




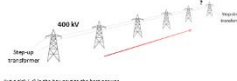
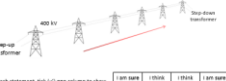




Progression toolkit: Transmitting Electricity

Learning focus	Transmission lines dissipate less power when they transfer power with a higher transmission voltage and lower current. When current is lower there is a smaller drop in voltage along their length.				
As students' conceptual understanding progresses they can:					
As students' conceptual understanding progresses they can:	Describe the heating effect of current on a conducting wire. P	Predict changes to current through transmission lines using $P = I \times V$.	Calculate power dissipated by a wire using $P = I^2 \times R$.	Explain the difference between transmission voltage and voltage drop along a wire.	Explain how the equation $P = V^2/R$ applies to transmission lines. B
Diagnostic questions	Hot line	Transmission current	Power dissipation	The right voltage	The right power
Response activities	Transmission lines		Talking volts		

Key:

- P** Prior understanding from earlier stages of learning **B** Bridge to later stages of learning

<p>Hot line</p> <p>BEST STUDENT WORKSHEET</p> <p>Hot line</p> <p>A big current flows through power lines. The bigger the current, the hotter the wires. When the wires are hotter, they dissipate more power.</p>  <p>Why does a bigger current heat up the power lines?</p> <p>For each statement, tick (✓) one column to show what you think.</p> <table border="1"> <thead> <tr> <th></th> <th>100% sure it's right</th> <th>75% sure it's right</th> <th>50% sure it's right</th> <th>25% sure it's right</th> <th>I am sure it's wrong</th> </tr> </thead> <tbody> <tr> <td>A. Electrons are causing friction lines to vibrate more so they heat up.</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B. Electrons are moving through the wires more quickly.</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>C. 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A power transformer raises the transmission voltage to 400 000 V.</p> <p>What happens to current when transmission voltage is increased?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A. Current decreases. <input type="checkbox"/></p> <p>B. Current stays the same. <input type="checkbox"/></p> <p>C. Current increases. <input type="checkbox"/></p> <p><small>Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. The document is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike license. www.bestevidencescienceteaching.org</small></p>	<p>Power dissipation</p> <p>BEST STUDENT WORKSHEET</p> <p>Power dissipation</p> <p>The power an electrical device has is calculated using $P = IV$. The resistance of the device is calculated using $R = \frac{V}{I}$.</p> <p>Rearranging the resistance equation: $V = IR$ Substituting this into the power equation: $P = IA(IR)$ When given: $P = I^2R$</p> <p>V is the voltage across the device. I is the current through the device. R is the resistance of the device. P is the power of the device.</p> <p>A transmission line has a resistance and is heated by current. It is warmer than its surroundings and dissipates power.</p> <p>1. What happens to the amount of power dissipated if the current through a transmission line is tripled?</p>  <p>$P = I^2R$</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A. Three times more power is dissipated. <input type="checkbox"/></p> <p>B. Six times more power is dissipated. <input type="checkbox"/></p> <p>C. Nine times more power is dissipated. <input type="checkbox"/></p> <p><small>Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. The document is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike license. www.bestevidencescienceteaching.org</small></p>	<p>The right voltage</p> <p>BEST STUDENT WORKSHEET</p> <p>The right voltage</p> <p>The transmission voltage at the start of these power lines is 400 kV.</p>  <p>400 kV = 400 000 V</p> <p>What is the transmission voltage at the end of the transmission lines?</p>  <p>Put a tick (✓) in the box next to the best answer.</p> <p>A. Exactly 400 kV. <input type="checkbox"/></p> <p>B. A little less than 400 kV. <input type="checkbox"/></p> <p>C. About 200 kV. <input type="checkbox"/></p> <p>D. Exactly 0 kV. <input type="checkbox"/></p> <p><small>Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. The document is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike license. www.bestevidencescienceteaching.org</small></p>	<p>The right power</p> <p>BEST STUDENT WORKSHEET</p> <p>The right power</p> <p>The power an electrical device has is calculated using $P = IV$. The resistance of the device is calculated using $R = \frac{V}{I}$.</p> <p>Rearranging the resistance equation: $V = IR$ Substituting this into the power equation: $P = I(IR) = I^2R$ When given: $P = I^2R$</p> <p>How do the variables in $P = I^2R$ relate to a transmission line?</p>  <p>Put a tick (✓) in one column to show what you think.</p> <table border="1"> <thead> <tr> <th></th> <th>100% sure it's right</th> <th>75% sure it's right</th> <th>50% sure it's right</th> <th>25% sure it's right</th> <th>I am sure it's wrong</th> </tr> </thead> <tbody> <tr> <td>A. P is power transferred along a wire.</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B. 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<p>Transmission lines</p> <p>BEST STUDENT WORKSHEET</p> <p>Transmission lines</p> <p>In this model, transformers make the transmission voltage high and the current low.</p>  <p>The model is safe because:</p> <ul style="list-style-type: none"> • The voltage is low (up to 1000 V) at each house. • The voltage of the transmission lines is no more than 20 V. • The high current is contained in a central low-voltage wire. <p>Predict</p> <p>How bright the second bulb will be:</p> <ul style="list-style-type: none"> • with the transformers • without the transformers <p>Explain</p> <p>In each case, why do you think the bulb will be this bright?</p> <p>Watch a demonstration of the transmission lines.</p> <p>Observe</p> <p>The brightness of the second bulb:</p> <ul style="list-style-type: none"> • with the transformers • without the transformers <p>Explain</p> <p>How your prediction and explanation connect?</p> <p>Try to improve your first explanation to explain what happens more clearly.</p> <p><small>Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. The document is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike license. www.bestevidencescienceteaching.org</small></p>	<p>Talking volts</p> <p>BEST STUDENT WORKSHEET</p> <p>Talking volts</p> <p>Two different voltage measurements relate to transmission lines:</p> <ul style="list-style-type: none"> • transmission voltage • voltage drop along the length of a transmission line.  <p>Some students are talking about calculations they can make for the transmission lines using different voltage measurements.</p> <p>Jasper: The power transmitted is about $400\,000 \times 1000$.</p> <p>Kesley: The power dissipated is about 1000×1000.</p> <p>Mia: Resistance of a transmission line is about 20 Ω.</p> <p>Sam: The resistance of a transmission line can be calculated using $R = \frac{V}{I}$.</p> <p>To answer</p> <ol style="list-style-type: none"> 1. Who is right about the calculations? Explain your answer. 2. Who is wrong about the calculations? What would you say to help them understand? <p><small>Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. The document is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike license. www.bestevidencescienceteaching.org</small></p>		
<p>PEOE Predict, explain; observe, explain</p>		<p>Talking heads</p>	