

**CLASSROOM TEST OF  
SCIENTIFIC REASONING**  
*Multiple Choice Version*

Directions to Students:

This is a test of your ability to apply aspects of scientific and mathematical reasoning to analyze a situation to make a prediction or solve a problem. Make a dark mark on the answer sheet for the best answer for each item. If you do not fully understand what is being asked in an item, please ask the test administrator for clarification.

**DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO**

1. Suppose you are given two clay balls of equal size and shape. The two clay balls also weigh the same. One ball is flattened into a pancake-shaped piece. Which of these statements is correct?
  - a. The pancake-shaped piece weighs more than the ball
  - b. The two pieces still weigh the same
  - c. The ball weighs more than the pancake-shaped piece

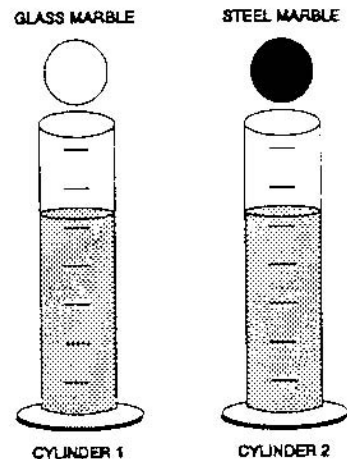
2. *because*

- a. the flattened piece covers a larger area.
- b. the ball pushes down more on one spot.
- c. when something is flattened it loses weight.
- d. clay has not been added or taken away.
- e. when something is flattened it gains weight.

3. To the right are drawings of two cylinders filled to the same level with water. The cylinders are identical in size and shape.

Also shown at the right are two marbles, one glass and one steel. The marbles are the same size but the steel one is much heavier than the glass one.

When the glass marble is put into Cylinder 1 it sinks to the bottom and the water level rises to the 6th mark. *If we put the steel marble into Cylinder 2, the water will rise*

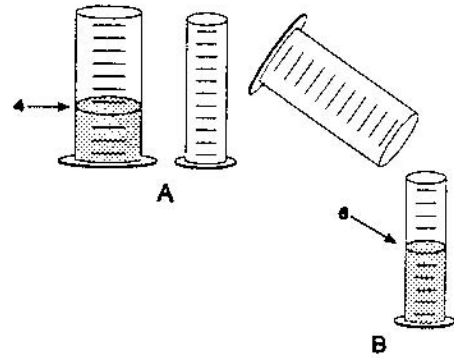


- a. to the same level as it did in Cylinder 1
- b. to a higher level than it did in Cylinder 1
- c. to a lower level than it did in Cylinder 1

4. *because*

- a. the steel marble will sink faster.
- b. the marbles are made of different materials.
- c. the steel marble is heavier than the glass marble.
- d. the glass marble creates less pressure.
- e. the marbles are the same size.

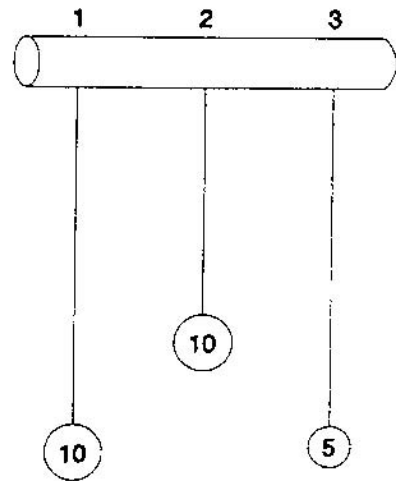
5. To the right are drawings of a wide and a narrow cylinder. The cylinders have equally spaced marks on them. Water is poured into the wide cylinder up to the 4th mark (see A). This water rises to the 6th mark when poured into the narrow cylinder (see B).



Both cylinders are emptied (not shown) and water is poured into the wide cylinder up to the 6th mark. *How high would this water rise if it were poured into the empty narrow cylinder?*

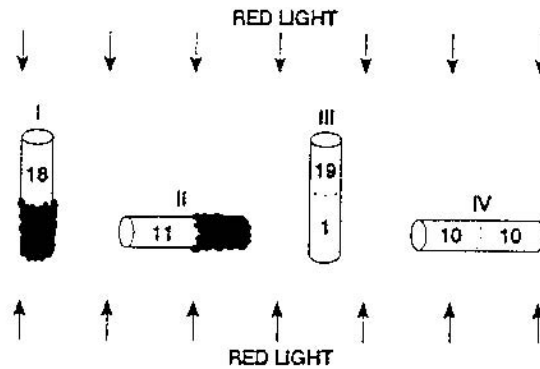
- a. to about 8
  - b. to about 9
  - c. to about 10
  - d. to about 12
  - e. none of these answers is correct
6. *because*
- a. the answer can not be determined with the information given.
  - b. it went up 2 more before, so it will go up 2 more again.
  - c. it goes up 3 in the narrow for every 2 in the wide.
  - d. the second cylinder is narrower.
  - e. one must actually pour the water and observe to find out.
7. Water is now poured into the narrow cylinder (described in Item 5 above) up to the 11th mark. *How high would this water rise if it were poured into the empty wide cylinder?*
- a. to about  $7 \frac{1}{2}$
  - b. to about 9
  - c. to about 8
  - d. to about  $7 \frac{1}{3}$
  - e. none of these answers is correct
8. *because*
- a. the ratios must stay the same.
  - b. one must actually pour the water and observe to find out.
  - c. the answer can not be determined with the information given.
  - d. it was 2 less before so it will be 2 less again.
  - e. you subtract 2 from the wide for every 3 from the narrow.

9. At the right are drawings of three strings hanging from a bar. The three strings have metal weights attached to their ends. String 1 and String 3 are the same length. String 2 is shorter. A 10 unit weight is attached to the end of String 1. A 10 unit weight is also attached to the end of String 2. A 5 unit weight is attached to the end of String 3. The strings (and attached weights) can be swung back and forth and the time it takes to make a swing can be timed.



- Suppose you want to find out whether the length of the string has an effect on the time it takes to swing back and forth. *Which strings would you use to find out?*
- a. only one string
  - b. all three strings
  - c. 2 and 3
  - d. 1 and 3
  - e. 1 and 2
10. *because*
- a. you must use the longest strings.
  - b. you must compare strings with both light and heavy weights.
  - c. only the lengths differ.
  - d. to make all possible comparisons.
  - e. the weights differ.

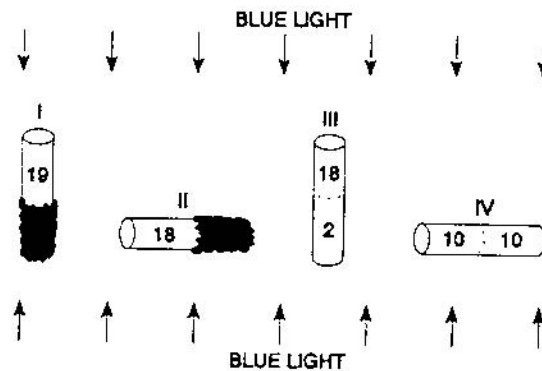
11. Twenty fruit flies are placed in each of four glass tubes. The tubes are sealed. Tubes I and II are partially covered with black paper; Tubes III and IV are not covered. The tubes are placed as shown. Then they are exposed to red light for five minutes. The number of flies in the uncovered part of each tube is shown in the drawing.



*This experiment shows that flies respond to (respond means move to or away from):*

- red light but not gravity
  - gravity but not red light
  - both red light and gravity
  - neither red light nor gravity
12. *because*
- most flies are in the upper end of Tube III but spread about evenly in Tube II.
  - most flies did not go to the bottom of Tubes I and III.
  - the flies need light to see and must fly against gravity.
  - the majority of flies are in the upper ends and in the lighted ends of the tubes.
  - some flies are in both ends of each tube.

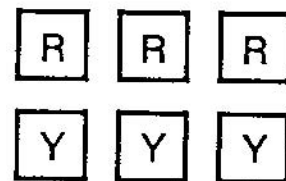
13. In a second experiment, a different kind of fly and blue light was used. The results are shown in the drawing.



*These data show that these flies respond to (respond means move to or away from):*

- blue light but not gravity
  - gravity but not blue light
  - both blue light and gravity
  - neither blue light nor gravity
14. *because*
- some flies are in both ends of each tube.
  - the flies need light to see and must fly against gravity.
  - the flies are spread about evenly in Tube IV and in the upper end of Tube III.
  - most flies are in the lighted end of Tube II but do not go down in Tubes I and III.
  - most flies are in the upper end of Tube I and the lighted end of Tube II.

15. Six square pieces of wood are put into a cloth bag and mixed about. The six pieces are identical in size and shape, however, three pieces are red and three are yellow. Suppose someone reaches into the bag (without looking) and pulls out one piece. *What are the chances that the piece is red?*

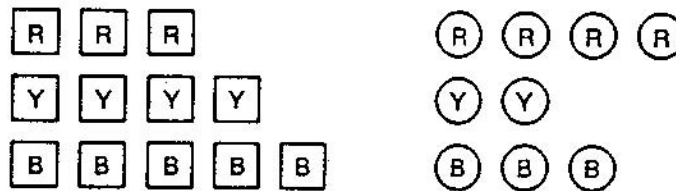


- 1 chance out of 6
- 1 chance out of 3
- 1 chance out of 2
- 1 chance out of 1
- cannot be determined

16. *because*

- a. 3 out of 6 pieces are red.
- b. there is no way to tell which piece will be picked.
- c. only 1 piece of the 6 in the bag is picked.
- d. all 6 pieces are identical in size and shape.
- e. only 1 red piece can be picked out of the 3 red pieces.

17. Three red square pieces of wood, four yellow square pieces, and five blue square pieces are put into a cloth bag. Four red round pieces, two yellow round pieces, and three blue round pieces are also put into the bag. All the pieces are then mixed about. Suppose someone reaches into the bag (without looking and without feeling for a particular shape piece) and pulls out one piece.



*What are the chances that the piece is a red round or blue round piece?*

- a. cannot be determined
- b. 1 chance out of 3
- c. 1 chance out of 21
- d. 15 chances out of 21
- e. 1 chance out of 2

18. *because*

- a. 1 of the 2 shapes is round.
- b. 15 of the 21 pieces are red or blue.
- c. there is no way to tell which piece will be picked.
- d. only 1 of the 21 pieces is picked out of the bag.
- e. 1 of every 3 pieces is a red or blue round piece.

19. Farmer Brown was observing the mice that live in his field. He discovered that all of them were either fat or thin. Also, all of them had either black tails or white tails. This made him wonder if there might be a link between the size of the mice and the color of their tails. So he captured all of the mice in one part of his field and observed them. Below are the mice that he captured.

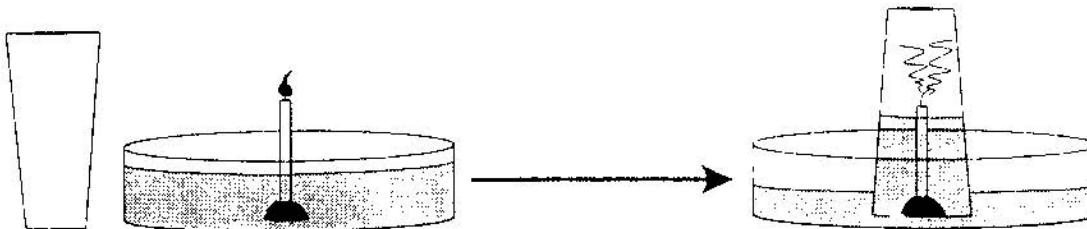


*Do you think there is a link between the size of the mice and the color of their tails?*

- a. appears to be a link
  - b. appears not to be a link
  - c. cannot make a reasonable guess
20. *because*
- a. there are some of each kind of mouse.
  - b. there may be a genetic link between mouse size and tail color.
  - c. there were not enough mice captured.
  - d. most of the fat mice have black tails while most of the thin mice have white tails.
  - e. as the mice grew fatter, their tails became darker.



21. The figure below at the left shows a drinking glass and a burning birthday candle stuck in a small piece of clay standing in a pan of water. When the glass is turned upside down, put over the candle, and placed in the water, the candle quickly goes out and water rushes up into the glass (as shown at the right).



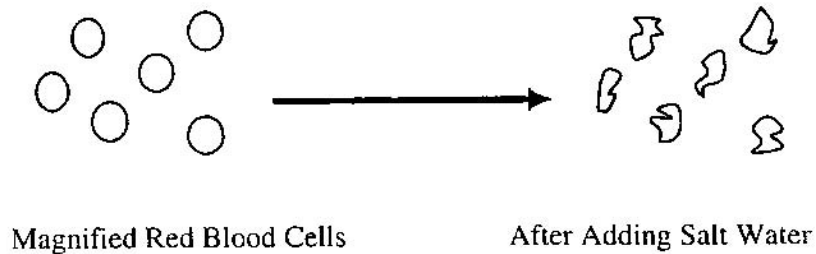
This observation raises an interesting question: Why does the water rush up into the glass?

Here is a possible explanation. The flame converts oxygen into carbon dioxide. Because oxygen does not dissolve rapidly into water but carbon dioxide does, the newly formed carbon dioxide dissolves rapidly into the water, lowering the air pressure inside the glass.

Suppose you have the materials mentioned above plus some matches and some dry ice (dry ice is frozen carbon dioxide). *Using some or all of the materials, how could you test this possible explanation?*

- Saturate the water with carbon dioxide and redo the experiment noting the amount of water rise.
  - The water rises because oxygen is consumed, so redo the experiment in exactly the same way to show water rise due to oxygen loss.
  - Conduct a controlled experiment varying only the number of candles to see if that makes a difference.
  - Suction is responsible for the water rise, so put a balloon over the top of an open-ended cylinder and place the cylinder over the burning candle.
  - Redo the experiment, but make sure it is controlled by holding all independent variables constant; then measure the amount of water rise.
22. What result of your test (mentioned in #21 above) would show that your explanation is probably wrong?
- The water rises the same as it did before.
  - The water rises less than it did before.
  - The balloon expands out.
  - The balloon is sucked in.

23. A student put a drop of blood on a microscope slide and then looked at the blood under a microscope. As you can see in the diagram below, the magnified red blood cells look like little round balls. After adding a few drops of salt water to the drop of blood, the student noticed that the cells appeared to become smaller.



This observation raises an interesting question: Why do the red blood cells appear smaller?

Here are two possible explanations: I. Salt ions ( $\text{Na}^+$  and  $\text{Cl}^-$ ) push on the cell membranes and make the cells appear smaller. II. Water molecules are attracted to the salt ions so the water molecules move out of the cells and leave the cells smaller.

To test these explanations, the student used some salt water, a very accurate weighing device, and some water-filled plastic bags, and assumed the plastic behaves just like red-blood-cell membranes. The experiment involved carefully weighing a water-filled bag, placing it in a salt solution for ten minutes and then reweighing the bag.

*What result of the experiment would best show that explanation I is probably wrong?*

- a. the bag loses weight
  - b. the bag weighs the same
  - c. the bag appears smaller
24. *What result of the experiment would best show that explanation II is probably wrong?*
- a. the bag loses weight
  - b. the bag weighs the same
  - c. the bag appears smaller