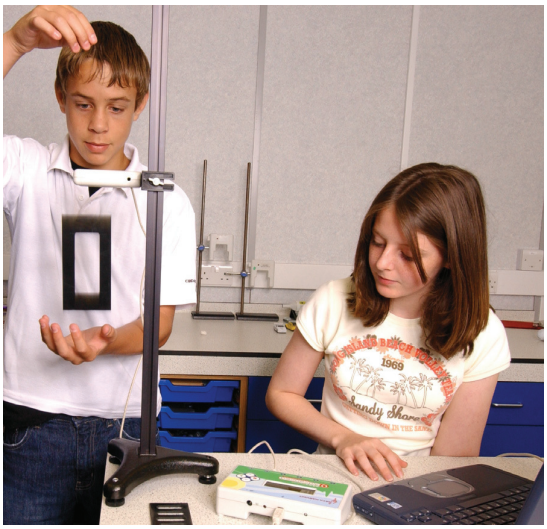
Preface and acknowledgements.

There are 44 experiments in this volume, covering practical work on motion and forces. 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 be automatically installed into the **EASY**SENSE software. The installed software creates an on screen worksheet, use the Open Worksheet route from the Home page. The student will see 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 software and open **EASY**SENSE. 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. The experiments cover a wide range of ability levels and curriculum requirements. They have been organised into topic areas, where possible. Within each topic area, higher numbered experiments 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 been written after use in a classroom and they have come from many sources. It is not the intention to suggest that they are original, they are experiment that users have asked for or have told us are useful for the teaching of science and introducing students to data logging.

The 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

Teacher's notes

Sensors required for each worksheet

Students instructions	Sensors used	Page
01 Introducing the Motion sensor; Distance, objects and materials	Motion	01 -.1
02 Introducing the Motion sensor; Detecting movement	Motion	02 -.1
03 Measuring speeds on a track	Light Gate	03 - 1
04 How does the angle of a slope affect the speed of cart rolling down it?	Light Gate	04 – 1
05 How does the weight of a cart affect the speed as it rolls down a slope?	Light Gates	05 – 1
06 Average speeds / velocity	Light Gates	06 – 1
07 Acceleration (calculated by students)	Light Gates	07 – 1
07a Acceleration (calculated by software)	Light Gates	07a – 1
07b Acceleration (Using double interrupt cards)	Light Gates	07b – 1
08 Acceleration at the top of slope then at the bottom of a slope	Light Gates	08 – 1
09 Measuring the speed of a cart with light gates (analogue)	Light Gates	09 – 1
10a Motion down an inclined slope using a Motion sensor (bottom)	Motion sensor	10a – 1
10b Motion down an inclined slope using a Motion sensor (top)	Motion sensor	10b – 1
11 Motion down an inclined plane using a Rotary Motion sensor	Rotary Motion sensor	11 – 1
12 Motion down an inclined plane using a Light gate and spoked pulley	Light Gate and Spoked pulley accessory	12 – 1
13 Motion up and down an inclined plane	Motion Sensor	13 – 1
14 Simple harmonic motion in a spring mass system	Motion Sensor	14 – 1
15 Simple harmonic motion (using Force and Motion sensors)	Force and Motion sensor	15 – 1
16 Simple harmonic motion (using a Rotary Motion sensor)	Rotary Motion and Force sensor	16 – 1
16a SHM Investigate the relationship between impulse and change in momentum	Rotary Motion and Force sensor	16a – 1
16b SHM Calculation of k from a graph of F vs. x	Rotary Motion and Force sensor	16b – 1
17 Period of an oscillating spring mass system	Motion sensor	17 – 1
18 Relationship between period and the length of the pendulum	Motion sensor	18 – 1
18a Relationship between period and the length of the pendulum (using a Rotary motion sensor)	Rotary Motion sensor	18a – 1
18b Relationship between period and the length of the pendulum (using Light Gates)	Light Gate	18b – 1

Sensors: Motion
Loggers: Any **EASY**SENSE

Logging time: Meters

Teacher's notes

Introducing the Motion sensor;

01 Distance, objects and materials

This is one of a pair of experiments designed to familiarise the student with the Motion sensor.

After completing the investigations the students should understand

- That the motion sensor measures distance
- That Information about velocity can be obtained from the distance-time graph.
- The limitations of the sensor in terms of size and distance of the reflecting object.

Investigation **02 Detecting movement** is particularly useful in showing students the relationship between time and distance, and provides a very good aid to helping the understanding of distance - time graphs graphs.

If you use an interactive white-board or project the image from a computer on to a wall via a projector a sample distance - timeline can be projected and the students invited to follow it. This acts an excellent stimulus and reinforces the concepts of distance-time graphs.

Alternatively, the **Predict** function of **EASY**SENSE can be used to create a distance-time line for the students to follow.

This experiment makes the students aware of the capabilities and problems of using the Motion Sensor. Working through the experiment will enable the students to use the Motion Sensor with confidence in subsequent work.

Apparatus.

1. An **EASY**SENSE datalogger*.
2. A Smart Q Motion sensor with the range set to record distance
3. Metre rule (a metal expanding rule is ideal).
4. Card, paper, wood (reflecting surfaces).
5. Scissors.
6. Wires of different diameters e.g. 2 mm, 1 mm, 0.5 mm.

The EASYSENSE Flash, Link and version 1.2 and lower Q3 and Q5 will require the powered version of the Motion sensor (product number 3705).

Set up of the logger and software.

The experiment uses the default Numeric display of **Meters**. Start **EASY**SENSE and select **Meters**, no further setup is required.

Notes.

General notes for use of Motion sensor.

The Motion sensor has a minimum detecting distance of about 170 mm. If the student moves closer than this the value stays the same, or if an object is inside the distance the value will not be valid.

The Motion sensor sends out pulses of ultrasound. The pulses strike a reflecting surface, and are reflected back to the sensor. The time taken for the sound to leave the sensor and return is used to calculate the distance. The quality of the reflecting surface is therefore critical for the functioning of the sensor. Surfaces that make good reflectors are usually obvious; they are hard and have a gloss finish. Surfaces that are not good reflectors may not be so obvious, some modern building materials and finishes have been deliberately engineered to have sound absorbing properties. Partition wall plaster board is a good example of a material that looks as if it should work but often will not.

Good reflectors	Need checking	Poor reflectors
Glass sheet	Plaster board partitions	Suspended ceiling tiles.
Acrylic sheet	Class room divider screens	Plastic foams
Sugar paper / stiff card	Office type partitions / notice boards	Soft folded / draped clothing
Compressed particle board		
Brick and plaster walls		
Wood		

The range of materials that do give good reflections is large. You do need to be aware of the technology the sensor uses and the type of reflecting surfaces that do cause problems.

If the students are using a surface held in front of the Motion sensor, any movement of the surface will cause erratic readings. It is best if the surface can be fixed in position using a retort stand or utility clamp.

The sensor is very good at selecting the nearest object, even when there is a wider object close behind it. The sensor will sometimes detect the further object even when thin layers of cloth and foam objects, partially obscure a more distant object.

It is possible for the sensor to pick up interference from other sensors in use in the room.

Refer to the sensor booklet that came with the sensor for further guidance. The sensor booklet can be downloaded from the Data Harvest website.

01 Measuring Distances.

The length of the lab may exceed 10 m, if so students will have to measure the length in two sections and add them together.

Sound absorbent ceiling tiles or walls may cause problems. It may help to put a large piece of card on the ceiling / wall with Blu Tack.

Students will find that thin straight wires are detected to quite a large distance, e.g. a 1.7 mm diameter wire was detected at 1.5 m.

Use **Options, Settings** to create an upper limit to the sensor axis, this tends to make the students stay within the most accurate sensing area of the Motion sensor.

Sensors: Motion
Loggers: Any **EASY**SENSE

Logging time: Meters

01 Introducing the Motion Sensor;

Distance, objects and materials

Read.

The Motion sensor enables you to measure distances between the sensor and an object up to10m away, or to show how an object is moving.

The Motion sensor sends out ultrasonic pulses 50 times a second. It times how long each pulse takes to travel to the object and return to the sensor. The sensor then calculates how far away the object is to within 3 mm.

In this experiment you will familiarise yourself with the Motion sensor by using it to measure the distances from you to various objects. The objects will be of different size and made of different materials so you can investigate the limits of the device.

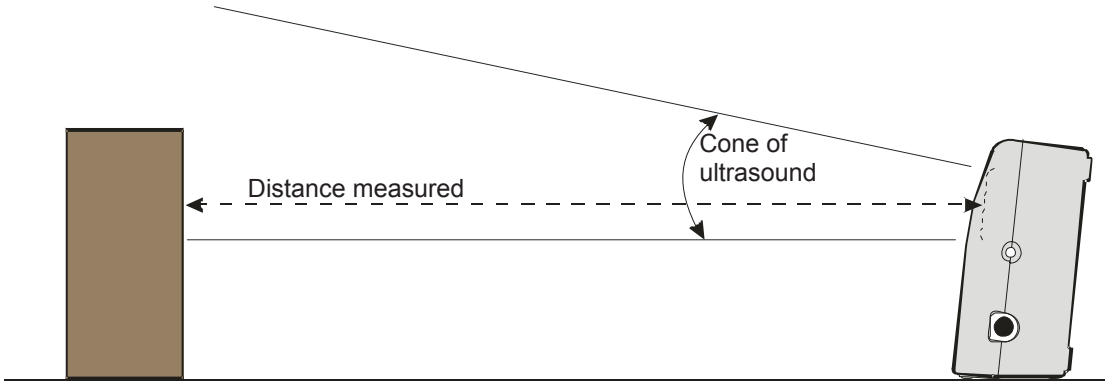
What you need.

1. An **EASY**SENSE logger
2. A Smart Q Motion sensor set to distance range.
3. A clear working space with direct line of sight to walls, notice boards etc. at a variety of distances.
4. A range of different sized and different shaped objects, pens, card, scissors and wires of different diameters.
5. A range of materials with different textures, solid card, foam sheet, felted cloth, glass etc.

What you need to do.

Measuring distances.

Use the Motion sensor to measure a variety of distances, including the dimensions of the laboratory.



Use the diagram above to set up the Motion sensor, notice the slight tilt on the Motion sensor, this is to keep the lower edge of the ultrasound cone parallel to the bench / desk surface.

Objects must be within the cone of ultrasound if you are to get good distance readings.

Note: Distance will be recorded in metres, pay close attention to where the decimal point is when doing calculations.

Measuring the room.

1. Start **EASY**SENSE and select **Meters** from the **Home page**.
2. Place the Motion sensor on the floor, pointing at the ceiling. Write down the value.
3. Place the sensor against a wall pointing to the opposite wall. Write down the value.
4. Repeat for the other pair of walls.

Your work area.

1. How high is the laboratory bench?
2. Find the length and width of the bench.

What is the smallest distance that the sensor will measure?

1. Place an object, a book for example, about 1 m from the sensor.
2. Slowly move the book towards the sensor.
3. Write down the minimum distance it will measure.

What is the smallest object the Motion Sensor can detect?

1. Use a variety of objects e.g. pen, rulers, pieces of card, wires etc. all placed about 30 cm away from the sensor to find the diameter of the smallest object it can detect.
2. Repeat at different distances.

What is the thickness of a book?

1. Place the Motion sensor on a bench pointing to the ceiling. Write down the distance.
2. Place the book to be measured on the bench, and place the sensor on the book. Point the sensor to the ceiling and write down the new distance reading.
3. Take the second reading away from the first reading, to find the thickness of the book.
4. You could modify this method to measure your height by placing the sensor above your head, recording the distance when you stand under the sensor and the distance when the space under the sensor is empty.

Do some materials reflect ultrasound better than others?

1. Hold samples of different materials 1m away from the sensor. Make sure your hand is not in the ultrasound cone.

Does moving the samples have an effect on the accuracy of the reading?

1. Try holding the material at different distances from the sensor if you have time.

Results and analysis

Measuring the room.

Length (l) = …….m

Breadth (b) = …….m

Height (h) = …….m

Use these results to work out the volume of the room in m^3.

Volume = l x b x h = …….m^3

Measuring the bench.

Height = …….m

Length = …….m

Breadth = …….m