Preface and acknowledgements.

There are 62 experiments in this volume, covering practical work on electricity and heat. 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 onscreen worksheet, use the Open worksheet route from the **EASY**SENSE Homepage. 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 experiments 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

Teachers notes

Sensors: Temperature
Loggers: Any **EASY**SENSE

Logging time: 15 minutes

Teacher's notes

01 The coffee problem

"Must phone off, the coffee is getting cold"

Read.

This is a classic problem. A simple search on the internet will reveal countless variations of the same experiment and as many explanations many of them requiring a good understanding of quantum physics!

In its simplest for the problem is "if I start with two liquids, one hot and one cold (cooler) and I mix them together, will the time taken for cooling be any different from adding the liquids together after the hot one had been allowed to cool a bit".

An alternative is the often quoted statement "hot water placed into a freezer will produce ice cubes quicker than cold water"

Every ounce of logic tells us it should make no difference. Practical experience leads us to *perceive* there is a difference. The investigation therefore attempts to measure the "problem" scientifically.

The variation used in this experiment is;

"I have just made a cup of coffee when the telephone rings. Should I put milk in before answering, or wait until the call is over? I want the coffee to be as warm as possible when I have finished the call."

This is a problem about the cooling of a mixture of hot and cold liquids.

In the experiment students will monitor the temperature of two beakers which each contain equal volumes of hot "coffee" (hot water) of the same temperature. In one beaker cold water will be added near the start (while the "coffee" is still very hot)and in the other the cold water will be added after five minutes (after the "coffee has been allowed to cool for a while). The cold water needs to be controlled as well, its temperature can alter as it is waiting to be used, it is unlikely that this has been done in the "casual" investigation.

Ask for predictions as to which cup will be at the highest temperature when the time for the experiment is finished.

One of the things that has been noticed when preparing the notes for this experiment is that great care is made in making the hot liquids the same temperature at the start but little effort is made in keeping the cold liquids controlled, cold things do warm up when left in the room!

Apparatus.

1. An **EASY**SENSE logger
2. 2 Smart Q Temperature sensors
3. 2 beakers of the same size (to hold at least 200 cm^3)
4. 2 measuring cylinders
5. Hot water
6. Cold water

Setup of software and logger.

Use the setup **01 Coffee problem**

If you wish to set up the logger manually, use the details in the table below.

Recording method	Total recording time
Graph	20 minutes

Notes.

The experiment uses simple water as the “coffee” for some students the idea of modeling is difficult; they have not developed the cognitive skills to transfer the information from one scenario to another. With this in mind, it would be worth the effort to give a repeat of the experiment using coffee and milk.

There may be slight difference between sensors, it is suggested that both sensors are placed in water of the same temperature for a few minutes to identify the difference (if any). This can then be taken into account when temperatures from the sensors are being compared.

Make sure the cooling drinks are in the same conditions, the differences are slight and any external input of energy or increase in energy loss will have a significant effect. Control direct sunlight, hot air from heating systems, air movements etc.

Placing the “coffee cups” on an insulating mat will prevent unequal heat loss from the cup to the “table”

Students should be encouraged to express their own ideas and predictions. It is a good investigation for creating discussion and this part of the work should not be neglected.

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Loggers: Any **EASY**SENSE

Logging time: 15 minutes

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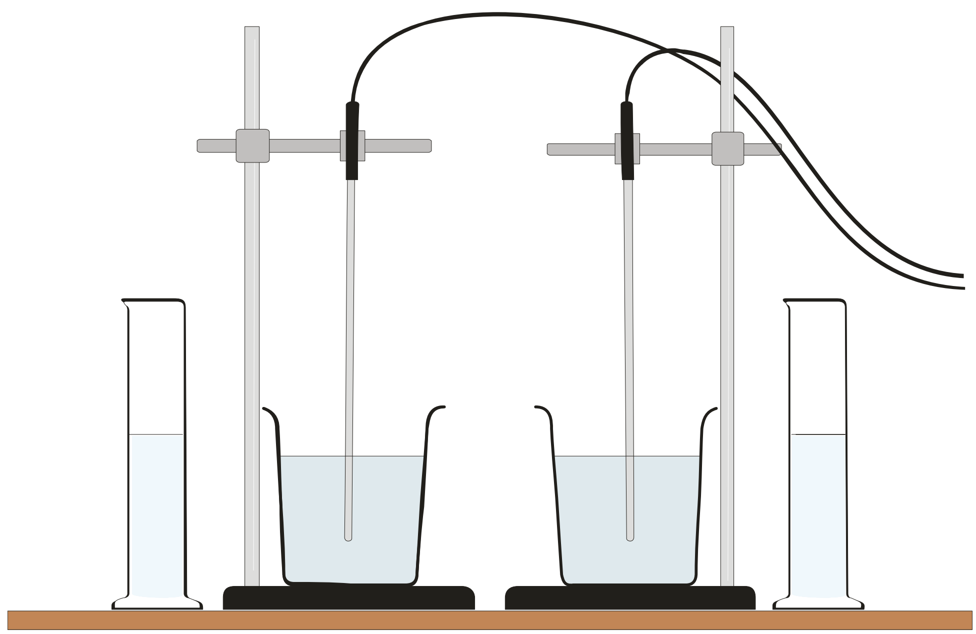
In the experiment, you will monitor the temperature of two beakers which each contain equal volumes of hot “coffee” (hot water) of the same temperature. In one beaker cold water will be added near the start (while the “coffee” is still very hot)and in the other the cold water will be added after five minutes (after the “coffee has been allowed to cool for a while)

Try to predict which will be at the highest temperature when the time for the experiment is finished.

What you need.

1. An **EASY**SENSE logger
2. 2 Smart Q Temperature sensors
3. 2 beakers of the same size (to hold at least 200 cm^3)
4. 2 measuring cylinders
5. Hot water
6. Cold water



What to do.

1. Assemble the apparatus as shown in the diagram. Clamp the temperature probes so they do not touch the sides of the cup and add approximately 100 cm^3 of hot water.

2. Start **EASY**SENSE and select **Open setup** from the **Home page**. Open the setup file Data Harvest Investigations \ Setup files \ Physics L3 Electricity + Heat \ **01 Coffee problem.**
3. Click **Start** to begin logging
4. After 1 minute add 50 cm^3 of cold water to one of the cups. Do not stir.
5. After five minutes add 50 cm^3 of cold water to the other cup. Do not stir.

Results.

Identify and label the set of data that corresponds to each of the beakers/temperature probes.

The results can be saved, printed or copied into your report document as required.

Questions.

1. What situation results in the water being warmest after ten minutes? Explain the result
2. What advice would you give to a person making the coffee as the telephone rings?

More to do.

1. Try the experiment with real coffee. Do you get the same results?
2. Does it matter if the milk is in the cup before or after you fill the cup with the hot drink? (Is this the same problem?)
3. Does the shape of the cup have an effect?
4. Do the cups you get from “take-aways” keep the drink hotter for any longer?
5. Does the cap on a “take out” coffee keep the drink hot?
6. What happens if the room is hot or cold?
7. What about cold drinks getting hotter?