

**STUDENT EDITION**

**HEY, HUMAN!, p. 22**  
**INVESTIGATE IT!**

1. They investigated whether dogs use facial expressions to communicate with their owners.
2. They had the owners perform different actions to study the influence of treats and the owners' faces on the dogs' behavior.
3. The findings suggest that dogs do try to communicate with their owners, even when food isn't involved.
4. No, scientists can't know for certain what the dogs were trying to communicate. Although the scientists could see that the dogs' facial expressions changed, the experiment didn't have any way to determine the intended meaning of the expressions.

**WHAT IN THE WORLD?, p. 32**

Workers with Metra, a commuter railroad in Chicago, Illinois, set fire to this train track last winter to fix damage brought on by the extreme cold. Frigid temperatures can cause the metal tracks to contract. That shrinking can break bolts that hold the tracks together and cause small cracks to form in the track, or even split a rail apart. Heating the tracks makes the metal expand so it's easier for workers to repair cracks or reattach broken sections. Once the fire has warmed the tracks, the workers put out the flames. Then they use a torch to weld the track, melting the metal to fill in any cracks, or bolt broken pieces together.

**PLASTIC OR THE PLANET?**  
**PLASTIC PREDICTIONS**

**Post-Reading Answers**

- |   |
|---|
| 1. <b>TRUE:</b> In laboratories, plastic pollution has been shown to affect the growth of species of bacteria that live in the ocean and produce most of the oxygen we breathe. |
| 2. <b>FALSE:</b> Microplastics (less than 5 mm in length) can be ingested by organisms and may release toxic chemicals.   |
| 3. <b>FALSE:</b> Experts predict the weight of plastic waste in the ocean will exceed that of all the fish in the sea by 2050.  |
| 4. <b>FALSE:</b> The equivalent of a garbage-truck load of plastic ends up in the ocean every minute.   |
| 5. <b>FALSE:</b> Only 9 percent of plastic used today is recycled.  |
| 6. <b>FALSE:</b> The average person in the U.S. uses 365 plastic bags per year.   |

**BAG BANS?**

1. 13
2. Answers will vary depending on one's home state.
3. California has statewide bans on plastic bags. In Colorado, only some local areas have bans on bags.
4. Answers may include that plastic bags are a very common plastic object that people use. The article states that shoppers in the U.S. use almost one plastic bag per day on average.
5. Answers will vary but should include evidence that supports students' opinions, such as how often single-use plastics are used and the damage plastic can do to the environment.

**PLASTIC BY THE NUMBERS**

1. The majority of plastic waste in 2015 was put in landfills: 75 percent.
2. The amount of plastic recycled increased by 1,660 tons from 2000 to 2015 (in thousands of tons).

3. The increase in recycling has not caused less plastic waste to end up in landfills, as more plastic is being produced each year. Since 2000 the amount of plastic produced has nearly doubled worldwide, and the amount of plastic waste generated in the U.S. has increased by roughly 9,000 tons (in thousands of tons).
4. Answers may include that by reducing the amount of plastic you use, including refusing single-use plastics and reusing plastic, you can help decrease demand for new plastic and reduce the amount that pollutes the environment. By recycling plastic, you can help reduce the amount that ends up in landfills.
5. Answers will vary but may include that the pie chart shows how little plastic is recycled compared to the amount put in a landfill, while the table shows the big increase in thousands of tons of plastic being generated over time.

**SPICE IT UP!**

**LIFE OF A FLOWERING PLANT**

1. The plant's stamen is a male reproductive structure on the plant. Pollen is produced at the top of the stamen, on the anther. The stamen stands out above the petals, so it is easy for pollen to get transferred to a pollinator.
2. Ginger is the root of a flowering plant. The roots absorb water and minerals from the ground. They also anchor the plant.
3. Answers may include that bark helps keep the tree upright, keeps water inside, and protects the tissues that transport water and food through the plant.
4. Answers may include that when an egg in an ovary on the flower on a *Myristica* nutmeg tree is fertilized by pollen, it grows into a seed. A fruit grows around the seed. If an animal eats the fruit, it may deposit the seeds of the fruit in its waste on the ground. The seeds may grow into a new tree.
5. Answers will vary but may include that nutmeg and cloves are derived from different structures of the plant. Cloves come from the flower buds of a plant, which support reproduction by attracting pollinators. The flower contains the reproductive structures. Nutmeg is a seed that grows in a later stage after the egg cell in a flower is fertilized. The seed is the part that will grow into a new plant.

**FEELING COOL**

1. Nerve cells carry electrical signals from the tongue to the brain. The brain then interprets that signal.
2. When menthol attaches to the protein, it opens a tunnel between the outside and inside of a nerve cell. That allows ions to flow—creating an electrical signal that can pass from nerve cell to nerve cell and send information to your brain.
3. Answers will vary but may include ice cream because it is cold and TRPM8 is activated by cold temperatures.
4. Answers may include that if something is very hot or very cold, it could damage tissue in the mouth. When your brain receives a signal that something is too hot or cold, you can respond by spitting it out.

**SPICE ROUTES**

1. Spices like pepper and cinnamon grow in tropical climates. The countries from which they were gathered from are located around the equator.
2. Spices like pepper and cinnamon grow only in tropical regions. Spices became very valuable in Europe because long journeys were required to get them. As a result, there was only a limited supply to meet a high demand.
3. Answers may include that the merchant may have sailed from Venice

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to Calicut, India, before returning to Venice and then sailing off again to London.

4. Answers may include that Venice is located on the coast. It is relatively central in Europe and closer to the spice routes that went to Asia than cities like London.

5. Answers may include that many European countries involved in the spice trade colonized Asian countries to take control of spice supplies and make more money.

**STAR WARS VS. THE REAL WORLD**

**FACT VS. FICTION**

Answers will vary.

**ROBOT DESIGNER**

Answers will vary.

**CODED INSTRUCTIONS**

Answers will vary but should include clear, one-step actions such as start a new row, pick up a cup, put down a cup, and turn a cup a certain number of degrees.

**INVESTIGATE IT! HEY, HUMAN!**

**ANIMAL INVESTIGATION**

Answers will vary but should include observations, a clearly stated research question, a hypothesis, data to be collected, and limitations of the investigation.

**GOT THE MESSAGE?**

1. Young chimpanzees are using visual signals (facial expressions) to communicate with dominant members of their troops. Possible hypotheses about the purpose of this behavior may include that the animals are communicating that they are not a threat so they will not be attacked.

2. Answers may include that a strong sense of smell helps animals pick up faint smells, such as the pheromones a lion leaves by rubbing against a tree.

3. Answers will vary but may include examples such as warning sounds that notify other animals in a population that danger is near so they can protect themselves or escape, or communication that helps organisms find mates so they can reproduce.

4. Answers may include that an example of interspecies communication is the bright coloring of a poisonous frog. It benefits both the frog and predator species. By signaling that it is toxic, the frog may keep itself safe from being eaten and may keep the predator safe by helping it avoid getting sick or dying if it were to eat the toxic frog.

5. Answers will vary but may include that dogs could communicate with their owners through sound by barking to warn of intruders, or with tactile communication by rubbing against or lying near their owners to strengthen bonds.

**MAKING FACES**

1. Scientists use measurements of how each facial muscle moved to classify horses' expressions.

2. Answers may include that by observing horses in different situations, the researchers have a better chance of recording many different types of facial expressions.

3. Answers may include that the system gives scientists around the world a method to record the facial expressions they see in the same way. That way, they can compare their data. Without the database,

different scientists might classify expressions in different ways, making it difficult to compare their data.

4. Answers may vary but could include that scientists have identified 17 different facial expressions in horses and that they share facial expressions with humans.

5. Answers may include that both studies investigated animal communication and that neither study gathered information that links the facial expressions they saw with any emotions the animals are feeling. Wathan's study mapped muscles in the horses' faces, while Kaminski's did not quantify the number of facial expressions that dogs make.

**FROZEN CONCERT**

**SOUND GAUGE**

1. Diamond; 12,000 meters/second is the fastest. Air at zero degrees Celsius; 331 m/s is the slowest. Diamonds are solids, so the particles are tightly packed and quickly transfer the sound energy. In a gas, the particles are more spread out than in a solid and take longer to transfer the sound energy to other particles.

2. Sound would travel slightly slower to the audience in the cold conditions in which the Finse ice orchestra plays. The speed of sound in air is faster at 20°C than at 0°C.

3. 0.67 seconds; It would take less time in seawater, so it can be inferred that seawater is denser than fresh water since sound waves travel faster through denser materials.

4. In general, sound travels faster in solids than in liquids or gases. The particles are packed closer together so the vibrations can move faster from one particle to another.

5. As ice instruments begin to melt, the sound would begin to travel slower. In general, sound travels slower through liquids than through solids.

**ALTERNATIVE INSTRUMENTS**

1. D

2. B

3. A piccolo trumpet would have a higher sound because it is smaller. Thus, the volume of air that vibrates is smaller. The smaller the volume of air, the higher the pitch.

4. Answers may include that they are more durable than metal instruments, they require less maintenance such as oiling, they are less expensive, and they are lighter. Answers will vary for the most critical factor but should include a justification for their choice.

5. Answers may include that ice has a different density than other materials used to make instruments, like metal and wood. The density of the material affects the way air vibrates and changes the sound waves that are made.

**MUSIC MAKER**

1. Answers will vary depending on the adjustments made but may include that the changes altered the way air moved through the straw and, as a result, affected the sound waves that were produced.

2. A short straw produces a sound with a higher frequency. The pitch produced by the shorter straws was higher. Thus, the sound waves had higher frequencies (see the top wave in the diagram from the article). The long straw created a wave with a lower frequency and larger wavelength (see the bottom wave in the diagram from the article).

3. Answers may include that the sounds made by bamboo or metal panpipes may be clearer and longer-lasting. The characteristics of a material used to make an instrument affect the sound produced. As

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the article noted, materials emit different sounds because they vibrate differently when hit.

**DESIGN A MUSEUM EXHIBIT**

Answers will vary.

**NEWS QUIZ**

1. b 2. d 3. c 4. a 5. a 6. b 7. b 8. b 9. c 10. a

**CHECK FOR UNDERSTANDING**

**PLASTIC OR THE PLANET?**

1. d 2. a 3. i 4. c 5. e 6. b 7. j 8. f 9. h 10. g

**SPICE IT UP!**

1. C 2. D 3. A 4. B 5. A

**ROBOTS: STAR WARS VS. THE REAL WORLD**

1. Answers may include that robots don't need to breathe, so they can easily work in the conditions in space.
2. The robots on the International Space Station need to hold tools designed to be used by humans so they have more human-like features. Those that work on other planets don't need to work as humans do so they have different features.
3. Answers may include that they may have smaller incisions and quicker recovery times because robots' arms are smaller and easier to maneuver than surgeons' hands.

4. Answers may include that engineers may incorporate features of familiar everyday digital devices and give the robot anthropomorphic (human-like) features.

5. Answers will vary but may include jobs that are dangerous, occur in confined spaces, or expose humans to unpleasant conditions such as those encountered in mining. Some advantages include that robots do not tire and can function in more hostile conditions than humans

**HEY, HUMAN!**

1. F 2. F 3. T 4. T 5. T

**FROZEN CONCERT**

1. percussion
2. acoustics
3. sound waves
4. metal
5. frequency
6. amplitude
7. wavelength
8. melting point
9. states of matter
10. Vapor