LITTLE BIG FUTURES

Communities and fire safety

SCIENCE (TEACHER NOTES)

In this communities and fire safety challenge, students working in small groups, will design, make, test and evaluate an electronic system to provide early warning in the event of a fire breaking out.

Learning outcomes

- explore a range of methods for fire detection
- evaluate a range of methods for fire detection and identify a workable solution
- understand the advantages of electronic systems that can provide an input into computer networks
- design, build and test an effective fire detection system that will act as an input to the Internet of Things (IoT)

Resources

- apparatus to explore a range of methods of fire detection through practical experimentation (see suggested practical activities)
- paper and pencil to design a fire detection system
- apparatus to build and test a range of different designs
- a micro:bit, Raspberry Pi or interface to a computer control system to represent the IoT
- digital video cameras to record the results of the practical work

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Lesson activities scheme of work

(approximately 5 hours including discussion, research and planning time)

	Activity	Resources
Activity 1 (10 mins)	**Introduction** Introduce the Crest Discovery award. Explain that the students will have to meet the assessment criteria.	Crest Discovery award passport.
Activity 2 (10 mins)	**Group discussion** Working in small groups, the students will discuss three introductory questions and come up with an agreed set of answers.	Computer with internet access (one per group). Discussion questions worksheet.
Activity 3 (2 x 1 hour lessons)	**Practical investigation** A circus of experiments that the pupils can work through in two 1-hour sessions. Divide the students into groups of two or three. For each experiment, the students should work through the method provided taking great care to follow any health and safety instructions.	The apparatus set out as a circus of experiments each with its own set of instructions. Activity 3 worksheet. Reference books Web access
Activity 4 (30 mins)	**Device design** Each group is given the task of designing a working heat detection device that could serve as an input to a computer control system and the IoT. The group must provide a set of clear, fully labelled/annotated 'technical' diagrams of their design together with working models and instructions for adjusting the sensitivity.	A wide range of apparatus that can be used by the students to build working fire detection systems.
Activity 5 (60 mins)	**Device building, testing and evaluation** Each group assembles the apparatus they need to build their fire detection device. If time allows, ask the students to demonstrate their devices, one at a time, with all of the students watching the demonstration.	The apparatus needed by each group to build and test their device.
Extension challenge (30 mins)	**Computer control** This is an additional activity to stretch the more able students. The students connect their 'heat sensor' to a computer control interface and create a burglar alarm script.	Control interface and software application. Heat sensing apparatus and buzzer. A copy of the Lumkani installation sheet.
CADP (20 mins)	**CREST Award Discovery Passport completion** Using their draft copy and any notes they have made during the project, the students complete a final copy of the CREST Award Discovery Passport.	Draft CREST Award Discovery Passport. Final copy of the CREST Award Discovery Passport for submission. Additional evidence of work carried out.

Activity 1 – introduction

Show the students a copy of the Crest Discovery Passport, explaining that it will be used at the end of the project to compile the evidence of their work. Provide each of your students with a draft copy of the CREST Award Discovery Passport for them to make notes on as they work through each of the activities. Go through this with them giving examples of the types of things they can include as evidence. This will help them to complete their final copy at the end of the project.

Activity 2 – group discussion

The purpose of the discussion is to get the students to think more deeply about fire detection systems, how they work and how they might be improved. The children will make use of their prior knowledge. This will also give you the opportunity to gauge the level of the students' existing knowledge of the subject.

Hand out a discussion questions worksheet to each group.

Q1. How might a fire detection system that does not rely on electrical circuits work?

Q2. Which type of sensor is better, digital or analogue?

Q3. How might fire detection systems connected by the Internet improve fire safety?

If there is time you could ask each group to feed back their answers to the whole class.

Activity 3 – practical investigations

The practical investigations will enable the students to gain an understanding of ways in which physical effects produced by an increase in temperature can be employed as an input to a control system.

For each of the methods tested, based on the threshold temperature needed to trigger the alarm, the students will be asked to consider how applicable the sensor might be to a range of applications based on what would be considered a 'normal' temperature range and a 'dangerous' temperature.

An instruction sheet is provided for each of the seven practical investigations together with a practical investigations worksheet for the students to record their findings and to answer the questions. The apparatus for each investigation should be set out in advance as a circus of experiments together with the relevant instructions.

Two hours have been allowed for the practical investigations. It does not matter in what order the students carry out the investigations. Time will be needed at the start of the activity to explain the safe use of the apparatus and at the end to discuss the experimental results and answers to each of the questions.

The students' findings will inform their work on activity 4 when they will be required to design a working electrical fire detection device.

Use the lists of apparatus below together with the instruction sheets to help you to set up each of the seven practical investigations.

Investigation 1 – bimetal strip demonstration

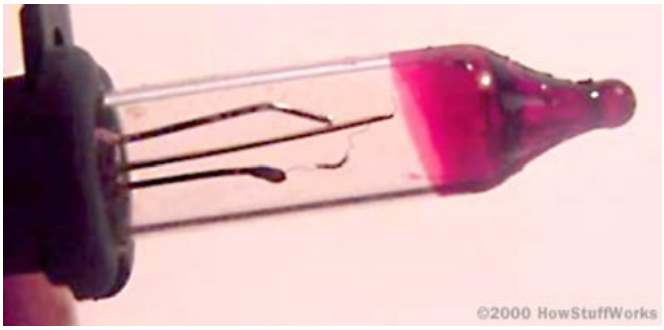
A hand held bimetal strip demonstration apparatus, Bunsen burner and heatproof mat.

Investigation 2 – thermistor

A 5KΩ thermistor, multimeter and two leads with crocodile clips, cold water, warm water and hot water.

Investigation 3 – observing a bimetal strip in action

A 'flashing lamp' that has a bimetallic circuit breaker built into it (red tipped Christmas tree lamps work well), lamp holder, battery, push switch, leads and hand lens.



Investigation 4 – melting wire

Two stands with clamps, two iron nails about 10 cm long, several lengths of lead free solder 2-3 cm long, battery, lamp, leads and two crocodile clips, tongs, heat proof mat and tealight candle.

Investigation 5 – melting wax

Two stands with clamps, two iron nails about 10 cm long, several thin pieces of paraffin wax, battery, lamp, leads and two crocodile clips, tongs, heat proof mat and tealight candle.

Investigation 6 – expanding water

A stand and clamp, two beakers and a boiling tube with a 30cm glass tube sealed into the top with a rubber bung. The apparatus is filled with coloured water halfway up the glass tube.

A long thin piece of wood to act as a float (a disposable bamboo skewer satay works well).

A beaker and supply of hot water.

The apparatus is placed in cold water for about three minutes- the children transfer it to hot water and record their observations/measure the rise in water level.

Investigation 7 – expanding air

A stand and two clamps, plastic syringe with cap, series circuit (battery, lamp and wires), beaker. The circuit is set up with a gap which will be closed by two contacts. One contact is attached to the end of the plunger. The other contact is held in a clamp a few millimetres above the plunger contact.

You will also need to provide a supply of hot water.

The students will half fill the syringe with air, seal it with the cap and place it nozzle down in the empty beaker. Hot water is added to the beaker. As the plunger moves up, the contacts will meet, the circuit is completed, and the lamp will light up.

Activity 4 – device design

Each group is given the task of designing a working heat detection device that they can build using the apparatus available to them.

Each group must provide a set of clear, fully labelled/annotated 'technical' diagrams of their design.

Activity 5 – device building, testing and evaluation

This activity may require a considerable amount of preparation in order to provide each group with the apparatus they need to build their heat detection device together with the appropriate safety instructions.

Explain to the students that before they will be allowed to test their devices they will be subjected to a 'health and safety' check and the test will only be allowed to proceed if the device passes this inspection.

If time allows test each system one at a time with all of the students watching the tests and contributing to the evaluation process. Ask them to provide helpful feedback and positive suggestions for improvement.

Extension – computer control

The students will find a way of connecting their heat detection device to the input terminals of a computer control interface and write a control program for a burglar alarm system.

The students should also consider how the alarm systems might be linked to warn residents of fires in their proximity.
A slightly different alarm should sound if the fire is in a neighbour's home (see Lumkani).