


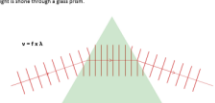
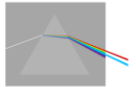

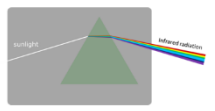

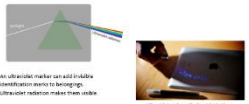
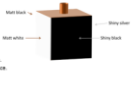

Progression toolkit: More than light

Learning focus	Electromagnetic radiation is made of vibrating electric and magnetic fields that can travel through a vacuum. Light and other types of EM radiation are organised in order of frequency across the EM spectrum.				
As students' conceptual understanding progresses they can:					
Diagnostic questions	Red light	What's light?	Under red	Beyond violet	Beyond 'beyond'
Response activities	Different colours		Detecting infrared		

Key:

P Prior understanding from earlier stages of learning

B Bridge to later stages of learning

<h3 style="text-align: center;">Red light</h3> <p style="text-align: center;">BEST STUDENT WORKSHEET</p> <p>Red light</p> <p>Red light is shown through a glass prism.</p>  <p>$v = f \lambda$</p> <p>The red light waves is refracted as it enters a glass prism, and again when it leaves.</p> <p>What properties of red light stay the same as it moves through a glass prism? Put a tick (✓) in the box next to the best answer.</p> <p>A its speed (v) is constant <input type="checkbox"/></p> <p>B its frequency (f) is constant <input type="checkbox"/></p> <p>C its wavelength (λ) is constant <input type="checkbox"/></p> <p>D None – its speed, frequency and wavelength all change <input type="checkbox"/></p> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<h3 style="text-align: center;">Different colours</h3> <p style="text-align: center;">BEST STUDENT WORKSHEET</p> <p>Different colours</p> <p>Red and blue light are refracted differently by a glass prism.</p>  <p>A light wave crosses the boundaries between air and glass.</p> <p>How do red and blue light waves compare?</p> <p>For each statement, tick (✓) one column to show what you think.</p> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th></th> <th>I am sure this is right</th> <th>I think this is right</th> <th>I think this is wrong</th> <th>I am sure this is wrong</th> </tr> </thead> <tbody> <tr> <td>A In glass, blue travels slower than red.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B Blue always has a higher frequency than red.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>C The frequency of blue light does not change.</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>		I am sure this is right	I think this is right	I think this is wrong	I am sure this is wrong	A In glass, blue travels slower than red.					B Blue always has a higher frequency than red.					C The frequency of blue light does not change.					<h3 style="text-align: center;">What's light?</h3> <p style="text-align: center;">BEST STUDENT WORKSHEET</p> <p>What's light?</p> <p>Light occurs naturally. Light can also be made artificially.</p>  <p>What are some properties of light?</p> <p>For each statement, tick (✓) one column to show what you think.</p> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th></th> <th>I am sure this is right</th> <th>I think this is right</th> <th>I think this is wrong</th> <th>I am sure this is wrong</th> </tr> </thead> <tbody> <tr> <td>A Light can travel through a vacuum.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B Light can make objects radioactive.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>C Light is a type of electromagnetic radiation.</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. 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You should only use the words Infrared light or Infrared and light.</p> <p>Infrared radiation and light</p> <p>There are several types of electromagnetic radiation that include _____.</p> <p>Blue light has a higher frequency than _____.</p> <p>We can see _____ with our eyes.</p> <p>The visible spectrum includes _____.</p> <p>The electromagnetic spectrum includes _____.</p> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<h3 style="text-align: center;">Detecting infrared</h3> <p style="text-align: center;">BEST STUDENT WORKSHEET</p> <p>Detecting infrared</p> <p>A thermal imaging camera can detect infrared radiation. The camera shows infrared radiation as different colours so that we can 'see' it.</p>  <p>Choose all the correct answers.</p> <p>Which of these objects are emitting infrared radiation?</p> <p>A Ice cream <input type="checkbox"/> B Electric fan <input type="checkbox"/> C Metal plate <input type="checkbox"/> D Filament bulb <input type="checkbox"/></p> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>
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<h3 style="text-align: center;">Beyond violet</h3> <p style="text-align: center;">BEST STUDENT WORKSHEET</p> <p>Beyond violet</p> <p>The Sun emits more than just light and infrared radiation. Ultraviolet radiation is also given off by the Sun. Ultraviolet radiation can be detected next to violet light.</p>  <p>An ultraviolet marker can add invisible identification marks to belongings. Ultraviolet radiation makes these visible.</p> <p>What makes the identification marks visible? Put a tick (✓) in the box next to the best answer.</p> <p>A The ink reflects ultraviolet radiation. <input type="checkbox"/></p> <p>B The ink reflects ultraviolet light. <input type="checkbox"/></p> <p>C The ink uses energy from ultraviolet radiation to make light. <input type="checkbox"/></p> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<h3 style="text-align: center;">Beyond 'beyond'</h3> <p style="text-align: center;">BEST STUDENT WORKSHEET</p> <p>Beyond 'beyond'</p> <p>Infrared, visible light and ultraviolet are types of electromagnetic (EM) radiation. The table gives information about each of them.</p> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th>EM radiation</th> <th>Approximate frequency</th> <th>Speed in a vacuum (empty space)</th> </tr> </thead> <tbody> <tr> <td>Infrared</td> <td>0.5-400 THz</td> <td>3×10^8 m/s</td> </tr> <tr> <td>Visible light</td> <td>400-800 THz</td> <td>3×10^8 m/s</td> </tr> <tr> <td>Ultraviolet</td> <td>800-1000 THz</td> <td>3×10^8 m/s</td> </tr> </tbody> </table> <p>$f = \frac{c}{\lambda}$ $\lambda = \frac{c}{f}$</p> <p>$f = 4.0 \times 10^{14}$ Hz $\lambda = 4.0 \times 10^{-7}$ m</p> <p>What do you think about EM radiation? For each statement, tick (✓) one column to show what you think.</p> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th></th> <th>I am sure this is right</th> <th>I think this is right</th> <th>I think this is wrong</th> <th>I am sure this is wrong</th> </tr> </thead> <tbody> <tr> <td>A There are more than 3 types of EM radiation.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B All EM radiation travels at the same speed.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>C All EM radiation travels through glass.</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. 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Light is absorbed best by the matt black surface.</p> <p>Predict</p> <p>Which colour surface do you think emits infrared radiation the most quickly?</p> <p>Explain</p> <p>explain why you think this colour emits infrared most quickly?</p> <p style="text-align: center; border: 1px solid black; padding: 2px;">Observe which colour surface emits infrared radiation most quickly.</p> <p>Observe</p> <p>Record measurements of infrared radiation emitted from each colour surface.</p> <p>Explain</p> <p>Make your prediction and explanation correct? Try to improve your first explanation to explain what happens more clearly.</p> <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<h3 style="text-align: center;">Ultraviolet lamp</h3> <p style="text-align: center;">BEST STUDENT WORKSHEET</p> <p>Ultraviolet lamp</p> <p>Barcode, printing factories and bank cards have invisible security markings. The markings can be seen using an ultraviolet lamp.</p>  <p>Some students are talking about looking at a barcode with the ultraviolet lamp.</p> <p>Sally: We use ultraviolet reflecting off the invisible markings.</p> <p>Tim: The UV ink glows in the ultraviolet.</p> <p>Verify the UV ink is the ultraviolet.</p> <p>Observe The ultraviolet light is a polychromatic colour.</p> <p>To answer</p> <ol style="list-style-type: none"> Who is right about ultraviolet? <ul style="list-style-type: none"> • Explain your answer. Who is wrong about ultraviolet? <ul style="list-style-type: none"> • What would you say to help them understand? <p style="font-size: small;">Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics. This document may have been edited. Download the original from www.BestEvidenceScienceTeaching.org. © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>									
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