Heating and Cooling Explained By The Particle Model

Notes: Part 2/4

What are Particles?

- Particles are the building blocks of all things.
- Some people call them molecules. Particles are NOT alive.
- How many particles do you think join together to make 1 single drop of water?
- There are more particles clinging together in a drop of water than the amount of humans that ever existed.

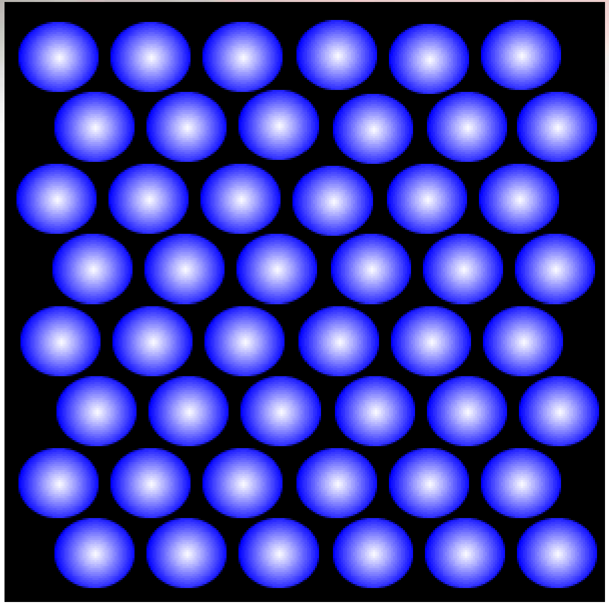
Click the Image Below To See Particles

Particles of a Liquid

- The little spheres represent water molecules.
- Molecules are in constant motion.
- The attractions water molecules have for each other keep them close together.
- They can move past each other but their attractions keep them from moving far apart from each other.

Download as SWF (.swf) What's this? Learn more →

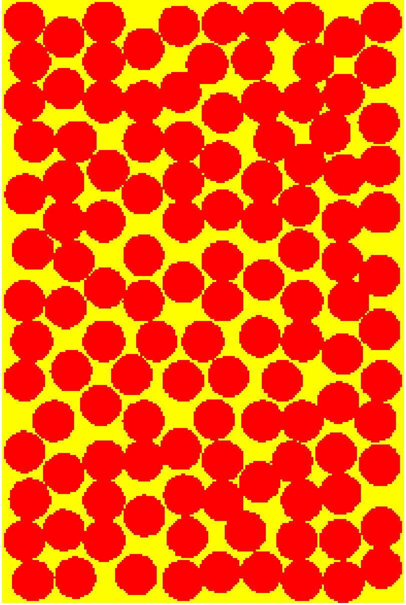
Particles in a Solid

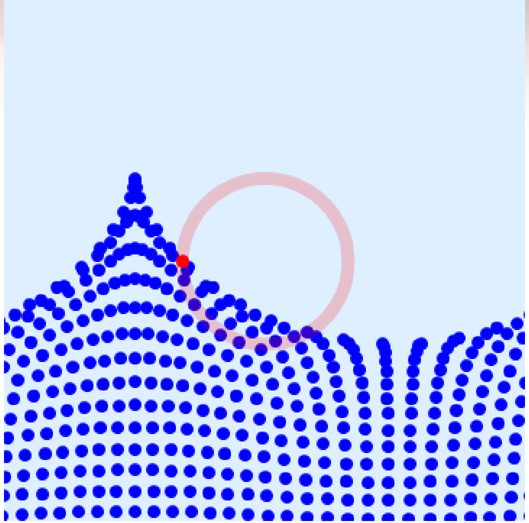


- The particles in a solid are in close contact.
- They vibrate in 1 spot.
- They hold each other tightly.
- Tiny spaces exist between them.

View full screen to see animations

Particles in a Liquid





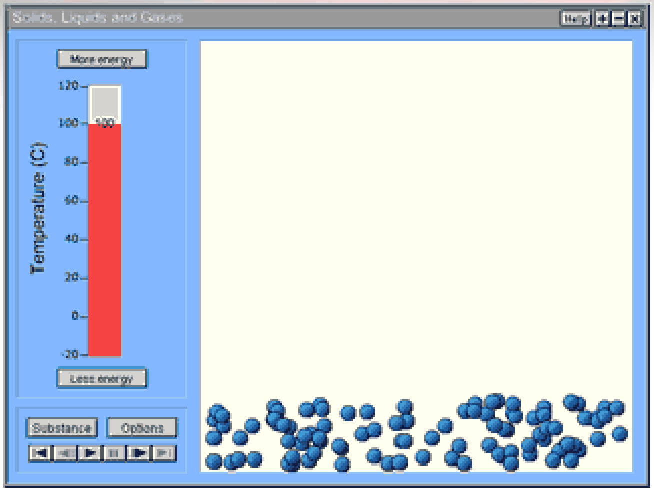
View full screen to see animations

The particles in a liquid vibrate.

They also slide and rotate around each other.

Do liquid particles have more energy or less energy than the particles in a solid?

Particles in a Gas



View full screen to see animations

The particles in a gas stay far apart.

They move with high energy.

They collide and bounce off each other like popcorn kernels in the popcorn machine.

They vibrate, rotate, and move freely.

Do gas particles have more energy or less energy than the particles in a liquid?

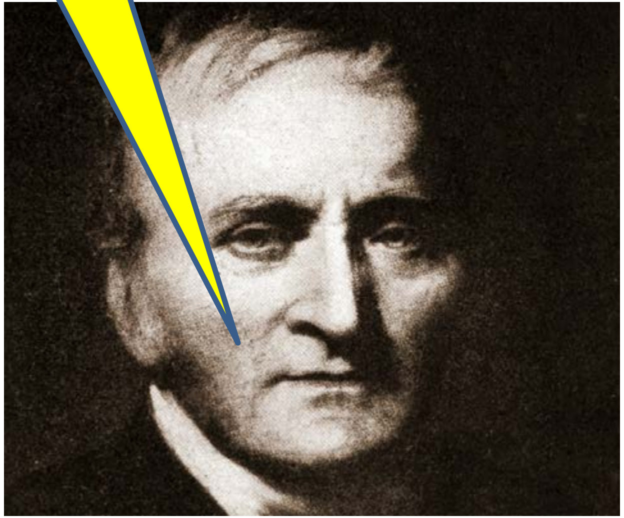
The Particle Theory

- 2600 years ago, Greek Philosophers held a meeting to decide once and for all that everything was made of tiny particles called atoms.

- Many other Philosophers disagreed with them. They argued endlessly.

- 100 years ago, John Dalton proved that these tiny particles did in fact exist.

- He also discovered some very interesting facts about particles.



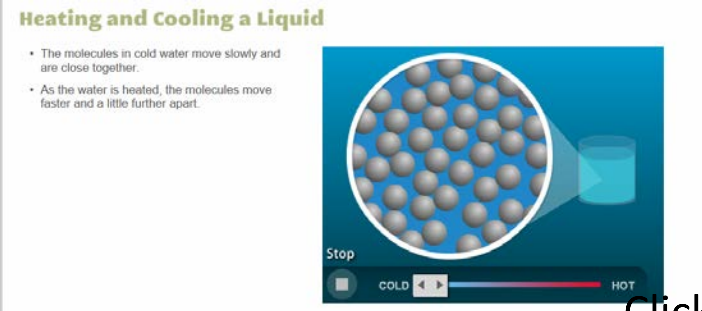
Particle Theory (memorize this)

1. All Substances are made of tiny microscopic particles that are <u>attracted to each other.</u>

2. Particles always have spaces in between them (Even in solids)

3. Particles are always moving. They never stop moving.

4. Particles move faster when heated. They move slower when cooled.
   Particles gain *kinetic energy when heated and Lose *Kinetic Energy When cooled.



**Kinetic energy is energy of motion.*

Click images to see simulation.

What is Temperature?

Temperature is the **average speed** of the particles in a substance.

High Temperature means Faster Particle Speed (high kinetic energy).

Lower Temperatures means Slower Particle Speed (lower kinetic energy)

Temperature is measured in degrees Celsius, degrees Fahrenheit, and in Kelvin (Only Scientists use Kelvin)

What is Heat?

Heat is **NOT** the speed of the particles.

Heat is the **TOTAL ENERGY** of all of the particles combined.

Heat is measured in Joules (J).

Heat vs Temperature

Energy depends on how much of something you have.

For example you can have 50 crazy people in a room (high energy) or 1 crazy person in a room (lower energy).

Heat vs Temperature

You can have a high temperature (fast) with low heat (not much TOTAL energy).

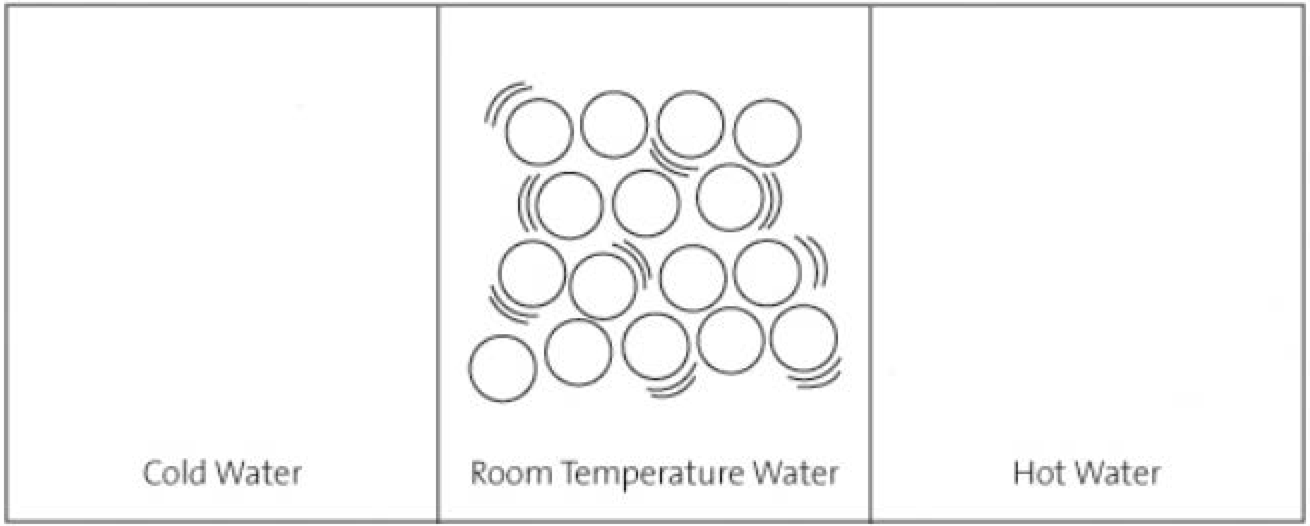
- Ex. 1 drop of boiling water.

You can have a high temperature (fast) with high heat (Lots of TOTAL energy).

- Ex. A bucket of boiling water.

Water Molecules at Different Temperatures

- The circles represent water molecules.
- The molecules are randomly arranged.
- They interact with each other because of their attractions.
- The motion lines show that they are moving.



How Does Heat Move?

Heat can move in 3 different ways

1. **Conduction**
2. **Convection**
3. **Radiation**

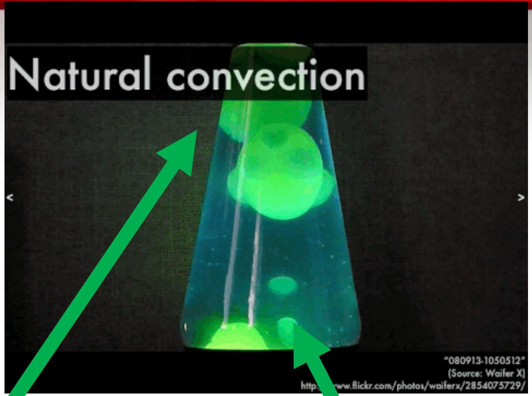
1.Conduction

(Be in PP slideshow mode to see animations)

- Heat spreads through **<u>collisions</u>**!
- Occurs mainly in **<u>solids</u>**, especially metals.
- One particle gets hot, gains **<u>kinetic energy</u>**, and starts to move **<u>faster</u>**.
- Then it **<u>collides</u>** hard with the particles next to it causing it to move faster.
- This **<u>collision</u>** spreads from particle to particle like a chain reaction.
- Think dominoes.

2. Convection

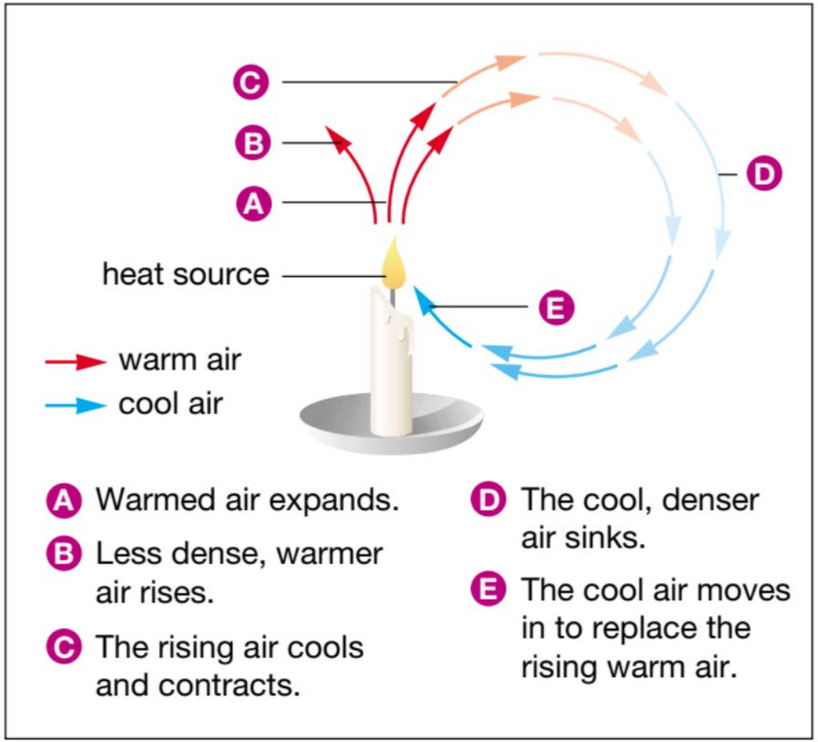
- Convection spreads heat only through **<u>liquids and gases….NOT SOLIDS.</u>**
- Hot particles rise. Cold particles fall.
- The air in a room is heated through convection.
- Lava lamps work because of convection.
- Water boiling in a pot undergoes convection.



Why are these liquid bubbles falling?

Why are these liquid bubbles rising?

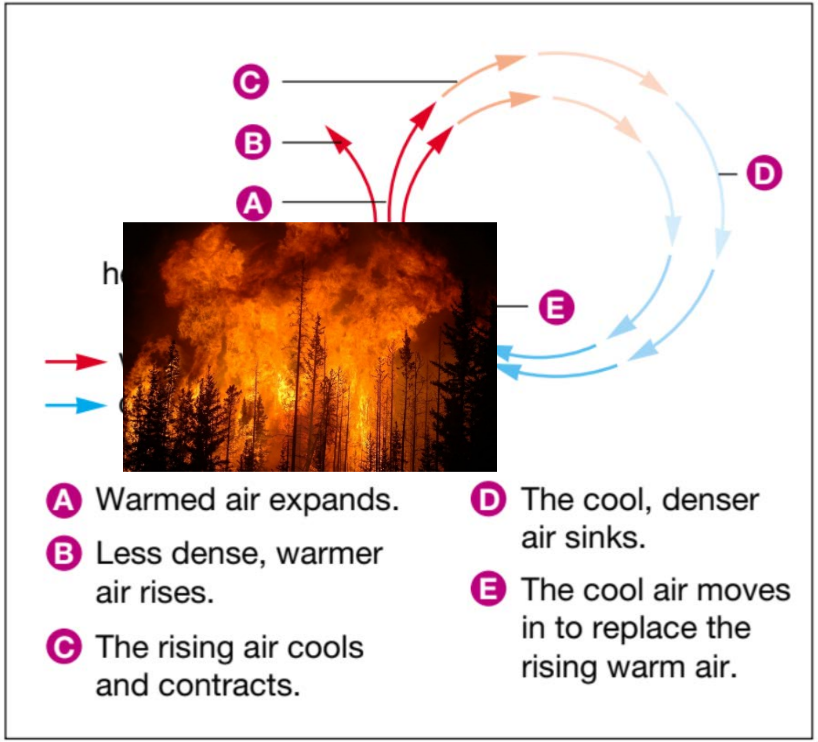
2. Convection



Convection creates air movement and that creates wind.

Voila! Heat is moved!

2. Convection



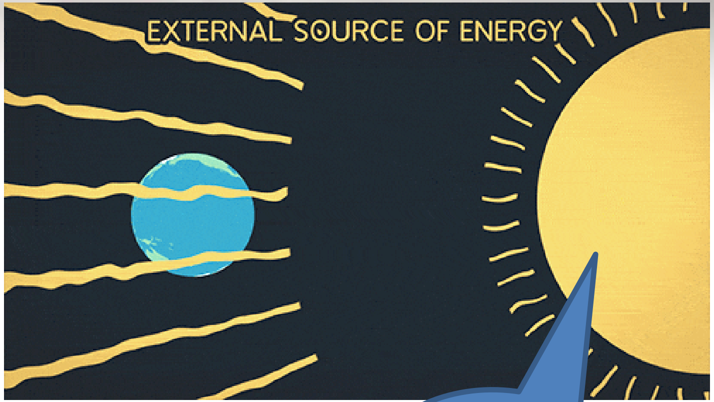
<u>How much more</u> air flow will this forest fire Create compared to the candle?

What kinds of winds will this fire generate?

Why don’t these liquids mix?

3. Radiation

- In space, there are **<u>no</u>** particles.
- That is a problem, because what is going to pass the heat from the sun to the earth?
- Welcome to **<u>Radiation</u>**!
- Radiation (also called electromagnetic Radiation…EMR) is a type of heat that **<u>does not</u>** need any particles to spread the heat around.
- Radiation sends its heat in WAVES at the speed of light. No particles needed.

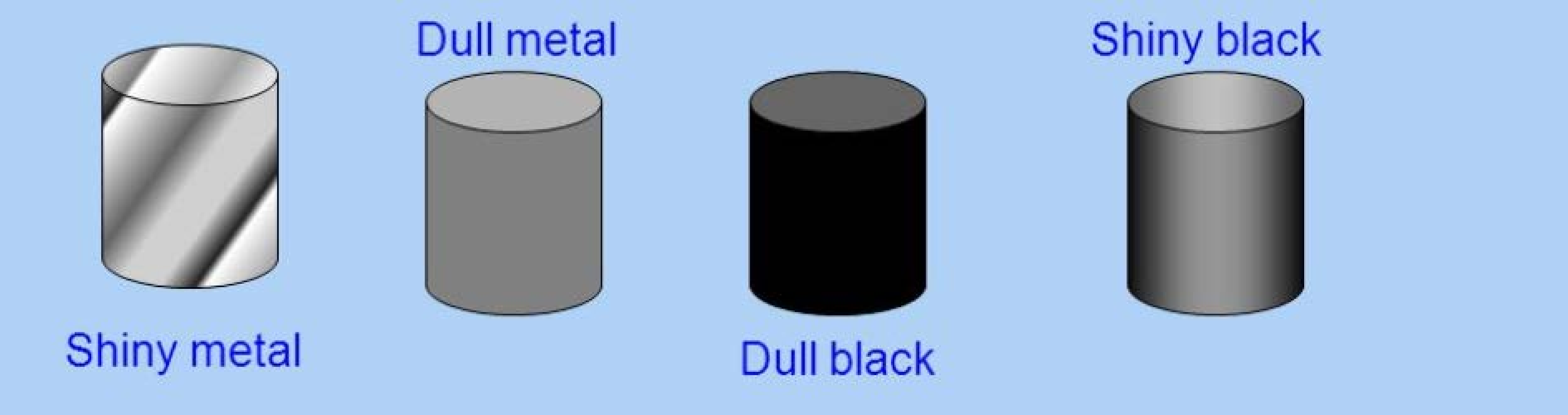


Particles are lame!

Materials Can Absorb Radiation

- Black Materials love to **absorb** radiation.
  - ❑ Black shirts heat up in the sun.
- White Materials love to **reflect** radiation.
  - ❑ White shirts stay cool in the sun.
- Shiny colors love to reflect radiation.
- Dull colors love to absorb radiation.

Materials Can Absorb Radiation



Coolest | **3rd Hottest** | **Hottest** | **2nd Hottest**

These 4 cans are exposed to the same amount of heat. After 10 minutes, their temperature Was recorded. Use your wisdom to rank them in order from hottest to coldest.

Phase Changes

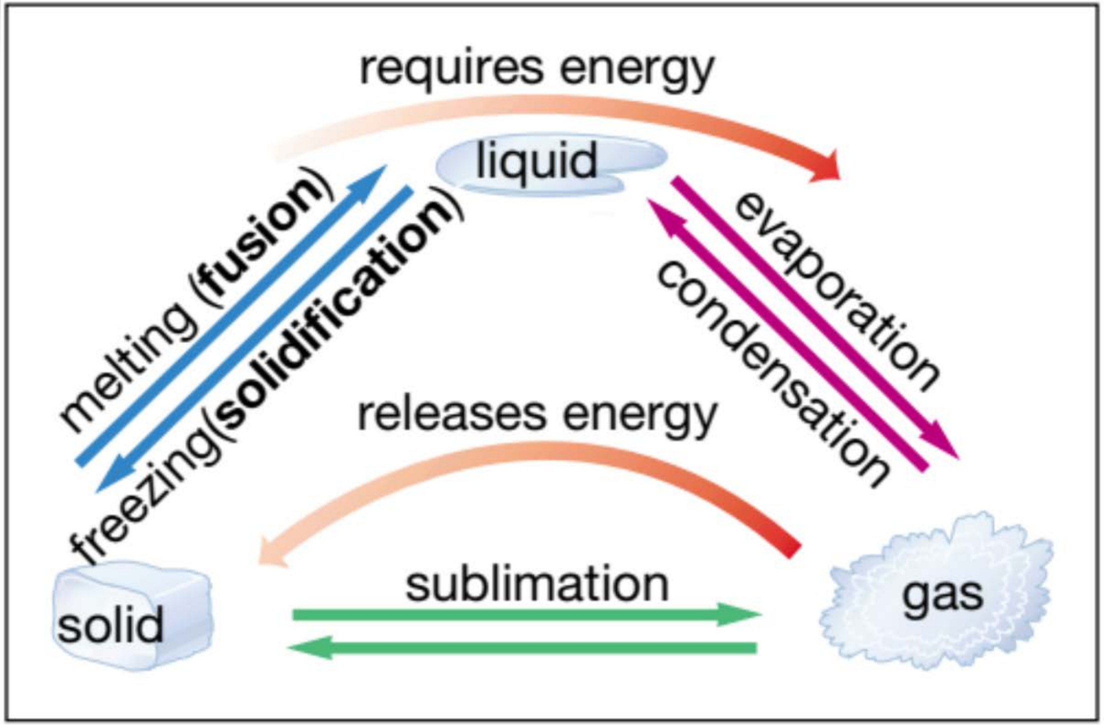


Figure 3.18 Changes of state

***Key Wisdom: You must <u>memorize</u> and <u>understand</u> this cycle.**

Phase Changes

Table 3 Melting and Boiling Points of Pure Substances

Substance	Melting point (°C)	Boiling point (°C)
oxygen	–218	–183
mercury	–39	357
water	0	100
tin	232	2602
lead	328	1740
aluminum	660	2519
table salt (sodium chloride)	801	1413
silver	962	2162
gold	1064	2856
iron	1535	2861

Tip: Freezing and melting temperatures are always the same.

Boiling and Condensation temperatures are always the same.

What temperature does oxygen boil at?

What temperature does water boil at?

What temperature does gold boil at?

What temperature does oxygen condense at?

What temperature does water condense at?

What temperature does gold condense at?

Phase Changes

Table 3 Melting and Boiling Points of Pure Substances

Substance	Melting point (°C)	Boiling point (°C)
oxygen	–218	–183
mercury	–39	357
water	0	100
tin	232	2602
lead	328	1740
aluminum	660	2519
table salt (sodium chloride)	801	1413
silver	962	2162
gold	1064	2856
iron	1535	2861

Tip: Freezing and melting temperatures are always the same.

Boiling and Condensation temperatures are always the same.

What temperature does oxygen melt at?

What temperature does water melt at?

What temperature does gold melt at?

What temperature does oxygen freeze at?

What temperature does water freeze at?

What temperature does gold freeze at?

Phase Changes

Evaporation Is So Cool!

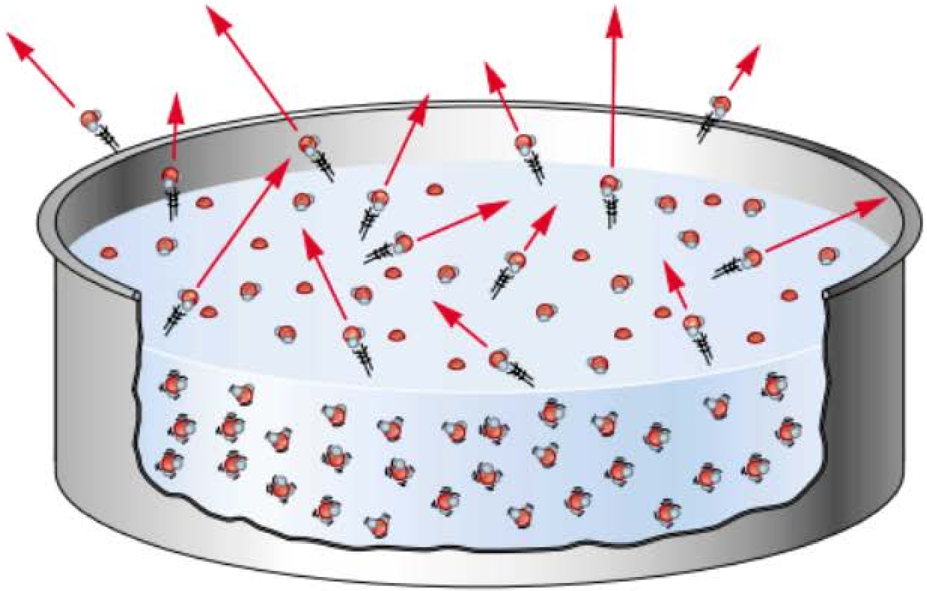


Figure 3.19 Evaporation cools a liquid, because the most energetic particles escape from its surface.

Evaporation Is So Cool! Haha Get it?

- When liquids evaporate off of your skin, that liquid will instantly cool you down.

- Warm, or even hot water will cool you down when you step out of the shower or hot tub.

- Why?

- Because the fast water molecules jump into the air (evaporate) leaving the slow ones behind. Slow particles are low energy and are hungry for your b.heat

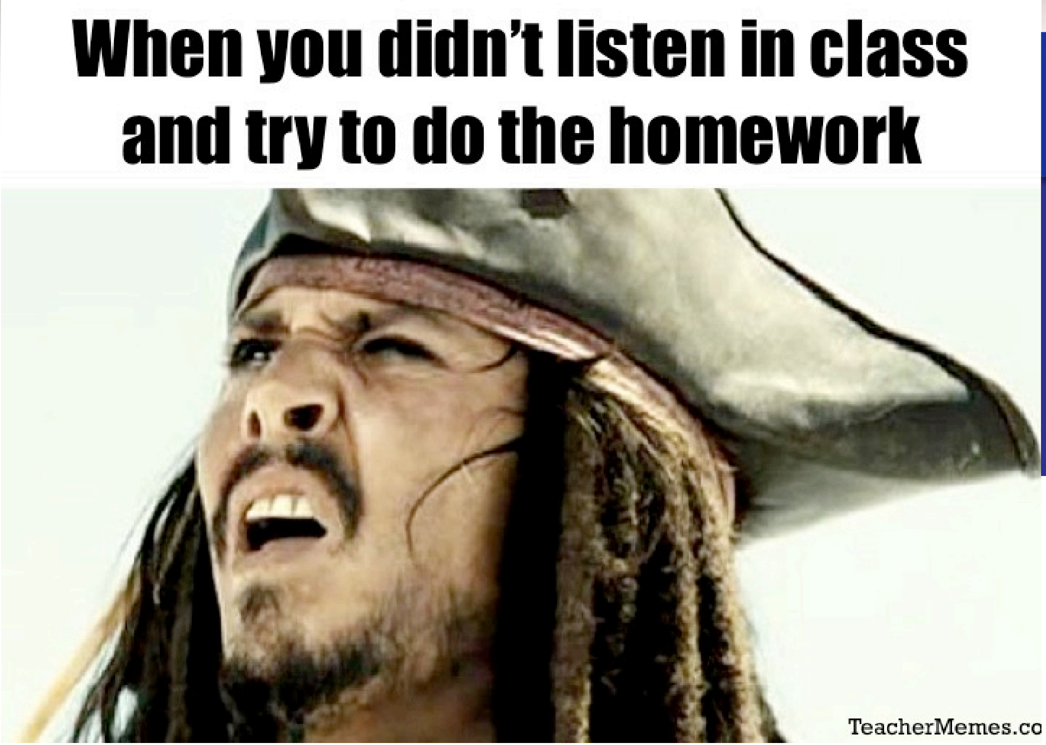
- Slow particles <u>feel</u> cold because they absorb body heat from you.

- The longer you are wet, the more heat the liquid will suck out o and the colder you will get. *Hypothermia

Why did you leave me you fast water particles. Th-th-them slow particles s-s-stealin m-my heat.

Evaporation Is So Cool! Haha Get it?

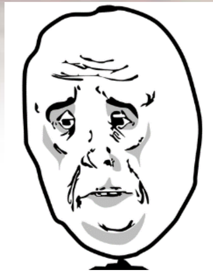
- Why do you think we sweat?


When you didn't listen in class and try to do the homework
TeacherMemes.co


FOCUS & ATTENTION
CONCENTRATE

Thermal Expansion and Contraction

Thermal Expansion & Contraction



- **Expand**: To get larger.
- **Contract**: To get smaller.

- As a kid, I left my basketball outside in the middle of winter.

- In the morning, when I went out to get it, the ball had shrunk and it was flat.

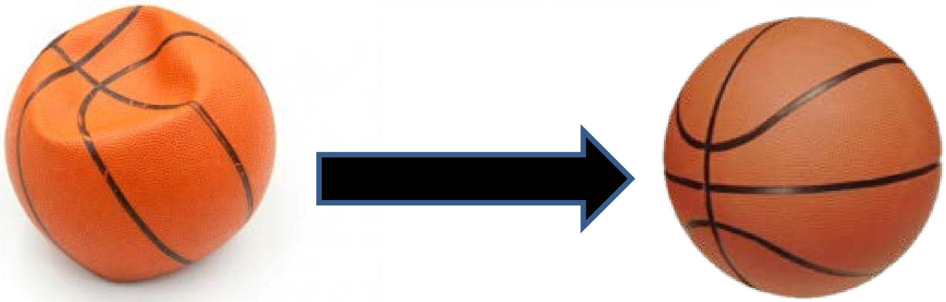
- There were no leaks. The same amount of air was inside the ball.

- What happened?

Thermal Expansion & Contraction

- When I took the ball inside, it became round and tight again.

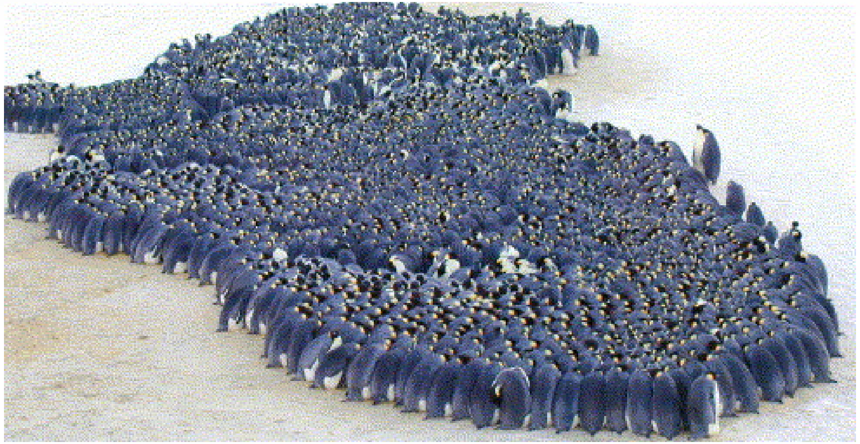
outside inside



- Was it magic?
- No, it was science.
- It was Thermal Expansion and Thermal Contraction!

Thermal Expansion & Contraction

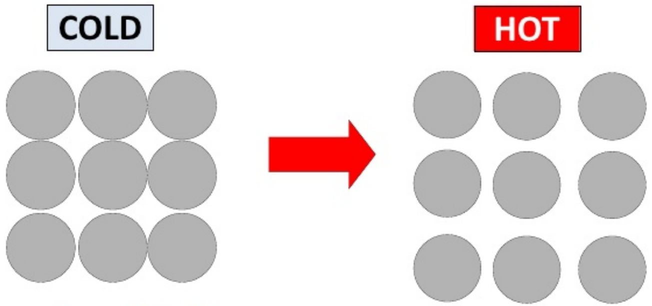
When particles **LOSE** kinetic energy from the cold, they slow down and **CONTRACT** by coming closer together. Think of penguins huddling when they are cold.

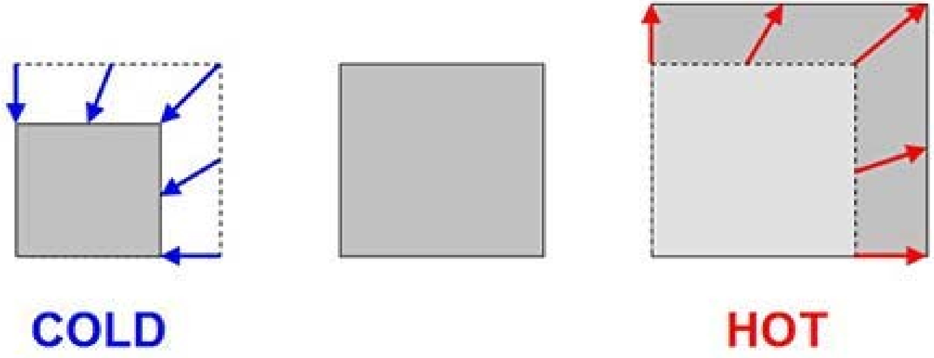


When particles **GAIN** kinetic energy from the heat, they speed up and **EXPAND** by moving away from each other. Think crazy people on the beach when it's hot.

Thermal Expansion & Contraction

EXPANSION & CONTRACTION OF SOLIDS



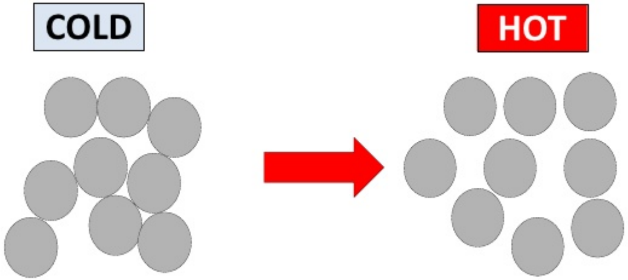


Expansion of Solids

As the temperature increases, the atoms **vibrate** more vigorously and these vibrations push the atoms **further** apart. Thus, the volume of the solid increases.

Thermal Expansion & Contraction

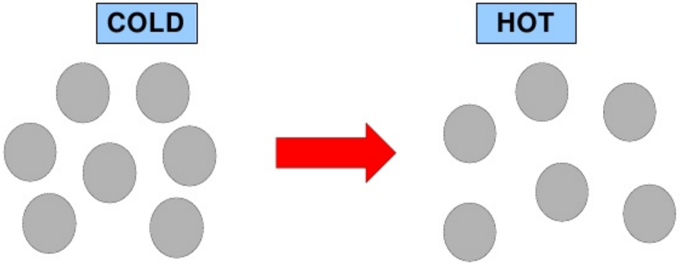
EXPANSION & CONTRACTION OF LIQUIDS



Expansion of Liquids

When the liquid is heated, the molecules have more energy and move more **vigorously**. The movement of the molecules overcome the forces of attraction between the molecules, allowing them to **move freely**. Thus, the volume of the liquid increases.

EXPANSION & CONTRACTION OF GASES



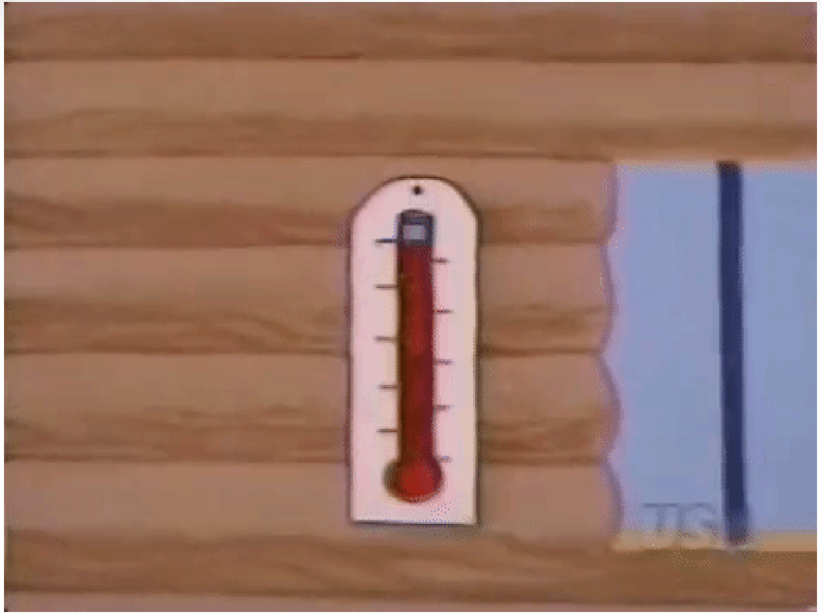
Expansion of Gaseous

When the gas is heated, the molecules gain more energy and **move faster** and further apart. This causes the volume to increase

Contraction of Gaseous

At a lower temperature, the molecules have **move slower** and have less energy. They are closer together causing the volume to decrease.

Thermal Expansion & Contraction



- A thermometer is just a liquid (alcohol) inside of a tube.
- When it gets hot, the liquid heats up and expands, stretching upwards in the tube.
- When it gets cold, the liquid cools and contracts, causing it to shorten down the tube.

Expansion & Contraction

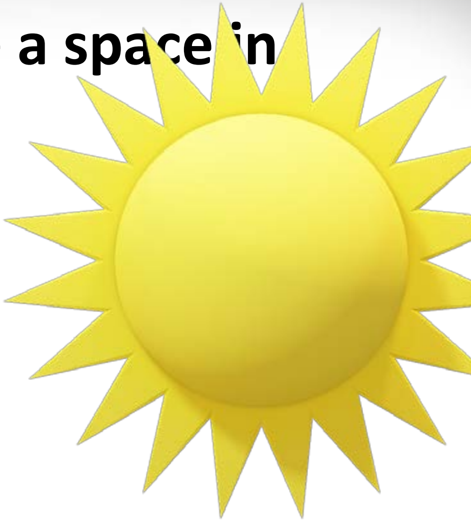
- **What is causing this balloon to inflate?**

Expansion Joints

- Whenever you are joining two pieces of railroad, sidewalk and anything made of metal, it is important to leave a space in between them.

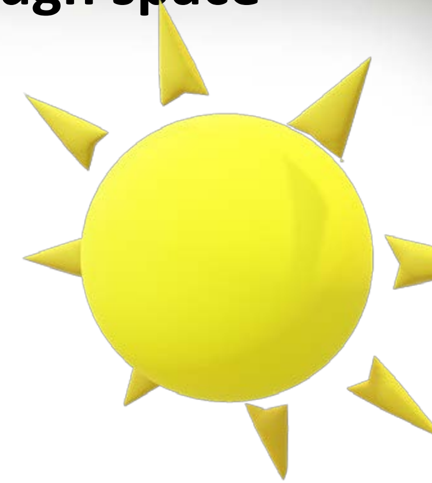
- Why?

- Because of thermal expansion and contraction.



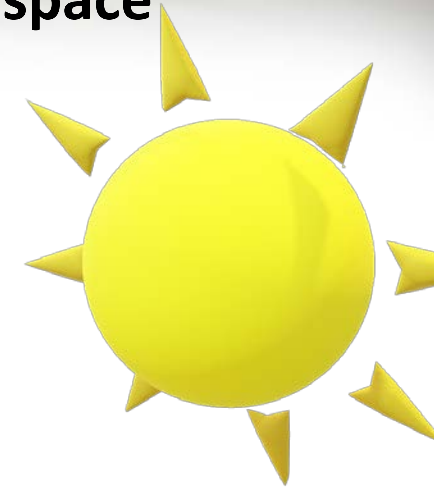
Expansion Joints

- **Here is what would happen if there was NOT enough space between the sheets of concrete or metal.**

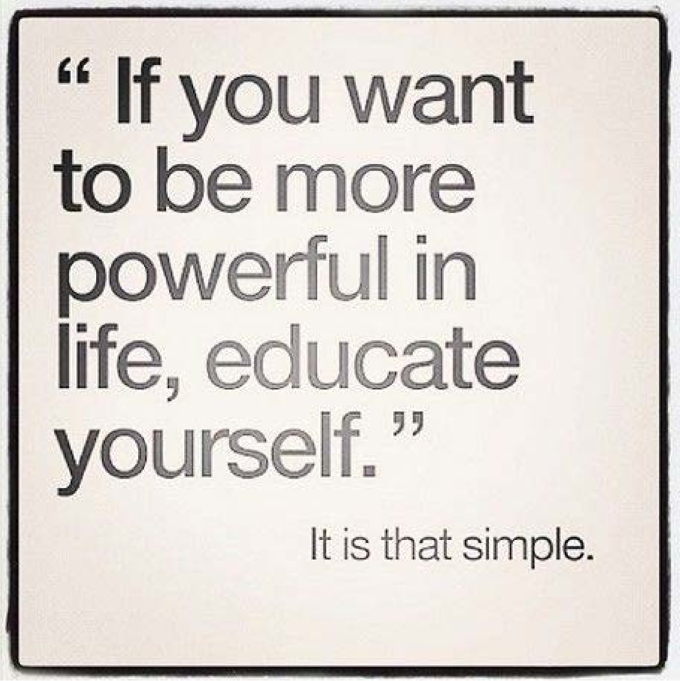


Expansion Joints

- **Here is what would happen if there WAS enough space between the sheets of concrete or metal.**



Stay in School, Kids!

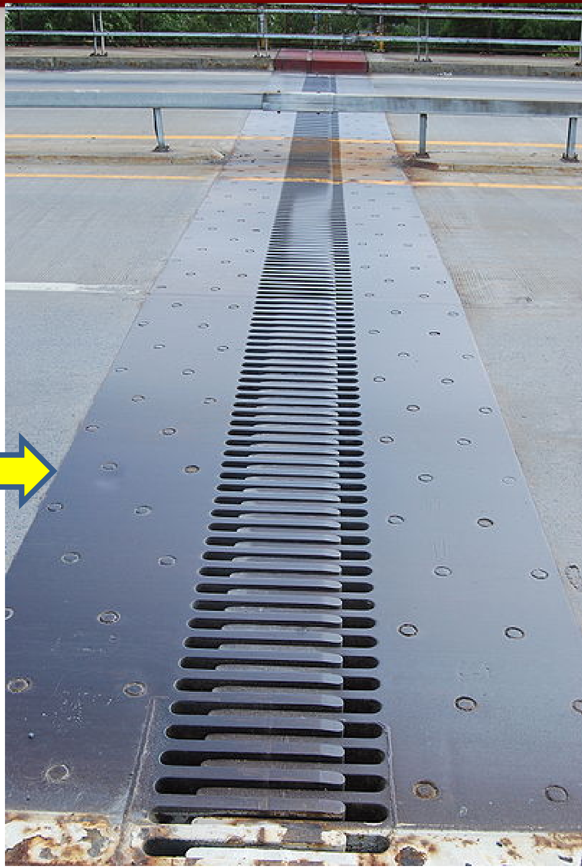


Epic Disasters—No Expansion Joints

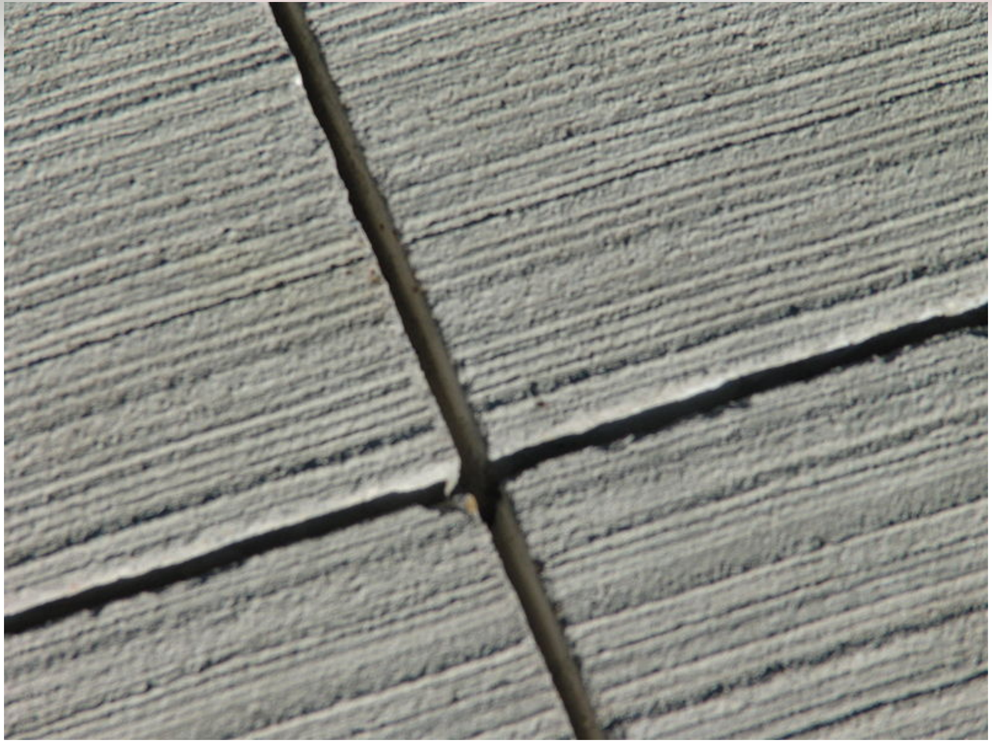
Epic Disaster—No Expansion Joints

The steel beams were joined too closely together. In the summer they expanded into each other causing them to buckle.

Today, bridge segments are connected using expansion joints. This gives the Metal segments Enough space To expand and contract without touching each other.



Expansion & Contraction



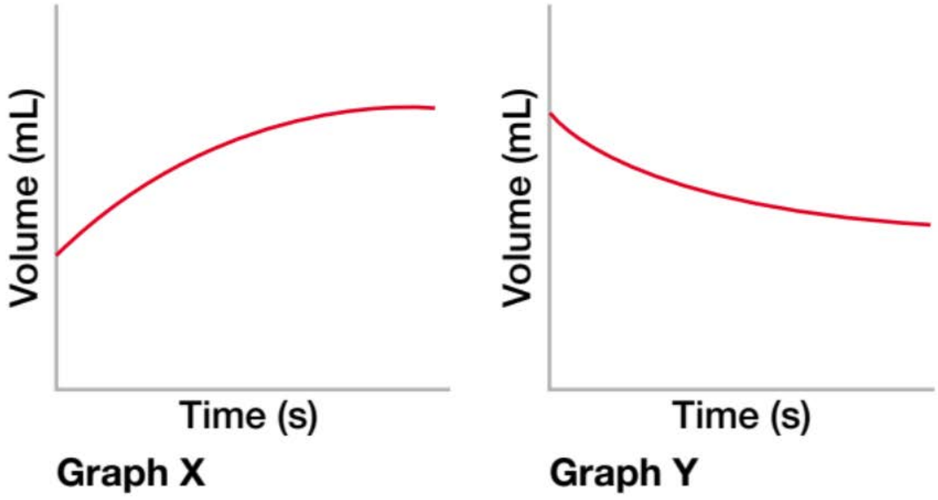
Why do they leave spaces in between sidewalk segments?

Expansion & Contraction

Why do these cables hang in the summer?

What will happen to them in the winter?

Graphs



**Volume: The amount of space an object takes up. **

What information do these graphs tell us?

Which graph shows us an object heating up? How do you know?


CONGRATULATIONS!
YOU'RE DONE!!!
memegenerator.net