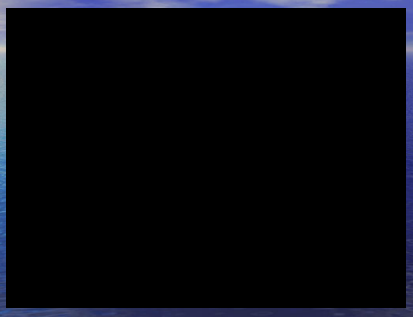
Changes of State

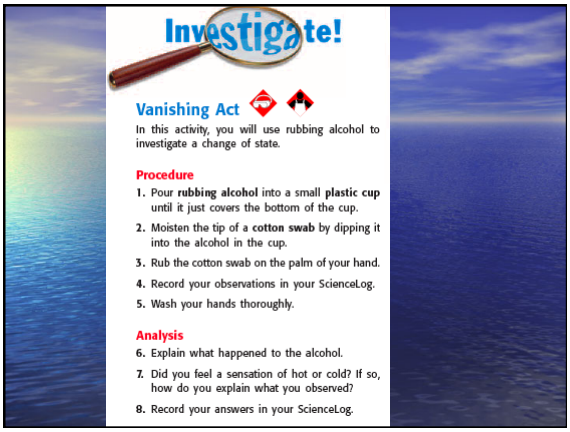
Phase Changes
Chapter 3, Section 2

Review from last Time

- 1. What are the 5 states of matter?
  - Solid
  - Liquid
  - Gas
  - Plasma
  - BEC (Bose Einstein Condensate)
- 2. How do the molecules move in the 3 main states?
  - 3 Main States of Matter

1. States of Matter



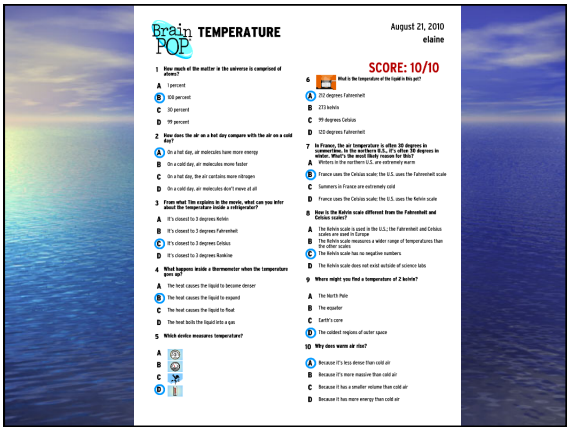


States & phases

- Each of the 5 states is also known as a **phase**.
- Elements and compounds can move from one phase to another phase when special physical forces are present.
- One example of those forces is **temperature**.
- The phase or state of matter can change when the temperature changes.
- Generally, as the temperature rises, matter moves to a more active state.

What about temperature??? Tell us about it Tim & Moby!

- Click here



BrainPOP TEMPERATURE

August 21, 2010
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SCORE: 10/10

1 How much of the matter in the universe is comprised of atoms?
A 1 percent
B 60 percent
C 30 percent
D 99 percent

2 How does the air on a hot day compare with the air on a cold day?
A On a hot day, air molecules have more energy
B On a cold day, air molecules move faster
C On a hot day, the air contains more nitrogen
D On a cold day, air molecules don't move at all

3 From what Tim explains in the movie, what can you infer about the temperature inside a refrigerator?
A It's closest to 3 degrees Kelvin
B It's closest to 3 degrees Fahrenheit
C It's closest to 3 degrees Celsius
D It's closest to 3 degrees Rankine

4 What happens inside a thermometer when the temperature goes up?
A The heat causes the liquid to become denser
B The heat causes the liquid to expand
C The heat causes the liquid to float
D The heat boils the liquid into a gas

5 Which device measures temperature?
A
B
C
D

6 What is the temperature of the liquid in this pot?
A 212 degrees Fahrenheit
B 273 Kelvin
C 99 degrees Celsius
D 120 degrees Fahrenheit

7 In France, the air temperature is often 30 degrees in summer. It is rarely below 0 C, 32 F, even in winter. What is the most likely reason for this?
A Winters in the northern U.S. are extremely warm
B France uses the Celsius scale; the U.S. uses the Fahrenheit scale
C Summers in France are extremely cold
D France uses the Celsius scale; the U.S. uses the Kelvin scale

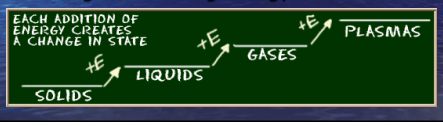
8 How is the Kelvin scale different from the Fahrenheit and Celsius scales?
A The Kelvin scale is used in the U.S.; the Fahrenheit and Celsius scales are used in Europe
B The Kelvin scale measures a wider range of temperatures than the other scales
C The Kelvin scale has no negative numbers
D The Kelvin scale does not exist outside of science labs

9 Where might you find a temperature of 2 kelvin?
A The North Pole
B The equator
C Earth's core
D The coldest regions of outer space

10 Why does warm air rise?
A Because it's less dense than cold air
B Because it's more massive than cold air
C Because it has a smaller volume than cold air
D Because it has more energy than cold air

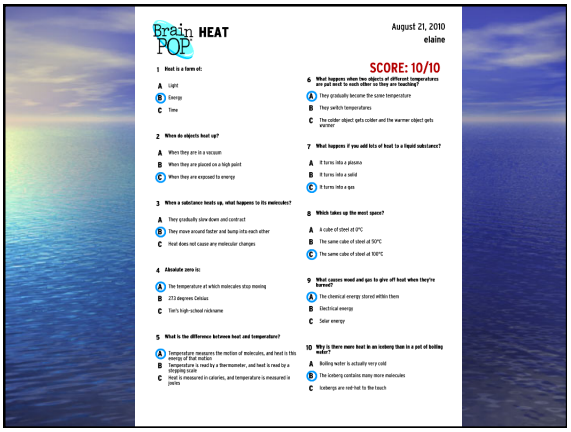
It's all about the energy!

- It's totally possible to go from a solid to a liquid to a gas, and back again.
- These are called state changes or phase changes.
- But it's all about the energy.
- Which state you go to depends on whether you are adding or removing energy.



States & Energy

- During a change of state, the energy of the substance **changes**.
- This is related to how the particles move.
- If you add energy to a substance, the particles **speed up**.
- If you remove energy from a substance, the particles **slow down**.
- In fact, **temperature** is a measure of the speed of particles.
- BrainPop: Heat



BrainPOP HEAT

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1 Heat is a form of:
A Light
B Energy
C Time

2 When do objects heat up?
A When they are in a vacuum
B When they are placed on a high point
C When they are exposed to energy

3 When a substance heats up, what happens to its molecules?
A They gradually slow down and contract
B They move around faster and bump into each other
C Heat does not cause are molecular changes

4 Absolute zero is:
A The temperature at which molecules stop moving
B 273 degrees Celsius
C Tim's high-school nickname

5 What is the difference between heat and temperature?
A Temperature measures the motion of molecules, and heat is this energy of that motion
B Temperature is read by a thermometer, and heat is read by a shopping scale
C Heat is measured in calories, and temperature is measured in joules

6 What happens when two objects of different temperatures are put next to each other so they are touching?
A They gradually become the same temperature
B They switch temperatures
C The colder object gets colder and the warmer object gets warmer

7 What happens if you add lots of heat to a liquid substance?
A It turns into a plasma
B It turns into a solid
C It turns into a gas

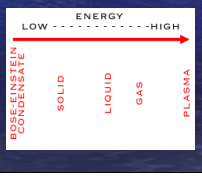
8 Which takes up the most space?
A A cube of steel at 0°C
B The same cube of steel at 50°C
C The same cube of steel at 100°C

9 What causes wood and gas to give off heat when they're burned?
A The chemical energy stored within them
B Electrical energy
C Solar energy

10 Why is there more heat in an iceberg than in a pot of boiling water?
A Boiling water is actually very cold
B The iceberg contains many more molecules
C Icebergs are red-hot to the touch

See, proof!

- Each state has a different energy "requirement".
- In order to be a plasma, you need a ton of energy because your particles better be moving!
- In order to be a solid or BEC, the particles are fine just chilling - so they don't need as much energy.

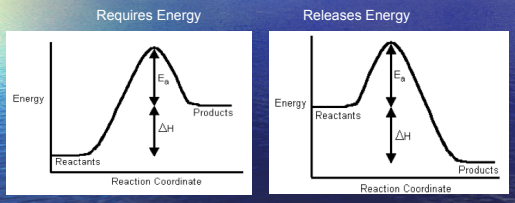


Two Types of Energy Change

1. **Endothermic**: energy is absorbed, or taken in, by a substance
   (absorbs heat - feels **colder**)

2. **Exothermic**: energy is removed, or taken out, of a substance
   (releases heat - feels **warmer**)

Endothermic and Exothermic



Endothermic Exothermic

2. An Endothermic Experiment

- **Endothermic**: energy is absorbed, or taken in, by a substance (absorbs heat - feels **colder**)
- Think of the ice bags the coach gives you if you get hurt

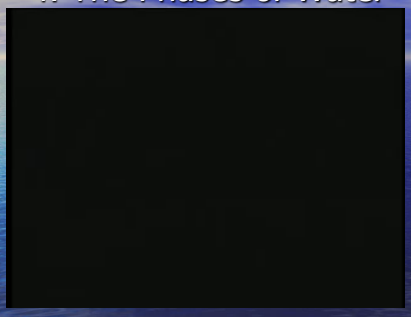
3. An Exothermic Experiment

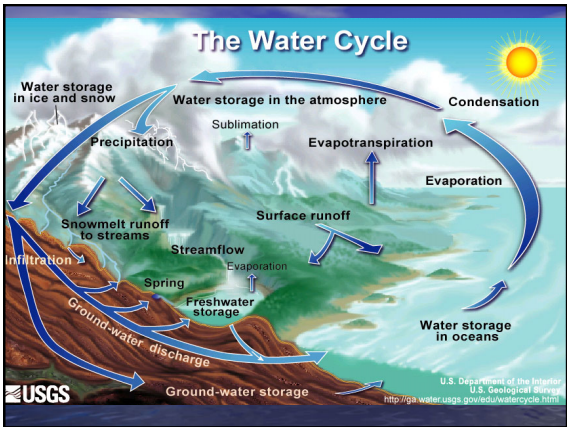
Exothermic: energy is removed, or taken out, of a substance (releases heat - feels **warmer**)

IS THAT A FACT????

Did you know, water is the only substance on Earth that can be found as a solid, liquid, and a gas at normal surface temperatures.

4. The Phases of Water



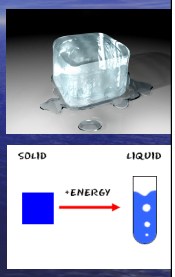


Brainpop: Tim & Moby

- The Water Cycle

Melting: Solid to liquid

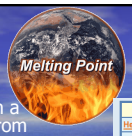
- Let's start with an ice cube.
- This ice cube starts off as a solid.
- When we add heat (energy), it begins to melt into a liquid.



How does melting work?

- When a substance is heated, it absorbs energy and its atoms and molecules begin oscillating, or moving.
- Eventually, they move so much that they break some of their bonds of attraction which are holding them tightly in place.
- They move *so* vigorously that they begin to move past one another, flowing like a liquid.
- Thus, as energy is being absorbed, this is an **endothermic** change.

- The **melting point** of a substance is the temperature at which a substance changes from the solid to liquid.
- Melting points range from low temps to very high temps.
- The melting point is typically a very unique property of a substance.
- We can use melting points to determine the identity of a substance.



Name	Sym	#	Melting Point	
Helium	He	2	0.95K	-272.2°C
Hydrogen	H	1	13.81K	-259.34°C
Neon	Ne	10	24.56K	-248.59°C
Fluorine	F	9	53.53K	-219.62°C
Oxygen	O	8	54.85K	-218.3°C
Nitrogen	N	7	63.25K	-209.9°C
Argon	Ar	18	83.8K	-189.35°C
Krypton	Kr	36	115.77K	-157.38°C
Xenon	Xe	54	161.36K	-111.79°C
Chlorine	Cl	17	171.65K	-101.5°C
Radon	Rn	86	202.15K	-71.8°C
Mercury	Hg	80	234.32K	-38.83°C
Bromine	Br	35	265.95K	-7.2°C
Francium	Fr	87	300.15	27°C
Cesium	Cs	55	301.65K	28.5°C
Gallium	Ga	31	302.91K	29.76°C
Rubidium	Rb	37	312.46K	39.31°C
Phosphorus W	P	15	317.35K	44.2°C
Potassium	K	19	336.65K	63.5°C

Awful Science Humor

- A small piece of ice which lived in a test tube fell in love with a Bunsen burner.
- "Bunsen! my flame! I melt whenever I see you" said the ice.
- The Bunsen burner replied: "It's just a phase you're going through."

Vaporization: **Liquid** to **Gas**

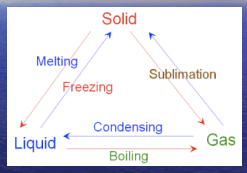
- Now let's take that water and put it into a pot over flame.
- Eventually, the water will start to boil and turn into a gas.
- Vaporization is the name of this process.
- **Boiling** is vaporization that occurs throughout a liquid.
- The temperature at which a liquid boils is its **boiling point**.
- The boiling point of water = **100°C**

How does boiling work?

- When you're heating a pot of water, the heat energy is making the water molecules move faster and faster.
- When enough thermal energy (heat) is added, the intermolecular forces in the substance are completely overcome and the liquid becomes a gas.

Animations

- States of matter
- Boiling Water
- Exothermic reactions

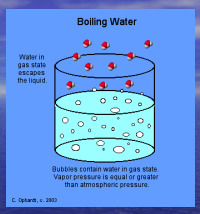


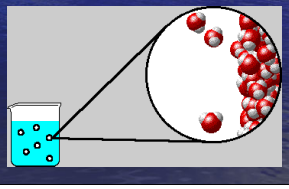
A Special Kind of Vaporization

- **Evaporation** is vaporization that occurs at the surface of the liquid, below its boiling point.
- This happens because as the liquid is heated, some particles manage to escape early, before the boiling point is reached.
- When they escape, they leave the surface of the liquid to become a gas.
- Sweating is a natural process used by humans to cool off.
- When we sweat, the water absorbs the heat (energy) and gives the sensation of cooling.

So Far…

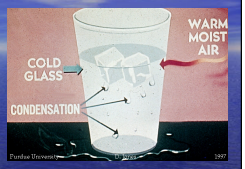
- We've gone from a solid to a liquid (melting) and from a liquid to a gas (vaporization.
- Can you go back the other direction?
- Of Course!



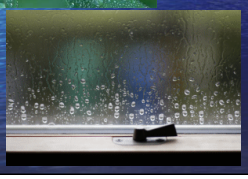


Condensation: **Gases** to **liquids**

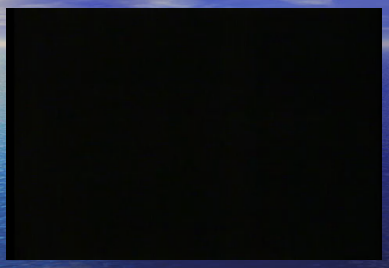
- Condensation happens when several gas molecules come together and form a liquid.
- It all happens because of a loss of energy.
- Gases are really excited atoms.
- When they lose energy, they slow down and begin to collect.
- They can collect into one drop.
- Water condenses on the lid of your pot when you boil water.
- It cools on the metal and becomes a liquid again.
- You would then have a condensate.



Examples of Condensation



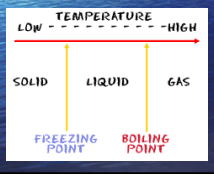
5. Eureka! Evaporation & Condensation



Freezing: **Liquids** to **Solids**

- Now let's reverse melting.
- Let's take our liquid water and put it in the freezer - where it will turn into a solid.
- The temperature at which a liquid changes into a solid is its **freezing** point.
- Freezing is an **exothermic** change, because energy is taken out of the substance.

How does freezing work?



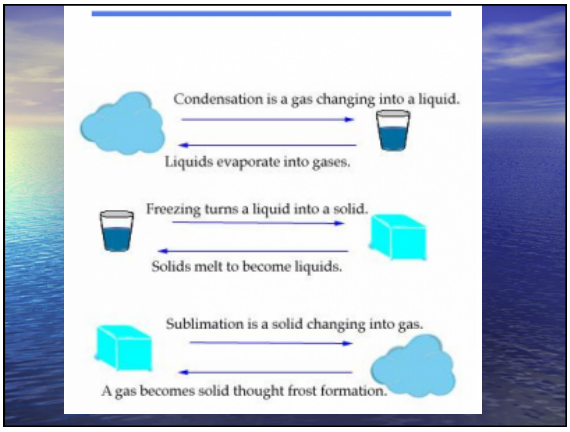
- As energy leaves, the particles begin to slow down.
- They become pulled into a more ordered arrangement, or a locked position.
- Or basically, into a solid!

Sublimation: **Solids** directly to **Gases**

- This phase change totally bypasses the liquid state.
- This is an **endothermic** change, because the only way this can happen is if the atoms are suddenly moved very far apart (think of how much space a gas wants to take up).
- And the only way the atoms can be moved far apart from one another is if the attraction between particles is completely overcome… which requires lots of energy!

Example of Sublimation

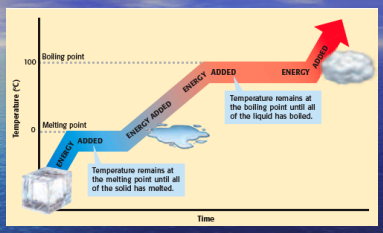
- **Dry ice** is an example of sublimation.
- Dry ice is solid carbon dioxide (CO_2).
- Carbon Dioxide is typically found as a gas.
- When it is frozen into a solid, it turns directly into a gas and totally skips the liquid stage.



Two more REALLY important Points

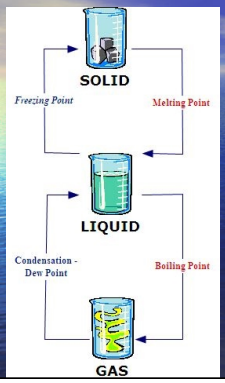
- First, all phase changes are **physical** changes, not chemical changes.
- This is because the substance stays the same before and after the state change.
- It is just changing its shape, not itself!

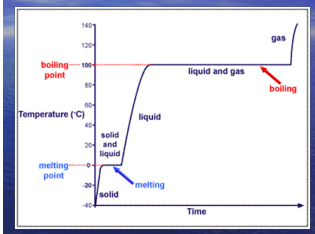
Two more REALLY important Points



- Second, the temperature of a substance does NOT change during a phase change.
- It only changes before or after the change.

States of Matter



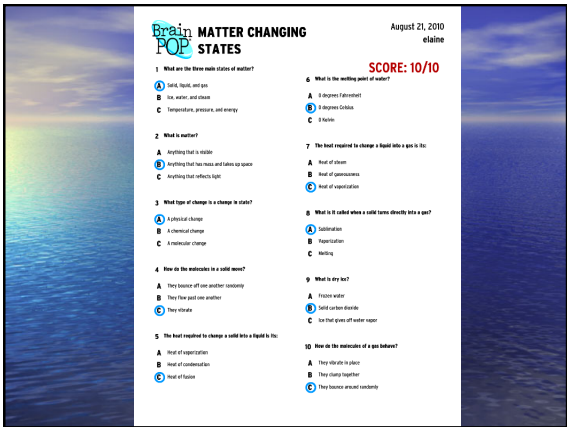


Summary: (fill in the boxes)

BrainPop: Change of State

Summarizing the Changes of State

Change of state	Direction	Endothermic or exothermic?	Example
Melting	solid → liquid	endothermic	Ice melts into liquid water at 0°C.
Freezing	liquid → solid	exothermic	Liquid water freezes into ice at 0°C.
Vaporization	liquid → gas	endothermic	Liquid water vaporizes into steam at 100°C.
Condensation	gas → liquid	exothermic	Steam condenses into liquid water at 100°C.
Sublimation	solid → gas	endothermic	Solid dry ice sublimes into a gas at –78°C.



Brain POP **MATTER CHANGING STATES**

August 21, 2010
elaine

SCORE: 10/10

1 What are the three main states of matter?
(A) Solid, liquid, and gas
B Ice, water, and steam
C Temperature, pressure, and energy

2 What is matter?
A Anything that is visible
(B) Anything that has mass and takes up space
C Anything that reflects light

3 What type of change is a change in state?
(A) A physical change
B A chemical change
C A molecular change

4 How do the molecules in a solid move?
A They bounce off one another randomly
B They flow past one another
(C) They vibrate

5 The heat required to change a solid into a liquid is its:
A Heat of vaporization
B Heat of condensation
(C) Heat of fusion

6 What is the melting point of water?
A 0 degrees Fahrenheit
(B) 0 degrees Celsius
C 0 Kelvin

7 The heat required to change a liquid into a gas is its:
A Heat of steam
B Heat of gaseousness
(C) Heat of vaporization

8 What is it called when a solid turns directly into a gas?
(A) Sublimation
B Vaporization
C Melting

9 What is dry ice?
A Frozen water
(B) Solid carbon dioxide
C Ice that gives off water vapor

10 How do the molecules of a gas behave?
A They vibrate in place
B They clump together
(C) They bounce around randomly