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| **5. Potential difference and energy LESSON PLAN**  **—** | | |
| **PROJECT ACTIVITY**  **1.** Please [click here to read p34](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=34) from the 6. Language of Science section of the EEF Improving Secondary Science Guidance Report  **2.** Please follow this [Link](https://docs.google.com/forms/d/e/1FAIpQLSev3pgjp5nTDRPgPF1e0OvEuCC-2bzdm9gOhx6-UnfxRCM24g/viewform?pli=1) to answer the questions below.  **a.** (Multiple choice) How often have you previously shown pupils the links between words and their composite parts in your lessons?  **b.** (Optional) Can you think of any examples of vocab in the module after this one with which you could do this? Or vocab in a module you are doing with another year group? | | |
| **LESSON SUMMARY**  This lesson formalises the idea of potential difference to its quantitative definition (work done per unit charge), allowing students to see that a battery stores energy. | | We also see that energy is transferred in any component with resistance and relate this energy transfer to PD, investigating the use of a voltmeter to measure this. |
| **OBJECTIVES** | **1.**  Understand potential difference  **2.**  Measure potential difference | |
| **EQUIPMENT LIST** | **•** DEMO: Rope loop (ideally speckled)  **•**  PRACTICAL TASK: Each group to receive 1 cell, 5 wires, 2 bulbs and 1 voltmeter. Ideally students will work in pairs, but groups could be up to 4 students.  **•**  Teacher should have one set of practical equipment for demonstration. | |
| **RESOURCES** | **•**  PowerPoint presentation  **•**  Worksheet | |
| **DIFFERENTIATION/**  **ADAPTATIONS** | **•**  Practical activity can be done virtually using PhET | |

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| **TIMETABLE & DESCRIPTION OF ACTIVITIES** | | |
| TIME  ACTIVITY  RESOURCES | DESCRIPTION | RESEARCH |
| 00:00 – 00:10  Starter  PowerPoint | **Slide 6:**  Interleaved questions | 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 – 00:30  Understand potential difference  Equipment for DEMO: rope loop (ideally speckled)  PowerPoint  Worksheet | **Think-pair-share:** why is this student wrong?  Electrons do not come out of the battery – this is a common misconception – they are already in the circuit (just as rope does not come out of the teacher!)  So what causes current to flow? The battery stores energy, and this energy is transferred to the circuit, and then to the components.  **Slide 10:** Rope loop part 3.  Modelling an intuitive understanding of potential difference with questioning (see slide notes for script), including revision of concepts from previous lesson.  **Slide 11:** Explain that what is stored in a battery is *energy,* not charge.  Potential difference is the potential energy per unit charge - in terms of the rope, that means the amount of energy transferred per length of rope. The potential difference is the amount of energy transfer that takes place as a section of rope moves from one point in the circuit to another– so to measure it we need to sample two points.  For this reason, voltmeters must be connected **across** a component.  **Slide 12:** Explain and show a voltmeter. Students copy down definition and symbol.  **Task 1:** Students complete task 1 on worksheet, then swap work, peer-mark and feed back to each other.  Once students have marked and fed back to each other teacher could assess using hands-up: “Who got everything right? Who wasn’t sure how to explain why ammeter and voltmeter are connected as they are?” etc. | Misconceptions research on IOP Spark: Many students think that electric current or electric charge (or ‘electricity’), rather than energy, is stored in a battery. [Link](https://spark.iop.org/many-students-think-electric-current-or-electric-charge-or-electricity-rather-energy-stored-battery)  6a. Language of science: Carefully select the vocabulary to teach and focus on the most tricky words – be careful to consistently refer to potential difference rather than voltage. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=33)  Misconceptions research on IOP Spark: Few pupils can say in words what the physical quantity measured by a voltmeter is. [Link](https://spark.iop.org/few-pupils-can-say-words-what-physical-quantity-measured-voltmeter)  6b. Language of science: Show the links between words and their composite parts – potential referring to capacity to transfer energy, difference reminding us that it compares two points. Also, volt-meter meaning measurer of volts [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=34)  EEF Teaching and Learning Toolkit, Peer Tutoring strand: The introduction of peer tutoring approaches appears to have a positive impact on learning. [Link](https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/peer-tutoring/) |
| 00:30 – 00:55  Measure potential difference  Practical equipment:   * PhET- DEMO * 1 cell * 5 wires * 2 bulbs (ideally but not necessarily different) * 1 voltmeter   per group  PowerPoint  Worksheet | **Practical:** Build a circuit containing a battery and 2 bulbs and measure the potential difference across each component. Students to explain, in terms of energy, why the potential difference of the battery is shared across the two bulbs.  The practical should be demonstrated before being performed by students. PhET is an excellent way to do this – https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc-virtual-lab  Students should be given 10 minutes to do the practical. Then they should be given 5 minutes to tidy up equipment.  **Explain** the findings of the experiment in terms of energy.  While students are answering the questions the teacher should circulate the room and monitor student responses, giving verbal feedback where appropriate (see slides for expected answers). | 5b. Practical work: Sequence practical activities with other learning – For practical activities that aim to improve understanding of scientific theory, you may have to help pupils to make links between the practical activity and the underlying scientific ideas. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=29)  5c. Practical work: Use a variety of approaches to practical science – Virtual experiments should not replace the real thing (in ordinary times), but they can support it. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=31)  4d. Memory: Encourage pupils to elaborate on what they have learnt – Students should see that potential difference of bulbs equals potential difference of battery. Using the definition of potential difference they can explain this in terms of conservation of energy, linking to previous learning**.** [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=27)  7c. Feedback: Provide feedback and comments rather than marks – While you are looking at pupils’ work, try to find common mistakes which lots of pupils make,  then feed back on these to the whole class. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=40) |
| 00:50 – 01:00  Plenary  PowerPoint or Exit Ticket (at the bottom of the worksheet) | Students give a thumbs up-thumbs sideways-thumbs down evaluation of several statements. Correct answers given in slide notes.  This activity can also be given as an exit ticket, included on the worksheet.  This activity allows the teacher to gauge to what extent common misconceptions around potential difference are still held by the class. | 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)  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) |