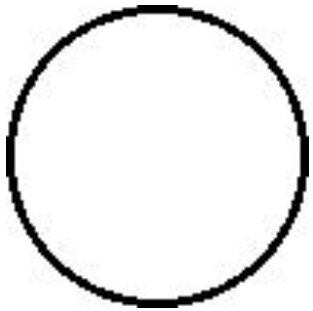
States of Matter



Learning objectives

- Explains what happens to temperature during changes of state.

A Closer Look: Thermal Expansion in Solids

The changes to particles at the unobservable level lead to changes you can see. You learned that thermal expansion occurs in gases, liquids, and solids. Scientists have used their knowledge of thermal expansion to create thermometers. Hot air balloons are able to float because of thermal expansion. Are there any negative effects to thermal expansion?

Yes, thermal expansion can have negative effects. Two common areas where engineers take steps to guard against thermal expansion are bridges and sidewalks. Look at the photo of the Golden Gate Bridge above. What looks like a metal grate near the bottom of the inset photo is an expansion joint. This joint allows for the metal to expand during high temperatures and for the metal to contract when it is cooler.

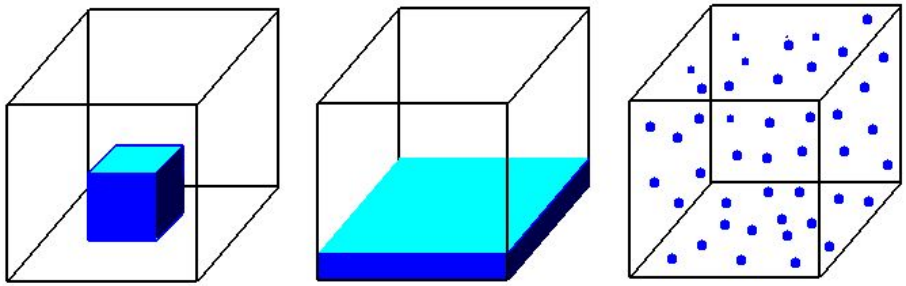
In the photo on the right, a construction worker is adding expansion joints to concrete. Sidewalks, roads, and parking lots made of concrete are places where the effects of thermal expansion and contraction can be observed. Cracked concrete is a place where thermal expansion has occurred.

It's Your Turn

ENGINEERING Connection When engineers build new bridges, how do they know how far the joint must be able to move? What criteria and constraints drive their decision? How do climate, natural resources, and economic conditions affect the solution? Research this scenario or another question that you have about thermal expansion. Create a digital presentation to share your findings.

Matter

- Matter is anything that has mass and volume.
- There are three main types of matter. They are solid, liquid, and gas.



Click here to learn more about the types of matter.

Paired work- complete in notebook

- Find the freezing point of water
- find the melting point of water
- Find the boiling point of water

Paired work- complete in notebook

- **Complete these sentences in your notebooks:**

- The freezing point is the temperature at which a L_____ changes into a S_____.
- The melting point is the temperature at which as S_____ changes into a L_____.
- The boiling point is the temperature at which a L_____ changes into a G_____.
- The **condensation** point is the temperature at which a G_____ changes into a L_____.

Investigation task – Page37

Changes Between Solids and Liquids When the temperature of the ice reached 0°C, the solid ice began to change to a liquid. While a substance is melting or freezing, the temperature remains constant until the change of state, or phase change, is complete. The point at which a substance changes between a solid and a liquid is referred to as the melting point or the freezing point. The melting point and the freezing point are always the same for a given substance.

When the ice changed to a liquid, the temperature remained constant. What do you think happens when water changes to a gas?

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

INVESTIGATION

Next Phase

Another group of students continued the experiment to see if this pattern was the same when a liquid changes to a gas. The students examined the temperature of a beaker on a hot plate starting at 50°C and continuing until the water was boiling. Their data and observations are recorded in the table below.

Time (min)	Temperature (°C)	Observations
0:00	50.8	Liquid
0:30	60.5	Liquid
1:00	67.0	Liquid
1:30	74.4	Liquid
2:00	81.5	Liquid
2:30	88.0	Liquid
3:00	93.3	Liquid + bubbles at bottom of beaker
3:30	100.3	Liquid + boiling
4:00	100.9	Liquid + boiling
4:30	101.0	Liquid + boiling
5:00	101.1	Liquid + boiling
5:30	100.7	Liquid + boiling
6:00	100.9	Liquid + boiling
6:30	101.0	Liquid + boiling
7:00	100.9	Liquid + boiling

Investigation task – Page37

5. Develop a claim supported by evidence and reasoning on what is occurring when only a liquid is present.

Answers may vary. Sample answers: the particles are moving faster and faster. Energy is being added to the water.

6. What explanation can you make about when two states of matter are present at the same time based on the evidence?

Answers may vary. Sample answer: The energy is going into changing the state of matter.

7. If you continued to heat the water after it turned into a gas, what do you think would happen to the temperature? Explain your answer.

Answers may vary. Sample answer: The temperature would rise as the gas continued to gain energy.

8. The glass is melting in the furnace. Explain why the temperature of the glass is not rising.

Answers may vary. Sample answer: The glass is changing from a solid to a liquid. The glass is at its melting point, so added energy is going into changing the state of matter.

Starter

- Video task https://edpuzzle.com/media/6197a866dcd99e419737b7d9

Task – experiment video

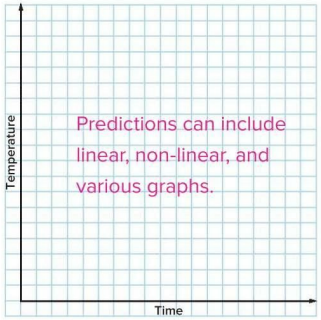
What happens to temperature during a change of state?

When the gallium was first picked up, it was at room temperature. Your body temperature is much higher than room temperature. What happens when the gallium is warmed by your hand?

Want more information?
Go online to read more about energy and states of matter.

LAB Phase Changes

When energy is added to a solid, such as ice, the energy increases the speed of the particles by increasing the kinetic energy of the particles. Ice eventually melts to liquid water when heated. On the graph below, draw a line to predict what will happen to the temperature of ice as it melts.



Safety

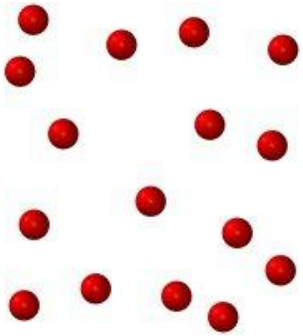
Materials

crushed ice
beaker
thermometer
stopwatch
stirring rod
hot mitts
hot plate

States of Matter

- The state of matter is determined by the movement of particles within the matter.

Solids **Liquids** **Gases**



Select a state of matter above to learn more about it or click here to take the Matter Self Quiz.

Matter Self Quiz

Question #1

Matter is anything that has _____ and _____.

Click here for answer. 

Answer #1

Matter is anything that has **mass** and **volume**.

Click here to go to Question #2. 

Matter Self Quiz

Question #2

What are the 3 main types of matter?

Click here for answer. 

Answer #2

Solids, liquids, and gases.

Click here to go to Question #3. 

Matter Self Quiz

Question #3

What determines what the state of matter will be?

Click here for answer. 

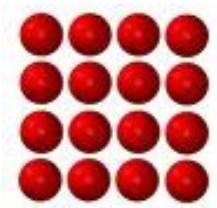
Answer #3

The movement of particles.

End of Quiz. Click here to return to States of Matter. 

Particle Motion of Solids

The particles in solids don't move much, but they do vibrate in place slightly.



Notice how the solid maintains its shape in the container.

- There are two basic types of particle arrangement in solids. Click here to find out more.

Solids Self Quiz

Question #1

How do the particles in solids move?

Click here for answer. 

Answer #1

They don't move much, they only vibrate slightly.

Click here to go to Question #2. 

Solids Self Quiz

Question #2

True or False: If you add kinetic energy to the particles of a solid, they will move faster.

Click here for answer.

Answer #2

True.

Click here to go to Question #3.

Solids Self Quiz

Question #3

True or False: solids have a definite shape and volume.

Click here for answer. 

Answer #3

True.

Click here to go to Question #4. 

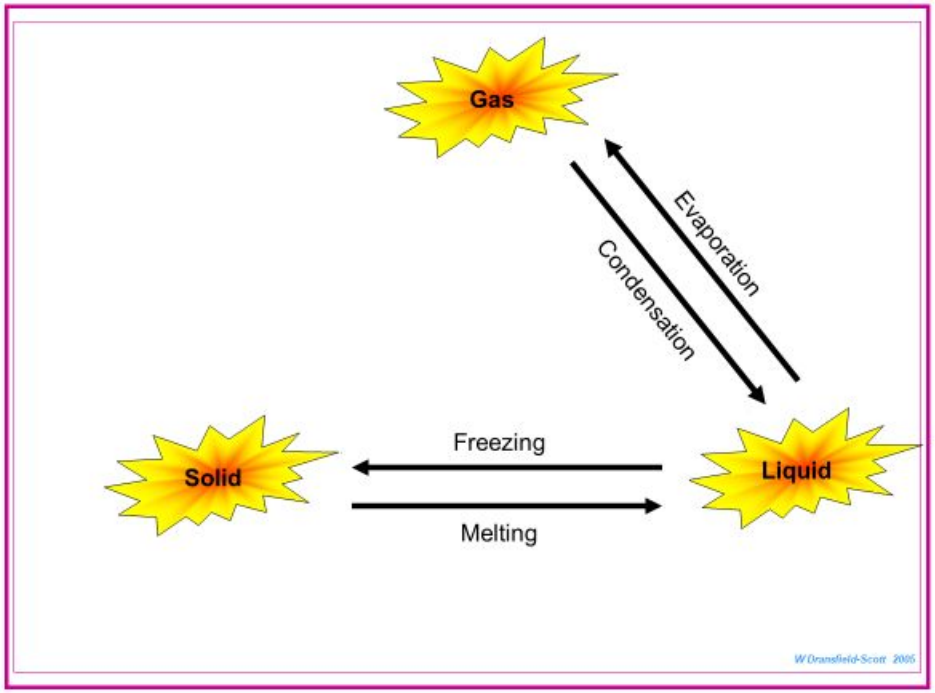
Task 3

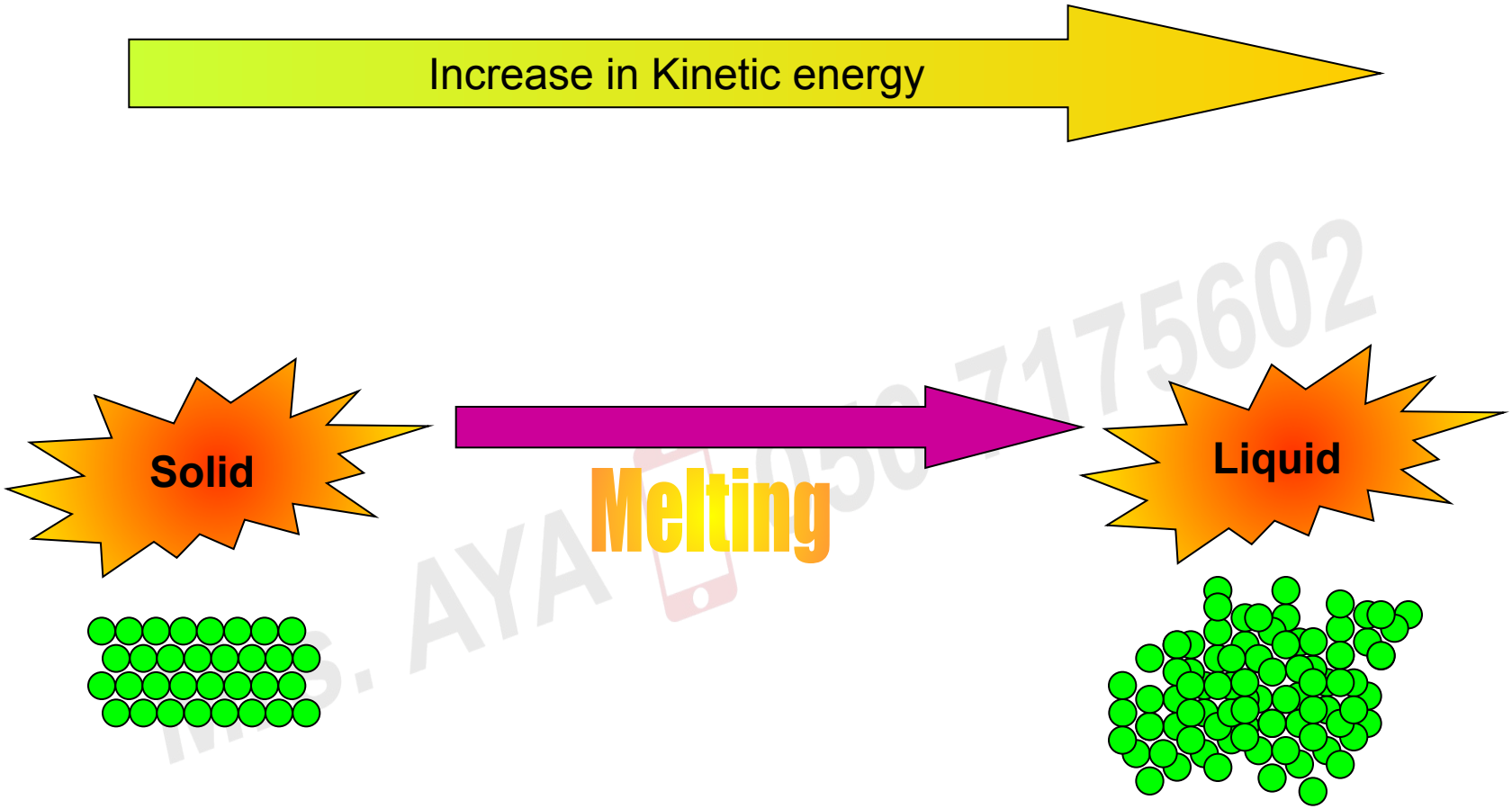
- Open inspire Science
- Read

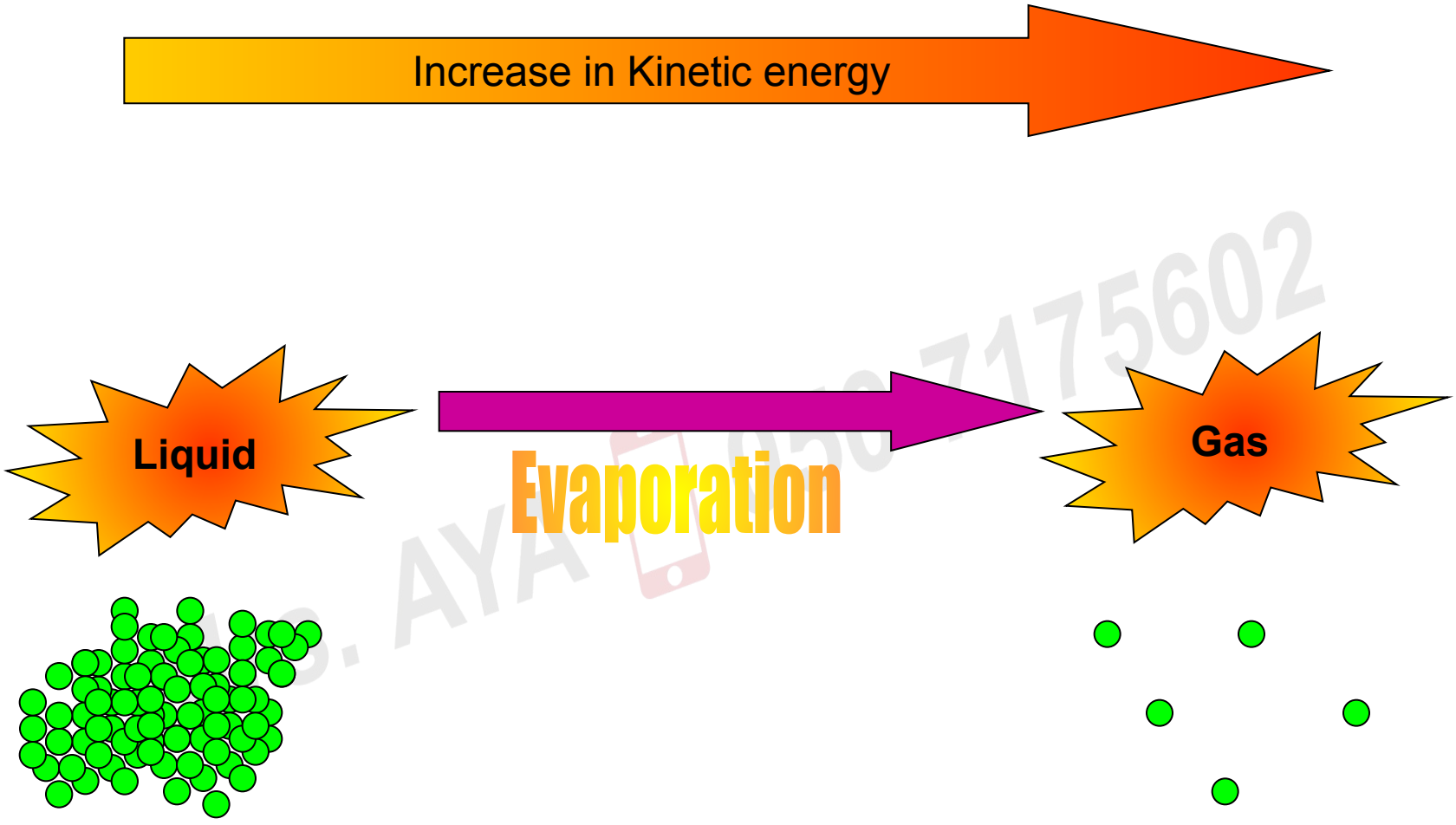
Exit ticket

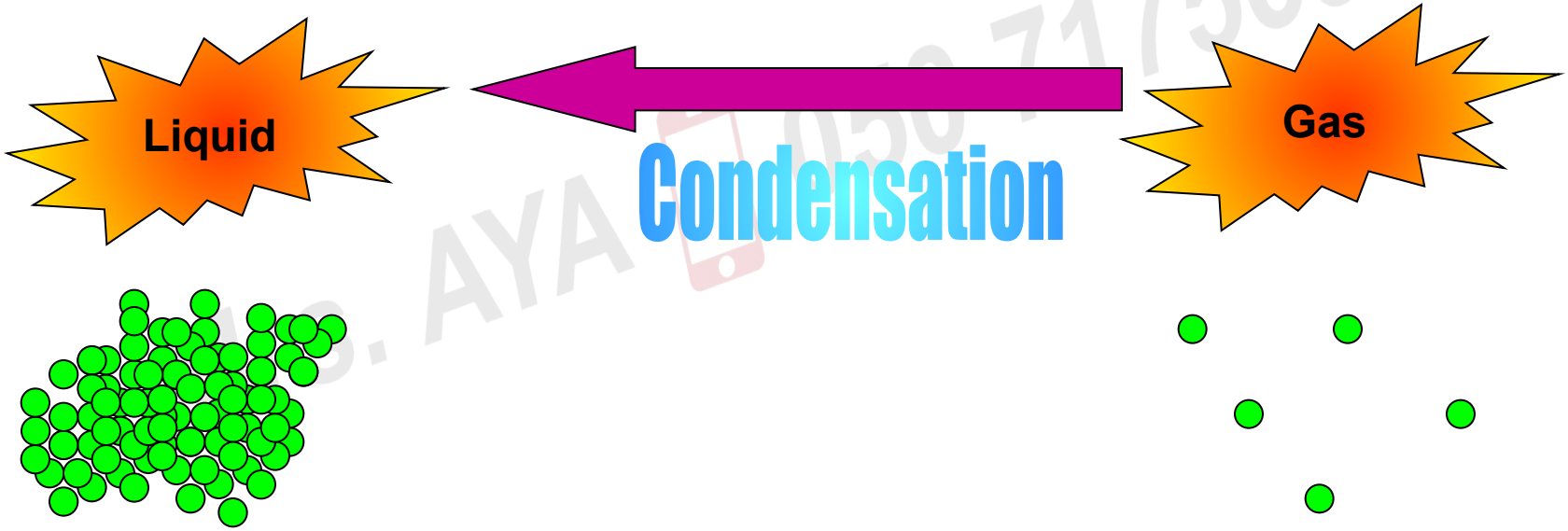
- https://edpuzzle.com/media/5eb736c5582fd33f72de0777

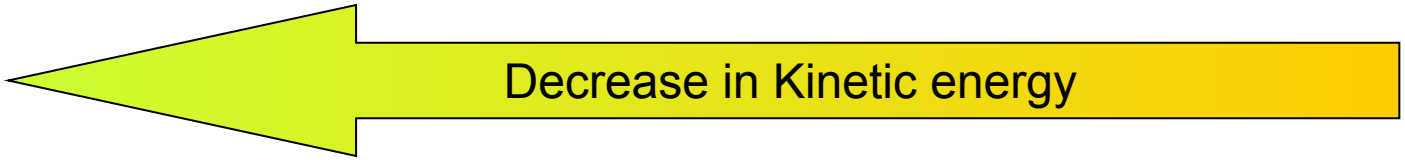
Starter- copy this diagram into your science notebook

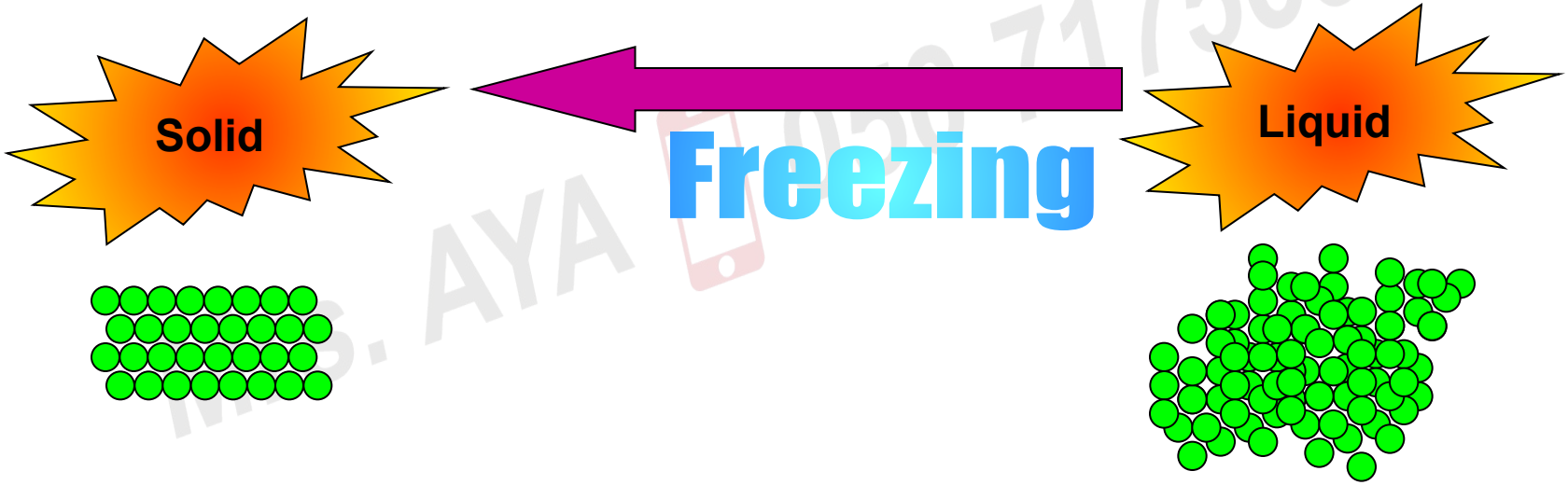












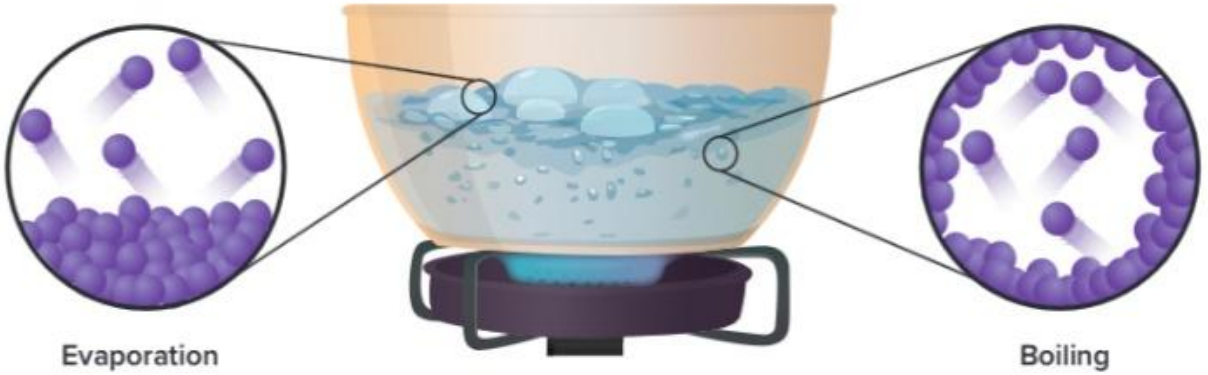
Changes Between Solids and Liquids When the temperature of the ice reached 0°C, the solid ice began to change to a liquid. While a substance is melting or freezing, the temperature remains constant until the change of state, or phase change, is complete. The point at which a substance changes between a solid and a liquid is referred to as the melting point or the freezing point. The melting point and the freezing point are always the same for a given substance.

When the ice changed to a liquid, the temperature remained constant. What do you think happens when water changes to a gas?

Changes Between Gases and Liquids When the temperature of a gas becomes low enough, the gas changes to a liquid. The change of state from a gas to a liquid is **condensation.**

EARTH SCIENCE Connection Changes between states of matter drive the water cycle. Water changes from a liquid on the ground into a gas and enters the atmosphere. When the water vapor in the atmosphere undergoes condensation, it forms clouds. The overnight condensation of water vapor often causes dew to form on blades of grass.

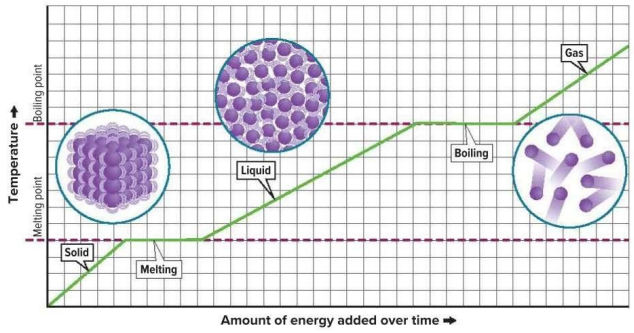
Vaporization The opposite of condensation is **vaporization,** the change in state from a liquid to a gas. There are two ways that vaporization occurs, boiling and evaporation.



Evaporation	Boiling
Vaporization that occurs on the surface of a liquid is called evaporation. Evaporation can occur during boiling and at lower temperatures. A small amount of room-temperature water in a glass, for example, evaporates in a few days without ever reaching the boiling point temperature.	Vaporization that occurs within a liquid is called boiling. Boiling does not occur until a liquid is heated to its boiling point, the point where a substance changes from a liquid to a gas. Once the boiling point is reached, the continued addition of energy vaporizes the liquid. Bubbles form within a liquid as it boils.

The boiling point and the condensation point are the same for a given substance. Whether a liquid is changing to a gas or a gas is changing to a liquid, a substance will always change phases at the same temperature. While a substance is boiling or condensing, the temperature remains constant until the phase change is complete.

Heating curves



Heating Curves The graph above is the heating curve for water. Just as in the graphs you created, it shows what happens to temperature as energy is added to a substance. As energy is transferred to a material, temperature increases when the state of the material is not changing. The kinetic energy of the particles increases. This increases the speed of the particles.

When a substance is changing state, temperature stays the same at the melting and boiling points. The potential energy of the particles increases. This increases the distance between the particles.

THREE-DIMENSIONAL THINKING

Construct an **argument** on how the existence of potential **energy** between particles supports or opposes the shape of a heating curve.

Answers may vary. Sample answer: When the state is changing, the energy is becoming potential energy. As temperature is a measure of the average kinetic energy, the temperature does not change because the average kinetic energy is not changing.

COLLECT EVIDENCE

How does the existence of potential energy and the attractions between particles help explain why gallium exists as different states of matter? Record your evidence (B) in the chart at the beginning of the lesson.

Task 2 – Inspire Science

INVESTIGATION

Changing Energy

GO ONLINE Explore the PhET interactive simulation *States of Matter: Basics*. Explore the simulation on your own. When you are finished, reset the simulation, and then follow the instructions below.

1. Return to the home page and go to Phase Changes lab.
2. Add energy by switching the toggle to *Heat*.
3. Think about which word or phrase in the graphic organizer below best describes what happens as heat is added to the solid. Draw a graphic organizer with your choices in your Science Notebook.

Temperature of solid	*Speed of particles*	*Distance between particles*
increased	increased	increased
decreased	decreased	decreased
stayed the same	stayed the same	stayed the same

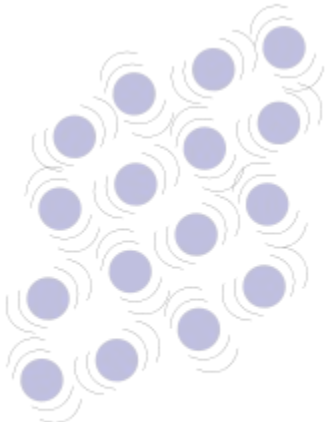
Energy

Energy: 1. ability to do work

2. ability to cause change

The particles move faster, pushing further apart. This means the whole object expands. After some time, the particles will be forced to change state. e.g. Solid to liquid.

BEFORE HEATING/
AFTER COOLING



AFTER HEATING/
BEFORE COOLING

THE PARTICLES THEMSELVES DO NOT EXPAND!

Wordwall

- https://wordwall.net/resource/2766613

- https://wordwall.net/resource/15143520

Determine whether each of the following is an example of potential energy (PE) or kinetic energy (KE).

_____ a spinning bicycle wheel

_____ an archer's stretched bow

_____ sprinting runners

_____ a swinging hammer

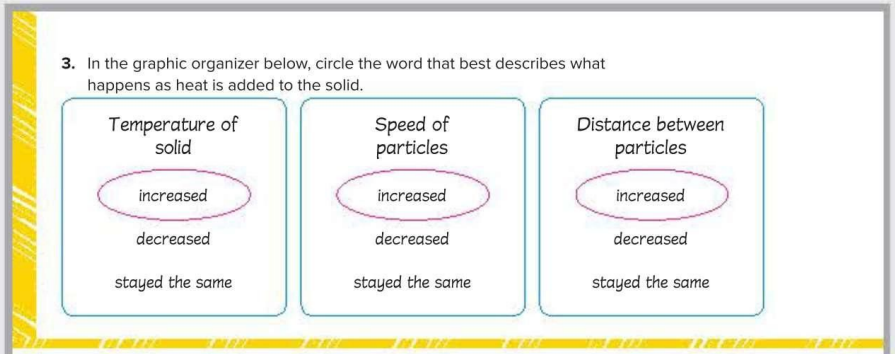
_____ an apple hanging from the branch of a tree

_____ an apple falling from a tree

_____ a rubber band flying through the air

_____ a rubber band that is stretched back

Copy table into Science Notebook



3. In the graphic organizer below, circle the word that best describes what happens as heat is added to the solid.

Temperature of solid	Speed of particles	Distance between particles
increased	increased	increased
decreased	decreased	decreased
stayed the same	stayed the same	stayed the same

Particle Arrangement If energy is continually added to a substance, there reaches a point where the particles cannot go any faster without changing to another state of matter. Recall that particles in gases are fast moving and spread out from each other. In liquids, particles are closely packed but can slide past each other. In solids, the particles are closely packed and held in a rigid formation. The reason each state of matter has different shapes is because of the particle attractions in each state of matter.

Particle Attraction When energy is added and the particles cannot move any faster in the current state of matter, the energy is used to overcome the attraction between particles and causes a change of state. The additional energy increases the potential energy of the particles. **Potential energy** is stored energy due to the interactions between particles or objects. The potential energy increases as the distance between particles increases. Conversely, the potential energy decreases as the distance between the particles decreases. The particles that are farther apart have greater potential energy. The potential energy of the particles, determined by the state of matter present, contributes to the total energy of a substance.

Kinetic Energy	Potential Energy
Relates to particle speed	Relates to the distance between particles/strength of attractions between particles
Measured by temperature of substance	Measured by state of matter
Increases as particle speeds increase	Increases as distance between particles increases
Decreases as particle speeds decrease	Decreases as distance between particles decreases
Increases as temperature increases	Increases as state of matter changes from solid to liquid to gas
Decreases as temperature decreases	Decreases as state of matter changes from gas to liquid to solid

THREE-DIMENSIONAL THINKING

For each each example (A, B, and C) draw a **model** of the particles in your Science Notebook.

1. Indicate how potential **energy** is changing (increasing or decreasing).
2. Indicate how the attractive forces are changing (increasing or decreasing).

A

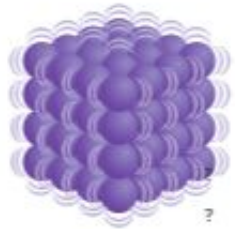
Condensing

Liquid

Potential Energy – _____

Attractive Forces – _____

B



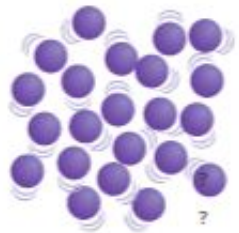
Melting

Liquid

Potential Energy – _____

Attractive Forces – _____

C



Boiling

Gas

Potential Energy – _____

Attractive Forces – _____

3D THINKING

3D THINKING: What happens to particles and energy during a change of state?...

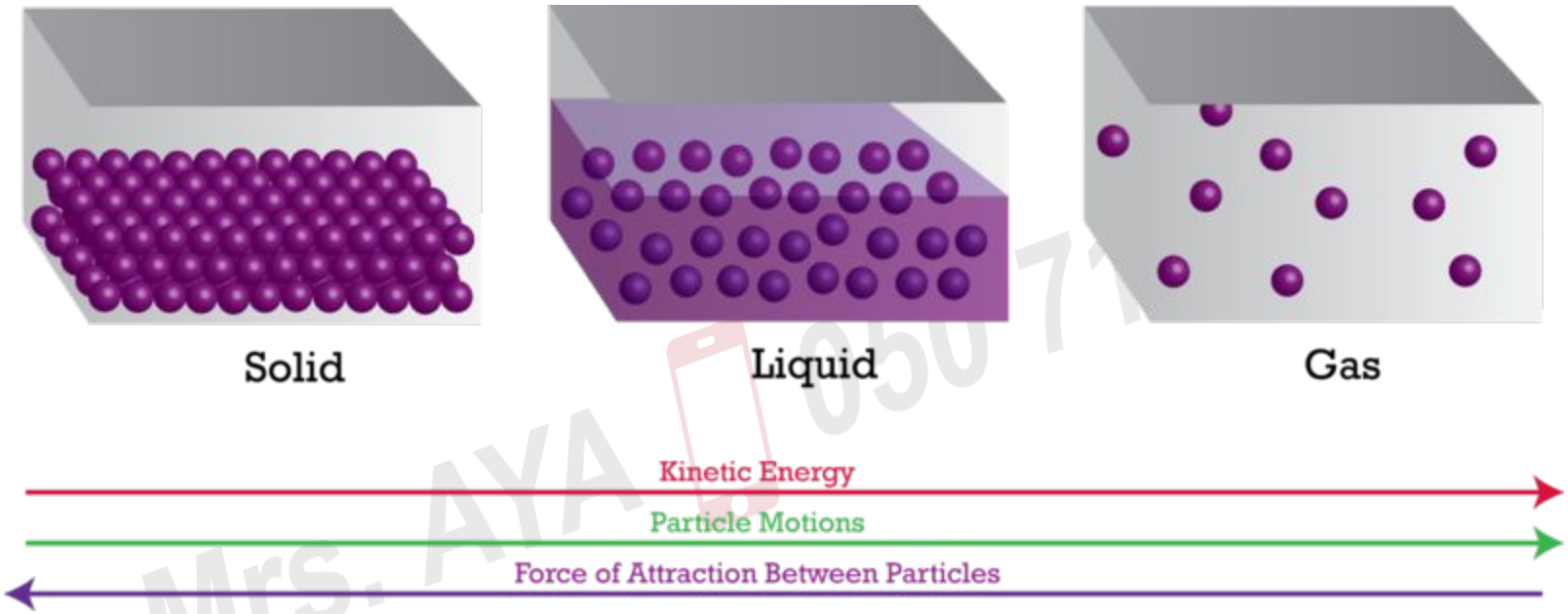
11 Jan 2022 - 10 Mar 2022

Description: Connect the DCI PS3.A: Definitions of Energy to the SEP of Developing and Using Models and CCC of Energy and Matter.

Visible to Students | Learning Resource

Location: Module: Energy and Matter / Lesson 2: States of Matter

Starter- copy into your notebooks



Class Video task

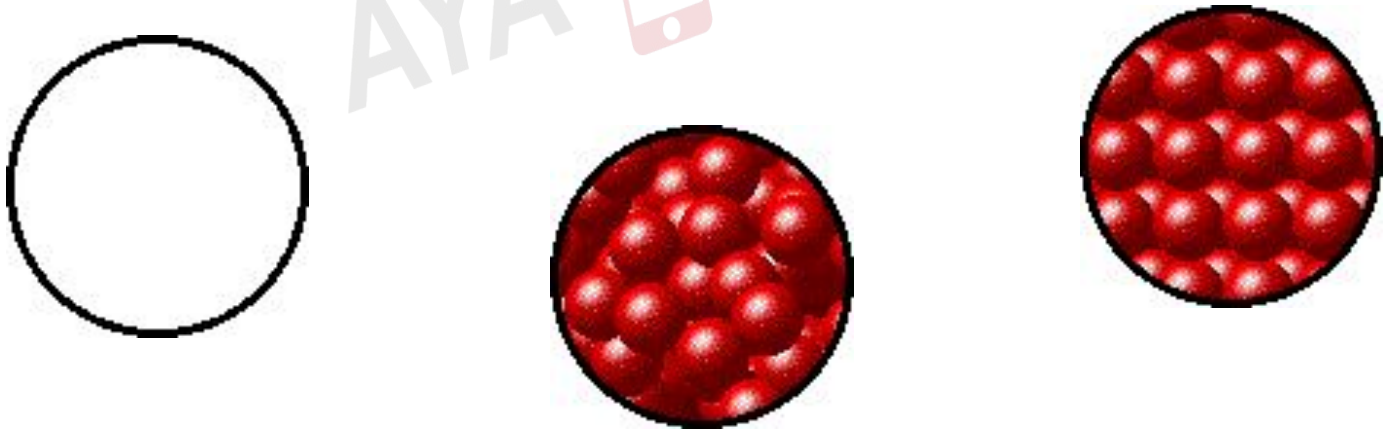
- https://edpuzzle.com/media/6145a9ac013c0041542e7bc1

Wordwall

- https://wordwall.net/resource/27142767
- https://wordwall.net/resource/17728775

G6 Elite Science

States of Matter



Learning objectives

- Explain- What happens to particles and energy during **a change of state**?
- Review **diffusion** in particles

Starter

- https://wordwall.net/resource/27114748

Breakout Room Tasks

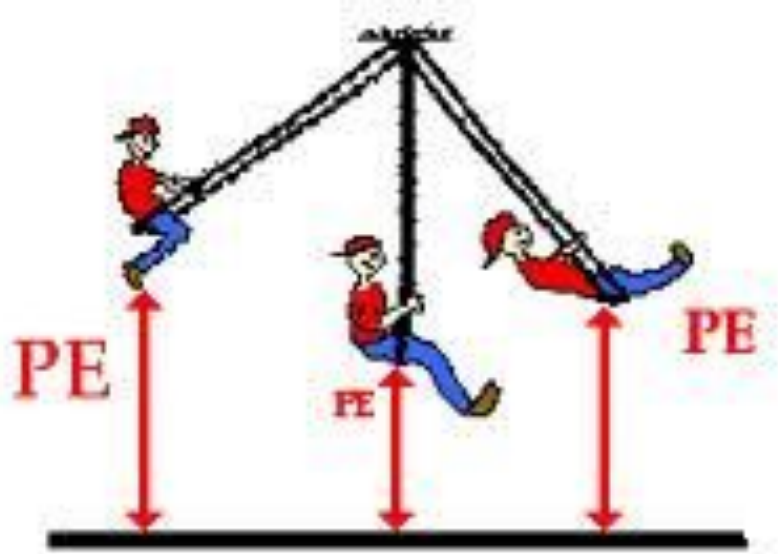
- Work your way up the activities starting with the red task

Two forms of Energy:

1. Potential Energy - stored energy

Potential energy **is stored** energy due to the interactions between particles or objects. The potential energy increases as the distance between particles increases.

Otherwise, the potential energy decreases as the distance between the particles decreases. The particles that are farther apart have more potential energy. The potential energy of the particles, determined by the state of matter present, contributes to the total energy of a substance.



2. Kinetic energy

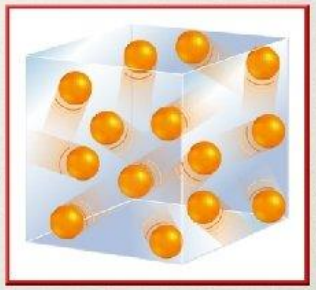
energy due to motion

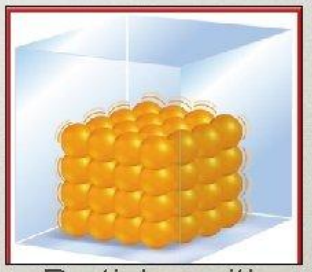
Kinetic Energy

Kinetic Energy is the energy of motion

- Particles with a lot of kinetic energy move fast and far apart
- Particles with little kinetic energy move slow & close together

Particles with a lot of kinetic energy





Particles with little kinetic energy

Exit ticket


SAFIYA AL HAMOUI
Today at 08:15 AM
Wednesday Exit ticket (complete during lesson time)
List 3 keywords you have looked at in today's Science lesson.
Useful
Extremely Useful
Comments