STEM CLUBS

NUMBER 1 FOR STEM

SURVIVAL STEM: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

STEM Learning activity resources

SUBJECT LINKS:

Design and technology, computing, engineering, physics and maths.

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Introduction

This programme has been created by STEM Learning, the largest provider of STEM education and careers support in the UK. It has been developed in partnership with Club leaders.

This programme is part of Survival STEM, a set of three programmes exploring science, technology, engineering and maths in survival scenarios.

Can you survive a zombie apocalypse?

A terrifying virus has been spreading around the world. In a matter of weeks, it has killed 90% of the world's population. Even worse, the victims don't stay dead. Now, these zombies are roaming the streets looking for their next meal: your brains! Your challenge is to stay alive until scientists find a cure. Be careful! One bite and you will become one of them.

This programme investigates how design and technology can help you survive a zombie apocalypse – from making a barricade to keep them out, to communicating with other survivors using Morse code.

Key information

AGE RANGE: 11–14

SUBJECT LINKS: design and technology, computing, engineering, physics and maths.

DURATION: a range of activities from 20 to 60 minutes – at least 6 hours in total.

FLEXIBILITY: complete the whole programme over a half term or choose individual activities to suit the needs of your Club.

RESOURCES: each activity includes a list of the resources required and a comprehensive set of Club leader and student notes in the form of guides.

IMPACT MEASUREMENT: each set of resources is designed to help evaluate and assess the progress of Club based learning on Club members. A useful set of assessment tools are available at www.stem.org.uk/enrichment/stem-clubs.

ACHIEVEMENT: students that successfully complete a complete set of activities can be rewarded with the downloadable STEM Clubs Certificate of Achievement. Successfully completing a set of themed activities enables students to enter for a CREST Discovery Award. Further information is available on the STEM Clubs website.

APPROPRIATE VENUES: Club leaders can run most activities in general spaces e.g. classrooms, halls, and outdoor areas. Some activities need to be conducted in labs and workshops – these are marked clearly in the Club leader guide and in the table below.

SAFETY: each activity includes details about significant health and safety considerations, such as appropriate eye protection, gloves, etc. Club Leaders should ensure that all equipment is handled with care, particularly sharp instruments. Advice and guidelines are available from CLEAPPS and SSERC, or see the STEM Clubs handbook (page 20). We recommend that practical activities are risk assessed before commencing and Club Leaders must follow their employer or organisations policies. Other activities: Visit www.stem.org.uk/resources/stem-clubs/ for a wealth of ideas for STEM-related Clubs.

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FURTHER SUPPORT: the STEM Clubs Best Practice Handbook includes comprehensive support for leaders of all STEM-related clubs. It can be found at www.stem.org.uk/stem-clubs/getting-started

Activities

1	**PROTECT THE PEOPLE:** students build and test pressure pad switches and simple circuits.	60 minutes	(Equipment required)
2	**SPREAD THE WORD:** students use simple circuits, Micro:bits or phone apps to code and decode simple messages in Morse code.	60 minutes	
3	**NECK PROTECTION:** students explore fabrics and materials to design and test a puncture-resistant 'neck protector' that will resist a zombie bite.	60 minutes	(Workshop required)
4	**SOLAR SNACKS:** students investigate how light can be focussed to heat marshmallows in a simple solar cooker, exploring one option for how survivors might cook when lacking power after a zombie virus spreads.	60 minutes	
5	**SILENT STEPS:** students design shoe covers that allow them to move silently over a variety of surfaces and avoid zombie detection, testing their ideas with a decibel/sound pressure meter or app.	30 minutes	(Workshop required)
6	**FOOD FOR THOUGHT:** students consider the characteristics of ingredients and foods, as well as the properties of packaging materials and preservation methods, to identify the best foods to grab on a raid to get food for their group of survivors.	30 minutes	(Food lab required)
7	**SIEGE SOLUTIONS:** students design and build a model siege engine to propel a table tennis ball or other small projectile as far as possible.	60 minutes	(Workshop required)
8	**NATURE'S REAL ZOMBIES:** students use the internet to research parasites that take over hosts to create some of nature's real zombies. They then present what they've discovered and choose their creepiest example.	30 minutes	
9	**GET CREST DISCOVERY AWARDS:** By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.		

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

1 Protect the people

Objective

Students build and test pressure pad switches and simple circuits.

TOPIC LINKS

- Physics: electricity, materials
- Design and technology: electronics, materials
- Computing: computational thinking

TIME

60 minutes

RESOURCES AND PREPARATION

- cardboard – thin and corrugated
- aluminium foil
- foam sheet (1–5mm thick)
- paper clips, crocodile clips
- wire
- batteries
- lamps, leds, buzzers
- scissors, craft knives
- tape, glue, glue sticks
- for optional extension activities: 12V parking sensor kit and power supply, Micro:bit, leads and 10k ohm resistors, conductive fabric squares; or data logging motion sensors.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Be sure to warn the pupils of the dangers associated with electrical circuits and encourage them to take care when assembling and testing electrical circuits.

Be sure to warn the pupils of the dangers associated with scissors and craft knives.

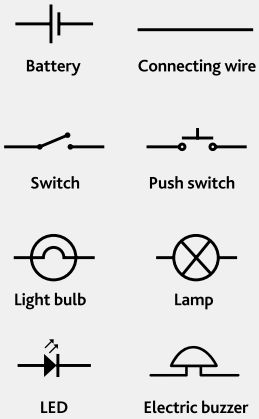
DELIVERY

1. Explain that a group of survivors need to build a warning system to detect any zombies that are prowling around the perimeter of their base. What types of sensor can the students think of? What materials could they use to improvise electrical circuits? For example, they could use a torch containing batteries and a lamp.
2. Students should then form small teams. Discuss which STEM roles students could take on in their team, for example: designer, electrical engineer, mechanical engineer (pad design). Students can take on these roles if they wish.
3. Review the student guide and the example pressure pad switch design.
4. Allow students time to select the materials they want to use in their pressure pad switch.
5. Assist students as they plan and make a simple pressure pad switch and warning circuit, following the instructions in the student guide.
6. Designate part of your room as the safe enclosure and ask teams to lay their pads around the perimeter. Test each pad and discuss the features and effectiveness of each design. Which pads would be best at helping the students to stay safe?

TIPS

- When gluing foil to card, keep the foil as smooth as possible.
- Successful pads will keep the foil layers apart until stepped on. When the person/zombie steps off the pad, the foil layers should separate again.
- Larger pads may need non-conductive spacers to stop the conductive top and bottom from touching accidentally.

Useful Electronic Symbols



EXTENSION IDEAS

1. Test the range and sensitivity of ultrasonic sensors, for example cheap aftermarket 12v parking sensor kits available from internet marketplaces. How could students use these to protect their perimeter?
2. Students could explore how to include a micro:bit, for example by using the programmable switches to simulate triggering a pad or by linking their pressure pad switches to the input contacts. (You'll need to include the pad in a pull-up resistor circuit – see link below to produce an LED warning for two zones.)
3. Students could use conductive fabric squares to try a textile-based approach.
4. Students could use motion sensors to trigger the buzzers

DIFFERENTIATION IDEAS

Support: if required, briefly review a simple circuit containing a push switch, battery and lamp. Provide kits of foil, card, crocodile clips or tape, wire, lamps and batteries.

Challenge: students can separate a large pad into zones or join small pads, each with its own indicator lamp or buzzer, as one branch of a parallel circuit, so they can tell which part of the perimeter has been triggered. Discuss how students could indicate each zone (e.g. by including a pad and lamp in each branch of the circuit) and avoid false alarms, for example from small animals.

USEFUL LINKS

Instructorless simple pressure pad switch
http://www.instructables.com/id/Use-a-DIY-Pressure-Plate-Switch-to-Automate-Your-H/

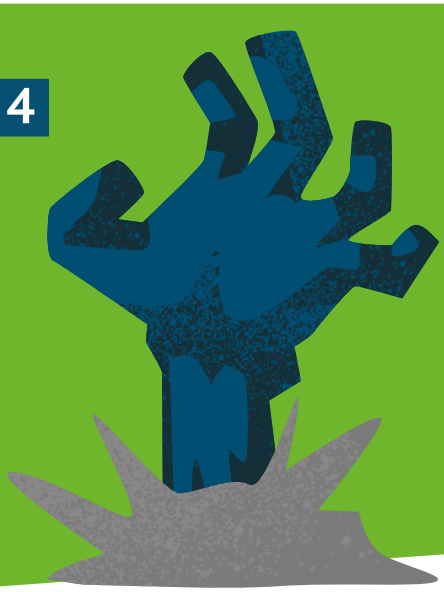
Add a switch to Micro:bit with a pull-up resistor circuit
http://learnlearn.uk/microbit/topics/microbit-input-from-external-switches/

Understanding electronic principles resources
https://www.stem.org.uk/resources/elibrary/resource/425048/understanding-electronic-principles

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

1 Protect the people



Briefing

The zombies are coming! Fortunately, you've found a safe place to hide and enough provisions to keep you and your team alive for the next few weeks. But in order to stay safe, you'll need to know if any zombies are prowling around outside your base.

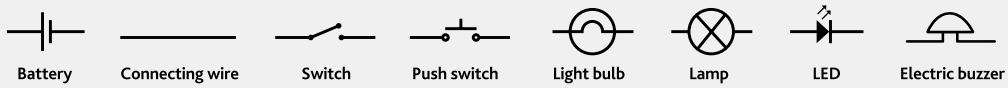
YOUR TASK **Plan and build a pressure pad sensor that warns you when zombies are nearby.**

WHAT YOU NEED TO DO

The first thing you need to do is build a pressure pad. A pressure pad is a switch that closes when it's stepped on. It's made of three layers: a top and bottom layer that both contain conductive material, and a space in between these layers that separates them. When stepped on, the top and bottom layers touch, completing a circuit.

1. Draw the circuit that your pressure pad will be part of. Remember, the circuit will only be complete when someone (or something) is stepping on the pressure pad. Your circuit needs to include a light or buzzer to tell you when there's a zombie nearby, and also a source of power.
2. Choose which materials you'll use for your top, bottom and middle layers. What properties will each one need? You may need to combine different materials in each layer to get the properties you want.
3. Think about how you'll keep the conductive layers apart, but allow them to touch when a zombie steps on your pad. Include a way to connect your pressure pad to the rest of your warning circuit.
4. Assemble your pad and connect it to your warning circuit.
5. Test your pad: will it keep you safe?
6. Consider how you could improve your design and make it more effective.

Useful Electronic Symbols



1. Pressure pads are used in real security systems and can easily be hidden under floors so that intruders don't know they've been detected.
2. The world's smallest switch consists of a single atom! It controls whether light can pass through a tiny gap. When a voltage is applied to two plates that are just an atom apart, one atom can move into the gap, which allows the current to flow. It's this current that blocks the light.
3. The giant switches that turn power networks on and off must work very quickly so they don't create giant electrical arcs, which are just like lightning! Sometimes they are also submerged in oil so there's no air between the contacts.

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

2 Spread the word

Objective

Students use simple circuits, Micro:bits or phone apps to code and decode simple messages in Morse code.

TOPIC LINKS

- Computing: computational thinking, programming languages, binary digits
- Physics: circuits

TIME

60 minutes

RESOURCES AND PREPARATION

Choose whether you will deliver the session using circuits, Micro:bits, or phone apps:

- for circuits: each group of pupils will need cells and holders, connecting wires, lamps or LEDs with holders, and switches (ideally push buttons)
- for Micro:bits: each group of pupils will need one or two Micro:bits, connecting wires, a computer and cable or Bluetooth link, and one of the links below to cut and paste programs. Review the links and test pasting programs, flashing and using the programs beforehand
- for apps: search your app store for free Morse code apps, for example those that control the phone's flash, or Morse code translator apps that allow code to be entered and automatically decoded. Examples include 'Morse Key' or 'Flashlight & Morse Utility'

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

DELIVERY

1. Introduce the scenario: the students are one of several groups of survivors trapped within their safe enclosures, while groups of drooling zombies roam the areas that separate them. With no phone signal, how can students communicate? If they shout to each other, the zombies will hear and come after them! Identify that Morse code is one solution.
2. Students should form small teams. Discuss which STEM roles students could take on in their team, for example: electrical engineer (circuit design), programmer/coder, switch designer, communications specialist and networking engineer. Students can take on these roles if they wish.
3. As appropriate, guide students as they build and test their simple circuits; flash and test the Morse program (first link), or the separate transmit and receive programs (second link) into their Micro:bit, or download a phone app. Students should then practise using the test messages.
4. Share feedback so far. Students need to maintain consistent gaps between dots and dashes and a pause between letters (the Micro:bit link provides timings, which students can change when they flash the program). Discuss how best to receive and remember the message, e.g. to record dots and dashes on paper, or as a video clip on a phone.
5. Students can then practise sending and receiving messages in their teams.
6. Teams should then pair up and take turns to send and receive one or more messages.
7. Share feedback. Which team (and method) was the best at sending or receiving? How can teams decide this: by speed or accuracy? Share ideas on how to improve the system to help survivor groups communicate.

TIPS

- Don't use buzzers – the zombies will hear!
- Students can use the link below to practise their dot, dash and pause consistency.

EXTENSION IDEAS

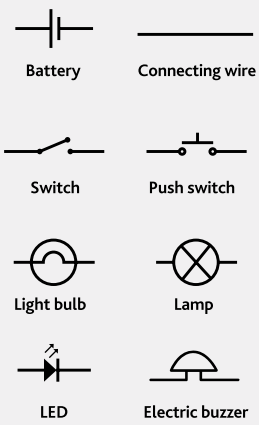
1. Students can explore the ready-made Micro:bit code using the links below and develop a chart to explain how the algorithm decodes a message in Morse code.
2. Teams can test lamp designs and powers, designing a fair test and exploring reflector shapes (e.g. parabola, cone, and hemisphere) and measuring range.
3. Students can research designs for Morse keys and build their own.
4. Play 'Chinese whispers': one team sends a short message to the next, which is repeated until it gets back to the original team. Does the message stay the same after being sent between so many teams?

DIFFERENTIATION IDEAS

Support: pre-load programs onto the Micro:bits, ready for teams to use. Sketch a sample circuit or build one for students to copy. Use the ready-made simple messages.

Challenge: get students to copy, paste and flash programs or design and build their own circuits. Teams can also write their own longer messages to code and transmit.

Useful Electronic Symbols



USEFUL LINKS

- **Micro:bit Morse program**
  http://microbit-micropython.readthedocs.io/en/latest/tutorials/network.html
- **Miles Booth's transmitter / receiver programs for Micro:bit**
  http://www.suppertime.co.uk/blogmywiki/2016/05/microbit-morse-code-transmitter/
- **Practise dots, dashes and pauses online**
  https://lcwo.net/transmit
- **Online Morse code translator**
  https://morsecode.scphillips.com/translator.html
- **Understanding electronic principles resources**
  https://www.stem.org.uk/resources/elibrary/resource/425048/understanding-electronic-principles

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

2 Spread the word

Briefing

You're safe within your enclosure! But there's no mobile phone signal and the landlines don't work. How can you communicate with other groups of survivors? You need to send some vital messages soon!

YOUR TASK **Create a transmitter and then send and receive your vital messages – in code!**

WHAT YOU NEED TO DO

Your club leader will explain what kind of transmitter you're going to build.

1. Build and test your transmitter by:

a. building a circuit to control a lamp,
b. following online instructions to paste a program into a Micro:bit, or
c. using a Morse app to control your phone's flash.

2. Practise using Morse code so your dots and dashes are clear and there's a pause between letters.

Practice words: Hello Morse Virus

3. Take it in turns to send a message between teams! How fast and accurate can you get at sending, receiving and decoding the messages?

Try sending the following messages:

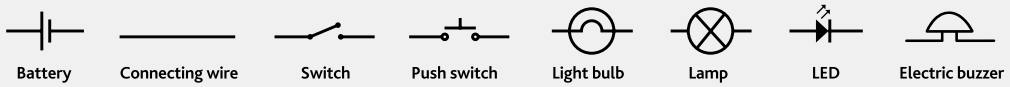
Medical emergency send first aid
25 zombies coming take cover
Urgent need food and water

Now think of a message of your own to send to another team!

INTERNATIONAL MORSE CODE

A	J	S	1	6
B	K	T	2	7
C	L	U	3	8
D	M	V	4	9
E	N	W	5	0
F	O	X
G	P	Y
H	Q	Z
I	R

Useful Electronic Symbols



FUN FACTS

1. Samuel Morse invented the first version of the Morse code in 1837, but it was very different to the Morse code that is popular today. It used numerical codes to represent words or phrases.
2. The dots and dashes used for each letter are linked to how often the letter appears in the English language, with more common letters being shorter and quicker to send. That's why 'E' is just a dot. This version of Morse code was first developed by Alfred Vail in 1840.
3. Today, some people use Morse code as an assistive technology if they are unable to communicate through other means.

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

3 Neck protection

Objective

Students explore fabrics and materials to design and test a puncture-resistant 'neck protector' that will resist a zombie bite.

TOPIC LINKS

Design and technology: Properties of materials

TIME

60 minutes

RESOURCES AND PREPARATION

- a range of fabric samples offering puncture and tear resistance, for example fake leather, pvc, ripstop, cordura fabric etc
- padding, wadding or insulating fabric samples, such as non-woven insulation and bubble wrap
- tools for cutting materials
- masses (in 50g or 100g increments) and hanger
- sticky tack, super glue or similar
- short screws e.g. 12–20mm long
- 15cm x 15cm x 2cm soft clay or polymer clay and bubble wrap to make a 'fake neck'
- 30cm ruler

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Eye protection should be worn when testing the strength of the neck protectors.

When using a glue gun or other strong adhesive products, be sure to warn students of the dangers of ingesting the chemicals as well as the physical harm that they can cause.

DELIVERY

1. Introduce the scenario: students are a group of survivors with a safe enclosure to live in, but they need to enter the 'zombie zone' to find food, medicine and other supplies, which puts them at risk of being bitten on the neck.
2. Students form small teams. Discuss which STEM roles students could take on in their team, for example: clothing designer, fabric designer/ engineer, safety engineer, anatomist etc. Students can take on these roles if they wish.
3. Teams discuss and agree the properties of a good neck protector, such as bite, tear and puncture resistance, comfort and fit, and the ability to take it on and off easily.
4. Teams explore the sample materials and consider which materials when combined would make a good composite material.
5. Teams design the perfect neck protector for one of the team member's neck. Students should consider the shape of the neck, the area to be covered and how the protector will be put on or taken off. The teams create detailed labelled diagrams that show the shape of their neck protector, the materials used and the measurements required.
6. Each team creates a basic prototype of the composite material they have invented to test the effectiveness of their design.

TIPS

- You could obtain samples of protective garments and the materials used to make them: Aramid, Kevlar(R) or Diolen fabric, cut-resistant fabric kitchen gloves, metal mesh butcher's gloves, leather and fabric bike jackets or trousers etc., for students to explore.
- You could also use a glue gun to create a composite material that can be tested.
- Do not allow pupils to wear the neck protection during the testing phase.
- Ask technicians to prepare the neck for testing ahead of the session.

7. Teams test their composite material with a simple drop test:

- make a 'fake neck' using a flat layer of clay or polymer clay about 15cm square and 1–2cm thick. Add a layer of bubble wrap, bubbles upwards, on top. Use sticky tack or super glue to fix 4–6 screws to the bottom of the mass hanger to represent teeth
- teams place their composite material on the 'fake neck' and drop masses onto it from 30cm, to see how much mass is required to puncture the material and pop some of the bubbles on the 'fake neck'. Students should record the level of damage to the fake neck. 'Reset' the neck after each team by smoothing it flat and replacing any burst bubble wrap

8. Discuss results, identifying the best elements of each team's ideas. Whose design would students trust the most?

EXTENSION IDEAS

1. Students can explore how to shape their neck protectors so they can be taken on and off.
2. Include solid materials like thin sheets of HDPE and discuss how this could be cut and drilled to provide lightweight armour plating to include in students' designs.
3. Students could develop their ideas into full body protective suit designs.
4. Hold a zombie-proof clothing fashion show.

DIFFERENTIATION IDEAS

Support: cut fabric samples into 15cm squares before beginning the session. Help teams identify that their composite material needs to include both puncture-proof and padding materials to minimise injury. Omit the design sketch if teams need more time to agree and assemble the layers in their composite material.

Challenge: teams must minimise the amount of fabric used in their composite material, so more people can have neck protectors made for them from a limited supply. Ask students to design how they will test their composite materials. Teams label and present their design sketches.

USEFUL LINKS

Students could use the following search terms to research suitable materials online:
PPE clothing, protective clothing, mesh shark suit, D30 armour.

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

3 Neck protection

Briefing

Zombies' spread their virus by biting uninfected people. Humans' necks are soft, exposed and contain large arteries and veins, which will help to quickly spread any bite-injected virus to the brain and body through the bloodstream. Nine out of ten zombies think necks are the tastiest part of the body!

YOUR TASK **Design and test a bite-proof neck cover to protect you from zombie bites.**

WHAT YOU NEED TO DO

1. In your team, agree what properties your neck cover needs to have so that it's protective but also reasonably comfortable. What kinds of damage might a zombie bite inflict on someone?
2. Explore the sample materials and consider their properties, which materials when combined do you think would be most effective in protecting your neck?
3. Design the perfect protector for your neck using the composite material you have created. Consider the following:

- the shape and size of the neck
- the area of the neck you would like to protect
- how it will be put on and taken off
- fastenings need to be zombie proof, but safe for you to use
- how much you will need of each material to make the composite
- draw a detailed design and identify components and their measurements
- could you create a 3d image using software

4. Create a prototype of the composite to test its ability to protect the model neck.
5. Test the prototype using the model neck provided and record the level of damage Find out which team's solution is the most effective:

- which composite is the most tooth-resistant
- which composite is best at protecting the neck from bruising
- record how much damage occurs

6. Consider how effective your composite is and how you could improve your design. If time allows try different composite materials to create the perfect material for your protector.

Remember, you are not a zombie! Do not test by wearing the neck protector prototypes and do not bite or hit it, as you might hurt someone.

FUN FACTS

1. You really can buy bite-resistant clothing! People who work or live with patients with challenging behaviour can be given bite-proof sweatpants and hoodies to protect them. Police dog trainers have to wear bite-resistant clothing every day at work!
2. Divers can buy lightweight chain mail suits to protect them from shark bites, and butchers often wear chain mail gloves when cutting meat.
3. A non-Newtonian fluid is a fluid whose viscosity (how easily it deforms) varies depending on how hard you hit it. You can recreate the effect by mixing 450g cornflour with 475ml water! How could this be used in protective clothing?
4. Bikers can now buy protective gear made from D30 – a non-Newtonian polymer that normally is soft and bendy, but almost instantly sets hard when it collides with something.

STEM CLUBS

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CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

4 Solar snacks

Objective

Students investigate how parabolas can focus light to heat marshmallows in a simple solar cooker. This is one way that survivors could cook in the powerless, dark world of the zombie apocalypse.

TOPIC LINKS

- Maths: parabolas, circles, prisms
- Physics: energy, light
- Design and technology: functional solutions to design problems

TIME

60 minutes

RESOURCES AND PREPARATION

This activity works best on a sunny day. On a cloudy day, perform the experiment with a halogen desk lamp. This could perhaps also be used as a demonstration on a sunny day.

- printed copies of the parabola template
- A4 corrugated card (four sheets per group)
- A3 thin card (one sheet per group)
- aluminium foil
- glue sticks, tape
- long bamboo or wood skewers
- marshmallows
- probe or infra-red thermometer
- transparent acrylic sheet (optional)
- halogen desk lamps for use on a cloudy day [caution: hot]
- protective gloves

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Students should handle halogen lamps with care and use protective gloves and eyewear.

DELIVERY

1. Introduce the scenario: there is no electricity or gas available to cook with and the zombies are beginning to associate smoke with humans. The survivors need to find ways to heat food and water that won't give away their location. One option is solar cooking.
2. Students form small teams. Discuss which STEM roles might help: optical engineer, thermodynamics scientist, energy engineer, food scientist etc. Students can take on these roles if they wish.
3. If time permits, briefly introduce parabolas, explaining that they are found in torch and car headlights to direct the light.
4. Guide teams as they carefully follow the step-by-step instructions to build a small parabolic solar cooker. If using outside, students can optionally use transparent acrylic sheet as a top cover, which helps trap heat. Do not try this if using halogen lamps.
5. Test the parabolic solar cookers with marshmallows and thermometers. See how fast the marshmallows melt, and/or what final temperature they reach.

TIPS

- Use the foil shiny side out and take care not to wrinkle it when gluing to the tin card.
- Don't forget to coat the two end formers in foil as well.
- It's important that as much light as possible can get below the marshmallows, which should be in small enough pieces so that they don't touch the foil.
- Angle the cookers so that they point at the sun or the lamp being used.
- If performing this experiment inside with halogen lamps, make the solar cookers shorter than the length of the long wooden skewers or just put a marshmallow directly under the lamp.

EXTENSION IDEAS

1. Students could research and build other forms of solar cookers.
2. Students can research 'rocket' stoves, which drastically reduce the smoke produced by burning wood. Why are rocket stoves important for people's health in less economically developed countries?
3. Build a large solar cooker using plywood and cook hotdog sausages or other snacks outdoors.
4. Research other foods suitable for cooking on a long skewer, like vegetable or meat kebabs or campfire bread twizzles.

DIFFERENTIATION IDEAS

Support: Make one model for students to copy. Pre-cut end formers from corrugated card, ready for groups to use.

Challenge: Ask teams to also make cookers based around hemispheric end formers and compare their performance. Discuss why the parabola works better: the shape focuses the light onto the axis, where the marshmallows are positioned. A hemisphere can't focus the light in the same way.

TOP TIP

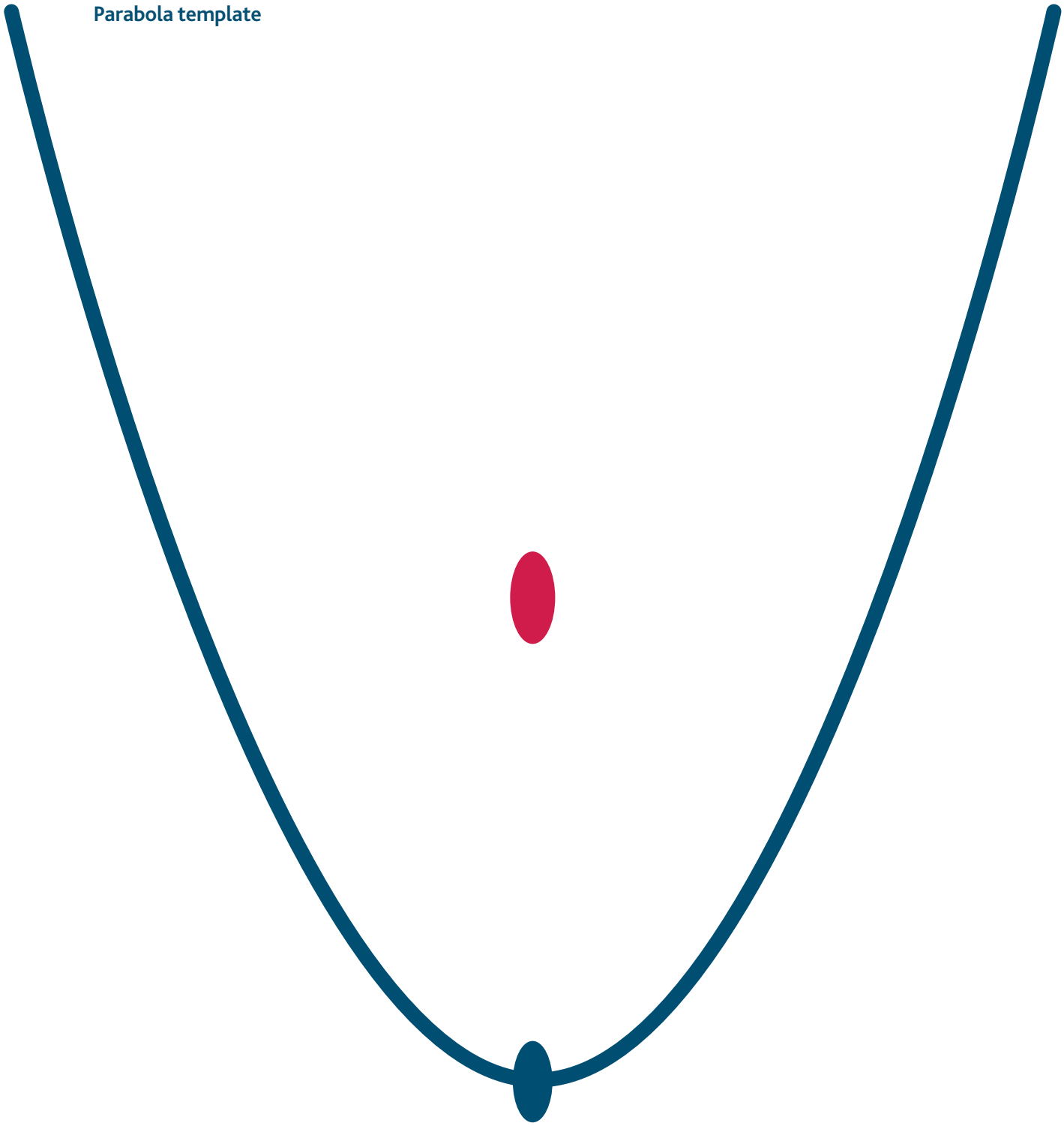
The red dot is the focus – the axis on which the skewer will go and on which the marshmallow will need to stick. Light needs to reflect off the parabola onto the marshmallow and that's vital.

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

4 Solar snacks

Parabola template



STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

4 Solar snacks

Briefing

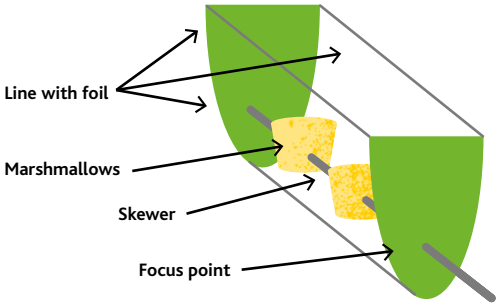
After a few weeks in the zombie apocalypse, there's no gas or electricity left for cooking. What's more, the zombies have learned that smoke and fires mean there are humans nearby to bite! You need to find a way to cook food that doesn't give away your location.

YOUR TASK **Build and test a parabolic solar cooker.**

WHAT YOU NEED TO DO

1. Use the parabola template to carefully cut four parabolas from corrugated card.
2. Use a skewer to accurately create a hole at the focus points.
3. Glue two pairs together to create two double thickness parabolas.
4. Use the glue stick to carefully cover one side of the thin card, and one side of each parabola, with foil. Make sure the shiny side faces out. Try not to create wrinkles.
5. Fold the thin card around the parabolas and tape it in place to create your solar cooker. Make sure the foil is on the inside!
6. Poke a skewer through the focus point at each end and make sure the skewer is straight in the cooker.

Image to the right omits one side of the card/foil reflector. (It wraps all round the parabola at each end to form a trough)



7. It's time to cook! Load one or two marshmallows onto your skewer. Make sure they don't touch the foil, so light can reflect onto them.
8. Angle your cooker to face the sun, or if inside, a halogen desk lamp. Take extra care when using the halogen lamps as they can generate a lot of heat and you could burn yourself. Use protective gloves and wear protective eyewear.

FUN FACTS

1. If you throw a ball, the trajectory it follows through the air is a parabola.
2. Any ray of light that's parallel to the parabola's axis of symmetry will be reflected onto the focus point. That's why parabolas are used to focus torch or headlight beams, and are also used in satellite dishes.
3. The simplest equation for a parabola is $y = x2$.

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

5 Silent steps

Objective

Students design shoe covers that allow them to move silently over a variety of surfaces and avoid zombie detection, testing their ideas with a decibel meter, sound pressure meter or appropriate app.

TOPIC LINKS

- Physics: sound
- Design and technology: properties of materials

TIME

30 minutes

RESOURCES AND PREPARATION

Adapt the materials to suit your resources.

- a variety of soft or fleecy fabric samples, large enough for students to use to cover shoes, or even newspaper
- padding materials of various thicknesses: insulation, wadding, foam sheets, foam pieces, cotton wool balls, biodegradable or polystyrene packing 'peanuts' etc.
- string, staples, tape, safety pins etc. for quickly binding or joining fabrics around and over shoes
- scrunched up small pieces of scrap paper to simulate dry leaves etc. (or find a suitable, quiet place outside to test)
- decibel/sound pressure meter, microphone and oscilloscope, an online oscilloscope (see link) or use free or low-cost phone apps (search for sound meter, decibel meter or sound pressure meter on your app store)

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

DELIVERY

1. Introduce the scenario: if students can find a way to make their footsteps as silent as possible over a range of different surfaces, even dry leaves, they will be able to safely roam outside of their base, helping them to find food and supplies more easily.
2. Students form small teams. Discuss which STEM roles students could take on, for example: acoustic engineer, soundproofing consultant, shoe designer, etc. Students can take on these roles if they wish.
3. Students use meters or apps to explore sound levels while walking in their normal footwear, on flat surfaces and if possible over gravel, dry leaves etc. and identify how loud walking can be on each surface and with different sole materials, identifying the quietest and loudest examples.
4. In their teams, students choose outer and padding materials to create shoe covers.
5. Teams test their cover designs over floors, leaves and other surfaces. Who is quietest on each surface?

TIPS

- You will need a quiet spot to test students' shoe covers.
- Agree how to standardise tests, for example students may wish walk equally quickly over each surface, or perhaps the same person should wear all of the shoe covers being tested, so that they can walk in the same way/ with the same gait in each test.

EXTENSION IDEAS

1. Create a simple noise obstacle course that includes other potentially noisy tasks as well as walking over dry leaves. Which team can complete the course making the least noise?
2. Develop the pressure/ snowshoe challenge idea and include materials to create a larger sole surface area.
3. Challenge students to think of other design solutions to the problem of dry leaves, for example by raising their sole on a bed of short, wooden dowels.
4. Extend the idea to design a complete 'silent suit', choosing suitable fabrics.

DIFFERENTIATION IDEAS

Support: give students a range of sole materials to compare, including thick felt or similar, leather or fake leather, furry fleece etc.

Challenge: state that zombies will hear anything louder than 20dB, or a decibel level of your choice. Include a discussion of pressure: by spreading their weight over a larger area (like snowshoes), might students reduce their noise levels even further?

USEFUL LINKS

Online virtual oscilloscope (Works well with a laptop microphone. Requires the latest Chrome browser.)
https://academo.org/demos/virtual-oscilloscope/

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

5 Silent steps

Briefing

You need to find food and supplies and make contact with other groups of survivors. You've learned that a zombie's hearing isn't as good as a human's hearing. This means that, so long as you don't make too much noise, you'll have a good chance of going undetected.

YOUR TASK **Create shoe covers that let you walk as silently as possible over different surfaces and materials.**

WHAT YOU NEED TO DO

1. Use a decibel meter or phone app to measure how loud you are when walking over different surfaces and materials. Which materials and surfaces are the loudest?
2. Explore the different fabrics and materials you could use to make your shoe cover. Identify those that you think will be most silent.
3. Create some shoe covers for one member of your team. The shoe covers don't need to be a perfect fit, they simply need to wrap over and around their shoes.
4. Test your shoe covers by walking over different surfaces and measuring how much noise is made. Which team is most likely to go undetected by the brain-hungry zombies?
5. Explain how your cover helps to reduce the sound produced when walking.

FUN FACTS

1. The decibel scale isn't linear. Instead, it's logarithmic. If you double the sound level, you don't double the number of decibels. Instead, twice the noise equals about 3dB more, no matter how loud you were at first.
2. Because the decibel scale is logarithmic, a sound that is 20 decibels is not twice as loud as a sound that is 10 decibels. Instead, a sound that is 20 decibels is 10 times louder than a sound that is 10 decibels.
3. Other logarithmic scales include the Richter scale for measuring earthquakes, and the pH scale for measuring acidity.

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

6 Food for thought

Objective

Students consider the characteristics of ingredients and foods, and the properties of packaging materials and preservation methods, to identify the best foods to grab while on a raid during the zombie apocalypse.

TOPIC LINKS

- Design and technology: characteristics of ingredients; properties of materials; evaluating against a specification.

TIME

30 minutes

RESOURCES AND PREPARATION

- paper and pens
- examples of food packaging – this will help to illustrate packaging options as well as give some information about the nutritional value of certain foods.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

DELIVERY

1. Introduce the scenario: students are groups of survivors who need to brave the hordes of wandering zombies in order to raid an abandoned supermarket and grab some desperately needed food.
2. Discuss which roles might help the raid team identify the best foods to grab, for example: nutritionist, food scientist, product development consultant, etc. Students can take on these roles if they wish.
3. Guide students as they consider and prioritise issues of nutrition, storage, taste and longevity and decide what factors are most important when choosing the food they will grab. As appropriate, introduce and discuss other examples of when people need to store long-lasting nutritious foods, such as on long expeditions. Give the students the opportunity to discuss their ideas, research nutritional values and explore storing/packaging techniques.
4. The best foods to grab in this situation would be high-energy foods, long-lasting foods and, of course, water and other fluids. High-energy foods include eggs, wholegrain products, nuts, fruits, sugary products (which are doubly good as sugary products take longer to spoil), quinoa, peanut butter, seeds and grains. Long-lasting foods include canned products, salted products (like jerky), sugary products (like cake and biscuits), pickled products, unopened jars and dried products (like dried fruits). Links to more information about high-energy and long-lasting foods can be found below.
5. Teams brainstorm types of food and narrow their choices to create a list of foods they will look for. Students could create a mind map. Ask each team to identify the five most important foods to grab, in case time is very short.
6. Give each team a short time to share their ideas and their five most important choices. Ask teams to justify their choices, especially their 'top five' in terms of nutrition, storage etc. Identify common ideas that emerge.

TIPS

- Make sure students have a shared understanding of the conditions they will have for food storage, so each group uses the same storage criteria.

EXTENSION IDEAS

1. Students can research bulk food supplies, adventure and expedition foods (e.g. freeze-dried meals) online.
2. Students can research home preservation methods and identify techniques that an isolated group of survivors could use, including traditional cold storage as well as drying, salting, pickling, fermenting, canning etc.
3. Students can design an allotment where they could grow their own vegetables, fruit, herbs etc. in a limited space (search for 'square foot gardening', 'container gardening' or 'permaculture gardening', for example).

DIFFERENTIATION IDEAS

Support: allow teams to have a generator and a chest freezer in their safe compound, so they can include frozen foods. Brainstorm supermarket sections and aisles to provide a more detailed stimulus. Discuss the kinds of food that can be stored for a long time versus food that will go off quickly.

Challenge: add further limitations, for example: forbid students from choosing prepared foods; teams must choose ingredients only; teams can only choose dried food; teams can only choose food they don't need to cook (they can rehydrate though).

USEFUL LINKS

High-energy foods:
www.eatthis.com/foods-for-energy/

Long-lasting foods:
https://lansky.com/index.php/blog/longest-lasting-foods-your-survival-pantry/#.WoRVta5l-M8

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

6 Food for thought

Briefing

Food is running out! You've bravely volunteered to take a van and raid an abandoned supermarket to grab essential food. But what should you grab? Remember, you only have a short amount of time before the zombies will start to come after you!

YOUR TASK **Evaluate the best foods to grab, based on nutrition, taste, storage, longevity and any other factors you think are important.**

WHAT YOU NEED TO DO

1. Understand your options. Your Club leader will let you know of any limitations, but assume you don't have any electricity, meaning that fridges and freezers won't work.
2. In your team, identify the factors you think will be most important, like nutrition, energy value, storage, how long they will last, and any other ideas. Use the food packaging provided by the Club leader to research packaging techniques and the nutritional value of different foods. Agree a priority order for your factors.
3. Choose what foods you will grab!

a. Make a list of up to 40 foods you would grab on a supermarket raid. Make sure these choices are in line with the priorities you decided upon earlier.

b. Identify the five most important foods to grab if you don't have much time. These should keep your group alive and full of energy for another couple of weeks until another raid is possible.

4. Present your ideas, linking to your priorities. Explain why your five most important foods are a good choice.

FUN FACTS

1. Spices and herbs are sometimes preserved by irradiating them with beta or gamma radiation – enough to kill any harmful bacteria but well within safe limits.
2. Some meal and snack pouches used by the US Army can last as long as five years without going bad. This is because the army uses a range of high-tech preservation methods to keep their food pouches safe to eat for many years.
3. 'Soylent' is an all in one liquid food replacement product you can buy as a powder. It is designed to provide 100% of your daily nutritional needs from plant sources – all you need to do is mix it with water.

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

7 Siege solutions

Objective

An antivirus has been found and needs distributing outside of the enclosure. Students design and build a model siege engine to propel a table tennis ball (antivirus) or other safe and suitable projectile as far as possible.

TOPIC LINKS

- Physics: energy
- Design and technology: properties of materials; performance of mechanical and structural elements

TIME

60 minutes

RESOURCES AND PREPARATION

Assemble a range of the material ideas below into identical kits, or allow groups to obtain materials on a first come, first served basis. Students may optionally research siege engines and their models on the internet.

- milk carton/plastic caps
- small and medium bulldog clips
- rubber bands (various lengths and thicknesses)
- string and tape (electrical tape works well)
- lolly/craft sticks
- round and square wooden dowels
- drinking straws
- flat headed push pins
- card
- small weights
- plastic or bamboo tablespoons
- table tennis balls or similar to use as antivirus capsules
- safety glasses

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Make sure that the pupils understand the dangers of working with projectiles and ensure that proper safety precautions are followed. This might include having strict testing guidelines for the siege engines and wearing protective clothing and eyewear.

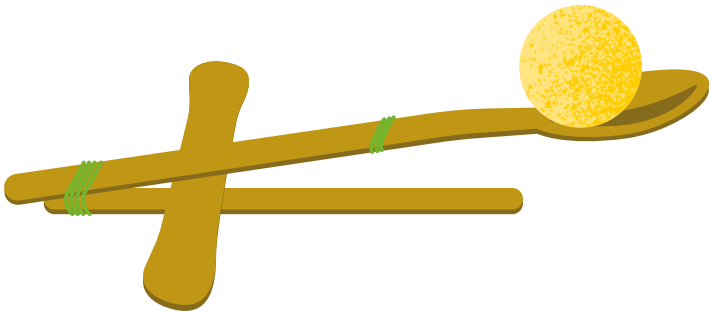
DELIVERY

1. Introduce the scenario: someone has managed to get a supply of an experimental antivirus, which may stop the zombie disease from spreading. This is contained in capsules that need to be thrown all around the enclosure so that when they break, the antivirus will be released into the air.
2. Students form small teams. Discuss which STEM roles students could take on in their team, for example: mechanical engineer, ballistics scientist, fabricator etc. Students can take on these roles if they wish.
3. Give each team an 'antivirus capsule' to consider. How could they fire or throw this as far as possible? Teams review the range of materials they can use.
4. Students discuss design ideas and agree their approach. If time and resources permit, teams can research more on the internet.

TIPS

- Remind students that the optimum trajectory is 45o.
- Ensure the projectile representing the anti-virus will not cause damage.
- Test in a sports hall or outside for extra strong models.

5. Teams select their materials, or receive handed-out kits. Reinforce that spare or replacement material is not available!
6. Remind teams that catapults and trebuchets use potential (or stored) energy to operate. They should think of how they can store energy in their own designs, such as with bent lolly sticks, stretched rubber bands, an open bulldog clip, a weight as a counterbalance, etc.



The rest of their machine needs to provide the strength and stability to control this stored energy.

7. Hold a competition to see which design is most powerful and which is most accurate. Congratulate teams – it looks like the antivirus is working!

EXTENSION IDEAS

1. Try testing with water balloons containing coloured water to mimic the antivirus spreading – how far does it go?
2. Allow students to request materials outside of those available to make a stronger model.
3. Explore how the distance of the projectile changes with the angel of trajectory.
4. Students could build larger models to fire or throw tennis balls.
5. Students could design and test air-powered devices or build and test water rocket kits.

DIFFERENTIATION IDEAS

Support: review the properties and possible uses of each material. Use the link below to illustrate a possible catapult design for teams to copy. Allow teams two opportunities to replace a broken part.

Challenge: teams design their device from scratch and can't replace any broken parts. Ask teams to explain their use of materials in terms of stiffness, flexibility, strength, storing energy, using levers as force multipliers etc.

USEFUL LINKS

Students can use the following search terms:
Model siege engine, ice lolly siege engine, model catapult, trebuchet, and ballista.

Or they can use the link below to explore a number of different siege engine designs:
https://littlebinsforlittlehands.com/popsicle-stick-catapult-kids-stem-activity/

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

7 Siege solutions

Briefing

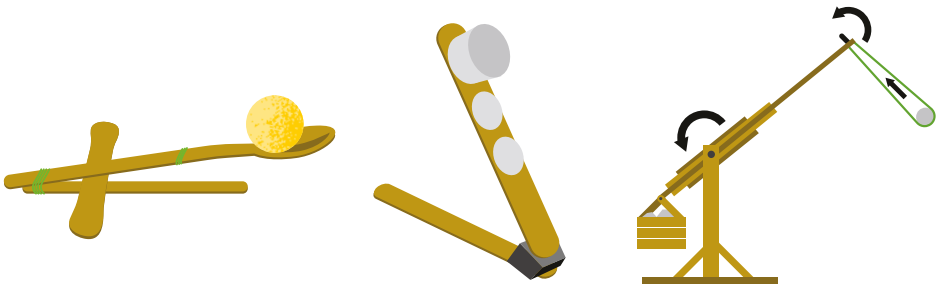
You have some experimental antivirus capsules that may stop the zombies from multiplying. You need to disperse these all around your safe enclosure. But how?

YOUR TASK **Build a catapult or other device to throw or fire an antivirus capsule as far as possible.**

WHAT YOU NEED TO DO

1. Take a look at an antivirus capsule. How could you throw or fire this as far as possible?
2. Look at what materials you have available. Since you're stuck in your safe enclosure, you can only use what's to hand.
3. Sketch some ideas. Think about how best to use each material and how you'll store and release energy to propel the capsule.
4. If you can, use the search terms below to research some ideas on the internet. Remember, you don't have many options for materials and you can't use electricity to throw or fire your projectile. Because of this, it may be best to look up medieval siege engines, as people in the medieval period didn't have electricity or a multiplicity of materials either!

Model siege engine, ice lolly siege engine, model catapult and model trebuchet.



5. Get your materials and build your design. Use your materials carefully – if any of them break, you may not have any more to use!
6. Test your design against other teams. Remember to wear protective eye glasses. Which design is most powerful and most accurate?

FUN FACTS

1. Mediaeval siege engines relied on potential energy to fire or throw their projectile. That is, energy stored in a tightly-wound or twisted rope, or a weight that was lifted high off the ground. Springs and elastic materials weren't available in Europe at the time!
2. Leonardo Da Vinci included many designs for siege engines in his famous sketchbooks, including a catapult, a giant crossbow, a steam-powered cannon, and even a tank. He designed these for some of the wealthy patrons who paid for his art. However, it's believed he was unhappy at having to do this, and he allegedly included deliberate mistakes in his designs.

STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

8 Nature's real zombies

Objective

Students use the internet to research some parasites that take over their hosts to create some of nature's real zombies. They then present what they discover and choose the creepiest example.

TOPIC LINKS

Biology: parasites.

TIME

30 minutes

RESOURCES AND PREPARATION

- internet access
- a data projector to allow students to show an image or video clip of their parasite and its host

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

DELIVERY

1. Give students the background: human zombies are a fictional idea whose origins lie in Haitian folklore. But nature is full of examples of how creatures can be overtaken and made into zombies. This most commonly happens when a parasite attacks and takes control over its host.
2. Discuss which STEM roles might help us understand these organisms and protect ourselves, for example: zoologist, parasitologist, medical parasitologist, tropical disease doctor, biochemist, and immunologist. Students can take on these roles if they wish.
3. Explain that students should choose one Latin name to research, which they will need to type carefully! Mention that the modern term for Latin names is 'binomial nomenclature'. Each name has two terms, the genus and species (e.g. Homo sapiens) and today, the species name in particular may not be a real Latin word.
4. Students research their parasite using the questions and their own ideas. Students may wish to bookmark an image or brief clip to share with the rest of the class.
5. Students each take one minute (or less) to share their discoveries and argue why it's the creepiest parasite. Students vote.
6. Highlight that parasites affect humans in real life and in many cases, like Malaria, can be a major killer for people living in developing countries.

TIPS

- Students can copy and paste the Latin names from the student guide into their search engine.

EXTENSION IDEAS

1. Students could create a brief PowerPoint presentation or video to share their discoveries with the group.
2. Students could design a fictional parasite that could be responsible for a zombie outbreak in your community.
3. Students could sketch their own new parasite based on the mutations that might occur now that people have become zombies.

DIFFERENTIATION IDEAS

Support: search for the Wikipedia page for each parasite. Compile links into a document or have each page loaded and ready to read.

Challenge: ask students to find one extra example of a parasitic creature that affects either animals or humans.

USEFUL LINKS

History of the idea of zombies
https://en.wikipedia.org/wiki/Zombie

STUDENT GUIDE: SUITABLE FOR AGE 11-14

Can you survive a zombie apocalypse?

8 Nature's real zombies

Briefing

Those Latin phrases below aren't spells: they're the scientific names of what can cause some of nature's real zombies! Each one is a parasite that has a creepy, gory way of using or controlling another creature – but which one is the worst?

YOUR TASK **Research one of nature's real zombies then argue why it's the worst!**

WHAT YOU NEED TO DO

1. Choose one of the scientific names below:

Ophiocordyceps unilateralis	Glyptapanteles glyptapanteles
Euderus set	Ampulex compressa
Leucochloridium paradoxum	Spinochododes tellinii
Cymothoa exigua	Paragordius tricuspidatus

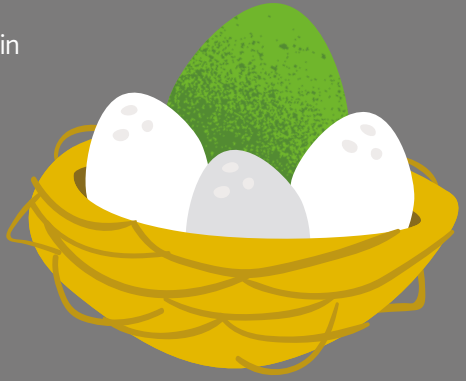
1. Carefully type the name into a search engine and find out more about it:

a. Does the parasite have an everyday name?
b. Where is the parasite found?
c. What creature does it affect? Remember, the animal that a parasite lives inside is called its 'host'.
d. How does the parasite control its host animal?
e. Why is the parasite creepy?

1. Plan how you'll share what you've discovered. You'll only have one minute to persuade your friends that you've chosen nature's worst zombie parasite!

FUN FACTS

1. Parasites might not turn humans into zombies, but there are many parasites in the world that affect human health, including the one that causes malaria.
2. Tapeworms, parasites that live in the gut, can grow up to 17 metres long!
3. Cuckoos are a type of brood parasite – an organism that tricks another organism into raising its young.



CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How could we augment ourselves?

9 Get CREST Discovery Awards

By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.

ABOUT CREST

CREST is a scheme that inspires young people to think and behave like scientists and engineers. It is student-led, flexible and trusted. CREST helps young people become independent and reflective learners. With no set timetable, projects can start whenever you want, and take as long as you need.

HOW TO GET YOUR CREST DISCOVERY AWARDS

It's easy to get your members' Discovery Awards, simply:

1. Sign-up for a free account - https://my.crestawards.org/
2. Have each member complete a CREST Awards Discovery Passport
3. Create a project eg. "Asteroid Impact", "Desert Island" or "Zombie Apocalypse"
4. Upload names
5. Upload two or three passports and any accompanying work
6. Assess individuals, have they:
   a. Completed around five hours of work on the project?
   b. Participated fully in the project?
   c. Reflected on their learning?
7. Type in your delivery and payment details.

TAKING THEIR WORK FURTHER

If members want to take activities further, they can work towards a CREST Bronze or Silver Award.

CREST Bronze Awards require around ten hours of enquiry, project-based work, and Silver Awards require thirty hours of work at GCSE or equivalent standard. Using one of the activities for inspiration, they choose a question or topic to investigate.

Guidance on how to run CREST Bronze and Silver Award projects is available on the CREST Awards website www.crestawards.org.

STEM CLUBS

NUMBER 1 FOR STEM

STEM Clubs Programme, led by STEM Learning

Achieving world-leading STEM education for all young people across the UK.

For more information on the programmes and publications available from STEM Learning, visit our website www.stem.org.uk