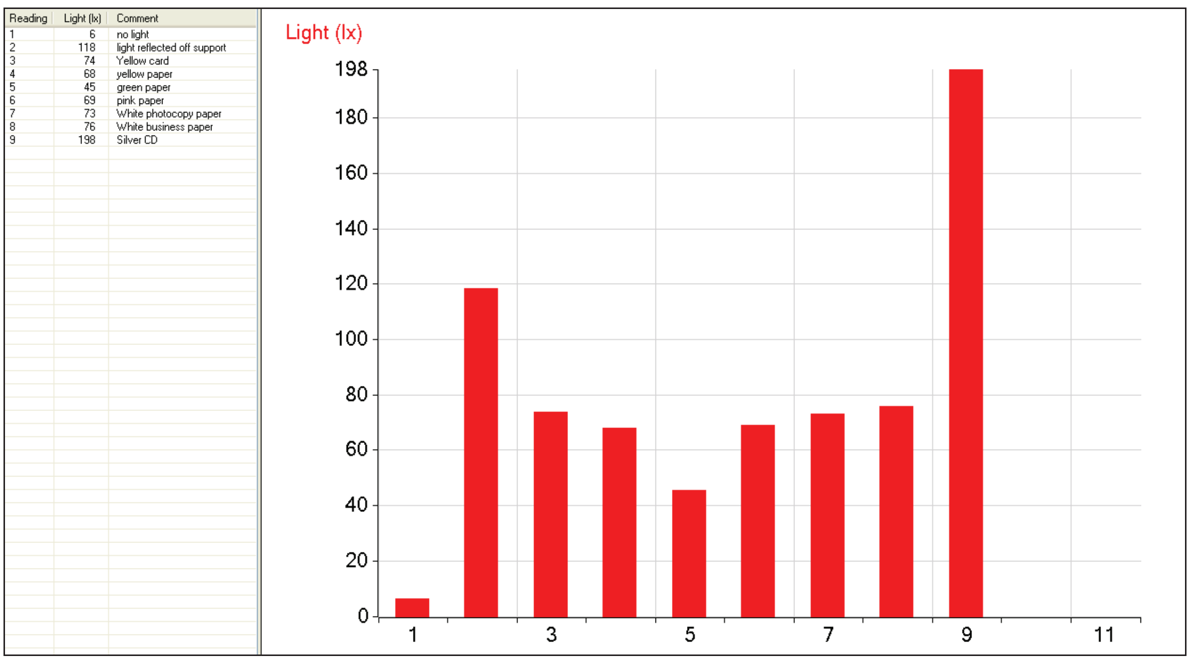
Description of colour of test paper	Reflection as Lx	Reflection index

Calculate the reflection index as: $\dfrac{\text{The light level for paper}}{\text{The light level for aluminum}} \times 100$

If you are using the activity as a data handling activity you will want to encourage the students to take repeat measurements. Get them to think about the difference between taking 3 measurements of the same paper one after another and 3 measurements after removing and replacing the paper.

Sample data.

Data from different coloured photocopy papers and card. A CD was used as the reference reflective material. A tungsten bench lamp was used as the illumination source.



Reading	Light (lx)	Comment
1	6	no light
2	118	light reflected off support
3	74	Yellow card
4	68	yellow paper
5	45	green paper
6	69	pink paper
7	73	White photocopy paper
8	76	White business paper
9	198	Silver CD

Description of colour of test paper	Reflection as Lx	Reflection index
Silver CD	198	100
Yellow card	74	37
Yellow paper	68	34
White photocopy	73	36
White business	76	38

Sensors: Light
Loggers: Any **EASY**SENSE

Logging time: Snapshot

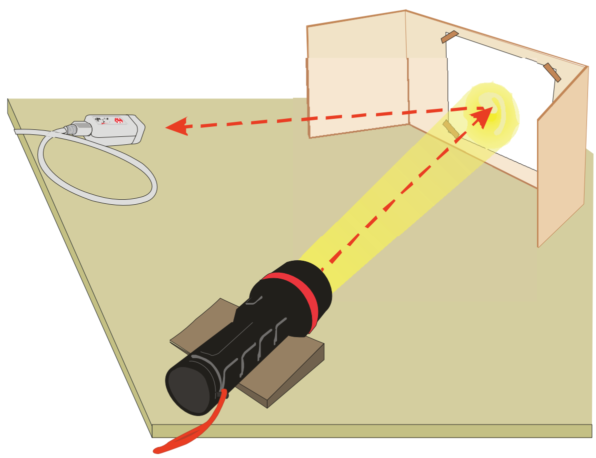
01 Reflectivity

Read.

You may have noticed that:

- On bright sunny days some colours are more difficult to look at than others e.g. the glare from a white page in a book can make it difficult to read.
- Using pale colours to paint a room that does not receive much light can make it look bigger and brighter.
- Film crews use large sheets of reflective material to direct light onto the scene they are filming.

In this investigation you will try to create a ‘reflection index’ for different materials. A piece of shiny aluminum will be used as the ‘best’ reflector and will become the standard against which the other materials are measured.



What you need.

1. An **EASY**SENSE unit
2. A *Smart Q* Light Level sensor (1000lx)
3. A piece of aluminum foil mounted on card with the shiny surface up most
4. Pieces of different colour or type of paper (the same size as the aluminum) of different perceived brightness
5. Constant light source e.g. a desk lamp
6. Retort stand, boss and clamp

What you need to do.

1. Place all the papers to be tested in row. Move them around to create an order of how bright your eyes see the colours. Place the brightest at one end and the dullest at the other. Mark the back of the paper with a number – starting from the brightest as 1. This will be your “visual index”
2. Connect the Light Level sensor to an **EASY**SENSE unit. Assemble the apparatus as shown in the diagram.
3. Start **EASY**SENSE select **Snapshot** from the **Home page**.

4. Click on the **Start** icon to begin logging. Turn the desk lamp on so the light shines onto the aluminium foil and reflects back to the sensor. Adjust the height of the lamp and the distance between the Light sensor and the foil card to get a reading close to the maximum limit of the sensor.
5. When the reading has stabilized, click in the graph area to record the light value. Double click in the comments cell alongside the reading and type in 'foil standard'.
6. Mark where the foil card was placed so you can site the other samples at the same spot.
7. Swap the foil card for one of the test papers. Wait a few seconds for the reading to stabilize and click in the graph area to record the light value as before. Type in a description of the sample in the comments column.
8. Repeat Step 7 for all the samples of paper.

Results and analysis.

Add a **Title** to the graph and then **Save** the results.

The results can be printed and copied into your report document as required.

Calculate the reflection index as:

$$\frac{\text{The light level for paper}}{\text{The light level for aluminum}} \times 100$$

Questions.

1. Which colour has the highest and which colour has the lowest reflective index?
2. Does the visual index match the reflection index? If not, which colours cause problems?
3. People often use pale colours to reflect light and keep cool in very sunny weather, is there any evidence in your experiment to support this?
4. There is evidence to suggest that not everyone sees colours in the same way. Compare your 'visual index' with other students in your class. Do you all agree?
5. Find the wavelength for the colours being used, if you have a spectrometer this can be an exact value if not use a simple conversion of the colour you have to a spectral colour e.g. pale green paper becomes green for the wavelength. Does a rough plot of wavelength against reflective index show anything? Is there a pattern?
6. What is the difference between how you see a colour and how the sensor sees a colour? What is the term given to describe how the brain interprets colour?

Extension.

1. Use a lens from a pair of sunglasses to shade the Light sensor. Does it reduce the light reflected from all colours equally? What does this say about how you see colours when wearing sunglasses? Could this ever be problem?
2. Create a simple experiment that tests if there is relationship between reflected light and heat.
3. Compare the reflective index between fluorescent light and light from a tungsten bulb and or sunlight.