Passage VI

Two students explain why the *smoke* (a mixture of gases and carbon particles) from burning wood in a fireplace rises up the chimney from the fireplace. They also discuss how chimney *efficiency* (the volume of smoke flowing out the top of the chimney per second for a given temperature difference between inside and outside the chimney) is related to chimney height.

Student 1

Smoke rises because the gases from burning wood are less dense than the air that surrounds the fireplace. Because the gases are hotter than the air, the gas molecules have a higher average speed than the air molecules. Consequently, the average distance between adjacent gas molecules is greater than the average distance between adjacent air molecules, and so the gas *density* is less than the air density. As a result, the upward *buoyant force* acting on the gases is stronger than the downward *force of gravity* acting on the gases, and the gases rise, carrying the carbon particles with them. The upward flow of smoke is maintained as new air enters the fireplace, causing more wood to burn.

As chimney height increases, efficiency increases. The taller the chimney, the greater the volume of hot gas, the stronger the buoyant force compared with the force of gravity, and the more rapidly smoke rises.

Student 2

Smoke rises because wind blows across the top of the chimney. When no wind is blowing, the air pressure at the bottom of the chimney is slightly higher than the air pressure at the top of the chimney. However, when air at the top of the chimney moves at a higher speed than air at the bottom of the chimney, the pressure difference between the bottom and the top of the chimney is so great that air is forced upward, carrying smoke with it. The departure of air from the bottom of the chimney, in turn, creates a pressure difference that forces new air into the fireplace, causing further burning and an upward flow of smoke.

As chimney height increases, efficiency increases. Generally, wind speed increases with altitude. The taller the chimney, the greater the difference in air speed, the greater the difference in air pressure, and the more rapidly smoke rises.

28. According to Student 1, which of the following quantities is *less* for the gases from burning wood than for the air that surrounds the fireplace?

- **F.** Average speed of the molecules
- **G.** Average distance between adjacent molecules
- **H.** Density
- **J.** Temperature

29. When wood was burned in 2 fireplaces that differ only in the height of their chimneys (keeping the same temperature difference between inside and outside each chimney), Chimney Y was found to be more efficient than Chimney X. What conclusion would each student draw about which chimney is taller?

- **A.** Both Student 1 and Student 2 would conclude that Chimney X is taller.
- **B.** Both Student 1 and Student 2 would conclude that Chimney Y is taller.
- **C.** Student 1 would conclude that Chimney X is taller; Student 2 would conclude that Chimney Y is taller.
- **D.** Student 1 would conclude that Chimney Y is taller; Student 2 would conclude that Chimney X is taller.

30. Which student(s), if either, would predict that smoke from burning wood will rise up the chimney from a fireplace on a day when the air at the top of the chimney is NOT moving?

- **F.** Student 1 only
- **G.** Student 2 only
- **H.** Both Student 1 and Student 2
- **J.** Neither Student 1 nor Student 2

31. When wood is burned in a fireplace, air in the fireplace, as well as gases from the burning wood, rises up the chimney. Student 1 would most likely argue that the air in the fireplace rises because the air is:

- **A.** hotter than the gases from the burning wood.
- **B.** cooler than the gases from the burning wood.
- **C.** hotter than the air that surrounds the fireplace.
- **D.** cooler than the air that surrounds the fireplace.

32. When the air inside a particular hot-air balloon cooled, the balloon and its inside air descended. Based on Student 1's explanation, the reason the balloon and its inside air descended is most likely that the:

- **F.** downward buoyant force acting on the balloon and its inside air was stronger than the upward force of gravity acting on the balloon and its inside air.
- **G.** upward buoyant force acting on the balloon and its inside air was stronger than the downward force of gravity acting on the balloon and its inside air.
- **H.** downward force of gravity acting on the balloon and its inside air was stronger than the upward buoyant force acting on the balloon and its inside air.
- **J.** upward force of gravity acting on the balloon and its inside air was stronger than the downward buoyant force acting on the balloon and its inside air.

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