1. At about 1,100-1,400 seconds, when the probe was placed inside the container, CO₂ levels remained stable on the graph.
2. The plant begins to undergo photosynthesis. This process absorbs CO₂, causing levels of the gas in the container to fall.
3. The CO₂ levels increase when the light source is turned off because plants release carbon during respiration. This process generally occurs at a slower rate than the rate at which the plant absorbs carbon dioxide during photosynthesis.
4. The slope of the line between E and F is 366 ppm over 1,000 seconds. The slope is greater, and therefore steeper, between E and F than between E and G. That means CO₂ levels are rising faster between E and F, because the plant can’t undergo photosynthesis in the dark. When the black paper is removed, the plant can undergo some photosynthesis, so CO₂ levels rise more slowly.
5. Yes, the experiment supports his solution. The plant removed carbon dioxide from the air when it underwent photosynthesis. The trees planted will need to be placed in areas where there is sufficient light so that they can undergo photosynthesis.

**HEAT-TRAPPING GASES**

1. Carbon dioxide
2. Methane; its GWP is 21 while that of carbon dioxide is only 1.
3. CFCs; they were not present in the atmosphere in preindustrial times.
4. Answers may include that the warming effect of carbon dioxide emissions would continue for a longer period of time because the gas can last for 100 years in the atmosphere.
5. Cutting down trees increases carbon dioxide in the air because less of the gas will be absorbed in photosynthesis. Deforestation is often done to increase farmland, and farming adds methane and nitrous oxide to the atmosphere.
6. Answers may vary but may include that planting trees addresses only atmosphere.

**AIR FILTER**

1. Both solutions aim to remove carbon dioxide from the atmosphere. This gas traps heat and is linked to climate change.
2. Answers may include that the Climeworks solution is more efficient at absorbing carbon dioxide but that it is expensive.
3. Answers may include that the waste plant produces CO₂ as it operates, which can be directly absorbed by Climeworks.
4. Answers will vary but may include that planting trees is less expensive and could have other benefits—such as providing homes and food for animals.

**CARBON TRANSPORT**

1. Factories burning fossil fuels, animal respiration, plants decaying
2. The arrow represents the process of respiration, during which plants release some carbon dioxide as they break down sugars for energy.
3. Oceans are similar to forests in that they both absorb carbon dioxide from the atmosphere.
4. If there are fewer marine plants, less carbon dioxide will be absorbed from the atmosphere during photosynthesis. CO₂ levels in the atmosphere would increase.
5. Humans can burn less fossil fuels, reduce deforestation, and protect the health of the oceans.

**A WINNING BALL**

**BRAIN UNDER ATTACK**

1. Both hemorrhagic and ischemic strokes occur when blood flow is reduced or blocked to parts of the brain. In hemorrhagic strokes, the cause is a burst or leaking blood vessel. In ischemic strokes, the cause is a blood clot that blocks blood flow.
2. False. High blood pressure and smoking can increase one’s risk of stroke. Reducing blood pressure—with medicine or diet and exercise—and quitting smoking can reduce the risk.
3. Answers may vary but should include sudden dizziness and loss of balance or coordination.
4. The longer blood flow is blocked, the more brain cells are affected. The more damage that occurs in the brain, the harder it is to recover brain function.
5. Answers will and could include that Amelia's ball may help only people who have moderate damage and those who have had damage in brain areas that control movement.

**MADE TO LAST**

1. B 2. A
3. Answers may include that the balls don’t need to be inflated, so people who don’t have pumps can still use them, and the balls are durable and can last a long time even if they are used on rough surfaces.
4. Answers may include that by having such material, the shoes would be lightweight, hold their shape, and wouldn’t wear out for a long time.
5. Answers will vary but may include that the material could be used to make other types of sports equipment or shoes that would last a long time.

**BE AN INVENTOR**

**Part 1:**

1. Amelia, a soccer player, struggled to kick a soccer ball with accuracy. She wanted to create a ball that could tell her when she had properly made a kick.
2. Answers will vary but may include that the ball needs to be able to detect when the person has kicked the ball in the right spot with the right pressure, and the ball needs to be able to alert the person when he or she is successful.

**Part 2:**

Answers will vary.

**UNDER PRESSURE**

1. Air pressure decreases with increasing altitude.
2. It’s roughly 36 kPa.
3. Altimeters measure altitude. They work by translating the air pressure outside the plane into altitude.
4. A ball should fly farther when kicked at the higher altitude. Because there is less air pressure, molecules are spread further apart. There should be less resistance against the ball as it flies through the air.
5. Answers will vary but may include that when a person kicks a ball with a lower air pressure, part of the kicking force is used to squeeze the air molecules closer together inside the ball—instead of pushing the ball forward.

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SHOOTING FOR THE STARS
LIFE ON MARS?
1. C  2. B  
3. There is no evidence of liquid water on the planet—a necessary ingredient for life as we know it.
4. Answers will vary but may include that scientists are searching for features, such as water and carbon, that are linked to life on Earth. That indicates that they think alien life might be similar to life on Earth.
5. Answers will vary but may include that samples should be taken in areas where there are indications that liquid water once flowed. Scientists believe liquid water is necessary for life to exist.

SIGN OF LIFE?
1. Living organisms could have produced methane in the past. The gas could have been stored underground and released later.
2. No. Nonbiological processes, such as rock chemistry and UV breakdown of organic molecules, could have produced the methane.
3. To produce methane, olivine, water, and carbon monoxide or carbon dioxide are needed. Olivine reacts with water to produce hydrogen, which reacts with carbon monoxide or carbon dioxide to form methane.
4. Answers will vary but may include that they could analyze the rocks near the source of the methane to see if the ingredients needed for rock chemical reactions are present, or if there are other signs of living organisms.

DESIGN A SPACE HABITAT
Answers will vary. Models should account for the basic needs of astronauts given the conditions found on Mars.

EXPLORE A STEM CAREER
Answers will vary.

FIGHTING DROUGHT WITH ORANGES
ADAPTED FOR DROUGHT
1. Stomata are small holes that allow plants to take in carbon dioxide. It’s likely plants in wet conditions would also open their stomata during the day.
2. Like the hairs on a globemallow, a cactus’s spines can divert the flow of wind and reduce the amount of water lost through evaporation.
3. Cacti, juniper tree, and mesquite tree. Cacti can have very deep or wide, surface-level roots. The juniper tree has both deep and wide roots. The mesquite tree has deep roots.
4. Wavy leaves reduce the amount of evaporation from the leaves so plants lose less water. Smaller leaves have less surface area for evaporation to occur.
5. Answers will vary but may include plants with waxy leaves, different varieties of cacti, or trees known to have specialized roots.

SOAK IT UP
Experiment designs will vary but should include placing an equal weight of each of the absorbent materials in a container and adding a certain amount of water to each container. Students should let the materials sit for a period of time, drain excess water from the materials, and reweigh them to see how much water they absorbed.
A bar graph would be the best choice to compare how much water each material absorbed.
1. Answers may include that the materials expanded in size as they absorbed water.
2. Answers will vary.
3. Answers will vary but may consider both how much water the materials absorbed as well as whether the materials are safe and biodegradable.

SALTWATER SOURCE
1. D  2. C  
3. Seawater is forced through a membrane that contains many tiny holes. Large particles like salt are prevented from flowing through the membrane—creating clean, fresh water.
4. Answers will vary but may include whether there are other ways to provide water to that region that use less energy or are less harmful to the environment; whether the region is close to the ocean; whether there are endangered marine organisms near the region that could be affected by the plants.
5. Answers will vary but may include that warming temperatures may cause areas to become drier and have less water—making desalination a possible solution. However, desalination requires a lot of energy that can release greenhouse gases into the atmosphere that may cause Earth’s temperature to rise.

TRACKING DROUGHT
1. 8  2. It has increased.  3. 2013
4. Answers may include that a low amount of precipitation in one year may cause a drought in the following year. 2013 was the worst drought year for California, even though there was more rain fell that year than the year before.
5. Answers may include that the prices increased in recent years because fewer crops were able to grow due to the lack of water in California.

CHECK FOR UNDERSTANDING
CHAMPION FOR TREES
1. Carbon dioxide is a greenhouse gas that traps heat.
2. Trees absorb carbon dioxide from the air and use it to create sugars through photosynthesis.
3. He believes that many adults do not think the worst effects of climate change will happen in their lifetimes.
4. Felix considered how many trees are estimated to be on the planet today, how many are disappearing each year, and how much carbon dioxide trees absorb.
5. The ancient plant material in fossil fuels contains carbon that was stored when the plant was alive. When the fuels are burned, that carbon is released into the atmosphere.

A WINNING BALL

SHOOTING FOR THE STARS
1. space  2. STEM  3. low gravity  4. simulators  5. spacesuits
6. water; oxygen  7. carbon dioxide  8. radiation  9. books
10. mathematicians

FIGHTING DROUGHT WITH ORANGES
ADAPTED FOR DROUGHT
1. g  2. i  3. f  4. a  5. c  6. h  7. d  8. e  9. b  10. j

CROSSWORD
ACROSS
12. greenhouse gases

DOWN
1. physical therapy  2. drought  3. famine  5. pectin  6. lignin
8. simulators

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