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| **Activity title** |
| **Make a playdough electrical circuit** |
| **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:⚠ |
| **Time required** |
| 30 minutes to 1 hour |
| **Activity summary** |
| You might think it’s going to be complicated, but doughnut worry 😊 because the instructions below will guide you through your own electric dough experiment at home.  We’re going to explain exactly what you need to make and test an electric dough circuit. Start off by making sure you’ve got all the things on the list. Once you’ve checked that out, you’re good to go!  In this activity you will be able to develop your practical skills, by measuring out ingredients, mixing them together and kneading the dough. You will also learn about electricity, including ionic and covalent bonds, as well as closed circuits. |
| **What equipment will you need?** |
| * DC power supply (4 x AA in a battery pack) * Light emitting diode (LED) – any colour * Cooker * Saucepan.   **For the green dough (insulator dough):**   * 225g plain flour * 115g sugar * 45ml vegetable oil * 120ml distilled water (available from chemists and in supermarkets) * 2 drops of green food colouring.   **For the red dough (conductive dough):**   * 225g plain flour * 45g salt * 15ml vegetable oil * 240ml cold tap water * 45ml cream of tartar * 2 drops of red food colouring |
| **How to do it** |
| **Step 1 – Make the green dough**   * Mix all the ingredients together in a bowl * If you feel the mixture isn’t green enough, add some more colouring   **Step 2 – Prepare to knead…**   * Sprinkle a light dusting of flour onto your work surface * Tip your dough out of the bowl onto the floured surface * Sprinkle a little flour on top of the dough, to make it less sticky * Add a little to your hands, too.   **Step 3 – Knead the green dough**   * Start kneading the dough – here’s how to do it:  1. Fold the dough in half towards you 2. Use the ‘heels’ of your hands to push the dough away from you 3. Turn the dough round by 90 degrees 4. Keep repeating steps 1 to 3 until the dough is soft and stretchy   **Step 4 – Make the red dough**   * Put all the ingredients for the red dough in a saucepan * ⚠Ask an adult to help you with the next few processes * Put the pan on the hob on a medium heat * Stir the ingredients gently until the mixture thickens   **Step 5 – Leave the dough to cool**   * ⚠Ask an adult to help you with these processes * Turn off the hob * Sprinkle flour onto your work surface * Tip the red dough out of the pan onto your floured surface * Leave it to cool * Knead the red dough   **Step 6 – Make a dough ‘hamburger’**   * Take a handful of green dough and make a ball * Repeat this twice with the red dough * Now use the dough to form a ‘hamburger’ shape (a green ‘burger’ between two halves of a red ‘bun’) – don’t eat it though!   **Step 7 – Make a circuit**   * ⚠Ask an adult to help you with these processes * Insert the terminal wires from your battery pack into the two red layers (as shown in the diagram) * Insert the longer leg of your LED into the same red layer as the positive terminal (red wire) of the battery pack * Insert the shorter LED leg into the other red layer   **Step 8 – Experiment!**   * Does the bulb light up? * Try moving the wires to different parts of the hamburger – does the light still work? * Which dough is the insulator and which is the conductor? |
| **Here’s the science bit** |
| **Conductors and insulators**  Good **conductors** allow electrical current to flow freely through them. That’s because they contain positively or negatively charged particles (‘**ions**’) that are able to move freely.  **Insulators** don’t allow electrical current to move freely through them. That’s because they have no charged particles or their ions are held in fixed positions and can’t move.  Sometimes a substance can be a conductor in one form but an insulator in another – salt is a great example of this.  **Bonds in molecules**  Solid salt (sodium chloride) is what you might like to sprinkle on your chips. It has ions that are held in a fixed position because of the **ionic bonding** between its two components, sodium and chlorine. Solid salt **doesn’t** conduct electricity.  When salt is dissolved in water, the ionic bonds break down. The molecules of salt separate into sodium ions (which are positively charged) and chloride ions (which are negatively charged). These ions move freely as the water molecules mix between them to prevent them forming ionic bonds again. Salt water **does** conduct electricity.  Sugar is very different. It has a far more complex chemical structure than salt. It’s made up of carbon, hydrogen and oxygen atoms that are all held together by strong **covalent bonds**. These bonds don’t break down easily, even when sugar is dissolved in water – the sugar molecules stay together and just mix in with the water molecules.  **Other substances**  When cream of tartar is added to water it breaks down and releases potassium ions, which are free-moving. So when we mix together the ingredients to make our red (conductive) dough, the sodium, chlorine and potassium ions in the dough allow the electricity to flow through it.  In our green (insulating) dough, the flour and sugar don’t break down to release ions, so electricity can’t pass freely through it.  We use distilled water because it’s very pure. Tap water often contains other elements that may conduct electricity, which would affect our dough.  **Insulators**  Did you know that electricity is lazy? Well it is!  If we don’t pass our circuit through the LED, the electricity will take the easier route through the conductive dough. The electricity will still be flowing but we won’t be able to see anything happening because it’s not going through the LED. We call this a short circuit. If we leave the circuit connected, the batteries will get very hot and eventually use up all their stored energy.  By inserting the layer of insulating dough in between the two conductive layers, we force the electricity to go round in a loop, passing through the LED. This is known as a **closed circuit**.  Do some investigative work by testing the effectiveness of other potential insulators.  We hope you enjoyed your electric dough experiment and learned a lot in the process. |
| **Three Christmas kisses and a wish** |
| It’s always great to reflect on a job well done. Demonstrate your electric dough experiment to a friend or family member and ask them to tell you three good things about it, and one thing that could be improved.  You could then use their feedback on your design to design another dough experiment that’s even better than the first.  Practice makes perfect… |
| **Festive fun** |
| After all that hard work, here are some dough jokes to make you smile:   * **Why do people sometimes refer to money as ‘dough’?**   Because everybody kneads it   * **What do bakers say when they make a mistake?**   Dough!   * **What’s the most popular sport for bakers?**   Taekwondough |
| **Did you know?** |
| * Breadcrumbs found during an archaeological excavation in Jordan are thought to be more than 14,000 years old! They were left by the Natufians, a hunter-gatherer tribe that lived in the area during the Epipaleolithic era, which was between the Paleolithic and Neolithic eras. * We know that in 2000 BC the Ancient Egyptians made fermented bread because an archaeologist found a 4,000-year-old triangular loaf under the foundations of a temple! The Ancient Egyptians produced around 50 varieties of bread and even used it to pay wages. Maybe that’s why some people still call money ‘dough’? * It’s steam that creates the pitta bread ‘pocket’. The steam makes the dough puff up. When the bread flattens and cools, it leaves a pocket in the middle. |
| **Number fun** |
| A baker makes a big ball of dough. He divides it into quarters and rolls each one into a small ball. He then divides each ball into quarters and rolls them into tiny balls.  How many balls of dough does he end up with? |
| The baker’s new assistant has made three different-coloured doughs: red, green and blue. He has divided each into a batch of 20 little dough balls. But he has a problem. The price of the dough balls depends on the colour, but he can’t remember how he worked it out. Can you help him to set the right price for each colour?  Red + Red + Red = 36p  Red + Green + Green = 28p  Green - Blue = 3p  *Answers:*  *Q1: 16 dough balls left*  *Q2: Red = 12p, Green = 8p, Blue = 5p* |