

Introduction

Sci-Files: Human Torch is an educational computer game, developed specifically for Science Year. It aims to make learning about combustion reactions, safety and risk more exciting, by harnessing pupils' enthusiasm for games and the paranormal, as in the X Files. In this television series, investigators solve cases using the same process as pupils do in a school science investigation. They think up hypotheses, test them, and analyse results. We hope *Human Torch* will show pupils that science is also about solving fascinating mysteries.

Pupils take the role of MI5 Special Projects investigators. They will:

- Watch video sequences that set the plot and develop it during the game in dramatic ways.
- Complete structured multimedia activities with clear learning outcomes, where they find clues, analyse them in a cartoon laboratory and interview experts.
- Carry out exciting experiments on combustion to reconstruct the crime, and learn about risk assessments and working safely.

The Plot

A woman is horribly burned to death - all that is left is a pile of ashes and a couple of body parts. Pupils are put on the case to investigate how it happened. They uncover two theories - the scientific 'wick effect', where human fat burns with the help of clothing material acting as a wick, and spontaneous human combustion (SHC). During the computer game pupils collect evidence to see whether each theory matches the evidence. However, the only conclusive proof comes when they reconstruct how the burning happened through a series of experiment in their own laboratory. Before they can do the practical they learn how to carry out risk assessments. The conclusions suggest that the wick effect is quite possible, but that the SHC explanations are rather unlikely. In a further twist, they discover new evidence that the victim was in fact murdered. The climax is the final game level where they have to apply their knowledge of fire safety to save their colleague's life, by avoiding fire hazards, and controlling the blaze.

The case consists of three parts:

- Level 1 of the interactive game (40-60 minutes) (see **Timing** below for short-cuts).
- A lesson carrying out experiments in the laboratory.
- Level 2 of the interactive game (30-40 minutes), where pupils finish solving the case.

Running the activity**The game**

Human Torch is a game of scientific investigation. At each stage in the computer game pupils have the same choices a detective solving the case would: whether to collect a new clue, analyse a clue in the laboratory, or consult one of several experts for an explanation or prediction. One of the options will help them complete their mission and solve the case. The others are dead ends or red herrings. The game choices have been designed to test pupils' understanding of investigations, and the science of safety and combustion. To encourage scientific thinking, pupils are given points for 'correct' choices. When pupils do not make the best available choice, a buzzing sound is heard. They will all finish the game eventually, but the better their thinking, the more points they will have collected by the end.

Lesson organisation

Human Torch is ideally suited to pupils working at a computer in pairs. This will encourage cooperative learning, as at each stage they can discuss the options before they make a decision. The game may also be used in a whole class teaching setting, using a laptop and projector or electronic whiteboard.

Timing

Level 1 may take some pupils a double lesson to complete. If time runs short, you can tell pupils to fast forward the game to the last mission – mission 6 – from wherever they are in the game. To do this, simply type in and enter 'humantorch' from anywhere in the game. Mission 6 is the practice 'risk assessment', which is important to do before the practical work, and takes 5-10 minutes.

IT issues

- *Human Torch* can be run across a network. However, if network speed is relatively slow the quality of the video will be improved if the CD ROM runs on individual computers. You can purchase a class set of CDs at minimal cost from ASE.
- Sound is an important element of the game. Pupils may need individual pairs of headphones.

Learning outcomes

Develop pupil knowledge and understanding:

- New materials are formed during a chemical reaction
- Fuels are substances that release heat energy when they burn
- Burning is a chemical reaction which requires air or oxygen
- Natural gas is called methane
- Working safely with burning materials
- Taking action to control risks

Sc1: Ideas and Evidence:

- The interplay between empirical questions, explanation and scientific evidence
- The importance of testing explanations by seeing if evidence matches the predictions
- How scientists work today: the roles of experimentation, evidence and creative thought

Sc1: Investigations

- Evaluating explanations of observations

Prior learning

That there are many gases.

Where the activity fits in

QCA Unit 7F Simple chemical reactions

Skills

Thinking skills: information-processing, reasoning, creative thinking. Investigative skills.

Citizenship

Recognise hazards in materials and physical processes, assess risks and take action to reduce them.

Language

Pupils will learn scientific terminology related to burning: hydrogen, methane, oxygen, carbon dioxide, water, carbon monoxide, product, evidence, and prediction.

Experiments

- There are six experiments available (see **Experiments** section for further details). Full instructions are on the pupil sheets, and requirements are given in the Technician's Notes. The experiments are short, taking about 10-15 minutes each. They could be done as a circus, with pupils doing several experiments during the course of a lesson.
- It is a good idea for continuing the game that the conclusions from all the experiments are shared with the whole class. They will be asked to 'input' these at the beginning of Level 2, in the form of yes/no statements. The more they get right, the more points they get.

Passwords

- Pupils are given a points score at the end of Level 1. In order to carry over the score to Level 2 (two lessons later) they are given a password based on their score.
- If pupils forget their passwords they are 'combust' (0-450 points), 'forensic' (450-600 points) or 'red herring' (600+ points).

Level 1 – at the computer

This section of the game is made up of six mini-missions. Each contains a puzzle for pupils to solve, and focuses on a particular science objective.

Mission 1

- Mission: To find out as many explanations as possible for how a body can burn to ashes.
- Science: Burning is a chemical reaction. Natural gas is methane, which is flammable, as is hydrogen.
- Outcome: Different possible explanations found are the scientific explanation of the 'wick effect' and two explanations for the paranormal phenomenon SHC, either (a) methane build up or (b) water breaking down to hydrogen, which then burns.

Mission 2

- Mission: To discover how someone could burn but the room remain intact.
- Science: Fuels release a lot of heat energy.
- Outcome: The scientific explanation says it was a long, slow burn, and that heat travels upwards not sideways. The paranormal explanation is that this was not a normal burning reaction.

Mission 3

- Mission: To find evidence that the body could have burned for many hours.
- Science: Burning is a reaction with the oxygen in air.
- Outcome: An oxygen cylinder is discovered. The scientific explanation says this could have provided enough oxygen to keep the burning going.

Mission 4:

- Mission: To explain how the victim's hand survived while the rest of the body burned.
- Science: The flammability hazard of liquid fuels like alcohol.
- Outcome: Alcohol is discovered on the hand. The paranormal interpretation is science cannot explain this. The scientific explanation offered is that the hand did not have enough fuel (fat) on to burn.

Mission 5:

- Mission: To look for the products of the burning reaction, and see if they fit with either theory.
- Science: Soot and water as products of burning
- Outcome: Both theories claim to be able to explain the burning products. The only way to disprove either theory is to reconstruct what happened by pupils doing experiments.

Mission 6:

- Mission: To prove pupils are safe enough experimenters to carry out potentially risky burning experiments.
- Science: Working safely with burning reactions, hazards, risks and risk control.
- Outcome: Pupils complete a risk assessment exercise, identifying hazards for an experiment, rating the risk, and thinking of ways to control it.

Case Notes

To maximise learning from the game, pupils should reflect on what they have discovered so far. One way to do this is to get them to write some case notes using the sheet provided. This could be a homework activity.

Experiments

There are six experiments. Each is designed to answer a particular unexplained puzzle from the game. For example, how can an object near the fire remain unburned? To answer this pupils carry out Experiment 4, comparing the temperature rise above and to the side of a burning candle. There is a pupil sheet for each experiment, which contain instructions, the risk assessment activity, and space for results and conclusions.

Experiment 1

- Question: Can the 'wick effect' explain how the victim burned?
- Method: Pupils make a human candle out of margarine (fat) and a cotton bud (the wick).
- Outcome: The fat will burn well with a wick, providing support for the 'wick effect' theory.

Experiment 2

- Question: Can 'spontaneous human combustion' (SHC) explain how the victim burned?
- Method: Pupils collect methane gas and make bubbles of it using washing up liquid. They try to burn the gas bubbles, to see whether the energy produced could light another splint.
- Outcome: Methane burns but the energy released is not enough to burn another splint. Therefore it is very unlikely that methane build up in the stomach would be able to set the body on fire. This is evidence against the SHC theory.

Experiment 3

- Question: Can SHC explain how the victim burned?
- Method: Pupils electrolyse acidified water, breaking it down to produce hydrogen. They collect the gas in see if it burns.
- Outcome: Water can be broken down to flammable hydrogen, but this takes a lot of energy (electrolysis). It is almost impossible it would happen in the body. Further evidence against the SHC theory.

Experiment 4

- Question: Can the 'wick effect' explain the unburned nearby objects?
- Method: Pupils measure how much heat from a candle flame travels upwards compared to sideways.
- Outcome: The temperature to the side of the candle rises much less, providing evidence for the scientific explanation (wick effect).

Experiment 5

- Question: Can the 'wick effect' be right? Did the oxygen cylinder allow the body to burn for many hours?
- Method: Pupils drop a splint into a tube of oxygen, measuring how long it burns compared to a splint in air. They can also make their own oxygen by reacting manganese dioxide with hydrogen peroxide.
- Outcome: Pupils find that materials burn longer in air, providing further support for the wick effect explanation

Experiment 6

- Question: Could a hand covered in alcohol burn without being damaged?
- Method: Pupils soak a piece of blotting paper (the hand) in alcohol. They clamp and set light to it to see if the paper can remain undamaged.
- Outcome: They should find that the paper is undamaged, because water in the alcohol absorbs the heat produced, providing yet further support for 'wick effect' theory.

Safety

- Pupils are shown how to carry out their own risk assessments as part of the computer activities. They put this into practice by doing a risk assessment for each laboratory experiment before they attempt it.
- It is important to check pupils' risk assessments before beginning the practical work. 'Model answers' are provided for your use.
- Pupils should wear eye protection for all the experiments.
- In Experiment 2, extreme care should be taken with the bag of methane. The gas is highly flammable
- In Experiment 5, we have provided the option of pupils making their own oxygen gas, in addition to testing it. Hydrogen peroxide is an irritant to the eyes and skin.

Level 2 – at the computer

This begins with pupils inputting their conclusions from the experiments. There are six yes/no statements, one for each experiment. If you wish to help pupils, the answers are:

Experiment 1: Yes
Experiment 2: No
Experiment 3: No
Experiment 4: Yes
Experiment 5: Yes
Experiment 6: Yes

Mission 7

- Mission: To find what produced the initial heat energy (spark) to set off the fire.
- Science: Fire safety – common fire hazards.
- Outcome: Pupils test all potential hazards and find none was responsible.

Mission 8

- Mission: To look for evidence to determine whether or not the victim was murdered.
- Science: Products of burning are oxides (in this case carbon monoxide).
- Outcome: The victim did not inhale carbon monoxide, so must have been dead before the fire.

Mission 9 and the 'fire game'

- Mission: To find out who committed the murder by interviewing the witnesses/suspects.
- Just as pupils find the evidence to prove which suspect did it, a video clip starts. Their on-screen partner investigator is 'attacked' and the room set on fire.
- The climax is a 'platform-style' game designed to reinforce the understanding of fires and safety that pupils have developed. Pupils must get through the room without being burned, and rescue their partner. They get points by 'picking up' objects that can control a fire, like fire-sand, blankets and fire extinguishers. They lose lives if they do not avoid flammable substances, like oil or gas.

Case report

To reinforce learning, it is important pupils have a chance to reflect on what they have found out by playing the game. One way to do this is for them to complete a case report using the sheet provided.

Experiment 1

Hazard	How to control the risk
Sharp pin	Use blunt pins.
Matches / flames	Behave sensibly.
Hot fat	Keep well back.
Fumes from burning fat	Use small quantities, have good ventilation.
Fumes from burning lid	Take care not to ignite lid.
Splashes/spitting from burning fat	Wear eye protection.

Experiment 2

Hazard	How to control the risk
Burning methane	Use small amounts, keep well back.
Burning plastic bag	Keep flames away from bag.
Spray from exploding bubbles	Wear eye protection.

Experiment 3

Hazard	How to control the risk
Acid	Use dilute solutions.
Spray from bursting bubbles	Wear eye protection.
Inhaling spray from bursting bubbles	Keep well back.
Electrocution	Use low voltage.

Experiment 4

Hazard	How to control the risk
Candle flame	Watch it carefully.
Bursting thermometer bulbs	Wear eye protection. Remove candle or thermometer if temperature approaches 100°C.
Burst thermometer	Ask the 'lab director' to clear up broken glass and spills.

Experiment 5

Hazard	How to control the risk
Flames	Wear eye protection.
Oxygen-making reaction	Use small quantities and stay back. Light splint away from apparatus.
Glass breaking	Check that the apparatus is stable.
Hydrogen peroxide	Do not handle. Wear eye protection.

Experiment 6

Hazard	How to control the risk
Alcohol causing fire	Keep quantities as small as possible, mop up spills quickly, keep away from flames.
Alcohol in eyes	Wash hands if alcohol gets on them. Wear eye protection.
Clamp falling	Keep away from edge of bench.