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| **Build a communication system for the moon** | | |
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| Learn about how electronic intercom circuits can help players communicate | | |
| **Subject(s):** Science, Design and Technology, Engineering  **Approx time:** 40-60 minutes |  | **Key words / Topics:**   * Sound waves * Circuit * Intercom * Resistor * Transistor * Capacitor * Loudspeaker |
| **Stay safe**  Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for:  • ensuring that any equipment used for this activity is in good working condition  • behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others  Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ | | |
| **Suggested Learning Outcomes** |  |  |
| * To understand how hearing works translating sound waves * To understand how sound waves can travel through string by vibration and wire by electrical signal * To be able to build an intercom circuit | | |
| **Introduction** |  |  |
| This resource uses the theme of football on the Moon to allow learners to develop their knowledge and skills in design & technology, mathematics and science. In this activity learners will use the theme of football on the Moon to learn about how electronic intercom circuits can help players communicate. | | |
| **Purpose of this activity**  Students will gain an understanding of how soundwaves travel and are received to allow them to be heard in the ear. Building on students pre-existing knowledge of circuits this activity focusses on how football players on the Moon could communicate to each other using electronics. Students then apply their skill to build an intercom circuit.  This activity could be used as a main lesson activity to teach about manufacturing electronic products and systems. It could also be used as part of wider scheme of learning focussed on developing electronic products. | | |
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| **Activity** |  | **Teacher notes** |
| **Introduction (5 minutes)**  Teacher to introduce the activity, learning to make a communication system to allow football players on the Moon to talk to each other. Teacher to explain how sound waves allow us to hear.  **Paper cup telephone (15-20 minutes)**  Teacher to explain and demonstrate how paper cup telephones allow sound waves to be transferred across string can carry the sound of a voice.  Learners, in pairs, make and test a paper cup telephone.  **Communications on the moon (5-10 minutes)**  Teacher to discuss the problems communicating on the Moon and why an electronic circuit is necessary.  Teacher to describe how an electronic intercom works by turning sound waves into electric signals and amplified through two loudspeakers.  **Intercom Circuit Demonstration (40-60 minutes)**  Teacher to discuss the intercom circuit diagram and how it works. Teacher to demonstrate the steps shown in the presentation to make the intercom circuit on a PCB.   * Step 1 - Solder the resistors R1 to R4 to the PCB * Step 2 - Solder the capacitors C1 to C3 the PCB. * Step 3 - Solder the transistors ZTX300 and ZTX500 to the PCB. Make sure they are the correct way round. * Step 4 - Solder flying leads to the loudspeakers LS1 and LS2. Then solder the leads into the correct polarity on the PCB. * Step 5 - Solder flying leads to the switch. Then solder the leads into the correct polarity on the PCB. * Step 6 - Solder flying leads to the 9V battery clip. Then solder the leads into the correct polarity on the PCB.   Learners to manufacture and test their intercom.  **Plenary (10-15 minutes)**  Students review each other’s work and discuss what went and what could be improved. Did the intercom circuit work? If not why not? |  | **Paper cup telephone**  Use sharp pencils and sticky tack to safely make the holes at the base of the paper cups.  **Intercom circuit**  Teacher to make PCBs prior to lesson using PCB making equipment. Alternatively, stripboard may be used to assemble the circuit.  **Intercom circuit notes**  *Operation*   * Weak electrical signals are produced when sound waves strike LS2. These signals must be amplified if they are to operate the second speaker LS1 and produce a sound output. * Transistor ZTX 300 in conjunction with R2, R3, and R4, is configured as an amplifier. * A signal is fed to the base of the transistor via C3.   Remember it takes 0.6V to switch on a transistor and if a tiny voltage in the region of mA was applied to the base, the transistor would immediately be switched off and no signal could pass through it.   * The capacitor known as a coupling capacitor (C3) is connected as shown. It allows the transistor to remain switched on and also pass the tiny speaker signal. Which is then amplified and appears as a larger signal at the collector of ZTX300. This signal is now fed via C2 to another transistor arrangement ZTX 500 in conjunction with R1, C1, SPEAKER, and LS1.This is known as a power amplifier, which is required to drive the speaker.  *Note*  This is a different type of transistor from say the conventional BC1O8. It is a PnP transistor, and as such connection arrangement is different. The output (this time at the emitter) is fed via the capacitor C1 to the output Speaker LS1.  **Stripboard**  Stripboard could be used as an alternative to a PCB. See teacher presentation slides 16 to 18. |
| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| * Place components onto the PCB/stripboard prior to soldering * Use helping hands to hold PCB/stripboard in place |  | * Learners to research what methods could be used to make the intercom wireless. |
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Paper cups and string * Sharp pencils and sticky tack * Electronic components (see PPt list on slide 7) * Soldering irons and stands * Helping hands * Wire strippers and cutters * Lead free solder * PCB making kit * Tracing paper to print PCB mask * Stripboard (see PPt slides 16-18) * Stripboard track cutters |  | Presentation – Build a communication system for the moon  Intercom Circuit PCB Artwork.bmp |
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| **Additional websites** | | | |
| * **YouTube – Science with Grammarsaurus: How does sound travel:**  https://www.youtube.com/watch?v=jx93Xr9vkck * **YouTube – Journey of sound to the brain:** https://www.youtube.com/watch?v=eQEaiZ2j9oc | | | |
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| **Related activities (to build a full lesson)** |  | |  |
| **Starters** (Options)   * Discuss how soundwaves travel and allow us to hear. Watch video **YouTube – Science with Grammarsaurus: How does sound travel:**  https://www.youtube.com/watch?v=jx93Xr9vkck * Discuss the problems of communicating on the Moon | | **Extension** (Options)   * Learners to research what methods could be used to make the intercom wireless.   **Plenary**   * Students review each other’s work and discuss what went and what could be improved. Did the intercom circuit work? If not why not? | |
| **The Engineering Context** | | | |
| * Engineers create and develop communication systems for numerous activities that take place in very different environments. For example, deep sea divers need to communicate underwater and armed forces have to communicate in all weather conditions. | | | |

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| **Curriculum links** | |
| **England: National Curriculum**  Design and Technology  KS3  Make   * select from and use specialist tools, techniques, processes, equipment and machinery precisely, including computer-aided manufacture   Technical knowledge   * understand how more advanced electrical and electronic systems can be powered and used in their products [for example, circuits with heat, light, sound and movement as inputs and outputs] | **Northern Ireland Curriculum**  Science  KS3  Developing pupils’ Knowledge, Understanding and Skills   * develop a range of practical skills, including the safe use of science equipment.   Learn about   * Forces and energy - Sound and light |
| **Scotland: Curriculum for Excellence**  Science  SCN 4-09c   * Applies knowledge and understanding of the properties of switching devices, for example, transistors and logic gates, to design and construct an electronic circuit which solves a practical problem. | **Wales: National Curriculum**  Science   * KS3 Range (Developing 1) * KS3 Range (How things work 3)   Design and Technology   * KS3 Range (Systems and control 16, 18) * KS3 Skills (Making 1, 2) |

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| **Assessment opportunities** |
| * Informal teacher assessment of soldering skills demonstrated. * Self/peer assessment of completed circuit. |