Contents

Life, Earth and Space Science Assessment Probes

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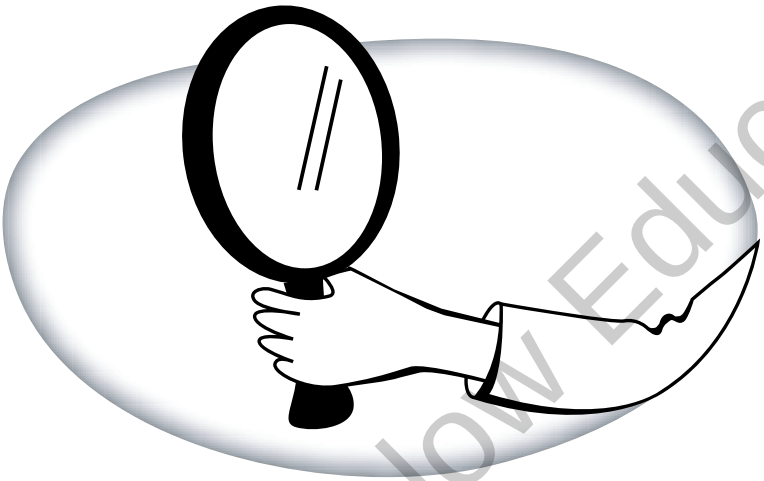
Can It Reflect Light?

Teacher Notes



Purpose

The purpose of this assessment probe is to elicit students' ideas about light reflection off ordinary objects and materials. The probe is designed to find out if students recognise that all non-light-emitting objects that we can see reflect some light or if they believe that only certain types of objects reflect light.

Related Concepts

light, reflection

Explanation

Assuming all of the objects on the list are visible to an observer, the best response is "All of the objects on the list can reflect light". The objects and materials on this list can be seen when light is reflected from the object or material and enters the eye. When we can see a non-luminous object, we know that some or all of the light striking the object is reflected to our eye. Otherwise we would not be able to see it. Most materials will absorb some wavelengths of light and reflect the rest. This accounts for why we see different colours. When we see white, all colours have been reflected back. Materials that absorb all light and reflect no light appear black. Black is the absence of light. Black objects whose features you can actually see do not absorb all the light that falls on them. With these objects, some reflection at the surface allows you to see their features. Some materials clearly reflect light better than others. Ordinary mirrors and light, shiny, smooth objects reflect light to the observer because the light bounces off the surface at a definite angle. When light hits rough surfaces, such as paper or rock, it is scattered and bounces back in many different directions. This scattering makes some objects appear dull.

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Curricular and Instructional Considerations

Primary Students

Students at this age engage in learning opportunities that involve examining the properties of a variety of objects and materials. The probe is useful at this year level for examining how students connect their ideas about certain observable properties of objects and materials to ideas about reflection of light. It is important for students to develop the generalisation that all visible objects reflect some amount of light, an important prerequisite to understanding how vision works (a topic that is traditionally studied in the middle years).

Middle Years Students

Students develop an understanding that non-luminous objects are seen as a result of light being reflected off the object and entering the eye. But they often fail to recognise the closely linked idea that if you can see something, then it must be reflecting light. This notion explains why each of the visible objects on the list reflect some light. Middle years students typically engage in learning activities that examine the directionality and angle of light as it passes through or reflects off objects. They frequently engage in activities that use mirrors. They use ideas about reflection and absorption to explain how colours are seen. At this level the probe is useful in determining whether students are "context-bound" in their thinking or if they are making the generalisation that an object, regardless of the type of material or colour, is reflecting some light if it is seen by the eye.

High School Students

Students develop more sophisticated ideas about light reflection and optics. But they may still be context-bound or persist in their intuitive notions that certain characteristics of objects, such as dull or bumpy surfaces, inhibit light reflection. The notion of light reflection by ordinary objects is fundamental to optics instruction and is used to understand image processes such as photography.

Administering the Probe

Be sure students are familiar with the objects on the list. Ask them to cross out any word or object they are unfamiliar with. You might consider explaining, or showing an example of, an object if students are not sure what it is. This probe can also be used as a card sort. In small groups, students can sort cards listing each item into two groups – those that reflect light and those that do not reflect light. Listening carefully to students' discussions with each other as they sort can lend insight into their thinking. This probe can be combined with "Apple in the Dark" to further examine students' ideas about the role of light.

Related Ideas in the *F–10 Curriculum: Science* Content Descriptions (ACARA 2014a)

Foundation Year Chemical Sciences

- Objects are made of materials that have observable properties (ACSSU003)

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Year 1 Physical Sciences

- Light and sound are produced by a range of sources and can be sensed (ACSSU020)

Year 5 Physical Sciences

- Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

Related Research

- Studies by Guesne (1985) and Ramadas and Driver (1989) revealed that middle years students will accept the idea that mirrors reflect light but may not accept the idea that ordinary objects reflect light (AAAS 1993).
- Students' ideas about reflection may be context-bound. Many students questioned in a study conducted by Anderson and Smith (1983) could describe light as bouncing off mirrors but not off other objects. A few students even lacked a conception of light bouncing or reflecting off any objects. The researchers also found that 61 per cent of the children they sampled thought colour to be a property of an object rather than reflected light off an object (Driver et al. 1994).

Suggestions for Instruction and Assessment

- By experimenting with light, F–4 students begin to understand that phenomena can be observed, measured and controlled in various ways (NRC 1996).
- "Light can be reflected by a mirror, refracted by a lens, or absorbed by an object" is a learning goal in the National Science Education Standards (NRC 1996). But use caution when addressing a standard such as this as it may imply to some students and teachers that only mirrors reflect light if other examples are not included. Provide students with a variety of materials to investigate reflection. There is a danger of students becoming context-bound if their experiences only include mirrors or shiny and smooth objects. Emphasise the generalisation rather than focusing exclusively on one type of object.
- Explicitly link the idea that if we can see an object, regardless of its observable physical properties, it is reflecting or emitting some light in order for us to be able to see it.
- Have students use an electric torch to observe light reflecting off smooth aluminium foil and rough aluminium foil. Connect this experience with an analogy of a ball (representing the light) bouncing on a smooth floor versus a bumpy surface. Take students outside to bounce a ball on a smooth pavement and then compare how the ball bounces on gravel or some other rough surface. Connect the idea to what happens to light on smooth and rough surfaces.
- Use real-life applications, such as remote-sensing images, to develop the idea that Earth materials such as water, vegetation, rocks, soil, sand and clouds reflect light that is detected by satellites.
- Ask students to draw and explain ray diagrams that compare light reflecting off smooth versus rough objects.

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- Identify various physical properties of materials and their associated vocabulary, such as *texture*, *lustre*, *colour*, *transparency*, *translucence* and *opaqueness* and compare and contrast what happens when light interacts with these materials.
- Alert students to the ways our English language refers to reflection, such as *reflection pools* and *seeing our reflection* in a mirror or shiny object. Reflection is almost always spoken of in the context of mirrors, shiny objects and water. Objects and materials like paper, wood, soil and rocks are seldom referred to as reflective materials.
- Modify the assessment probe by having students come up with their own list of things they think reflect light and things that do not reflect light. Have them use their own list to explain their reasons for deciding whether an object or material reflects light.

Related Resources

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Beach Sand

Teacher Notes

Purpose

The purpose of this assessment probe is to elicit students' ideas about weathering, erosion, deposition and landforms. It is designed to determine if students recognise that sand on a beach may have come from distant mountains and landforms as a result of the weathering of rock, subsequent erosion and deposition.

Related Concepts

weathering, erosion, deposition, rock cycle, landforms

Explanation

Molly's idea is the best response. In this example the beach sand is formed from the wearing away of rock at the Earth's surface. The weathered rock is carried away by wind and water (eroded) where it eventually ended up in the ocean. The small particles of rock were tossed about by the ocean, washing up on the beach as sediment. While it intuitively appears that the sand originated from the ocean, which is partially correct, it actually came from somewhere else before ending up in the ocean. Wind and rain constantly erode mountain summits, hillsides and other landforms that are made up of rocks. These rocks are composed of many common minerals, such as quartz, feldspar and mica. The small pieces of rock and minerals, such as quartz, find their way into streams and eventually the mouth of rivers where they are washed out to sea. Currents can carry the sediments many kilometres away, eventually depositing them along a shoreline. Many of the world's beaches are made up of quartz-rich sand. When you walk along a beach you may be walking on tiny grains from mighty mountains, far away

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from the shoreline. Although there are exceptions, such as coral beaches, and other complex processes are involved, this probe addresses, at a simple level, how a common type of beach is formed as a result of weathering of landforms.

Curricular and Instructional Considerations

Primary Students

Students come to school aware that the Earth is made up of a variety of materials and landforms. Children are encouraged to observe materials in their environment, such as sand, and develop their own explanations of how they came to be. They observe fundamental processes of the rock cycle and begin to construct an understanding that rocks, as well as landforms, undergo change. This probe can be used to find out students' early ideas about weathering and erosion before they put the more complex pieces together in middle years Earth and space science.

Middle Years Students

Students develop more complex understandings about weathering, erosion and sedimentation, including the long periods of time it takes for these processes to occur. They use the idea of a rock cycle to explain the continuous process of wearing down and building up. They begin to use ideas about geologic processes to explain formation of a variety of landforms, including beaches. This probe can be used to assess how students use their ideas about weathering, erosion and sedimentation to explain processes that result in weathering of mountains and formation of landforms, such as a beach. While students may describe the processes, the notion that the sand may have come from distant mountains may be counterintuitive, and points out the need to design instruction that explicitly targets this phenomenon.

High School Students

Students use their understandings of the rock cycle, geologic processes and the timescales involved to explain complex phenomena that involve changes in the Earth system. They also investigate a variety of other factors that affect beach formation over time and examine different types of beaches. This probe is useful in determining if students have grasped fundamental ideas about weathering, erosion and deposition in the middle years before they encounter more sophisticated concepts related to beach formation.

Administering the Probe

Be aware that some students may have never visited a coastal area, similar to the context used in this probe, which would affect their notions of what a beach is and how it was formed. Some students may have visited volcanic beaches or island beaches where shell and coral reef material predominates. Be sure students understand the context the probe is set in. You might include additional props, such as photos of the area that show mountains and rivers in the distance or have students examine the particles in sand. This probe may be used with "Mountain Age" (p. 157) to elicit ideas about weathering of rock in a different context.

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Related Ideas in the *F–10 Curriculum: Science Content* Descriptions (ACARA 2014a)

Year 1 Earth and Space Sciences

- Observable changes occur in the sky and landscape (ACSSU019)

Year 4 Earth and Space Sciences

- Earth's surface changes over time as a result of natural processes and human activity (ACSSU075)

Year 6 Earth and Space Sciences

- Sudden geological changes or extreme weather conditions can affect Earth's surface (ACSSU096)

Year 8 Earth and Space Sciences

- Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales (ACSSU153)

Related Ideas in the *Senior Secondary Curriculum: Earth and Environmental Science* Content Descriptions (ACARA 2014d)

Unit 1 Development of the Geosphere

- Rocks are composed of characteristic assemblages of mineral crystals or grains that are formed through igneous, sedimentary and metamorphic processes, as part of the rock cycle (ACSES019)

Related Research

- Earth (and space) sciences have a unique aspect of scale that may be problematic for students. For example, comprehending the length of time it takes for mountains to erode is difficult for some students (Ault 1994).
- A study by Freyberg (1985) revealed that many students think the Earth today is the same as it has always been and that any changes to the Earth (such as formation of a beach) were sudden and comprehensive. But it is important to note that students in this study did not have formal instruction in the topics addressed (AAAS 1993).
- Happs (1982) found students tend to use different meanings for rock fragments than scientists who classify the fragments by average size. For example, instead of using particle size to distinguish between boulders, gravel, sand and clay, students associate the particles with their origin. Sand is defined as coming from a beach or desert rather than being a particle of a certain average size (Driver et al. 1994).

Suggestions for Instruction and Assessment

- Fundamental processes of the rock cycle, such as erosion, transport and deposition, that lead to later understandings of the processes that form beaches can be observed by primary students using simple materials they can manipulate. Start with observation before explanation.
- Primary students can examine sand with magnifiers to observe the particles and compare the pieces to actual rock

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samples, particularly ones that contain minerals that are recognisable such as quartz or mica. This helps them understand the origin of sand from rock, and the rock can be later traced back to landforms such as mountains and exposed bedrock.

- Be sure to combine students' observations of and interest in certain phenomena, such as tumbling solid rock, or eroding sand in a stream table, with the role the phenomena play in shaping the surface of the Earth (e.g. beaches, wearing down of mountains, widening of rivers).
- When using stream tables to investigate erosion and deposition phenomena, be sure to trace back the origin of the sand. It is also important to explicitly address the fact that the processes the stream tables are modelling in a very short time actually occur over long periods of time. The sedimentation process is understandable and observable but the span of time involved is difficult for students to grasp, particularly up through the middle years.
- Combine an understanding of the use of models with understanding the process of beach formation. This is a good time for students to understand how models are used and the benefits as well as limitations of models in illustrating phenomena.
- Challenge students to explain the statement, "When you sink your toes in the sand on a beach you might be feeling the tiny grains of mighty mountains."
- Provide students with a single grain of sand from a beach and ask them to trace back the origin of the grain of sand. What journey did it take before ending up on the beach? This can be developed into an engaging performance assessment task.
- Help students distinguish between *weathering* and *erosion*. Some students use these terms interchangeably. Weathering is the wearing away whereas erosion is the carrying away.
- Develop the notion that the type of beach formation described in this context occurs in beaches in many places throughout the world. Be sure students aren't limited by context.

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