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| **4. What affects current? LESSON PLAN**  **—** | | |
| **PROJECT ACTIVITY**  **1.** Please [click here to read p20](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=20) from the 3. Modelling section of the EEF Improving Secondary Science Guidance Report  **2.** Please follow this [Link](https://docs.google.com/forms/d/e/1FAIpQLSdps-Z4ndpP_VczMUhIlwrsueBlVyqujBQ9WbRzoTlQemnacg/viewform?pli=1) to answer the questions below.  **a.** (Multiple choice) How familiar were you already with the Focus Action Reflection (FAR) approach?  **b.** (Optional) Please share any examples/ideas that you have for ensuring that your pupils are familiar with the underlying idea that an intended model is based on (NB these ideas do not have to be for Yr7/8 electric circuits). | | |
| **LESSON SUMMARY**  This lesson introduces the concepts of potential difference and resistance qualitatively, by analogy to the rope model seen in lesson 1. | | The intuition of PD as a pushand resistance as an opposition to the push will be developed quantitatively in subsequent lessons. |
| **OBJECTIVES** | **1.**  Understand current is affected by potential difference and resistance  **2.**  Understand the difference between current and potential difference | |
| **EQUIPMENT LIST** | **•**  DEMO: 4m length of rope, tied in a loop | |
| **RESOURCES** | **•**  PowerPoint presentation  **•**  Worksheet | |

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| **TIMETABLE & DESCRIPTION OF ACTIVITIES** | | |
| TIME  ACTIVITY  RESOURCES | DESCRIPTION | RESEARCH |
| 00:00 – 00:10  Starter  PowerPoint | **Slide 6:**  What is electric current?  Sketch a circuit diagram of this drawing. How could we measure the current? | 4c. Memory: Provide opportunities for pupils to retrieve knowledge they previously learnt [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=26) |
| 00:10 – 00:35  Understand current is affected by potential difference and resistance  PowerPoint  Worksheet  Demo   * Rope loop | **Slide 9:** Rope model redux  Current is represented by how fast the rope is moving. This can be changed in two ways: **how hard the teacher is pushing the rope** (be careful not to say how fast!) and **how hard the pupil grip is**.  Set up the rope loop demonstration as in lesson 1.   1. **Increase PD 🡪 current increases.**   **Teacher pushes harder 🡪 rope flows faster**  (NB take care to refer to the push as ‘harder’ and **not** ‘faster’ (see misconception).  Highlight that the teacher is transferring more energy to push the rope harder, and the student would feel their hand getting warmer due to increased friction. This is analogous to increased energy transfer at a bulb (greater heating up and glowing) when current increases. How would we see this in a real circuit with a bulb? **Bulb would get brighter (because energy is given out as light).**   1. **Increase resistance 🡪 current decreases**.   **Introduce a second student ‘bulb’ gripping the rope 🡪 rope flows slower.**  The teacher is pushing the same as before (hard to control, but say you are pushing the same).  Draw pupils’ attention to the fact that the flow decreases everywhere in the circuit all at once (current is still the same everywhere in the circuit).  Mention that the energy put into the circuit by the teacher is instantly ‘shared’ between the two students (each student’s hand experiences less friction and gets less warm than it would if their hand were the only one in the circuit because the rope is passing through it more slowly). How would we see this in a real circuit with bulbs? **Bulbs would get dimmer.**  **Slide 10:** Students copy boxed sentences in books introducing terminology **resistance** and **potential difference**.  “The current in a circuit is **determined** by a balance between the push of the battery, and the resistance of the rest of the components – just as with the rope loop the speed of the rope is set by balancing between the teacher’s push and the students’ grip.  In a circuit, the **push** is called the **potential difference of the source.** It is measured in volts.  The opposition is called **the resistance**. It is measured in Ohms.”  **Slide 11:** Students complete table on worksheet (**Task 1**) drawing parallels between rope model and real circuit.  Students should copy this into their books and fill it in as you explain it.  How could we tell, in a real circuit, that the current was changing? We would see the **brightness of the bulb** change.  **If the current through a bulb increases, the bulb gets brighter.**  **If the current through a bulb decreases, the bulb gets dimmer**  **Slides 12-14:** Students have 15s thinking time on each slide to choose which bulb is brighter (see slides for details).  **Task 2:** Worksheet asking students to predict what will happen if extra components are added to a circuit. Solutions and misconceptions given on **slides 16-20**. | 1b. Preconceptions: Develop pupils’ thinking through cognitive conflict and discussion – students are likely to express or conceive the powering of the rope in terms of how fast it is being pulled, rather than how hard (see ‘same current’ misconception below)**.** [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=12)  3a. Modelling: Use models to help pupils develop a deeper understanding of scientific concepts – models help pupils to link observations to the sub-microscopic and symbolic levels and to build a richer understanding**.** [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=19)  Misconceptions research on IOP Spark: Many pupils think that a battery supplies the same current, regardless of the circuit in which it is used. [Link](https://spark.iop.org/many-pupils-think-battery-supplies-same-current-regardless-circuit-which-it-used)  Misconceptions research on IOP Spark: Few pupils use the Voltage-Resistance-Current (VRI) model of a series circuit. [Link](https://spark.iop.org/few-pupils-use-voltage-resistance-current-vri-model-series-circuit)  Misconceptions research on IOP Spark: Many pupils see circuit behaviour as a sequence of causes and effects, rather than seeing the whole circuit as an interacting system. [Link](https://spark.iop.org/many-pupils-see-circuit-behaviour-sequence-causes-and-effects-rather-seeing-whole-circuit)  4a. Memory: Pay attention to cognitive load – structure tasks to limit the amount of new information pupils need to process – an intuitive understanding of resistance and PD is developed prior to learning quantitative definitions. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=25) |
| 00:35 – 00:50  Current and potential difference  PowerPoint  Worksheet | Explicit discussion of misconception: ‘Many students do not understand the difference between current and potential difference. (What *is* the difference between them in the rope model? A: How fast vs. how hard).’  Who can explain the difference between current, and potential difference?  In a circuit, a battery provides a push. This causes a current to flow.  The battery does not produce current! It just pushes it around, the same way I did not produce the rope – I just pushed it around.  The size of the current depends on the size of the push, but also on the resistance of the rest of the circuit – so even if a battery has a fixed **potential difference**, we have no way of predicting the size of the current without knowing the **rest of the circuit**.  [NB rope analogy falls down somewhat after this point, as if it really did behave in the same way as a circuit then if resistance were 0 the rope would move around infinitely fast. You can just say that the speed of the rope is determined BOTH by how hard you push AND how hard the student gripping the rope ‘resists’]  **Task 3:** Worksheet. Questions adapted from Best Evidence Science Teaching diagnostic resources ([www.BestEvidenceScienceTeaching.org](http://www.bestevidencescienceteaching.org/)).  Last 5 minutes to be spent demonstrating answers (provided on slides). | 1c. Preconceptions: Allow enough time to challenge misconceptions and change thinking – by explicitly pointing out the misconception students are more likely to become aware of whether they hold it. This misconception is further discussed in later lessons. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=13)  2c. Self-regulation: Promote metacognitive talk and dialogue in the classroom – It is helpful to discuss wrong ideas and why they’re wrong, as well as why the right idea is right and this helps pupils to examine their preconceptions. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=16)  2b. Self-regulation: Model your own thinking to help pupils develop their metacognitive and cognitive knowledge – Model an explanation of what happens in a circuit, making the distinction and relationship between PD and current explicit [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=16)  Misconceptions research on IOP Spark: Few pupils can clearly distinguish the ideas of electric current and potential difference. [Link](https://spark.iop.org/few-pupils-can-clearly-distinguish-ideas-electric-current-and-potential-difference) |
| 00:50 – 01:00  Plenary  PowerPoint | **Slide 26: Questions**  Which is brightest? activity, adapted from BEST resources.  **See slide notes for question, answers and misconceptions.**  Responses from students should be verbal or with hands up as described in slide notes – if any students express the identified misconceptions these should be explicitly discussed. | 7a. Feedback: Find out what your pupils understand - It is important that you build up an accurate picture of the current understanding of all your pupils [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=38)  4d. Memory: Encourage pupils to elaborate on what they have learnt – Elaborative interrogation involves prompting pupils to  generate an explanation for an idea that they have learnt. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=27)  1c. Preconceptions: Allow enough time to challenge misconceptions and change thinking [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=13) |