

Warm-Up | Liquids



The Postulates of Kinetic Theory

- All **matter** is composed of small particles.
- These particles are in constant random motion.
- **Collisions** between particles are perfectly elastic.
- The particles obey **Newton's** laws of motion:
 - I. The motion of an object changes only if it is acted on by an unbalanced force.
 - II. The relationship between the mass (m), acceleration (a), and applied force (F) of an object is $F = ma$.
 - III. For every action, there is an equal and opposite reaction.



Lesson Objectives

By the end of this lesson, you should be able to:

- Describe how the postulates of **kinetic-molecular** theory apply to liquids.
- Describe how kinetic-molecular theory explains the properties of liquids, including **compressibility** and shape.

Science Practice: Use the kinetic-molecular theory model to explain the behavior of liquids.

**Words to Know**

Fill in this table as you work through the lesson. You may also use the glossary to help you.

viscosity	the thickness or resistance to flow of a liquid
surfactant	a compound that reduces the repulsion (tension) between two liquids, or a liquid and a solid, or a liquid and air
dissolve	to integrate a solid, liquid, or gas into a host liquid (solvent)
surface tension	the property of the surface of a liquid that allows it to resist an external force
immiscible	referring to two liquids separating when mixed
miscible	referring to a solid, liquid, or gas becoming integrated into a host liquid (solvent)

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Lesson Question

How do scientists describe the behavior of particles in liquids?

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Particles in Liquids

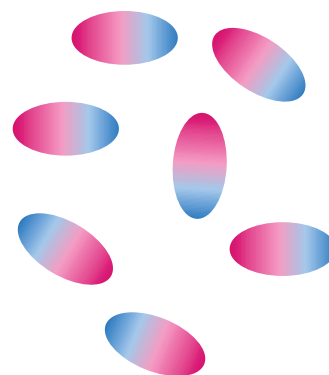
- Kinetic energy comparable with **intermolecular** attractions
- Denser than **gases**
- Fixed **volume** (not compressible)
- Particles not fixed in place
 - Able to flow
 - Take shape of container

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Intermolecular Forces and Condensation

Intermolecular forces

- Affect interactions between **particles**
- Stronger forces  more **energy**
- Condensation: **kinetic**
energy < intermolecular forces
- **Evaporation** /boiling: kinetic energy > intermolecular forces



Instruction

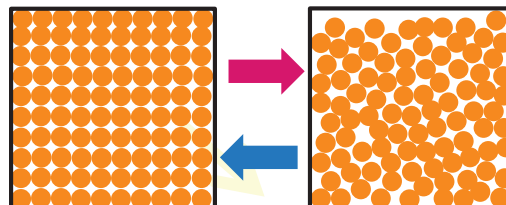
Liquids

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Intermolecular Forces and Freezing

- Liquid particles: **constant**, random motion
- **Solid** particles: fixed in place, vibrate
- Freezing: kinetic energy < intermolecular forces
- **Melting**: kinetic energy > intermolecular forces



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Viscosity

Viscosity: the thickness or **resistance** to flow of a liquid

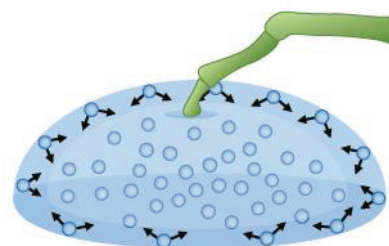
- Inversely correlated to **temperature**
- Directly correlated to size (**mass**) of particles
- Directly correlated to **strength** of intermolecular forces

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Surface Tension

Surface tension: the tendency for a liquid surface to **resist** penetration

- Directly correlated to intermolecular **attraction**
- **Surfactant** can reduce surface tension



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Compressibility

Liquids are incompressible.

- Application: **hydraulics**
 - Liquid used to transmit force
- Examples
 - Car **brakes**
 - Airplane flaps
 - Construction equipment
 - Robotics

Dissolving

Liquids can **dissolve** solids, other liquids, and gases.

- **Dissolve**: when a solid, liquid, or gas becomes integrated into a host liquid (**solvent**)
- Particles become evenly dispersed among liquid particles
- **Miscible** liquids: dissolve in each other

Dissolving

Immiscible liquids: cannot dissolve in each other

- Particles remain separate

Summary

Liquids

?

Lesson
Question

How do scientists describe the behavior of particles in liquids?

✓

Answer

(Sample answer) Scientists describe particles in the liquid state as having lower kinetic energy than a particle in the gas state. The volume occupied by liquid particles remains constant, but the shape can vary.

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Particles in Liquids

- Particles in liquids move apart from each other just enough to lose the geometric shape of the solid, but not far enough to become a **gas**; liquids are in the middle.
- Liquid particles have the ability to flow; they are in contact with each other but can slide past one another.
- When liquid particles gain enough kinetic energy to overcome their intermolecular attractions, the liquid becomes a gas. This is called evaporation/**boiling**.
- When liquid particles lose energy so that the intermolecular forces become strong enough to hold the particles in fixed positions, the liquid becomes a solid.

Summary | Liquids

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Properties of Liquids

- Many of the properties of liquids depend on intermolecular forces.
- As intermolecular forces become stronger, boiling points increase.
- **Viscosity**, or resistance to flow, depends on intermolecular forces as well as temperature and particle size.
- Surface tension depends primarily on intermolecular forces; **surfactants**, which disrupt these forces, can decrease surface tension.
- Because liquid particles are in constant contact, liquids are incompressible.
- Because liquid particles are not fixed in place, liquids can dissolve other substances.

Use this space to write any questions or thoughts about this lesson.