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تمقتبسة عن:
Reference: Roy Kennedy, Massachusetts Bay Community College, Wellesley Hills, MA

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Matter and Energy

Roy Kennedy
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2009, Prentice Hall
Are matter & energy related

• Matter is any particle with mass and volume
• Energy is simply matter that is moving
• 0 Kelvin is defined as the temperature when matter does not moving
• So temperature is related to moving mass
• Therefore: temperature and mass are related to energy
• That’s why any chemistry or physics equation with energy must relate mass and temperature.
Around you

- Everything you can see, touch, smell or taste in your room is made of matter.
What Is Matter?

- **Matter** is anything with mass.

- Typically, we think of tiny little pieces of mass as **atoms** and **molecules** because those 117 elements behave Newtonian. There are over 200 smaller particles that behave Quantunian.
Energy: it’s just Mass and Velocity

• Electrical
  ✓ Kinetic energy associated with the flow of electrical charge.

• Heat or Thermal Energy
  ✓ Kinetic energy associated with molecular motion.

• Light or Radiant Energy
  ✓ Kinetic energy associated with energy transitions in an atom.

• Nuclear
  ✓ Potential energy in the nucleus of atoms.

• Chemical
  ✓ Potential energy in the attachment of atoms or because of their position.
Atoms and Molecules

- **Atoms** are the tiny particles that make up all matter.
- In most substances, the atoms are joined together in units called **molecules**.
  - Yes, the atoms are joined in specific geometric arrangements.
Any matter can exist in one of 3 States

- Solid
- Liquid
- Gas
Structure Determines Properties

• The atoms or molecules have different structures in solids, liquids, and gases — leading to different properties.
Solids

• The particles in a solid are packed close together and are fixed in position.
  ✓ Although they may vibrate.
• The close packing of the particles results in solids being incompressible.
• The inability of the particles to move around results in solids retaining their shape and volume when placed in a new container and prevents the particles from flowing.
Solids, Continued

• Some solids have their particles arranged in an orderly geometric pattern—we call these **crystalline solids**.
  ✓ Salt and diamonds.

• Other solids have particles that do not show a regular geometric pattern over a long range—we call these **amorphous solids**.
  ✓ Plastic and glass.
Liquids

- The particles in a liquid are closely packed, but they have some ability to move around.
- The close packing results in liquids being incompressible.
- The ability of the particles to move allows liquids to take the shape of their container and to flow. However, they don’t have enough freedom to escape and expand to fill the container.
Gases

• In the gas state, the particles have complete freedom from each other.
• The particles are constantly flying around, bumping into each other and the container.
• In the gas state, there is a lot of empty space between the particles.
  ✓ On average.
Gases, Continued

- Because there is a lot of empty space, the particles can be squeezed closer together. Therefore, gases are compressible.
- Because the particles are not held in close contact and are moving freely, gases expand to fill and take the shape of their container, and will flow.
Matter: is it pure or impure

- **Pure Substance** = All samples are made of the same pieces in the same percentages.
  - Salt
- **Mixtures** = Different samples may have the same pieces in different percentages.
  - Salt water
Mixtures

Heterogeneous
1. Made of multiple substances, whose presence can be seen.
2. Portions of a sample have different composition and properties.

Homogeneous
1. Made of multiple substances, but appears to be one substance.
2. All portions of a sample have the same composition and properties.
Matter has Properties

• **Physical Properties** are the characteristics of matter that can be changed without changing its composition.
  ✓ Characteristics that are directly observable.

• **Chemical Properties** are the characteristics that determine how the composition of matter changes as a result of contact with other matter or the influence of energy.
  ✓ Characteristics that describe the behavior of matter.
H$_2$O Physical verses H$_2$O Chemical
## Physical Properties

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<th>Melting Point</th>
<th>Boiling Point</th>
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<td><strong>Solid</strong></td>
<td><strong>Liquid</strong></td>
<td><strong>Gas</strong></td>
</tr>
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</table>
Some Physical Properties of Iron

- Iron is a silvery solid at room temperature with a metallic taste and smooth texture.
- Iron melts at 1538 °C and boils at 4428 °C.
- Iron’s density is 7.87 g/cm³.
- Iron can be magnetized.
- Iron conducts electricity, but not as well as most other common metals.
- Iron’s ductility and thermal conductivity are about average for a metal.
- It requires 0.45 J of heat energy to raise the temperature of one gram of iron by 1°C.
<table>
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<th>Chemical Properties</th>
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<tr>
<td>Oxidizing</td>
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</tbody>
</table>
Some Chemical Properties of Iron

• Iron is easily oxidized in moist air to form rust.
• When iron is added to hydrochloric acid, it produces a solution of ferric chloride and hydrogen gas.
• Iron is more reactive than silver, but less reactive than magnesium.
Quiz: is it a Physical or Chemical Property

• Salt is a white, granular solid = physical.
• Salt melts at 801 °C = physical.
• Salt is stable at room temperature, it does not decompose = chemical.
• 36 g of salt will dissolve in 100 g of water = physical.
• When a clear, colorless solution of silver nitrate is added to a salt solution, a white solid forms = chemical.
Matter has Properties, Matter can also go through Changes

• Changes that alter the state or appearance of the matter without altering the composition are called **physical changes**.

• Changes that alter the composition of the matter are called **chemical changes**.

  ✓ During the chemical change, the atoms that are present rearrange into new molecules, but all of the original atoms are still present.
Is it a Physical or Chemical Change?

• A physical change results in a different form of the same substance.
  ✓ The kinds of molecules don’t change.

• A chemical change results in one or more completely new substances.
  ✓ Also called chemical reactions.
  ✓ The new substances have different molecules than the original substances.
  ✓ You will observe different physical properties because the new substances have their own physical properties.
Phase Changes Are Physical Changes

- Boiling = liquid to gas.
- Melting = solid to gas.
- Subliming = solid to gas.
- Freezing = liquid to solid.
- Condensing = gas to solid.
- State changes require heating or cooling the substance.
  ✓ Evaporation is *not* a simple phase change, it is a solution process.
Quiz: is it a Physical or Chemical change

- Evaporation of rubbing alcohol = physical
- Sugar turning black when heated = chemical
- An egg splitting open and spilling out = physical
- Sugar fermenting into alcohol = chemical
- Bubbles escaping from soda = physical
- Bubbles that form when hydrogen peroxide is mixed with blood = chemical
Separation of Mixtures

- Separate mixtures based on different physical properties of the components.
  - Physical change.

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<tr>
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<th>Technique</th>
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<td>Density</td>
<td>Centrifugation and decanting</td>
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</table>

Tro's "Introductory Chemistry", Chapter 3
Distillation: different boiling points

- Mixture of liquids
- Boiling flask
- Burner
- Condenser
- Cold water in
- Cold water out
- Clamp
- Receiving flask
- More volatile liquid

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Filtration: different solubility's
Exothermic Processes

- When a change results in the release of energy it is called an **exothermic process**.
- An exothermic chemical reaction occurs when the reactants have more chemical potential energy than the products.
- The excess energy is released into the surrounding materials, adding energy to them.
  - Often the surrounding materials get hotter from the energy released by the reaction.
An Exothermic Reaction

- Reactants
- Surroundings
- Products

Potential energy

Amount of energy released
Endothermic Processes

- When a change requires the absorption of energy it is called an **endothermic process**.
- An endothermic chemical reaction occurs when the products have more chemical potential energy than the reactants.
- The required energy is absorbed from the surrounding materials, taking energy from them.
  - Often the surrounding materials get colder due to the energy being removed by the reaction.