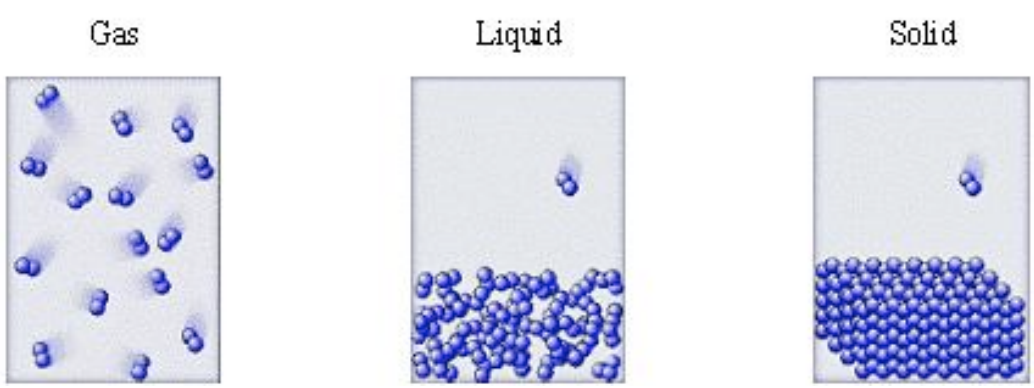
CLUE A

<u>Water Everywhere</u>

1 Water flows as a **liquid**. Water freezes into a **solid**. Water **evaporates** or boils to form a **gas**. Water in all its **phases** is important on global and local levels. For example, the human body is made up of 55–75 percent liquid water. People use it to cook, bathe, and drink. Water as a **solid** or **liquid** is the focal point of many sports and hobbies. Swimming, water skiing, and boating use **liquid** water. Hockey, figure skating, and snowboarding need **solid** water. On a global level, water as **solid, liquid,** and **gas** plays a key role in the Earth's climate and in shaping the land.

2 So what's so special about water? How can it serve so many functions? Take a closer look—a much closer look. No, closer. Okay, there you go. Now that you're at the **<u>molecular</u>** level, what do you see? Whether it is a **solid, liquid**, or **gas**, we see water molecules at this level. So, what is different at this level for **solid, liquid**, and **gaseous** water? Let's answer that question for more than just water; let's look at patterns in the **molecules** for most substances when they are in different phases of matter. Then we will pay closer attention to water.

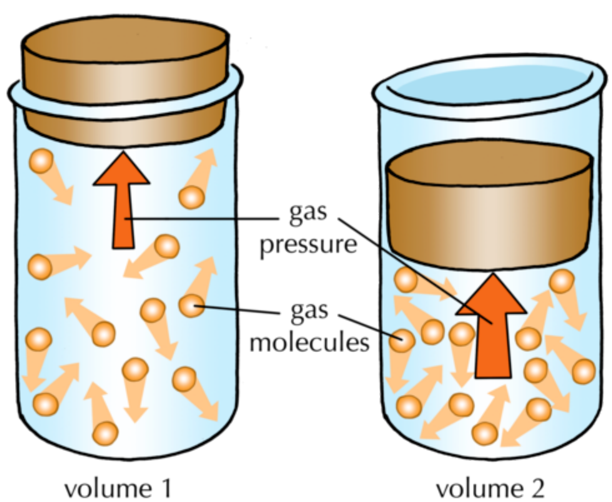


CLUE B

The Molecular View

What you see at the **molecular** level are tiny **particles** (*atoms or molecules*).
All these **particles** are in constant, random motion. They behave like bouncy
balls that are free to move and collide with one another. In addition, they are
3 **attracted** to each other. The closer the **particles** are to each other, the greater
the **attraction** between them. The farther the **particles** are from each other,
the less **attraction** there is between them.

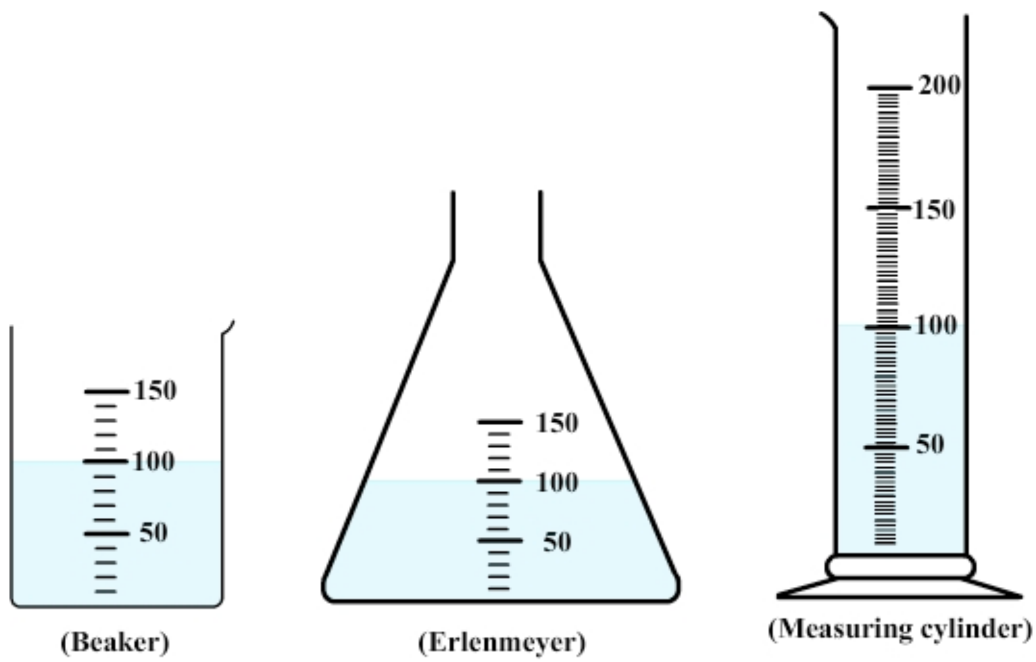
In a **gas**, the **particles** are farther apart from each other than in **solids** or
4 **liquids.** The molecules are less **attracted** to each other. **Large distance**
between particles and **weak attraction** between particles are characteristics
of the **gas** phase of matter. Since **gas** particles have so much **energy**, they
move around quickly and spread out to fill up everything. That is why their
volume can change depending on how big the containers are.



CLUE C

What happens to **particles** when **temperature** of a **gas** decreases? They slow down and the energy of motion decreases. They don't bounce as far apart. That means less distance between **particles**. **Particles** get so close to each other that their **attraction** increases. When that happens, a **liquid** forms. That is, water **<u>condenses</u>**. In the **liquid** phase of matter, **particles** are much closer than in the **gas** phase. But they are still free to move past each other.

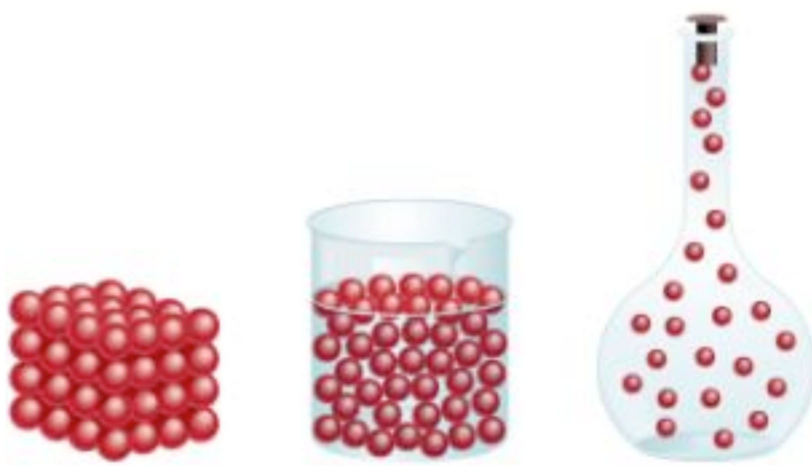
Unlike **gas**, if you measure 100 mL of **liquid** and put it in different shape and size containers, even though it looks like a different amount, the **liquid** will still be 100 mL. That is, the volume will stay the same!



CLUE D

6 Now imagine what happens to these **particles** when **temperature decreases** even more. What happens to the energy of motion of each **particle**? Everyday experience tells you the answer. A **solid** is formed as their motion slows down and the **attraction** increases!

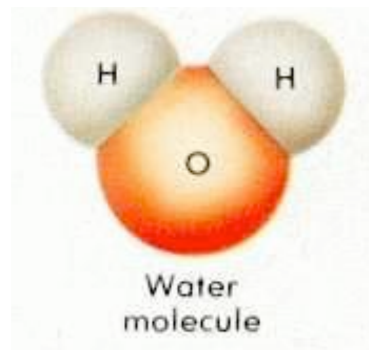
7 The temperature at which **a solid** forms is called the **freezing point**. At the **freezing point**, energy of motion decreases enough to allow **particle attraction** to take over. **Particles lock in place** and are right next to each other. Also, **solids** can only **vibrate** in one location. That is, the particles still move, but not very much. **Solids** *keep their shape*, while **liquids and gases** *take the shape of their containers.* **Solids** also have the same **volume**.



CLUE E

8 Now, imagine water in its three phases: as a **gas** in the atmosphere, as a **liquid** in a lake, and as **solid** ice covering that same lake in the winter. What's different about water molecules in these three phases of matter? Does water have *different* types of molecules in each phase? No, the molecules are the *same*. Let's think about the molecules and how they behave in each phase.

9 You know that the formula for water is H_2O. One **molecule of water** is made up of two hydrogen atoms and one oxygen atom. Each hydrogen atom bonds to the oxygen atom. As you see in the figure below it makes a V-shape or sometimes it's called the "Mickey Mouse" molecule. Can you see why?

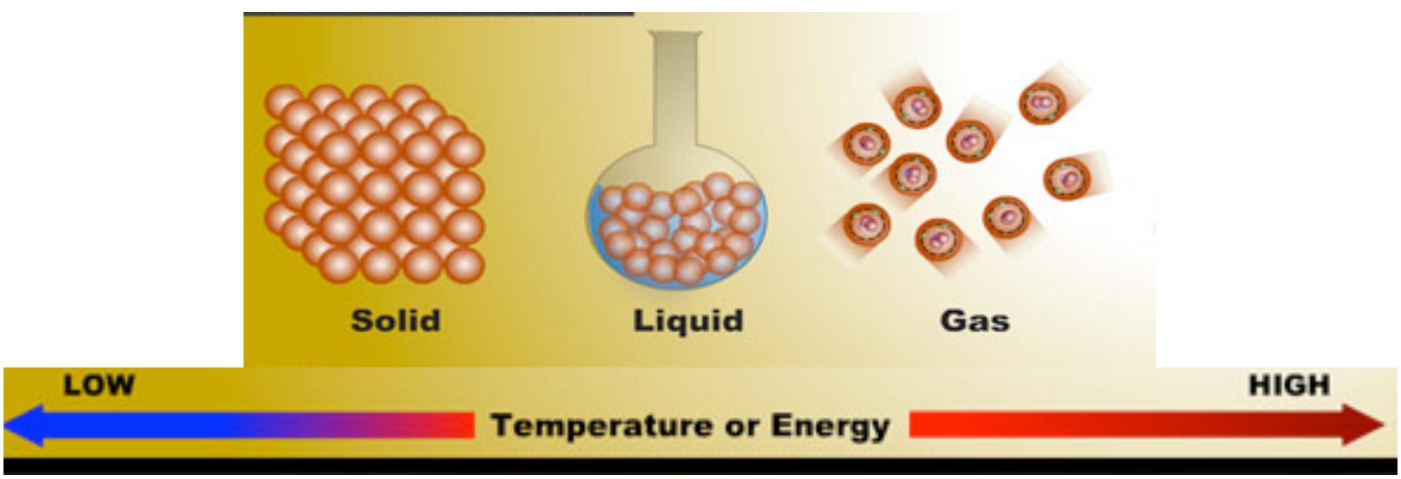


Water molecule

CLUE F

Now the water molecules are the same in each phase. However, the space
between the molecules are different in each phase. **Water molecules** in the
gas phase **move fast** and are **too far** apart to be attracted to each other. When
10 the molecules **slow down** enough, the *distance between them* *<u>decreases</u>*.
That's when they are close enough for attractions between molecules to hold
water molecules together, and they form a **liquid**.

As water **cools to form ice**, the molecules get **<u>more attracted</u>** to each other.
11 They form a **solid**. This prevents **solids** from taking the shape of their
container, and helps **solids** keep their shape. As the water molecules get
closer together, they become ice!



CLUE G

<u>It's Just a Phase, But it Matters</u>

12 The water we drink is a **liquid** at room temperature, but the oxygen we breathe is a **gas** at the same temperature and the salt we eat is a **solid**. Would we survive if these essential substances were a different phase of matter? Imagine trying to breathe **liquid** oxygen or drinking **solid** water!

13 Life on Earth is possible, in part, due to the phases of matter in which water and other substances exist. Knowing about the factors that make different phases helps you understand your everyday world and how life is sustained. And, understanding how the world around you works makes life much more interesting!