CHAPTER 3
STATES OF MATTER

OBJECTIVES

- Students will:
  - explain kinetic molecular theory
  - differentiate between solids, liquids, and gases
  - explain changes of state
  - discuss various properties of fluids (liquids and gases), specifically buoyancy and density

3.1

MATTER AND ENERGY

MATTER AND ENERGY

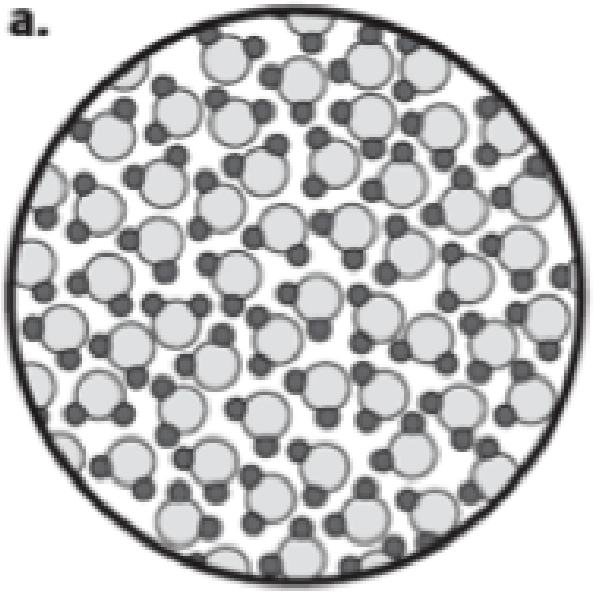
Kiinetic Molecular Theory: All matter is made of atoms and molecules. These tiny particles are always in motion.

At the same temperature, more massive particles move more slowly than less massive ones. An increase in temperature results in an increase of motion.

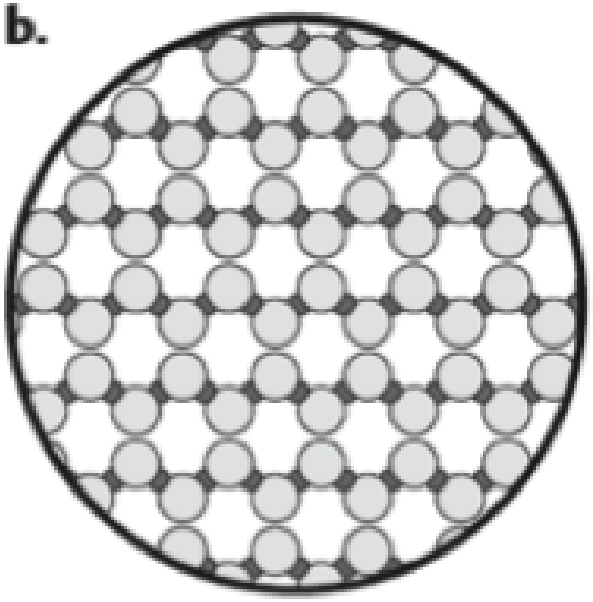
Which drawing represents a solid?

A

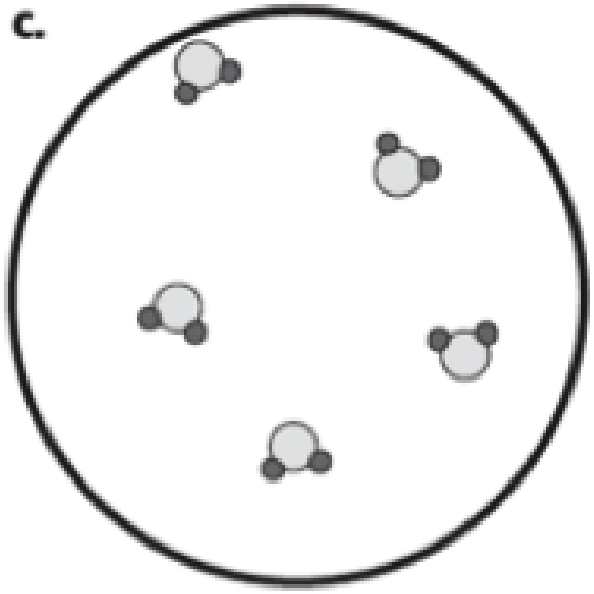
a.



b.



c.



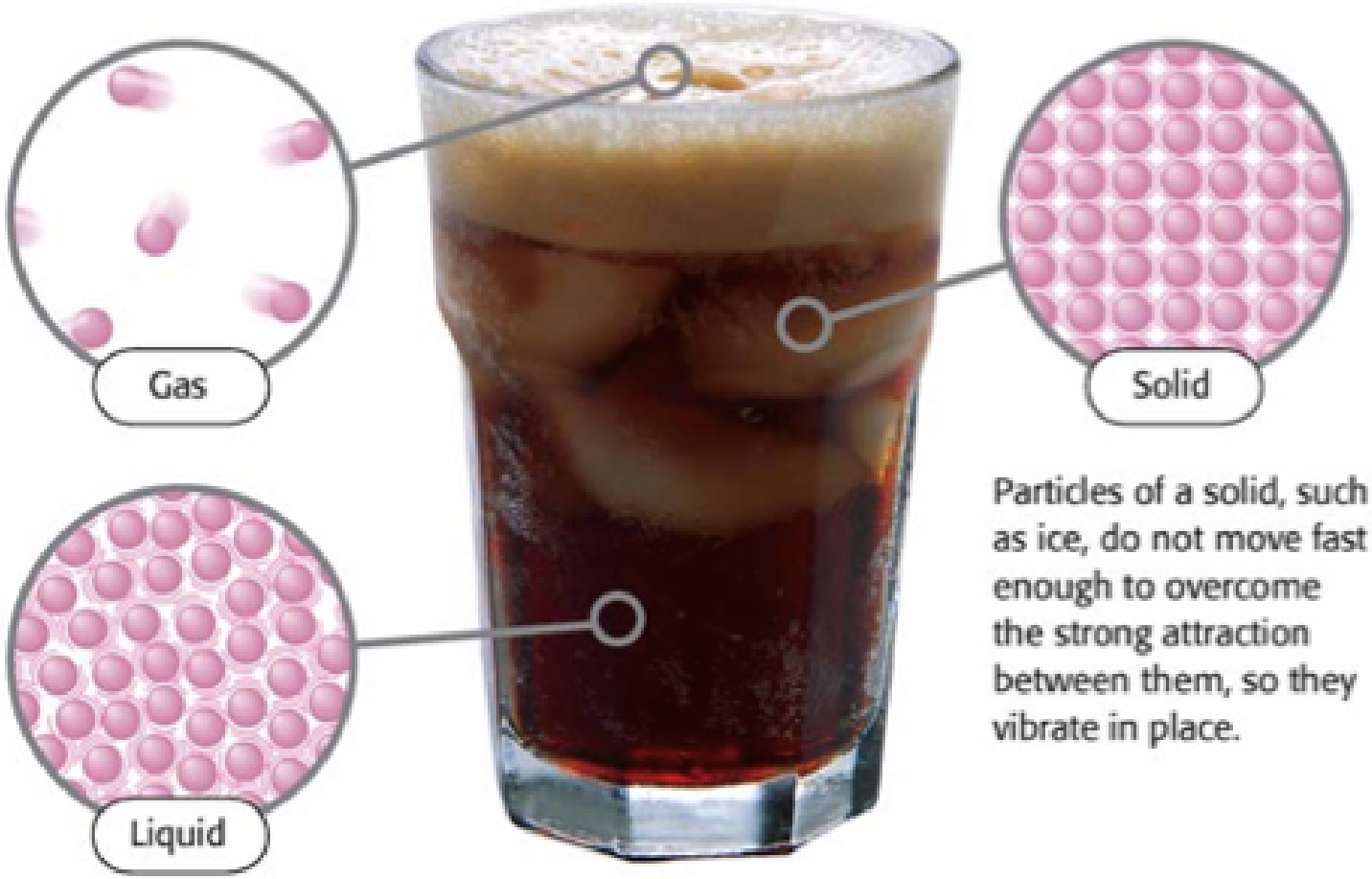
STATES OF MATTER

solid: particles are packed closely together, particles don't move, they vibrate.

liquid: particles move over and around each other

gas: particles move freely and separate

Particles of a gas, such as carbon dioxide, move fast enough to overcome nearly all of the attraction between them. The particles move independently of one another.



Particles of a liquid move fast enough to overcome some of the attraction between them. The particles are able to slide past one another.

Particles of a solid, such as ice, do not move fast enough to overcome the strong attraction between them, so they vibrate in place.

	DEFINITE SHAPE	DEFINITE VOLUME
SOLID		
LIQUID		
GAS		

There is a fourth state of matter called **plasma**.

Plasma

- is the most common form of matter in the universe! (~99%)
- has no definite shape or volume
- is made of charged particles...it's ionized
- examples include fire, lightning, Aurora Borealis....

Getting back to the kinetic molecular theory…

Energy is the ability to change or move matter…or the ability to do work.

The energy of motion is called **kinetic energy**.

All particles contained in matter are in motion, therefore, they have kinetic energy.

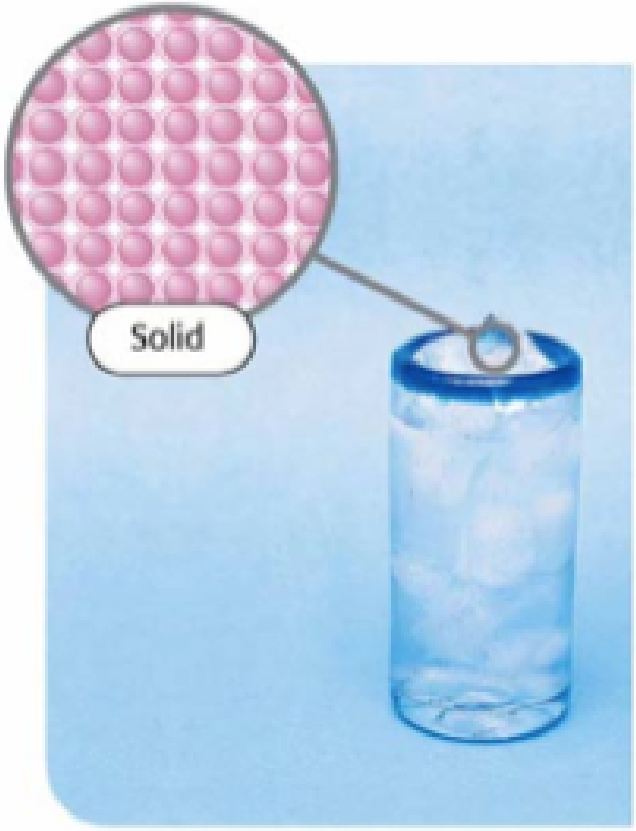
Which state of matter has the most energy?

Which state of matter has the least energy?

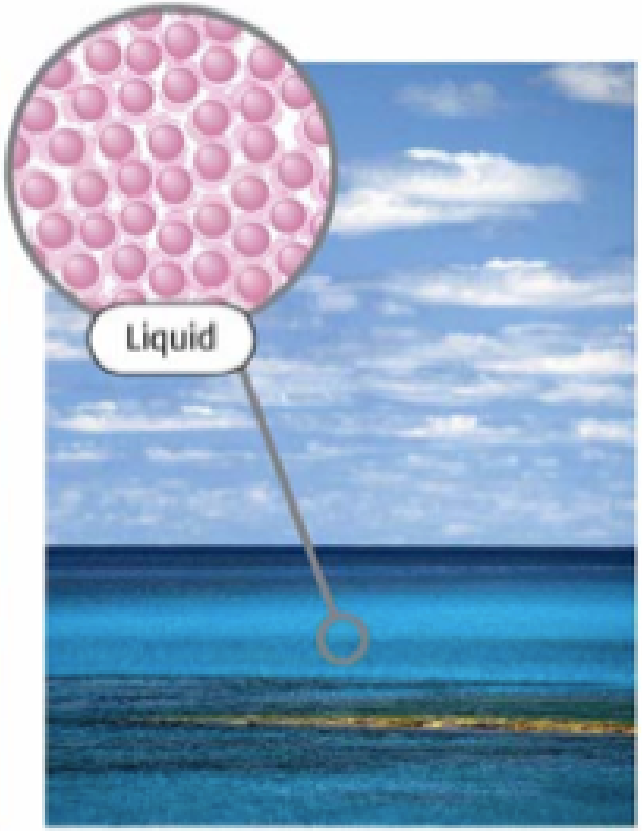
Temperature is a measure of average kinetic energy.

- increased KE = increased Temperature
- decreased KE = decreased Temperature

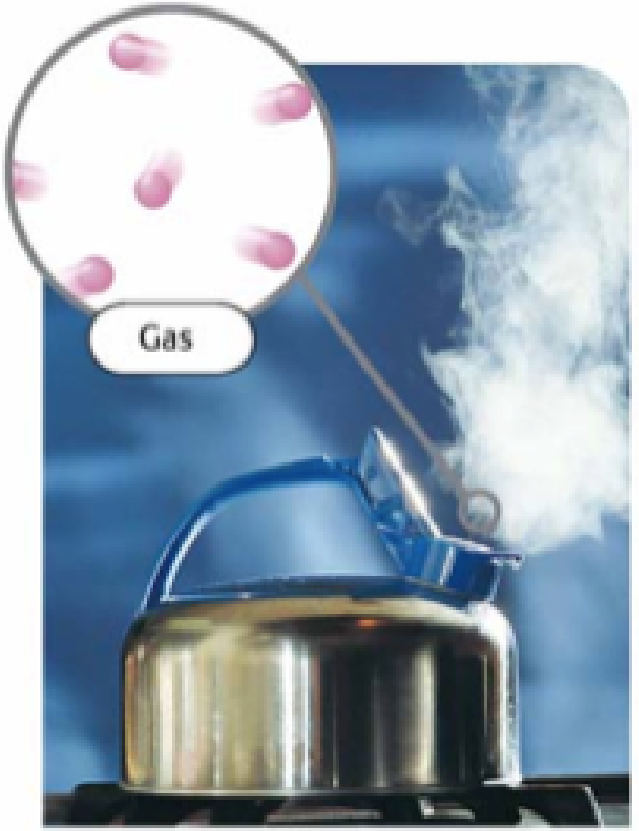
Kinetic Energy and States of Matter



The particles in an ice cube vibrate in place. Compared to the particles in liquids and gases, they have the least kinetic energy.



The particles in ocean water move around. They have more kinetic energy than the particles in a solid but less than those in a gas.

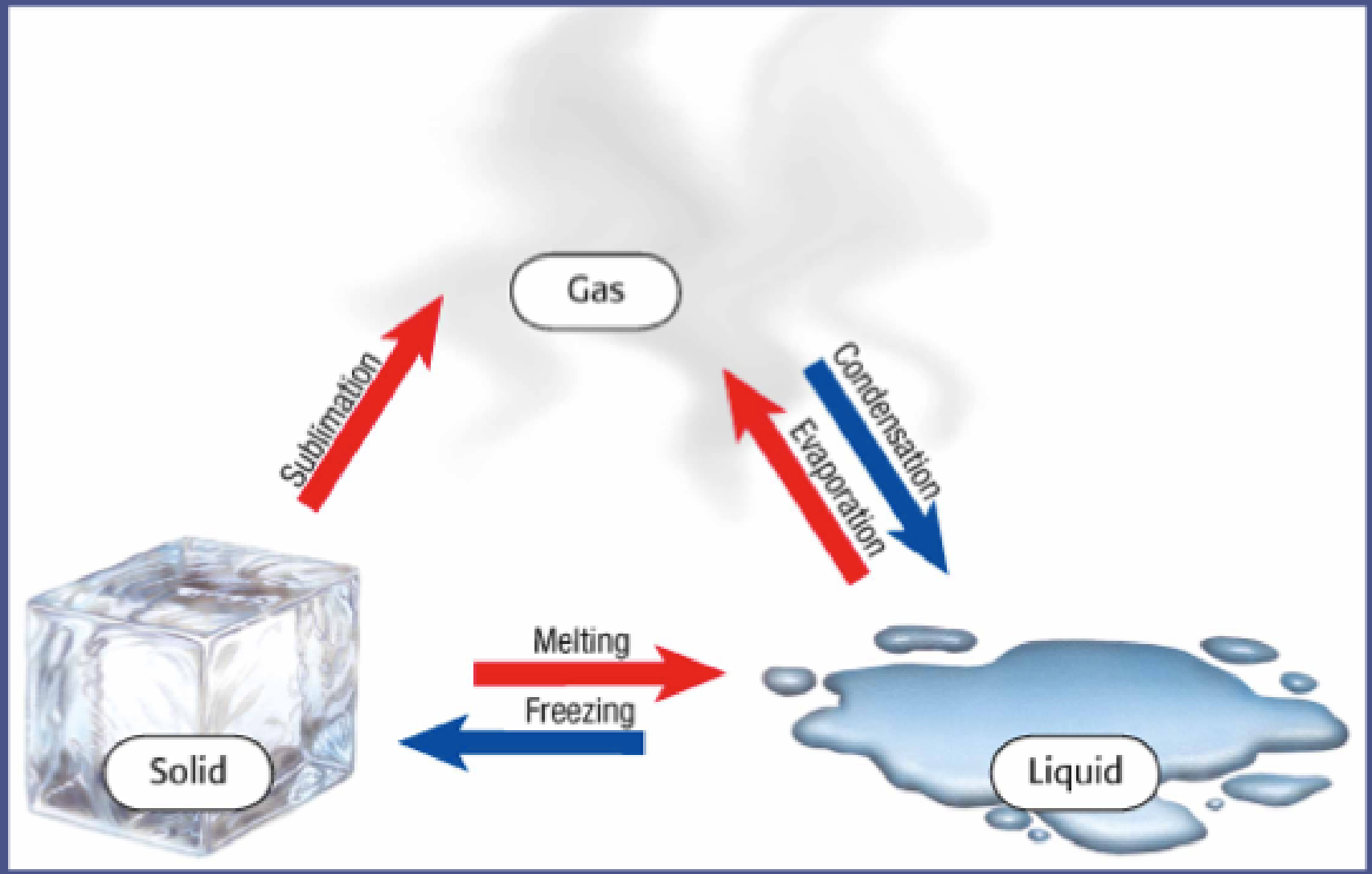


The particles in steam move around rapidly. Compared to the particles in solids and liquids, they have the most kinetic energy.

3.2

Changes of State

Changes of State



Changing the state of matter is a **physical change**, because the composition of the substance itself does not change.

evaporation: changing a substance from a liquid to a gas

sublimation: changing a substance from a solid directly to a gas

More physical change vocabulary:

condensation: changing a substance from a gas to a liquid

melting point: the temperature at which a solid changes to a liquid

boiling point: the temperature at which a liquid changes to a gas

Final thought for changing states...

When a substance goes through any change--either physical or chemical--mass and energy are conserved (that is, they stay the same)!

Neither mass nor energy can be created or destroyed!!!

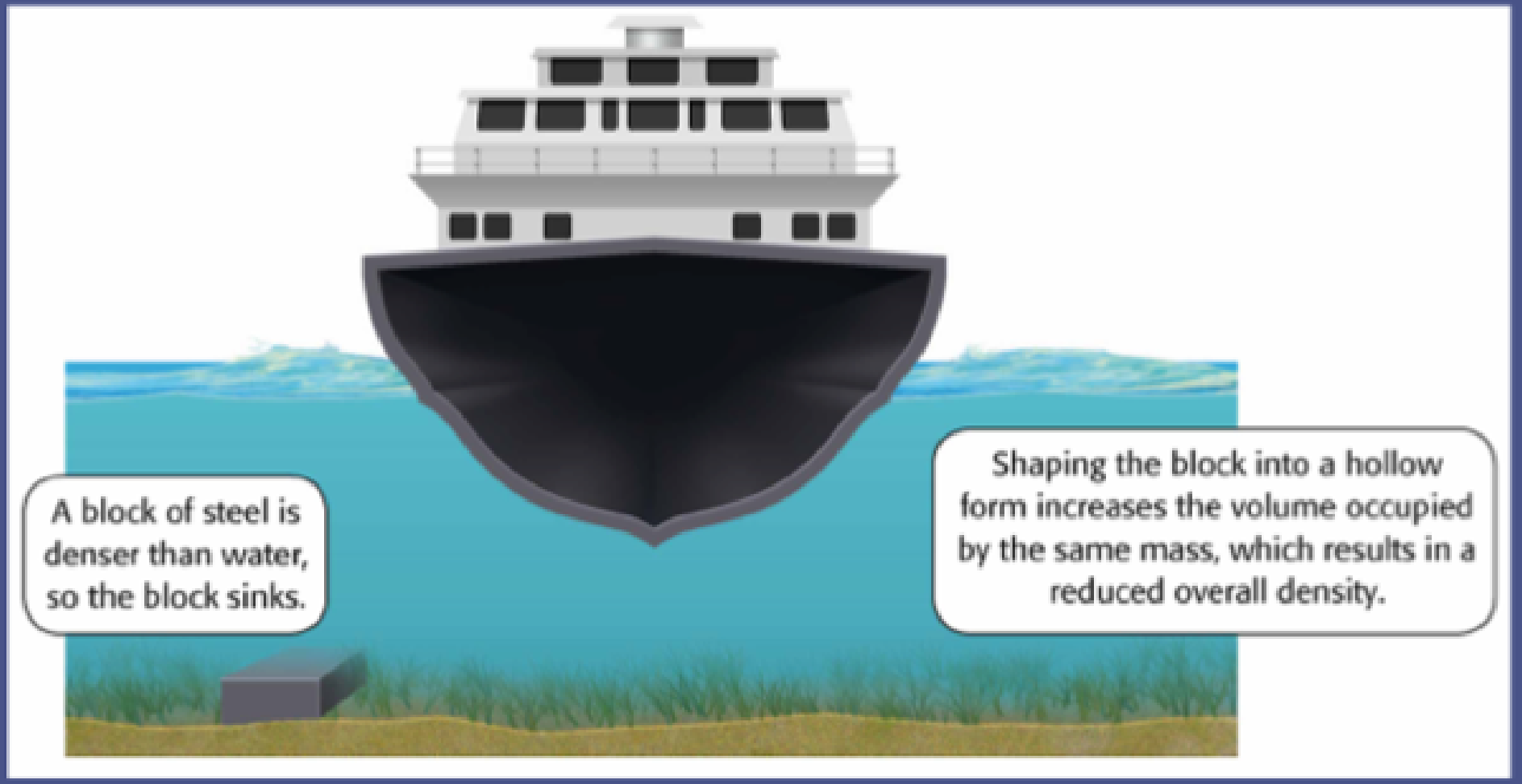
3.3
Fluids

FYI... A **fluid** is any matter that is able to flow. Fluids include both liquids AND gases... However, this section only discusses liquids.

What IS density?

If I place a silver candlestick into liquid silver, will the candlestick sink, float, or stay where it is?

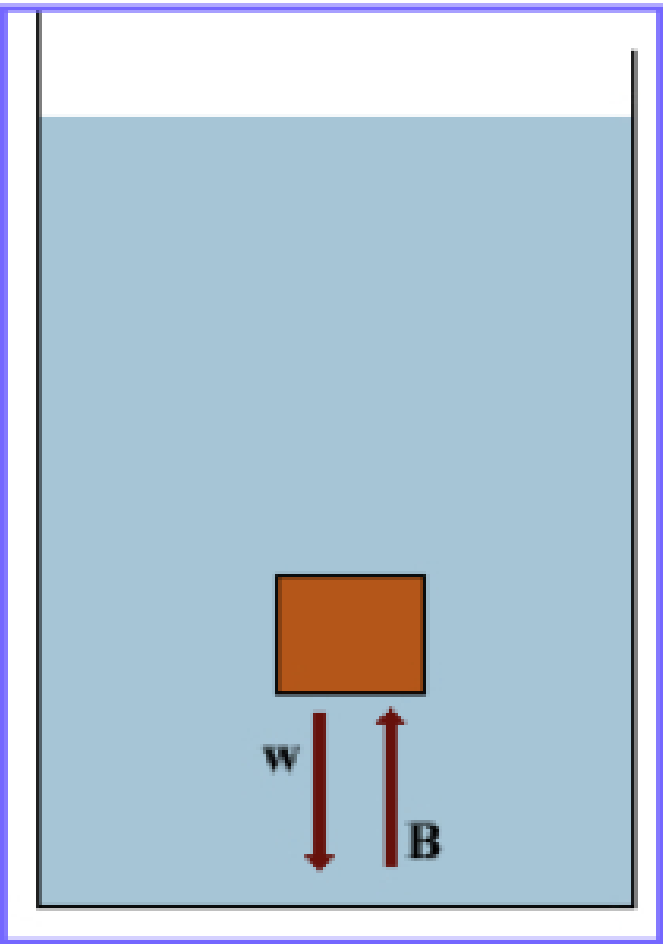
Density


A block of steel is denser than water, so the block sinks.
Shaping the block into a hollow form increases the volume occupied by the same mass, which results in a reduced overall density.

Why do some objects sink while other objects float?

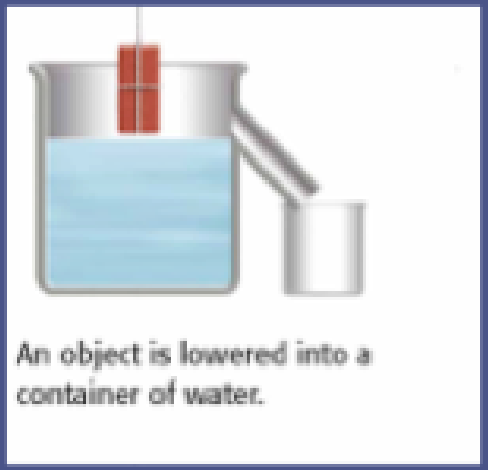
Objects sink or float based on their DENSITY.

Buoyant Force: a measure of the upward force a fluid exerts on an object

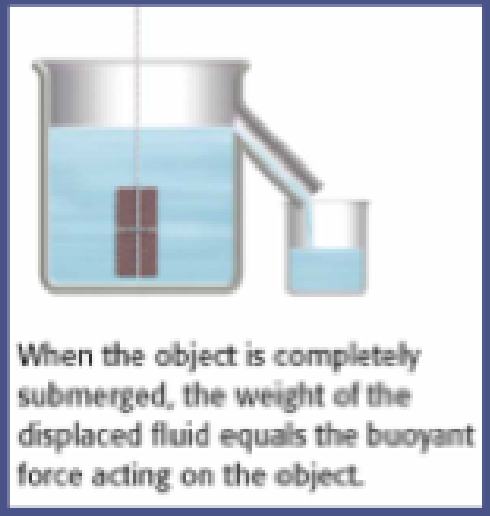


Archimedes' principle is used to find buoyant force.

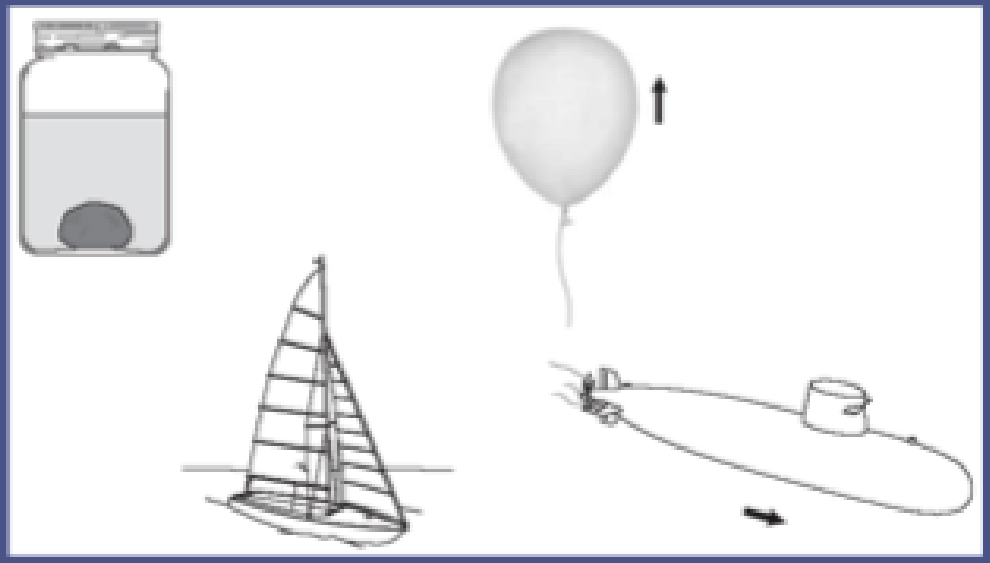
- The buoyant force on an object in a fluid is an upward force equal to the weight of the fluid that the object displaces.



An object is lowered into a container of water.



When the object is completely submerged, the weight of the displaced fluid equals the buoyant force acting on the object.



1. Is the buoyant force on the lump of gold greater than, less than, or equal to the gold's weight?
2. Is the buoyant force on the balloon greater than, less than, or equal to the balloon's weight?
3. Is the buoyant force on the boat greater than, less than, or equal to the boat's weight?
4. Is the buoyant force on the submarine greater than, less than, or equal to the submarine's weight?

Fluids exert pressure evenly in all directions.

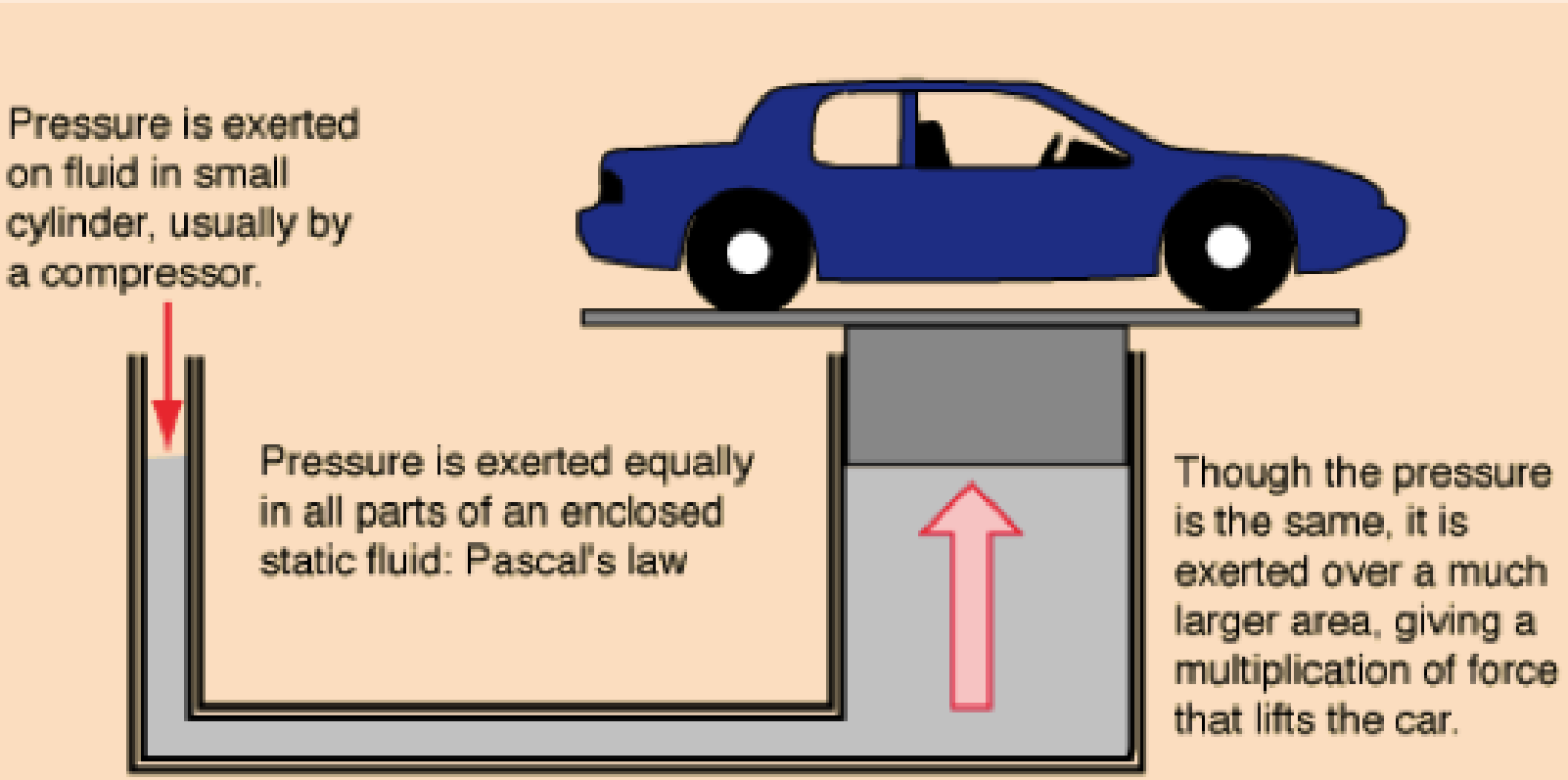
- **pressure:** the amount of force exerted per unit area of a surface

- example: when you pump up a bicycle tire, air particles constantly push against each other and against the tire walls

The unit of pressure is the **pascal** (Pa)

Pascal's Principle

If the pressure of a container is increased at any point the pressure increaes at all points by the same amount.



Fluids in Motion

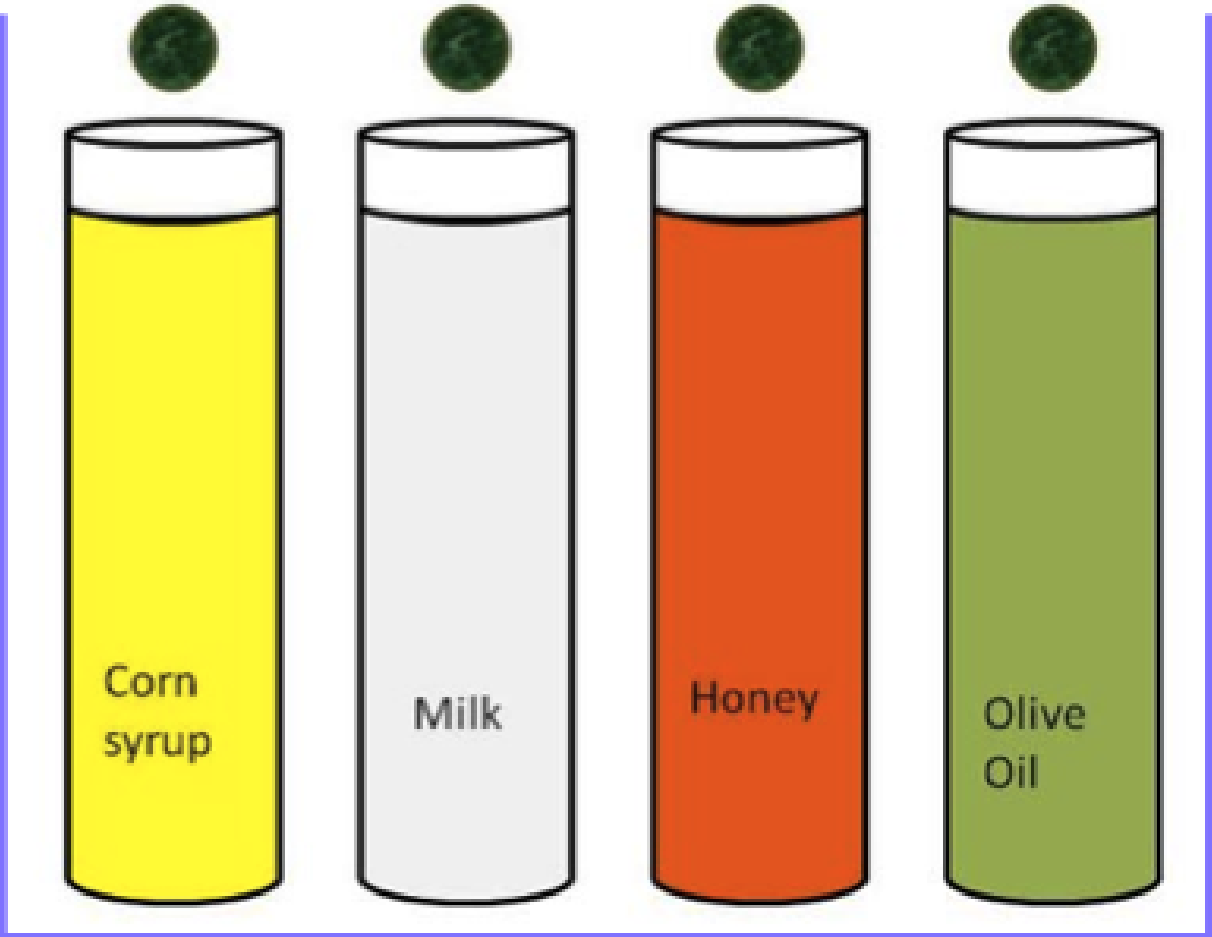
What happens when you place your thumb over the end of a garden hose with the water running?

Because the area is smaller, the water exits faster.

Fluids move faster through small areas than through larger areas, if the overall flow rate remains constant.

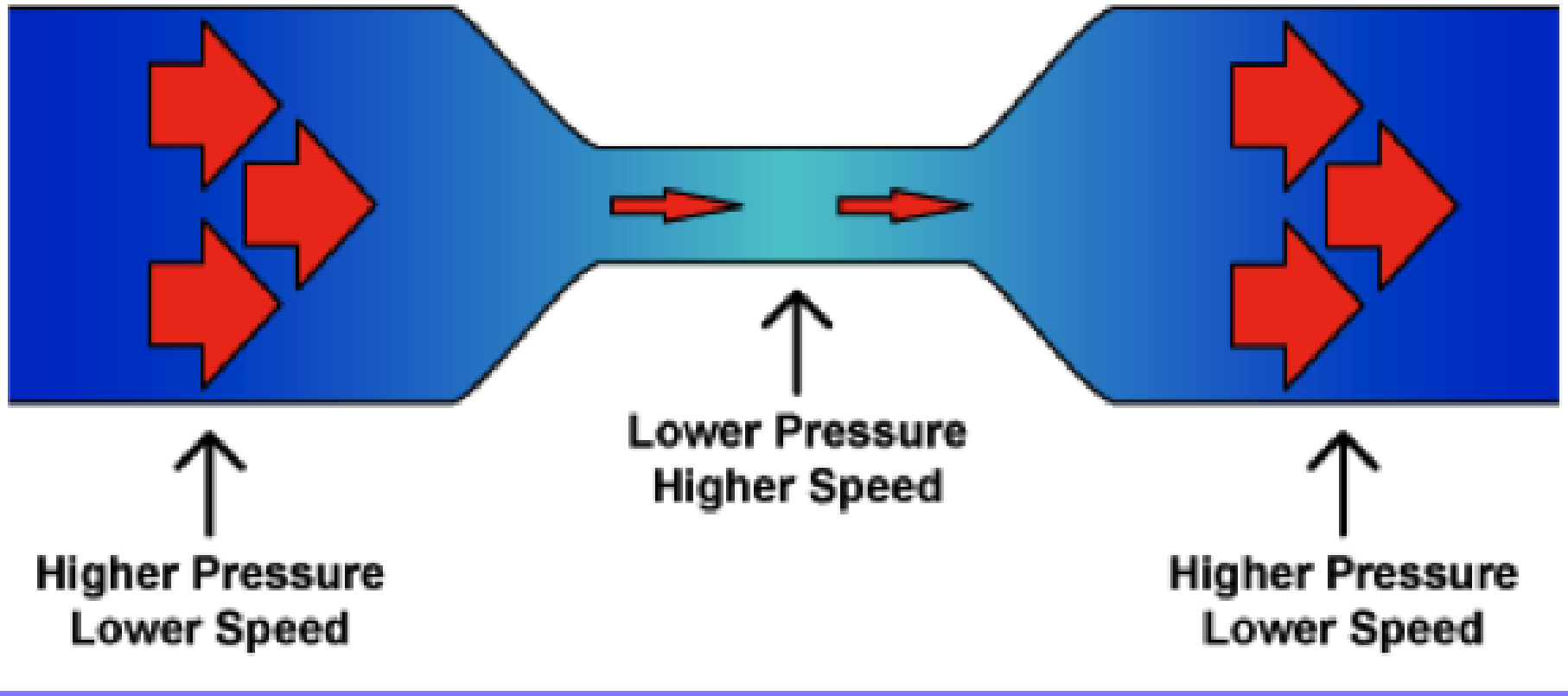
Viscosity: A material's resistance to flow

For liquids, as the temperature increases, viscosity decreases.



Bernoulli's Principle

As the speed of a moving fluid increases, the pressure of the moving fluid decreases.



3.4
Behavior of Gases

Gases are special because….

- Gases expand to fill their containers.
- They spread out easily and mix with one another.
- They have low densities and are compressible.
- Unlike solids and liquids, gases are mostly empty space.

Gas Laws

The volume of a gas is the same as the volume of the gas's container.

However, there are other things to consider, like temperature and pressure.

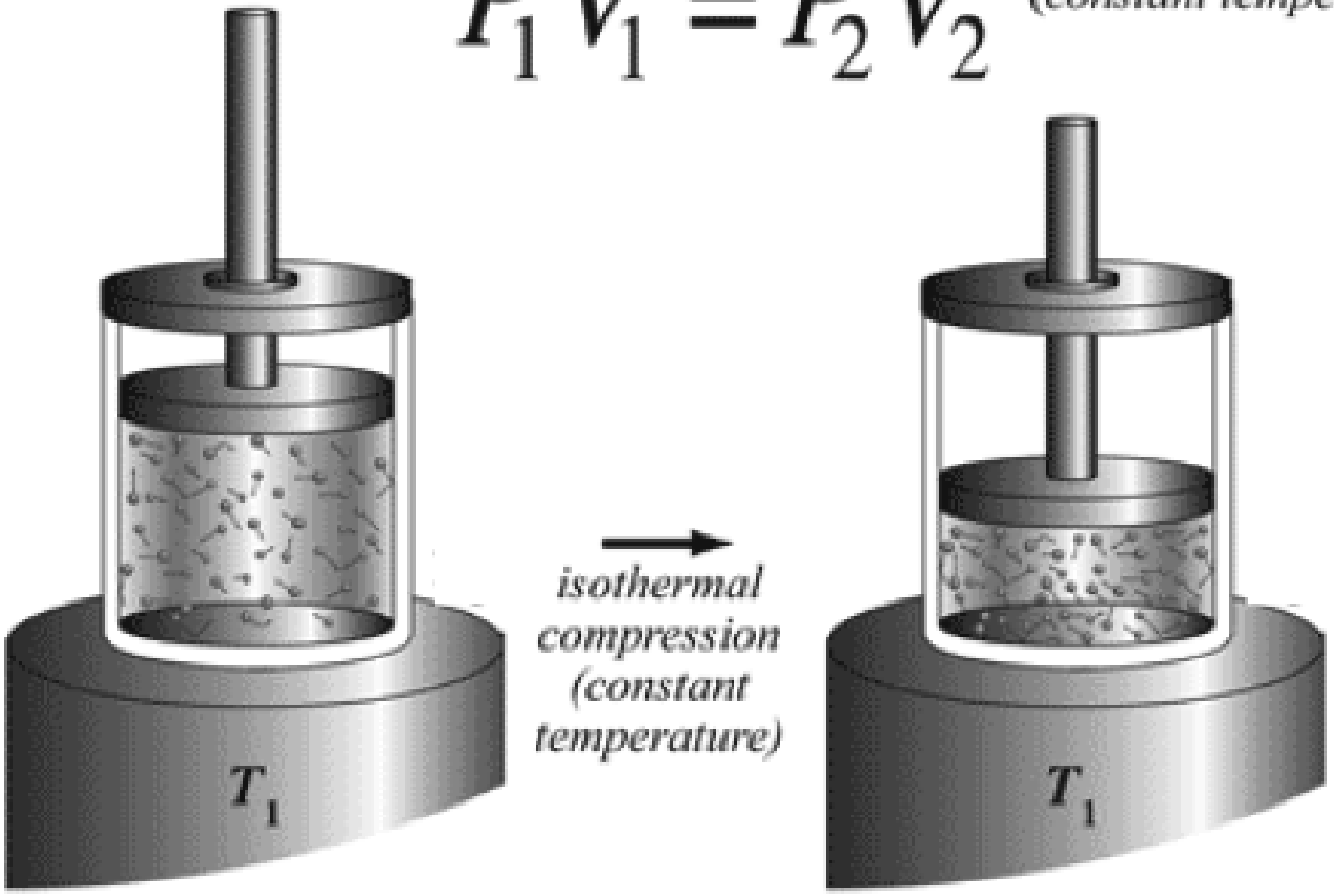
The gas laws will help you understand and predict the behavior of gases in specific situations.

Boyle's Law

- relates the pressure of a gas to its volume
- **For a fixed amount of gas at a constant temperature, the volume of a gas increases as the gas's pressure decreases.**
- **The volume of a gas decreases as the gas's pressure increases.**

Boyle's Law

$$P_1 V_1 = P_2 V_2 \quad \textit{(constant temperature)}$$



The product of pressure and volume is constant.

Gay-Lussac's Law

- relates the pressure of a gas to temperature
- **The pressure of a gas increases as the temperature increases, as long as the volume does not change.**
- **The pressure decreases as the temperature decreases.**

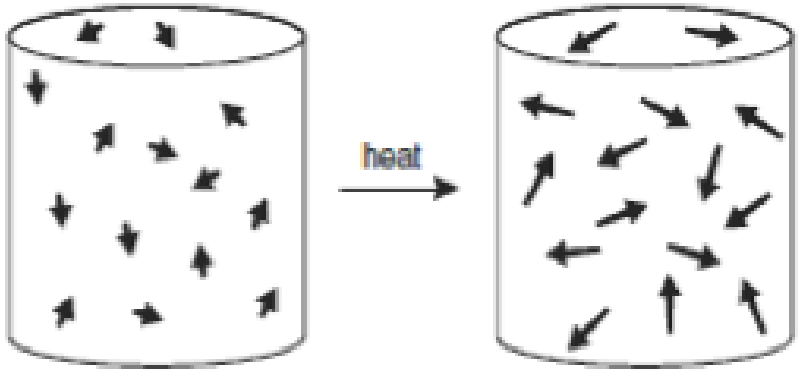


Figure 8.5 Pressure–temperature relationship for gases. As the temperature increases, the gas particles have greater kinetic energy (longer arrows) and collisions are more frequent and forceful.

Charles's Law

- relates temperature to volume
- **For a fixed amount of gas at a constant pressure, the volume of the gas increases as the gas's temperature increases.**
- **The volume of the gas decreases as the gas's temperature decreases.**

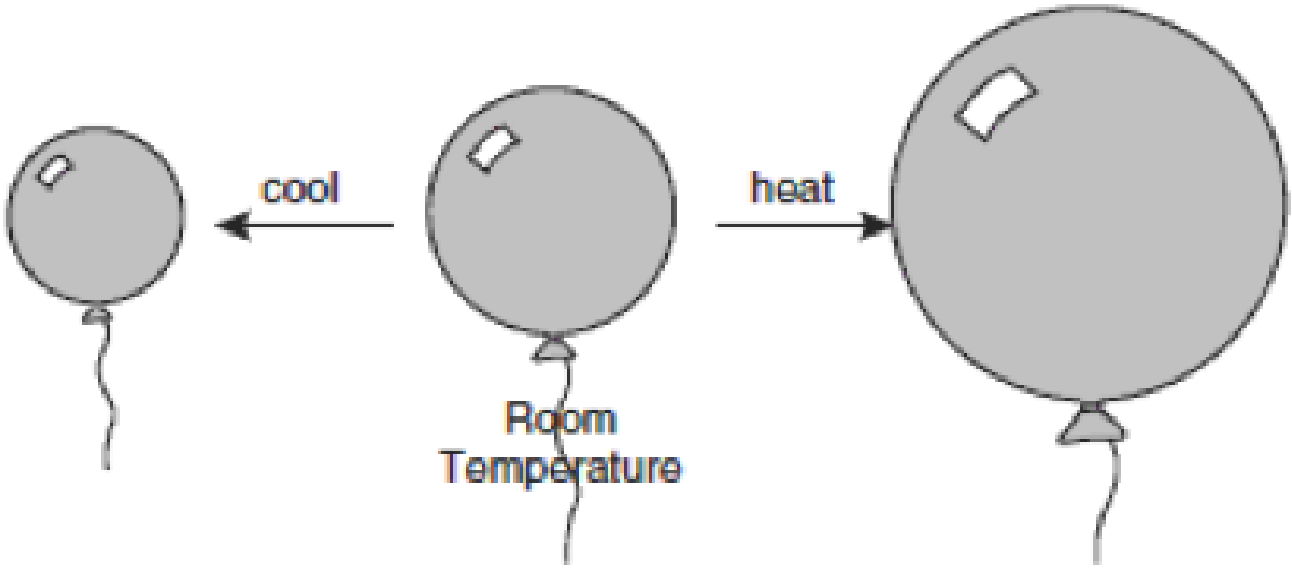


Figure 8.4 Volume–temperature relationship for gases.