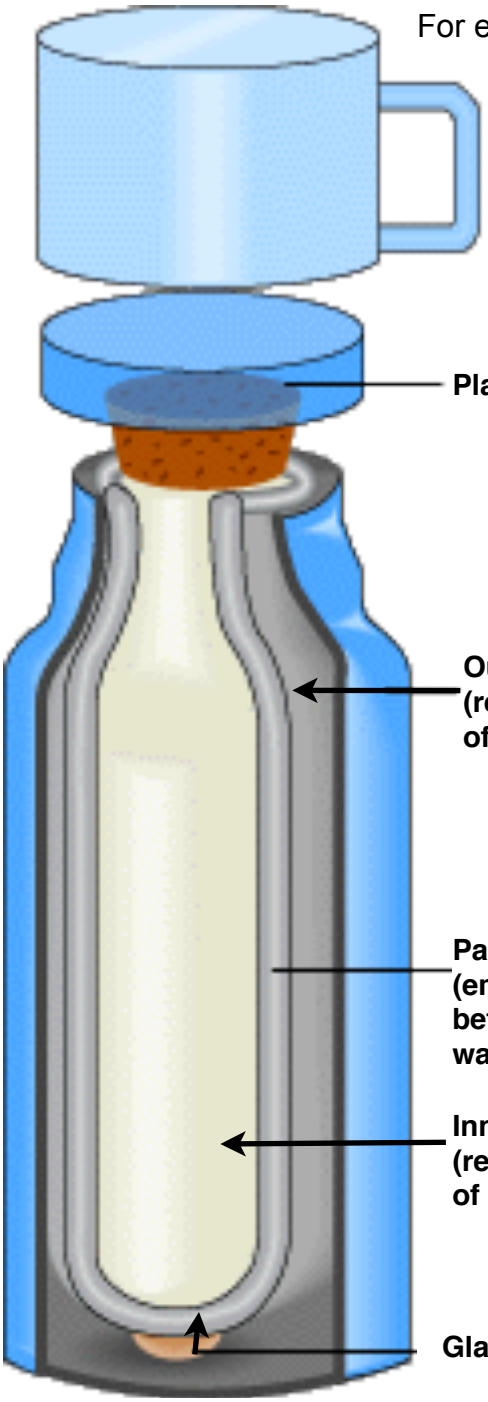
Name: _____

HOW DOES IT WORK?

How can a vacuum bottle keep your hot drink hot and at other times keep your cold drink cold? Surprise, it's all about HEAT! Use your knowledge about heat transfer (and the info on the back of this sheet) to describe how each part of the bottle works to keep energy from either entering or escaping.



For each part, describe the type of heat transfer that is prevented.

Plastic cap: _____

_____

_____

Outer/inner silvered wall of vacuum bottle: _____

_____

_____

Challenge: Does the outer or inner silvered wall keep your drink hot? Why?

_____

_____

Partial vacuum between walls: _____

_____

_____

Why does a styrofoam or paper cup keep a hot drink warmer than a metal cup? What kind of heat transfer is happening? (Similar question: why do they give out those cup sleeves at coffee shops?)

_____

_____

_____

_____

CONDUCTION In the process of **conduction** (kuhn-DUHK-shuhn), heat is transferred through a substance, or from one substance to another, by the direct contact of molecules. All molecules are constantly in motion. Fast-moving molecules have more heat energy than slow-moving molecules.

When fast-moving molecules collide with slow-moving molecules, heat energy is transferred from the faster molecules to the slower molecules, causing the slower molecules to move faster. Now these molecules have enough energy to collide with other slow-moving molecules. This process is repeated over and over. In this way, heat energy is transferred from molecule to molecule throughout a substance. Because all matter is made of molecules, conduction can take place in solids, liquids, and gases. But conduction takes place best in solids, because the molecules of a solid are in direct contact with one another.

Some substances conduct heat better and more rapidly than other substances. These substances are good **conductors** of heat. Metals, such as iron and aluminum, are good heat conductors. Silver is one of the best conductors of heat. Copper is another good conductor of heat. Why do you think the bottoms of pots and pans are often made of copper?

Substances that do not conduct heat easily are called **insulators.** Glass, wood, plastic, and rubber are examples of good insulators. Why should the handles of pots and pans be made of wood or plastic instead of iron or aluminum?

Air is also a good insulator. That is why the best way to stay warm in extremely cold weather is to wear several layers of clothing. Layers of clothing will trap air close to your body and prevent the loss of body heat.

CONVECTION Heat transfer by **convection** (kuhn-VEHK-shuhn) takes place in liquids and gases. Heat energy is transferred through liquids and gases by means of up-and-down movements called convection currents. When a liquid or gas is heated, the molecules begin to move faster. (They have more energy as a result of being heated.) As the molecules move faster, they move farther apart. This means that the heated liquid or gas is now less dense than the surrounding liquid or gas. The less-dense liquid or gas rises, carrying heat with it.

Warm air near the surface of the Earth is heated by the Earth and becomes less dense than the cooler air above it. The warm air tends to rise. Hang gliders and soaring birds rely on updrafts of warm air to help keep them aloft. Because cooler air is denser than warmer air, it tends to sink, just as a dense rock sinks in water. As warm air rises and cool air sinks, convection currents are formed. These currents transfer heat throughout the Earth's atmosphere and contribute to the Earth's weather. Convection currents are also formed in the Earth's oceans as warm water rises to the surface and cold water sinks to the bottom.

RADIATION Heat energy is transferred through empty space by **radiation** (ray-dee-AY-shuhn). Heat from the sun reaches the Earth by means of radiation. The heat energy is in the form of invisible light called infrared radiation. Other familiar forms of heat transfer by radiation include the heat you can feel around an open fire or a candle flame, the heat near a hot stove, and the heat given off by an electric heater. Now can you explain why you can toast marshmallows over a fire even if the flames do not touch the marshmallows?

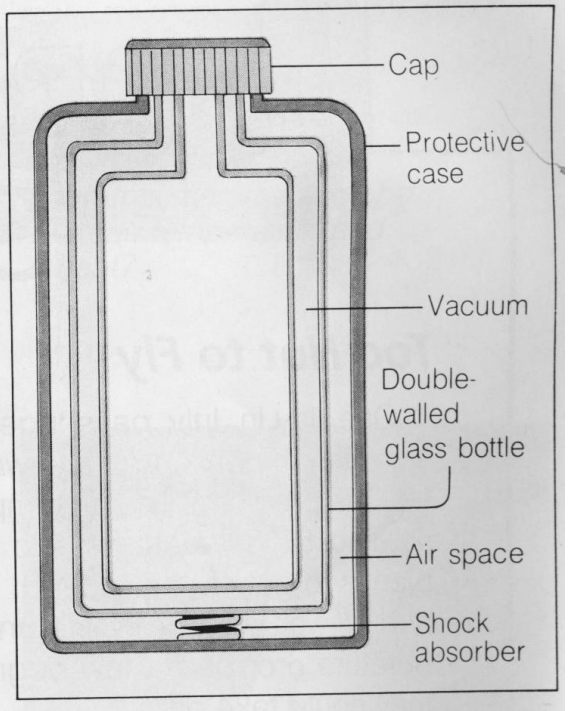


Figure 1–7 *A thermos bottle keeps liquids hot or cold by preventing heat transfer by conduction, convection, or radiation. The glass bottle reduces conduction. The air space between the bottles, which is a partial vacuum, prevents heat transfer by convection because there are so few air molecules to carry the heat. A silvered coating on the surface of the bottle prevents heat transfer by radiation. Why is the cap usually made of plastic?*