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Floating Logs

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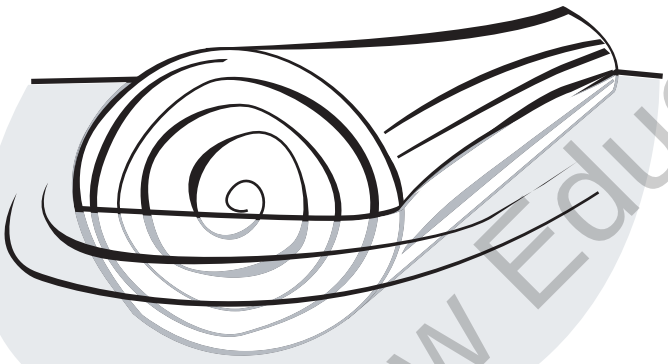

Purpose

The purpose of this assessment probe is to elicit students' ideas about density. The probe is designed to find out if students think changing the size of an object affects its density.

Related Concepts

characteristic properties, density, intensive properties of matter, sinking and floating.

Explanation

The best response is B: Half of the larger log floats above the water surface. The degree to which a solid object will float when placed in water depends on the density of the material. When a second object is compared with a floating solid, a solid object with a lesser density will float higher above the water's surface, an object with the same density will float at equal levels and an object with a greater density will be more submerged. Density is a characteristic property of matter, which means that it is independent of the amount of material. If one sample of material is very large and another sample of the same material is very small, the proportion (ratio) of the mass to volume of each sample is still the same, so the density remains the same. The first and second logs were both cut from the same tree, so they are made of the same material and have close to the same density (there may be a slight difference because the logs are not made of a homogeneous material). Since the densities are for practical purposes the same, the two different-sized logs will float at equal levels. One-half of the first log floated above the water's surface, so one-half of the second (larger) log will also float above the water's surface.

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Curricular and Instructional Considerations

Primary Students

At the primary level, students have observational experiences with floating and sinking objects of different sizes and shapes. They are able to describe observable properties of objects, such as how much of an object floats above the water's surface. They begin to develop an understanding of the unifying theme of constancy and change: even though some things may change (such as size), other things may stay the same (ability to float). This probe may be useful in determining students' ideas about floating objects, but the concept of characteristic properties, such as density, should wait until the middle years.

Middle Years Students

In the middle years, instructional experiences with density progress from observational (floating or sinking and heavy for its size) to a conceptual understanding of density as a characteristic property of matter. Students begin to use mathematics to quantitatively describe density. The middle years may be the time to make the distinction between extrinsic properties such as size, mass or weight and characteristic properties such as density. By the end of the middle years students should understand that two objects composed of the same substance will have the same characteristic properties, which can be used to identify them or predict their behaviour. Students begin to use technical vocabulary such as *mass, volume* and *density.* But it is important to determine if they have a conceptual understanding of density before introducing the $D = M/V$ relationship (density equals mass divided by volume).

High School Students

Density experiences at the high school level include symbolic representations of density using the variables of mass and volume to calculate proportional relationships. Applications of density are extended to an understanding of the Earth, astronomy, life science and the designed world. But a conceptual understanding of density still eludes many high school students.

Administering the Probe

You may wish to use props to help younger students visualise the manner in which the first log is floating with respect to the water's surface and to show students what it means when logs float on their sides, rather than upright like a buoy. Place an object that floats in a clear container of water so that students can see what is meant by "above and below the water's surface" and "floating on its side", or draw a picture to explain it. Show students a second object composed of the same material that is longer and wider than the first object, but don't place this object in the water.

The probes "Comparing Cubes" (p. 19) and "Solids and Holes" (p. 37) can also be used to determine if students recognise that density is a characteristic property of matter.

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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)

Year 1 Chemical Sciences

- Everyday materials can be physically changed in a variety of ways (ACSSU018)

Year 4 Chemical Sciences

- Natural and processed materials have a range of physical properties; These properties can influence their use (ACSSU074)

Related Ideas in the *Senior Secondary Curriculum: Chemistry* Content Descriptions (ACARA 2014c)

Unit 1 Properties and Structure of Matter

- Materials are either pure substances with distinct measurable properties (for example, melting and boiling point, reactivity, strength, density) or mixtures with properties dependent on the identity and relative amounts of the substances that make up the mixture (ACSCH025)
- Differences in the properties of substances in a mixture, such as particle size, solubility, magnetism, density, electrostatic attraction, melting point and boiling point, can be used to separate them (ACSCH026)

Related Research

- Ideas that interfere with students' conception of density include the belief that when you change the shape of something you change its mass and the belief that heaviness is the most important factor in determining whether an object will sink or float (Stepans 2003).
- Many students have misconceptions about volume that present difficulties for understanding density (Driver et al. 1994).
- Driver et al. (1994) described a study conducted by Biddulph and Osborne (1984) in which some students ages 7–14 suggested that things float because they are light and, when asked why objects float, offered different reasons for different objects. The same study asked children ages 8–12 how a longer candle would float compared with a shorter piece; many students thought the longer candle would sink/float lower (Driver et al. 1994).
- Some students use an intuitive rule of "more A, more B". They reason that if you have more material, density increases or makes an object sink more (Stavy and Tirosh 2000).
- Students' ways of looking at floating and sinking include the roles played by material, weight, shape, cavities, holes, air and water (Driver et al. 1994).

Suggestions for Instruction and Assessment

- This probe can be followed up with an inquiry-based investigation using wooden dowels of different lengths and thicknesses.

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- Try a very small piece of Ivory soap (a soap that floats) versus the rest of the bar of Ivory soap. Or use a soap that sinks, cut off a tiny piece, and ask students if they think that piece of soap will float, sink or float differently depending on its size. Sometimes students think that a tiny piece of an object will behave differently from the whole object.
- Investigate the floating and sinking of the same kind of material – for example, Styrofoam balls – with different sizes and the same shape. Similar investigations can be conducted with strawberries, blocks of wood or rubber objects.
- Investigate the floating and sinking of the same kind of material made of different shapes. For example, would a block of Styrofoam float the same way as a Styrofoam sphere? Again, this investigation can be conducted with other materials.
- When middle years or high school students have developed the conceptual understanding of density, have them use mathematics to support their explanations with proportional reasoning. It is counterproductive to start by using $D = M/V$ if students have not developed a conceptual understanding of density first.

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Needs of Seeds

Teacher Notes

Purpose

The purpose of this assessment probe is to elicit students' ideas about seeds. It specifically probes to find out if students recognise that a seed has needs, similar to other organisms, that allow it to develop into the next stage of its life cycle.

Related Concepts

germination, life cycles, needs of organisms, seeds

Explanation

The best response is that seeds need water, air and warmth. Like all living things, the plant embryo inside a seed needs water, air, food and warmth to carry out the life processes that will support its germination and growth. The young plant embryo needs food as its source of energy and building material for growth. But the food it needs is already contained within the seed in the form of a cotyledon, since a young sprout does not yet have the leaves to enable it to carry out photosynthesis. Air is necessary for seeds to respire. Seeds must take in oxygen to use and release energy from their food. Seeds also require a warm temperature and water for the life-sustaining chemical reactions that take place in the cells of the young plant embryo to occur. But some seeds, such as acorns, need to go through a cold period before they germinate. Too much liquid water "drowns" seeds by preventing them from taking in oxygen and causes them to rot. Some seeds can sprout in humid air without the need for a moist surface. Hence, the right amount of water needs to be available.

Seeds can sprout without soil as long as they have a source of moisture. Sunlight is not needed, as evidenced by the way many seeds germinate when covered by soil. Seeds have sprouted in microgravity in space. Gravity affects the ability of the sprout to send its early root structures downward, but seeds can sprout even in conditions where gravity is much less than that on Earth. Fertilisers are

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not needed by seeds. They are used by plants once they have established roots and can take in these substances from the soil to contribute essential elements to the cells that make up their plant structures.

Curricular and Instructional Considerations

Primary Students

Primary students typically have experiences germinating seeds and growing plants. Early experiences focus primarily on the seed's need for water and warmth. Since students often plant their seeds in soil and water them, they may not realise that soil is not necessary for a seed to germinate. Likewise, since the seeds are in soil, they may think darkness is a requirement and that sunlight would harm a seed. Investigations that involve germinating seeds under various conditions help students recognise that some factors are needed for germination and others are not. Students can eventually distinguish between the needs of seeds and the needs of the growing plant.

Middle Years Students

Middle years students typically have more systematic experiences investigating plants and their needs. The seed's cotyledon is recognised and investigated as a source of food for the developing sprout and seedling before it grows into a plant capable of making food from carbon dioxide and water using energy from sunlight. As students develop an understanding that all living things carry out similar life processes, they recognise that seeds also need oxygen as well to carry out cellular respiration. At this level students should be able to distinguish between what seeds need to germinate and what complete plants need to function.

High School Students

Although basic germination experiences take place in primary the and middle years, this probe may be useful in determining if students retain misconceptions related to germination. High school students learn about specialised factors that can affect germination, such as the need for some seeds to travel through animals' digestive systems in order to open the seed coat or the need for some conifers to be exposed to fire in order to release seeds. They may also investigate the concept of inhibitors where chemicals released by some plants will inhibit the germination of other seeds in their area.

Administering the Probe

You may wish to use visual props with the probe. Show students an ungerminated bean seed and a germinated seed or show them a picture of a sprout or an actual sprout if there are students who do not know what a sprout is. For older students you may substitute the word *germinate* for *sprout.* Remove any of the terms that may be unfamiliar to young children.

This probe can also be used as a card sort. Write the words on cards and have students sort them into piles of things seeds need to sprout and things seeds do not need to sprout. Listen carefully as they discuss their ideas about which pile to put their cards in.

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

Foundation Year Biological Sciences

- Living things have basic needs, including food and water (ACSSU002)

Year 2 Biological Sciences

- Living things grow, change and have offspring similar to themselves (ACSSU030)

Year 4 Biological Sciences

- Living things have life cycles (ACSSU072)

Year 6 Biological Sciences

- The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094)

Year 9 Biological Sciences

- Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)

Related Research

- Many children think that plants always need light to grow, and they apply this idea to germination (Driver et al. 1994).
- Driver et al.'s study of a large sample of 15-year-olds showed that many of the students thought that respiration only occurred in the cells of leaves of plants since these cells have gas exchange pores. They did not see things like seeds as exchanging gases (Driver et al. 1994).
- Some students fail to recognise a seed as a living thing; therefore they do not recognise that seeds have needs similar to those of other living things (Driver et al. 1994).
- Students appear to believe that food and light are necessary for all stages of plant growth. But prior to instruction they often do not understand that light is a requirement for food making but not a requirement for growth. A study conducted by Roth, Smith and Anderson (1983) found that students held strongly to the idea that light is always required by plants even in the face of contrary evidence such as seedlings germinating in the dark (Driver et al. 1994).
- Russell and Watt (1990) interviewed younger students about their ideas related to conditions for growth, focusing on germinations as well as vegetative growth. Ninety per cent of the 60 children interviewed identified water as necessary. Only a few mentioned air, gases, "food" (which to them was soil nutrients), sun, light or heat (Driver et al. 1994).
- Some students have difficulty distinguishing between germination and vegetative growth (Driver et al. 1994).

Suggestions for Instruction and Assessment

- This probe could be followed up with an inquiry-based investigation. Have students make predictions and test their ideas with seeds that germinate easily, such as bean seeds.
- Examine seeds, helping students see where water is taken in, gases are exchanged and

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food is stored for the young embryo. Rather than focusing on naming the parts of a seed, help students understand how the seed contributes to the growth and life functions of the young plant.

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