

**Assessment Schedule – 2012**

**Earth and Space Science: Demonstrate understanding of physical principles related to the Earth System (91193)**

**Evidence Statement**

QUESTION ONE								
Expected Coverage			Achievement		Merit		Excellence	
Heat energy from the sun heats black or dark road surface via radiation, so that it is hotter than air temperature. Hot road heats air particles by the road surface by conduction. Air is still, so no cooling breeze and so the air above the road stays still and hot. Hot air is less dense than cool air and so it rises. Light travels in straight lines and when it hits the area of hot, less dense air, it bends slightly (due to refraction – term not required), because of the different densities of the hot and cool air. If the light hits the hot air at a shallow enough angle, total internal reflection occurs and it is seen as a watery illusion or shimmer on the road.			Describes how road absorbs heat energy from the sun, which radiates heat energy to heat the air above the road.		Explains: • How road heats air above it to a higher temperature than surrounding air temperature. • The effect heated air has on resulting air densities.		Explains in detail: • How differing air densities result in light rays being distorted/bent (and seen as an illusion on the road). • If angle of incidence shallow then (total internal) reflection can occur, resulting in optical illusion of water on road.	
Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Identifies that heat energy comes from the Sun.  OR Includes a statement relevant to the question context, eg refraction of light, bent light rays.	Describes that heat energy from the Sun heats the road.	Describes that road absorbs heat energy from the Sun. OR In turn the heat energy from the road heats the air above it.	Describes how road absorbs heat energy from the sun AND then heats the air above the road.	Explains one of: • How road heats air above it to a higher temperature than surrounding air temperature. • The effect heated air has on resulting air densities or layers of air OR the resulting effect on the air produces convection currents above the road.	Explains both of: • How road heats air above it to a higher temperature than surrounding air temperature. • The effect heated air has on resulting air densities or layers of air OR the resulting effect on the air produces convection currents above the road.	Explains one of: • That differing air densities or air layers above the road bend the light rays. • If the light is at a shallow angle then this can create an optical illusion of water on road.	Explains in detail: • How differing air densities or air layers above the road result in light rays being distorted / bent (and seen as an illusion on the road). • If the light is at a shallow angle then this can create an optical illusion of water on road.

Evidence can be provided by diagram: Reference [www.physicsclassroom.com/Class/refn/u1414.cfm](http://www.physicsclassroom.com/Class/refn/u1414.cfm)

<b>QUESTION TWO</b>			
<b>Expected Coverage</b>	<b>Achievement</b>	<b>Merit</b>	<b>Excellence</b>
<p>How reflective different surfaces of the earth are to the Sun's radiation (albedo), affecting the amount of heat energy that is on the Earth's surface.</p> <p>Clouds that form in the lower atmosphere (big fluffy low clouds): reflect the Sun's short wave radiation (heat and light energy) back into space. This means less heat energy would reach the Earth's surface, therefore causing localised cooling and lower surface temperatures. Increasing low cloud coverage increases Earth's albedo, as the clouds reflect energy, and so the Earth becomes more reflective of the Sun energies.</p> <p>Clouds that form further up in the atmosphere (high wispy clouds) act like a blanket around the Earth. They transmit the short wave radiation from the Sun through to the Earth. The Earth radiates long wave/infrared radiation back into the atmosphere. This is absorbed by these clouds and then reflected back to the Earth's surface causing a rise in the temperature.</p> <p>Evidence can be provided by annotated diagrams.</p>	<p>Describes how either low clouds or high clouds affect the surface temperature of the Earth.</p>	<p>Explains how low and high clouds affect surface temperature in terms of absorption, reflection and radiation of energy.</p>	<p>Comprehensively explains the effect on surface temperature by low and high clouds in the atmosphere.</p> <ul style="list-style-type: none"> <li>• How low clouds increase albedo and how low clouds transmit, absorb, reflect and radiate short/long wave energy.</li> <li>• How high clouds transmit, absorb, reflect and radiate short/long wave energy.</li> </ul>

Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Describes that cloud block the sun. No heat energy reaches earth's surface.	Describes how EITHER: Lower clouds are more dense / white and block heat energy. OR Clouds allow only the transmission of some heat and light.	Describes EITHER how: Clouds can cause an increase in surface temperature by preventing heat loss from earth's surface. OR Clouds reflect the radiated heat and less heat reaches the surface.	Describes how BOTH: Clouds can cause an increase in surface temperature by preventing heat loss from earth's surface. Clouds reflect the radiated heat and less heat reaches the surface.	Explains how high and low clouds will affect surface temperature in terms of ONE of transmission, absorption, reflection AND radiation of energy.	Explains how low and high clouds will affect surface temperature in terms of TWO of transmission, absorption, reflection AND radiation of energy.	Candidate comprehensively explains ONE of: • How low clouds transmit, absorb, reflect and radiate short/long wave energy. • How high clouds transmit, absorb, reflect and radiate short/long wave energy. (Reasoned statement)	Candidate comprehensively explains the effect on surface temperature by low and high clouds in the atmosphere. • How low clouds <b>increase reflection</b> and how low clouds transmit, absorb, reflect and radiate short/long wave energy. • How high clouds transmit, absorb, reflect and radiate short/long wave energy by letting through short radiation and trap long wave radiation (more reflection from low clouds).

Evidence can be provided by diagram: Reference : [www.climate4you.com/climateandclouds.htm](http://www.climate4you.com/climateandclouds.htm)

<b>QUESTION THREE</b>			
<b>Expected Coverage</b>	<b>Achievement</b>	<b>Merit</b>	<b>Excellence</b>
<p>Light from the sun travels through space by radiation.</p> <p>Sunlight is made up of three primary colours: red, blue and green. Red is the longest wavelength colour, and blue is the shortest wavelength colour.</p> <p>Sunlight is made up of multiple colours of light, each with their own wavelengths.</p> <p>When there are lots of gas particles in the atmosphere that are smaller than the wavelength of light, there is lots of scattering of the light. The molecules in the earth's atmosphere do not scatter much of the red light, but do scatter much of the blue wavelength light from the sun.</p> <p>As the sun is setting it is still lighting up the sky with all the colours of white light but it is at such a low angle that all the colours of light have to travel further through the earth's atmosphere. As the light rays hits the dust and molecules of gas in the earth's atmosphere the shorter wavelength colours of indigo, violet, blue and yellow are absorbed or scattered, while longer wavelength colours of orange and red are transmitted. We therefore only see the longer wavelength colours, and so the sunset is seen as red.</p>	<p>Describes:</p> <ul style="list-style-type: none"> <li>• Light energy travels through space by radiation and different colours of light have different wavelengths.</li> </ul>	<p>Explains in depth:</p> <p>The effect on red or blue light after a particle has interacted with it.</p> <p>AND</p> <p>Setting sun has a low angle in the sky, so light travelling through more atmospheric particles.</p>	<p>Explains comprehensively:</p> <p>The effect of the atmosphere on the absorption of blue and red light in terms of their wavelengths.</p>

Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	<ul style="list-style-type: none"> <li>Candidate states light has different wavelengths</li> </ul>	<p>Candidate states:</p> <ul style="list-style-type: none"> <li>The colour of sunlight is affected differently by the atmosphere ie blue scattering or red light transmission.</li> </ul> <p>Evidence can be provided by diagrams.</p>	<p>Candidate describes ONE of:</p> <ul style="list-style-type: none"> <li>Light has different wavelengths (colours) which are affected differently by the atmosphere.</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Light travels further in the atmosphere when the sun is low, with more scattering of blue light so only red light gets through.</li> </ul>	<p>Candidate describes:</p> <ul style="list-style-type: none"> <li>that red light has a long wavelength OR blue light has a short wavelength.</li> </ul> <p>AND</p> <ul style="list-style-type: none"> <li>the effect the atmosphere has on the different wavelengths.</li> </ul>	<p>Candidate:</p> <ul style="list-style-type: none"> <li>Explains that light coming into the atmosphere collides with particles.</li> <li>Explains the effect that a particle interacting has on red or blue light is different.</li> </ul> <p>(Can state either colour or wavelength.)</p>	<p>Candidate explains:</p> <ul style="list-style-type: none"> <li>Explains that light coming into the atmosphere collides with particles.</li> <li>Explains the effect that increasing particle interaction scatters more blue light making the sun look red.</li> </ul>	<p>Candidate explains:</p> <ul style="list-style-type: none"> <li>In detail how all colours of light can be absorbed; but the shorter wavelengths (blue light) is absorbed, reflected and scattered more often than the longer wavelengths (red light) resulting in the sky being seen as a red colour when sun at low angles in the sky.</li> </ul>	<p>Candidate explains:</p> <ul style="list-style-type: none"> <li>In detail how all wavelengths can be absorbed; but shorter are absorbed, reflected and scattered more often than longer resulting in the sky being seen as a red colour when sun at low angles in the sky. The further distance means there are more collisions between particles and light resulting in increased scattering and absorption of shorter wavelengths with transmission of longer wavelengths (red).</li> </ul>

Evidence can be provided by diagram: Reference: [www.physics.org/article-questions.asp?Id=108](http://www.physics.org/article-questions.asp?Id=108)

### Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 6	7 – 12	13 – 18	19 – 24