Kinetic Theory of Matter

Matter & Energy

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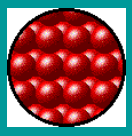
Kinetic Theory of Matter

1) All matter is made up of atoms and molecules that act as tiny particles.



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Kinetic Theory of Matter

2) These tiny particles are always in motion.

- State of matter depends on its molecular motion as measured by temperature
- ↑ temperature = ↑ motion of particles
- ↓ temperature = ↓ motion of particles

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Kinetic Theory of Matter

3) At the same temperature, the heavier particles move slower than the lighter particles.

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Temperature

- A measure of the **average** kinetic energy (K.E.) in a sample.

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Absolute Zero

- Temperature at which all molecular (particle) motion stops.
- 0 Kelvin (-273 °C; -459 °F)

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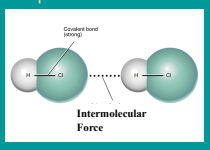
Intermolecular Forces (IF's)

- Force of attraction between molecules/particles.



- Become stronger as molecules get closer together; therefore IF's are strongest in solids.

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States of Matter

The Four States of Matter

- Solid
- Liquid
- Gas
- Plasma

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States of Matter

The Four States of Matter

Basis of Classification of the Four Types

- Based upon particle arrangement
- Based upon energy of particles
- Based upon distance between particles

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States of Matter

Solids

- Particles are held by intermolecular forces (bonds between molecules)
- Particles of solids are tightly packed, vibrating about a fixed position. In other words, they do not move out of position.
- Solids have a definite shape and a definite volume.

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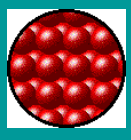
States of Matter

Solids

Particle Movement



Examples

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States of Matter

Liquids

- Particles of liquids are tightly packed, but are far enough apart to slide over one another. (intermolecular forces have weakened)
- Liquids have an indefinite shape and a definite volume.
- So, liquids take the shape of whatever container they are in but they cannot be squeezed into a smaller volume

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States of Matter

Liquids

Particle Movement

Examples

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States of Matter

Gases

- Particles of gases are very far apart and move freely. (intermolecular forces have been completely broken)
- Gases have an indefinite shape and an indefinite volume.
- b/c particles are not close together, they can be squeezed into a smaller space
  - ex. Pumping up a bicycle tire

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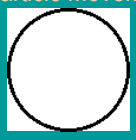
States of Matter

Gases

Particle Movement



Examples

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States of Matter

Plasma

- A plasma is a gaslike mixture of + and – charged particles
- A plasma is a very good conductor of electricity
  - ex. Fluorescent lights, stars
- Plasma, like gases have an indefinite shape and an indefinite volume.
- Most common state of matter in the universe.

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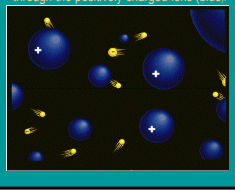
States of Matter

Plasma

Particles

The negatively charged electrons (yellow) are freely streaming through the positively charged ions (blue)



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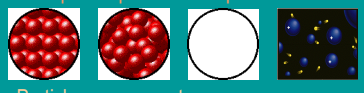
States of Matter

The Four States of Matter

The Classification and Properties of Matter Depend Upon Microscopic Structure



- Particle arrangement
- Particle energy
- Particle to particle distance

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Phase Changes

- Melting/Freezing
- Boiling(vaporization)/Condensing
- Sublimation
- Evaporation

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Melting/Freezing Point

- Change from solid to liquid and liquid to solid.
- Same temp.; if melting, particles are gaining energy; if freezing, particles are losing energy.
- The stronger the IF's, the more energy needed to weaken the IF's, therefore higher melting point temperature.

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Melting/Freezing Continued

- During the phase change, the temp. remains **constant.** (flat/horizontal region on a phase diagram.)
- After all the sample has changed phase, the temp. will change.
- During the phase change, potential energy (P.E.) is changing, but K.E. is constant.

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Boiling/Condensation Point (Vaporization)

- Change from liquid to gas and gas to liquid.
- Same temp.; if boiling, particles are gaining energy; if condensing, particles are losing energy.
- The stronger the IF's, the more energy needed to break the IF's, therefore higher boiling point temperature.

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Boiling/Condensation Point (Vaporization)

- During the phase change, the temp. remains **constant.** (flat/horizontal region on a phase diagram.)
- After all the sample has changed phase, the temp. will change.
- During the phase change, potential energy (P.E.) is changing, but K.E. is constant.

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Sublimation

- Changing directly from a solid to a gas.
- Also, changing directly from a gas to a solid.
- Skipping the liquid state.

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Evaporation

- Liquid to gas but not necessarily at the boiling point temperature.
- Some particles gain enough K.E. to overcome the IF's and become a gas.
- Remember, temperature is a measure of the average K.E.!

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Thermal Expansion

- **Thermal expansion-** matter expands as it gets hotter and contracts when it cools
- Exception- water actually expands when it freezes (due to locking of hydrogen bonds b/w water molecules)
- Ex. Expansion joints on bridges, run hot water over jar lid to open it, gaps in sidewalk

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States of Matter

Microscopic Explanation for Properties of Solids

- Solids have a definite shape and a definite volume because the particles are locked into place
- Solids are not easily compressible because there is little free space between particles
- Solids do not flow easily because the particles cannot move/slide past one another

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States of Matter

Microscopic Explanation for Properties of Liquids

- Liquids have an indefinite shape because the particles can slide past one another.
- Liquids are not easily compressible and have a definite volume because there is little free space between particles.
- Liquids flow easily because the particles can move/slide past one another.

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States of Matter

Microscopic Explanation for Properties of Gases

- Gases have an indefinite shape and an indefinite volume because the particles can move past one another.
- Gases are easily compressible because there is a great deal of free space between particles.
- Gases flow very easily because the particles randomly move past one another.

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States of Matter

Microscopic Explanation for Properties of Plasmas

- Plasmas have an indefinite shape and an indefinite volume because the particles can move past one another.
- Plasmas are easily compressible because there is a great deal of free space between particles.
- Plasmas are good conductors of electricity.

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