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| **6. Resistance  LESSON PLAN**  **—** | | | | |
| **PROJECT ACTIVITY**  **1.** Please [click here to read p25](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=25) from the 4. Memory section of the EEF Improving Secondary Science Guidance Report  **2.** Please follow this [Link](https://docs.google.com/forms/d/e/1FAIpQLSdMykooQXcJ3Ax6P7RJkyjCky08VZL_gYiC20ONSuNLEzdRKw/viewform?pli=1) to answer the questions below.  **a.** (Multiple choice) How often you say you consciously think about cognitive load when planning your lessons?  **b.** (Optional) Please share any specific examples/ideas that you have for minimising cognitive load in a physics lesson (NB these ideas do not have to be for Yr7/8 electric circuits). | | | | |
| **LESSON SUMMARY**  The core of this lesson is a practical investigation to calculate the (unknown) resistance of a component – this gives students an opportunity to apply the | | | knowledge and skills developed in previous lessons, as well as requiring scientific numeracy (to calculate and compare resistance values using Ohm’s law). | |
| **OBJECTIVES** | | **1.**  Know resistance is the ratio between PD and current  **2.**  Calculate resistance | | |
| **EQUIPMENT LIST** | | **•**  PRACTICAL TASK: Each group to receive 1 cell, 5 wires, 1 ammeter, 1 voltmeter and a range of objects to calculate the resistance of (bulb, unmarked resistor, metal key, pencil lead [mechanical pencil refill]). Ideally students will work in pairs, but groups could be up to 4 students. | | |
| **RESOURCES** | | **•**  PowerPoint presentation  **•**  Worksheet | | |
| **DIFFERENTIATION/**  **ADAPTATIONS** | | **•**  Higher attaining classes – show rearrangement of current = PD/resistance to resistance = PD/current (or challenge them to do it themselves) – slide 10  **•**  Higher attaining classes – why conductors conduct and insulators insulate (slide 11)  **•**  Practical activity can be done virtually using PhET | | |
| **TIMETABLE & DESCRIPTION OF ACTIVITIES** | | | | | | |
| TIME  ACTIVITY  RESOURCES | | DESCRIPTION | | | RESEARCH | |
| 00:00 – 00:10  Starter  PowerPoint | | **Slide 6:**  Interleaved questions TBC | | | 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 – 00:15  What is resistance?  PowerPoint | | **Slide 10:** Explanation of resistance. Analogy to how hard rope from lesson 1 is being gripped: even with the same push, current is reduced (i.e. current is not inherent to battery, but is determined by the resistance the battery is connected to).  Resistance equation is introduced and students are invited to apply it to two sample problems – the solutions are then demonstrated, step-by-step, on the board.  **Slide 11:** Resistance changes from material to material.  **Slide 12:** Quick quiz (AfL) – answers given on slide notes. | | | 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 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)  2b. Self-regulation: Model your own thinking to help pupils develop their metacognitive and cognitive knowledge – demonstrate numeracy explicitly, step-by-step to help students build up a systematic approach to dealing with equations in physics. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=16)  4a. Memory: Pay attention to cognitive load – structure tasks to limit the amount of new information pupils need to process. – Use worked examples or partially solved examples that take pupils through each step of a process**.** [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=25)  4b. Memory: Revisit knowledge after a gap to help pupils retain it in their long-term memory. In this case, the ‘forgetting gap’ (for knowledge about conductors and insulators) is from KS2 to now. [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=26) | |
| 00:15 – 00:55  How can we calculate resistance?  Practical equipment:   * 1 cell * 5 wires * 1 bulb * 1 resistor * 1 insulator * 1 conductor * 1 ammeter * 1 voltmeter * 1 metal key * 1 pencil lead * Students’ pencil case and contents   per group  PowerPoint  Worksheet | | **Practical:** Students plan an experiment to calculate the resistance of a variety of objects.  This brings together learning from this lesson and previous lessons, including:   * Interpreting a circuit diagram and building a circuit * Connecting ammeters and voltmeters correctly * Making and justifying predictions of resistance of different materials   Students follow up the experiment by answering questions on the worksheet.  Students who finish early can move on to the extension task, or be assigned a role helping other groups who are struggling (at teacher’s discretion).  In the last 5-10 minutes of this activity students should pack away experimental equipment, then the follow-up questions should be answered in a whole-class discussion. Answers are given in the notes under slide 12.  Make sure ground rules for discussion are well-established. | | | 2a. Self-regulation: Explicitly teach pupils how to plan, monitor, and evaluate their learning – Planning the experiment is broken down to a step-by-step procedure that allows students to link their learning to reach a desired outcome**.** [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=15)  4b. Memory: Revisit knowledge after a gap to help pupils retain it in their long-term memory [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=26)  4d. Memory: Encourage pupils to elaborate on what they have learnt – This approach supports learning by integrating new information with existing prior knowledge, helping to embed it in the long-term memory**.** [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– there are opportunities to do this both while students are carrying out the practical, and during the discussion**.** [Link](https://educationendowmentfoundation.org.uk/public/files/Publications/Science/EEF_improving_secondary_science.pdf#page=40) | |
| 00:55 – 01:00  Plenary  PowerPoint | | **Slide 18:** A student is trying to find the resistance of a pencil, but the results make no sense. What have they done wrong? (see slide notes for answers). | | | EEF Teaching and Learning Toolkit, Feedback strand: When giving feedback, compare what a learner is doing right now with what they have done wrong before. [Link](https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/feedback/) | |