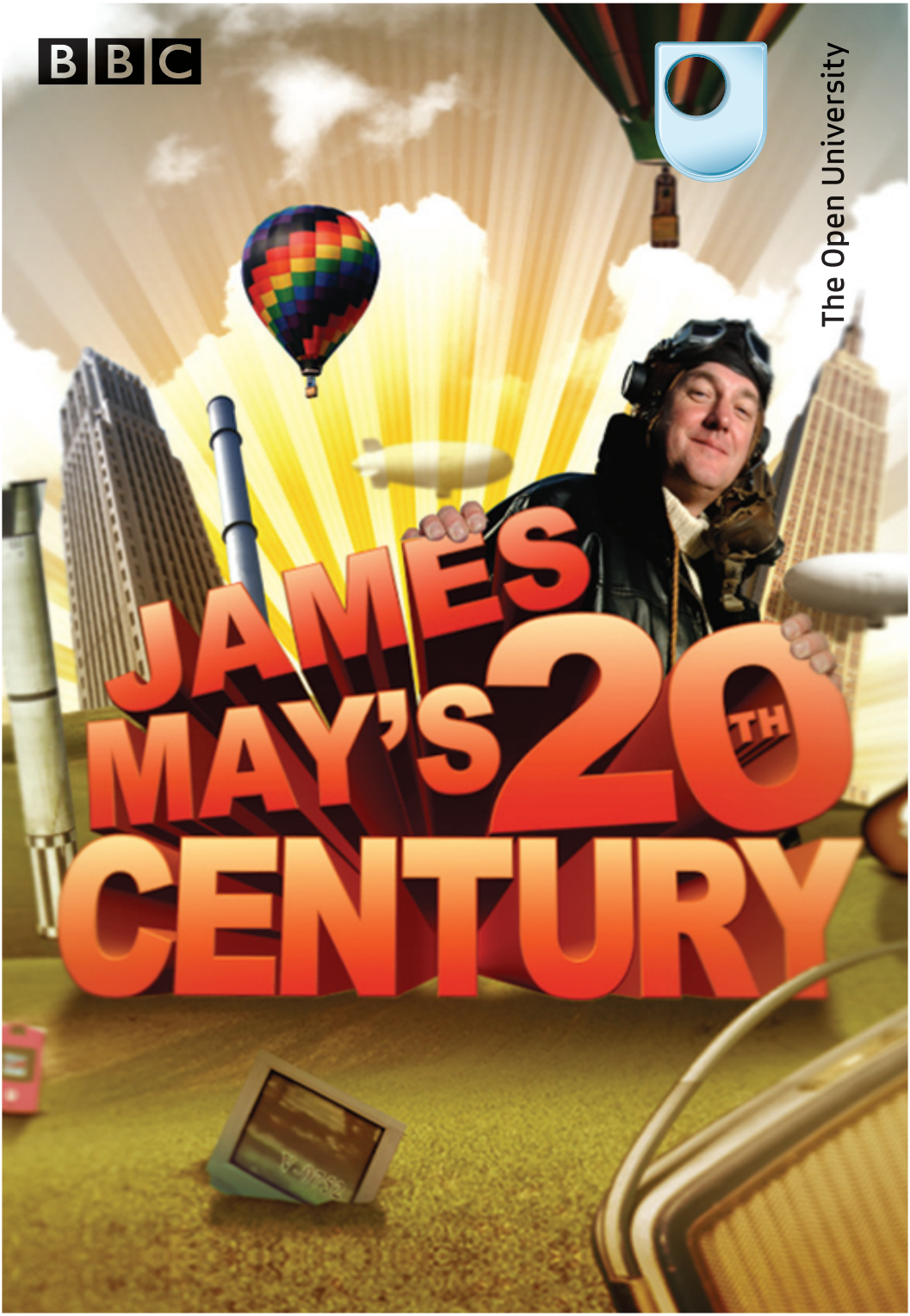
BBC

The Open University

JAMES MAY'S 20TH CENTURY



The twentieth century is full of innovation and packed with technological developments that might surprise you. This is your chance to explore some of them and find out how they work.

I've had a great time making this series. I hope you enjoy it too.

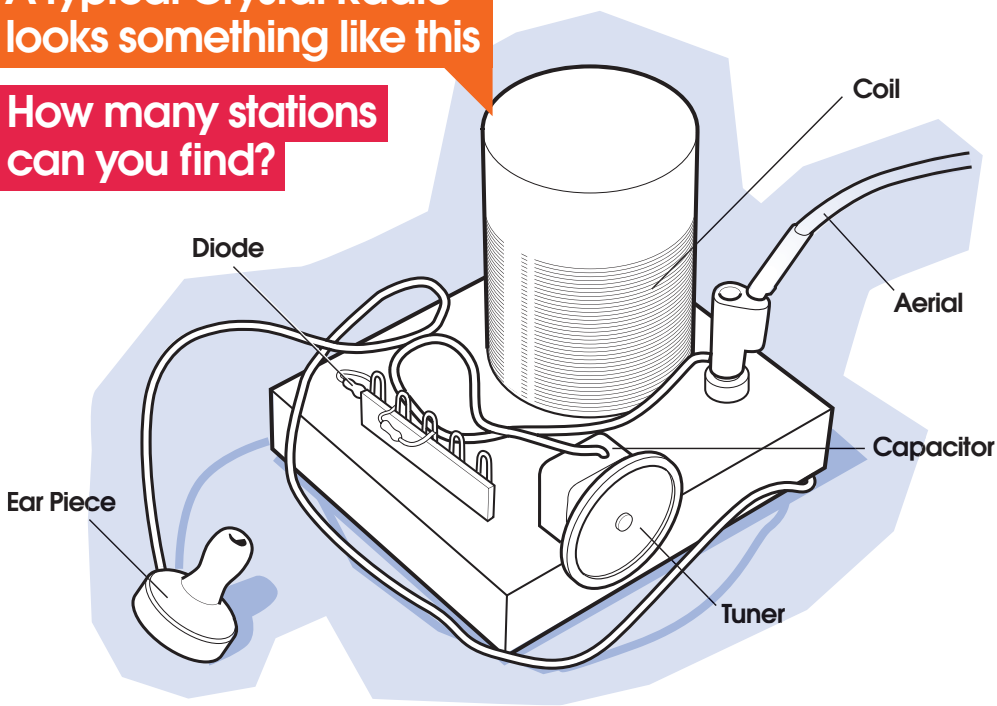
James May

Tuning in with your Crystal Radio

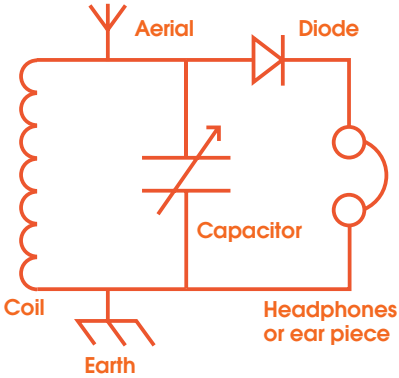
BBC

A typical Crystal Radio looks something like this

How many stations can you find?



Wiring layout

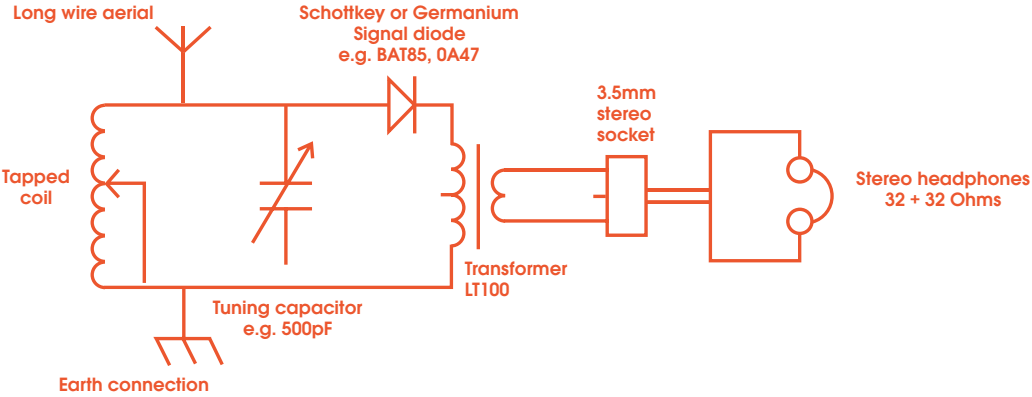


Know where to get a kit from?

www.sogifted.co.uk
www.amazon.co.uk
www.arcsandsparks.com
www.toyday.co.uk

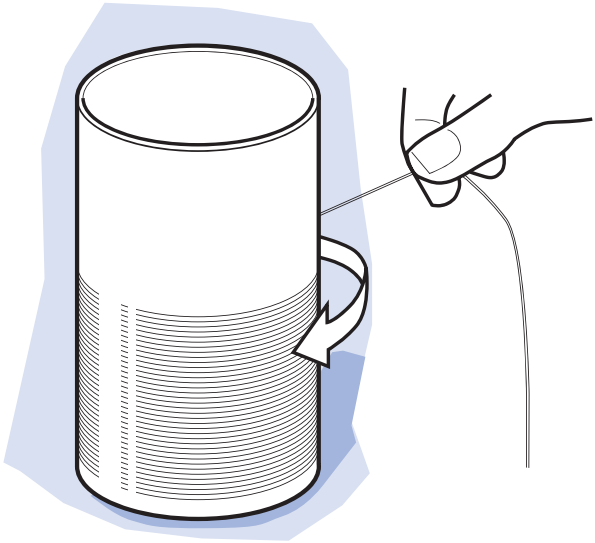
For a crystal set factsheet and more wiring layouts, go to open2.net

If you have some experience and want to build your own crystal radio, these are the parts you need



The coil

You need to wind about 60 turns of the 0.5mm enamelled wire onto a cardboard toilet roll holder. When you connect to this you may need to use between 20 and all 60 of these turns.



The aerial

You will need about 20m of aerial and good ground connection such as a water pipe.

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How does a Crystal Radio work?

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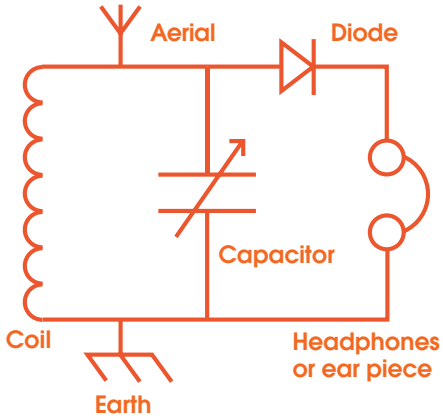
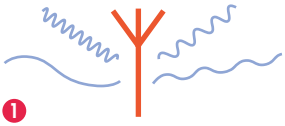
The left hand side of the circuit in the diagram consists of an aerial connected to a coil and a capacitor

What do the coil and capacitor do?



The aerial

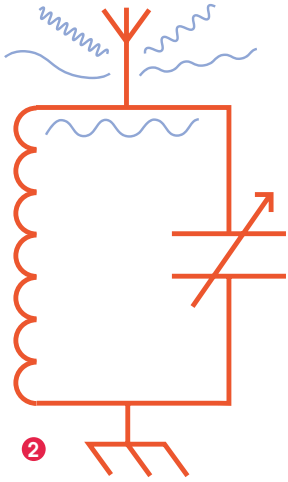
The aerial converts radio waves into an electrical current (see 1). The air around you is full of radio waves of different frequencies; these radio waves are absorbed by conductors (such as the aerial). When radio waves encounter a conductor they produce tiny currents. These currents vibrate at the same frequencies as the radio waves that are being absorbed.



1

The coil and capacitor

Connecting a coil and capacitor (see 2), produces an electrical circuit that will vibrate at a particular frequency. It's the electrical equivalent to a weight bobbing up and down (vibrating) on a spring. If I alter the weight or the strength of the spring, it will vibrate at a different frequency. Similarly by varying the capacitor or coil's value, I can vary the frequency at which the circuit vibrates; I can tune the circuit. Just like the weight on the spring, it will only vibrate continuously if it's driven at the right frequency. Connecting the aerial to this circuit enables me to isolate just one of the many radio frequencies absorbed by the aerial.

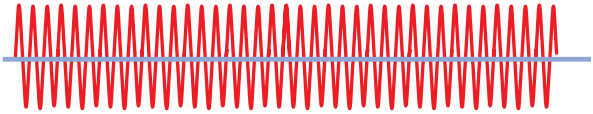


2

What are Radio waves?

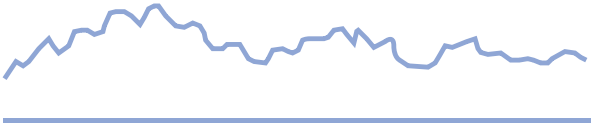
The radio waves your crystal set will tune to are made up of two parts. A high frequency vibration (called the carrier wave ❹); this is what your coil and capacitor tune in to. An audio signal (❺) which is the sound you actually hear. The audio signal is added to the carrier wave (❻). This is what the left hand side of your circuit delivers. Incidentally this type of radio wave is called an Amplitude Modulated (AM) wave because the music (or whatever) is carried in the variation of its amplitude (❻).

❹



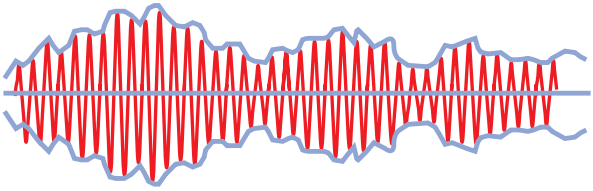
Carrier wave

❺



Audio signal

❻



The right hand side of the circuit consists of a diode and an ear piece (or headphones) and its purpose is to isolate the audio signal.

The diode

Diodes are simple electronic devices that allow current to flow in just one direction. Placing one at this point in the circuit ensures that only the positive part of the wave gets through. If the diode faced the other way only the negative part would get through.

The ear piece

The ear piece consists of a small diaphragm which vibrates in proportion to any current that passes through it. It's far to slow to respond to the carrier wave so it just responds to the slower variations in amplitude of the audio signal, which is exactly what we want.

Where's the battery?

There's no battery needed to power your crystal radio. It's powered entirely by the radio waves collected by the aerial.

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Rocket Experiments

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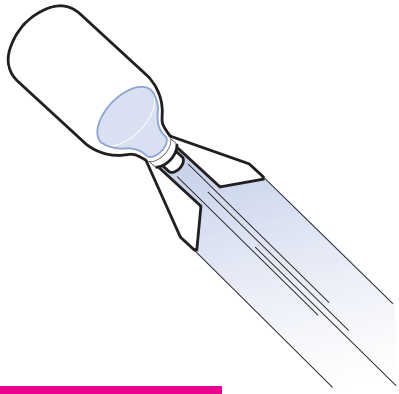
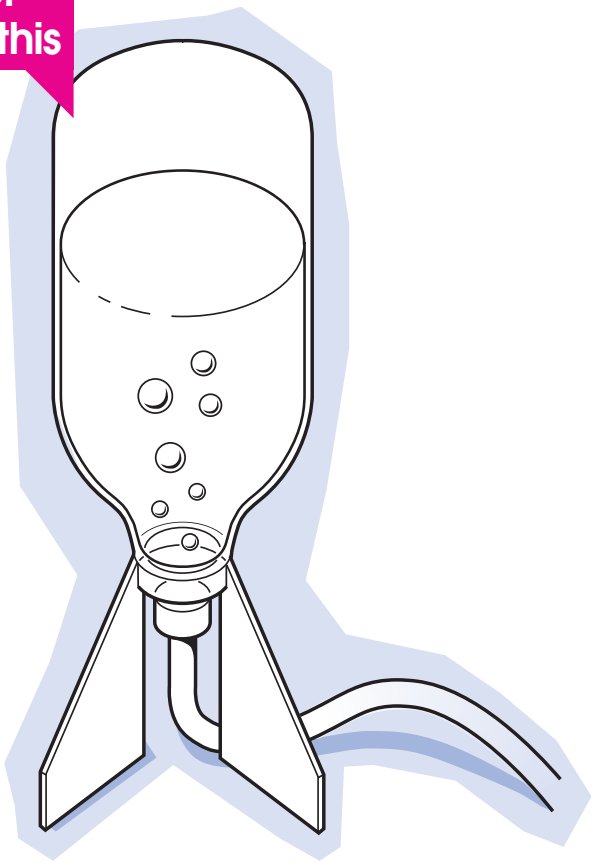
A typical water rocket looks something like this

It works by pushing water out at high speed in order to develop thrust.

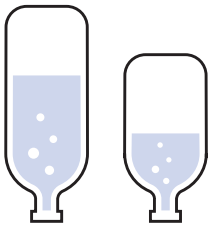




You can vary:

- the amount of water
- the size of the bottle

In theory you could vary the pressure too, but in this case that's fixed.



Know where to get a kit from?

www.maplin.co.uk
www.rokit.com
www.gadgetshop.com

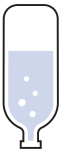
The kit will not include a footpump, you will need one for this experiment.

As James pointed out, rockets work even in the vacuum of space. Your water rocket flies in reaction to throwing out the water, not the water pushing against the atmosphere. The mass of water going in one direction is balanced by the rocket accelerating in the opposite direction. This is often stated as Newton's third law of motion: "To every action there is an equal and opposite reaction".

Q Why does the rocket go only a short distance if you put too little water in it?

A The water is heavy compared to the air. Pushing water out of the rocket rather than air provides a lot of thrust. The force on the rocket is proportional to the mass of the water being pushed out (as well as the pressure pushing it out). Once your rocket runs out of water the air continues to push out, but air is very light (it has a low mass) and so provides very little thrust. Try one with just air. Despite the pressure being the same there's almost no thrust.

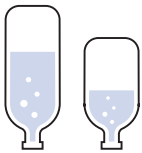
Q Put plenty of water in your rocket and it won't go very far either. Why?



A The rocket only has a little air in it and so runs out of compressed air long before it uses up all of its water. Also, your rocket is now heavy and requires much more thrust to accelerate it.

Ideally you want the pressure in your rocket to push out all of the water. So, for the best possible performance you need to carefully judge the water/air volume ratio. The best water/air ratio (to give maximum height) will depend on the pressure of release but it's around 3 to 1, air to water respectively.

You can also change the bottle size. The small bottle is lighter; it starts with less water, so the rocket accelerates much more quickly. A large bottle accelerates at a lower pace but the thrust lasts longer.



You can begin to see why the Saturn V rocket is so large. You have to lift the rocket plus all that fuel, in order to do that you need more thrust and that requires more fuel and that, in turn, requires even more thrust...

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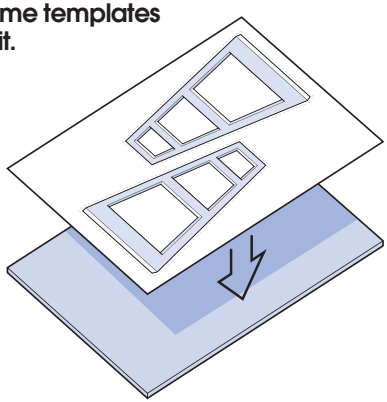
The Ames window

BBC

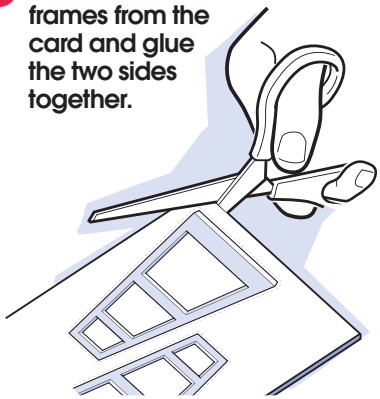
James introduces the idea of optical illusions being used to camouflage ships.

Here is an illusion for you to try...

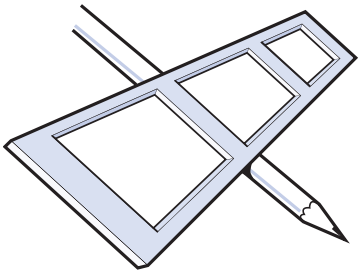
1. Find a thick piece card and glue the frame templates to it.



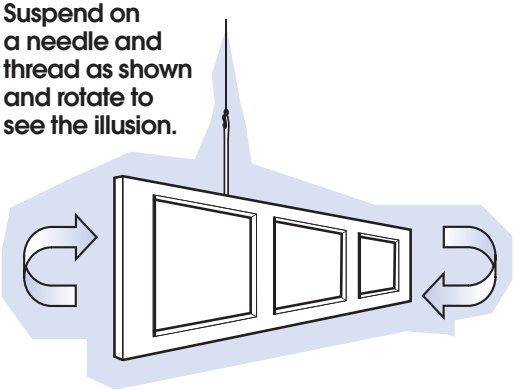
2. Cut out the frames from the card and glue the two sides together.



3. Find the centre of gravity by balancing the frame on a pencil. This will show you where to insert the pin.



4. Suspend on a needle and thread as shown and rotate to see the illusion.



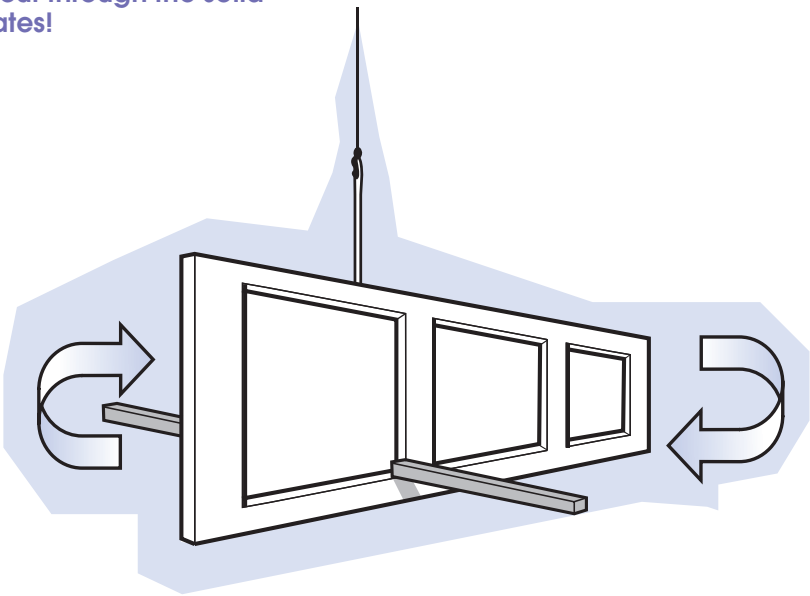
To look at more illusions, go to open2.net

The Ames trapezoid or Ames window is an illusion developed by the American scientist Adelbert Ames, Jr. Ames designed a number of demonstrations in visual perception showing that our perceptions do not always give us correct information about the physical stimulus.

What to do

You might have to work a little to see this illusion. Suspend your window using a needle and thread then allow it to rotate. After a while you'll see that rather than rotating all the way round it appears to oscillate back and forth. It may have to be held at some distance before you see the effect.

Once you see this illusion it's so powerful that you can place a stick across the window frame and it will appear to cut through the solid frame as it rotates!



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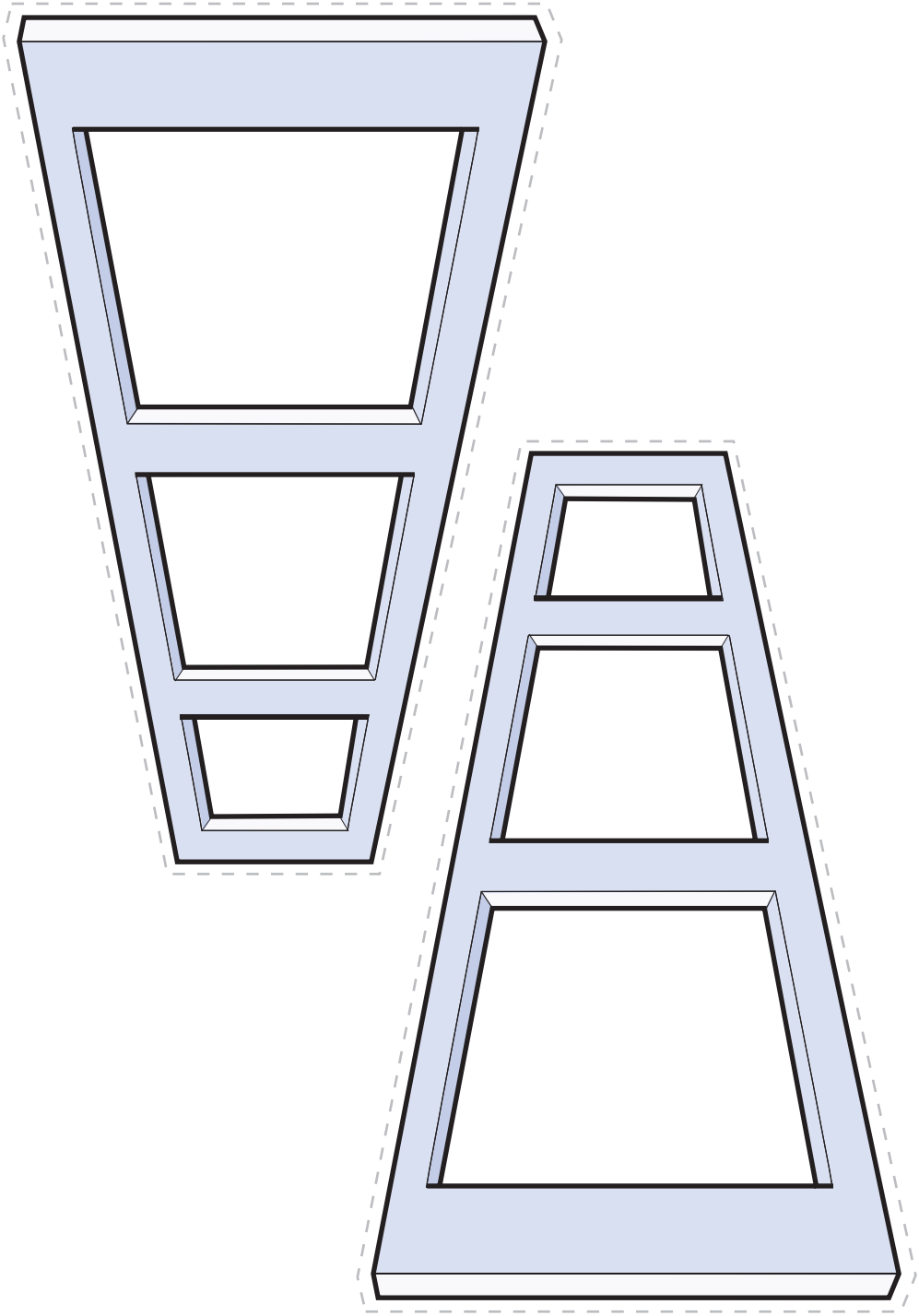

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Choose from courses in: technology, science, environment, information technology, humanities (such as the arts, history, geography, music), social sciences, business and management studies, law, mathematics, health and social care, languages.

Beginning to study

If you have no experience of higher education deciding to become an undergraduate student can be a big step. Our Openings programme of short introductory courses has been specially designed to give you the chance to test the water before committing yourself. Short courses, such as Robotics and the Meaning of Life, and Introducing Astronomy, are for people who may already have study experience, but who don't want to commit to a full undergraduate course straight away.

Robotics and the meaning of life: a practical guide to things that think (T184)

This online course will introduce you to robotics and the design of intelligent machines. It allows you to investigate the relationship between robots and humans.

Introducing astronomy (S194)

This course will develop your understanding of such topics as violent stellar explosions, distant galaxies and the 'big bang', with sections on planets, stars, galaxies, extraterrestrial life, and the origin of the Universe.

Other Open University courses on offer include:

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If you're interested in global health issues; how the body works; statistics; or the scientific rationale for common screening procedures and treatments, this course is for you.

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We live in a networked world. Information and communication technologies (ICT) are all around us - in homes, offices, shops, schools and hospitals.

This course looks inside these technologies, explores how they work in a range of situations (including entertainment, transport and health) and considers where they might take us next.

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Executive Producer for The OU: Mark Jacobs

Broadcast Project Leader: Sally Crompton

Broadcast Project Manager: Diane Morris

Graphic Designer: Lee Johnson

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