Supporting Online Material for

Farewell, Lecture?

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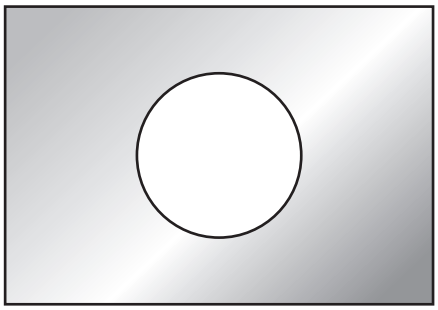
Consider a rectangular metal plate with a circular hole in it.

When the plate is uniformly heated, the diameter of the hole

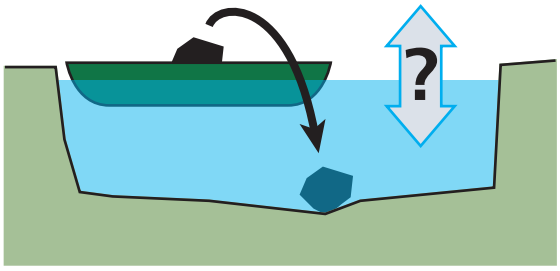
1. increases.
2. stays the same.
3. decreases.



A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.

After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than



it was when the boulder was in the boat.

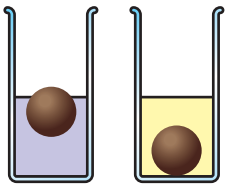
When we hold a page of printed text in front of a mirror, the text on the image in the mirror runs from right to left:

The New York Times

Why is it that right and left are interchanged and not top and bottom? Because:

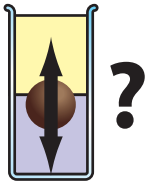
1. the mirror is oriented vertically.
2. we have two eyes in the horizontal plane.
3. the Earth's gravitation is directed downward.
4. a habit we have when looking at images in a mirror.
5. It only appears to run from left to right.

Consider an object that floats in water, but sinks in oil. When the object floats in water, most of it is submerged.



If we slowly pour the oil on top of the water so it completely covers the object, the object

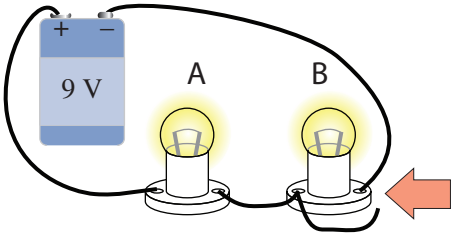
1. moves up.
2. stays in the same place.
3. moves down.



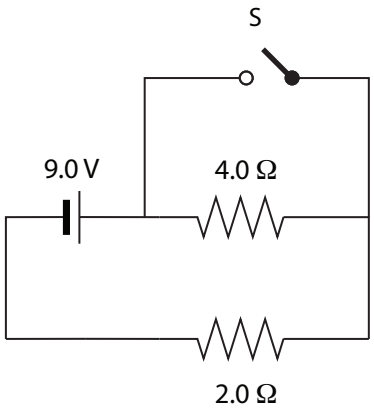
Two versions of the same question (first as a clicker question, then in a more traditional problem format). Students often have more difficulty with the clicker question than with the traditional problem, which they solve by rote.

Two light bulbs A and B are connected in series to a battery. When the wire indicated by the red arrow is connected accross B, bulb A

1. burns more brightly
2. burns as brightly
3. burns more dimly
4. goes out



For the circuit at right, calculate the current through the 2.0-Ω resistor (a) when the switch S is open and (b) when the switch S is closed.



ANSWERS

1. Increases. As the plate is heated, it expands uniformly, and so all the atoms making up the plate get spaced out farther. The only way for the atoms constituting the perimeter of the hole to get farther apart from one another, is to increase the perimeter (and therefore the diameter) of the hole. Alternatively, imagine drawing a circle with the same diameter as the hole on a similar plate without hole. As the plate is heated, it expands uniformly and so the diameter of the circle must increase.

2. Lower than. In the boat, the rock displaces an amount of water whose weight is equal to the weight of the rock. In the water it displaces its volume. Because the volume of water that weighs as much as the rock is much larger than the rock's volume, the level of the pond must go down.

3. A habit we have when looking at images in the mirror. To see the reflection of an object in the mirror, the object must face the mirror. To see the image of a newspaper facing you in a mirror, you must rotate it 180° about some axis. Out of habit, most people chose the vertical. You could, however, just as well flip the paper about the horizontal, in which case top and bottom would be interchanged.

4. Moves up. When it is floating in the water, the ball displaces a volume of water whose weight is equal to the weight of the ball. With the oil added, both a volume of water and a volume of oil is displaced, the sum of which must equal the weight of the ball. Because of the additional displaced oil, the volume of water displaced after the oil has been added must be less than before and so the ball has to move up.

5. Burns more brightly. With the wire connected across bulb B, that bulb is "shorted out" meaning all current flows through the wire and none through the bulb. The wire, having virtually no resistance, essentially puts both sides of the bulb at the same potential and therefore no current can flow through the bulb. So, after the wire is connected across B, the situation is identical to having just bulb A connected across the terminals of the battery. The resistance of A by itself is smaller than that of A and B combined and so a greater current flows through the circuit. Consequently, A burns more brightly.

6. (a) 1.5 A. (b) 4.5 A. Note: the current in b is much larger than in a, confirming that A in question 5 burns more brightly after the wire has been connected across it.