



States of Matter



OCM BOCES Science Center
Darlene Devendorf

Focus

Matter having **properties** is a major concept of the NYS ELS* K – 4 Core Curriculum.

First Grade: Last year in First Grade your students may have experienced our “*Properties*” kit where they focused on object properties. In addition to basic properties of color, shape, and texture, students made observations about solids, liquids and gases.

Second Grade: States of Matter


Third Grade: Next year your students will review and apply these concepts in the kit titled “*Water Cycle*” which focuses on water moving through our world as a solid, liquid and gas.

* NYS Elementary Level Science



Focus: Concepts



- Objects have properties that can be observed, described and measured.
 - All objects are made of matter.
 - Matter exists in three states.
 - Temperature can affect the state of matter.
 - Changes in properties can be observed and described.
- 

Focus – Concepts in Content

In this kit students will compare the properties of **matter** in **solid, liquid and gas form**. These properties are dependent upon the conditions of the surroundings. The main condition is the amount of energy in the matter which can be measured by **temperature**.

Students will **investigate** the effects of changing **energy** level on the **state of matter**. Students will have the opportunity to explore thermometers - how they work and that they measure the amount of energy.

Thermometers will be used while making observations of change of state. They will be used to measure **freezing point** temperature, **melting point** temperature and **boiling point** temperature (as matter freezes and melts).

Students will be introduced to the terminology used to refer to changing state. The terms introduced are “**evaporate**” and “**condense**.”





The Kit



Materials:

There is a materials list on page 7 of the DSM* **Teacher Guide**. Please refer to this list to verify the activity related items but do not use this list as an inventory of the kit contents. Use the **Packing List** as a guide to the kit contents. Contact the Science Center with any materials issues.

Packing List:

This list is found in the kit's white envelope. In our kits, we provide the basic materials and many of the DSM designated "Teacher-Provided Items".

On our Packing List, the items listed with an asterisk are considered consumable. We do not expect to get each of these items returned, just the ones that you did not need to use.

The Kit -2



Teacher Guide:

The Teacher Guide for States of Matter has been purchased from Delta Science. It is a loose leaf binder that includes the information needed for you to guide your students through the unit.

Please return a complete Teacher Guide with your kit so that your colleagues at other schools will have all the materials necessary for the unit.

Teacher Information Packet:

This resource is found in the kit's white envelope. It contains the Science Center's contact information, a kit overview, and the kit's link to the "Elementary Level Science Core Curriculum Major Understandings". Each activity is listed with an essential question and the related major understandings.

Preparation



This unit involves some materials preparation - **Teacher Guide (TG) pp. 11 - 12** provides an overview of Classroom Management, Advance Preparation, and Materials Management.

Classroom Management Notes:

During this unit your students will be working with water as a liquid and as a solid.

Distribution of materials, specifically water and butyl stearate, will be an issue. You will also need to distribute ice.

This can be done from distribution “stations” or by providing a set of materials for each group. There are 8 .5-gal containers, 5 5-qt pails and an ice bucket provided with the kit that can be utilized. (You may have some plastic shoebox style containers or small trays to add to the mix.)

Mops, sponges and extra paper towels will be helpful to have on hand.

Preparation - 2



This unit involves some materials preparation - **Teacher Guide (TG) pp. 11 - 12** provides an overview of Classroom Management, Advance Preparation, and Materials Management.

Materials Management:

The TG refers to the need for ice.

Some of the ice will be water frozen in a specific shape - such as in the 1-oz. cups that are provided.

Some of the ice will be referred to as “crushed”. The **crushed ice** is used to quickly cool a pail of water. You can replace crushed ice with ice cubes or purchased bagged ice. There is a hammer provided should you choose to crush ice.

You will need to freeze water for ice and to keep ice frozen. This can be done at school or home. In either case, ice can be effectively kept in a frozen state for up to 4 hours in a cooler. (Use crushed newspaper to fill any extra air space in the cooler.)

Preparation - 3



Materials Management: Butyl stearate

- Butyl stearate is a material that is used for several of the activities. Butyl stearate is one of the most common stearic (fatty) acids used in cosmetics. It is not a hazardous material but students should be cautious not to ingest it or get it in their eyes.
- The useful quality of butyl stearate for States of Matter is that its freezing point and melting point is around room temperature. Therefore, it is easy to have it change state in the classroom environment.
- Due to its “oily” nature it is best to keep it contained in the zip lock bags as directed and to keep it in a solid state (cooled). Yourself or another adult will want to personally do the set up for this item .

FYI: Alternative Student Activity Pages

OCM BOCES Science Center States of Matter “Learning Log”

In addition to or in lieu of the student activity pages found in the Delta Science Module Teacher Guide (see “Copy Masters”), there is a teacher created “Learning Log” on the Grade 2 page of Science Units: Grade Level Resources (Science Center web site)

It is in a MS Word format so that you can edit it (adopt and adapt) and a PDF format for printing.

My States of Matter

Learning Log
Read, Write & Draw



My Name _____

Slides in this PowerPoint will reference this resource.

Act. 1: What is a solid?

Vocabulary

predict – to guess about what will happen based upon what you already know

property – a characteristic of something

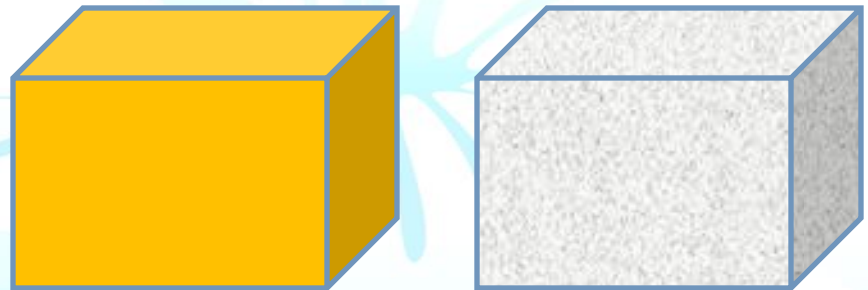
shape – the form or outline of an object

size – how big something is (volume)

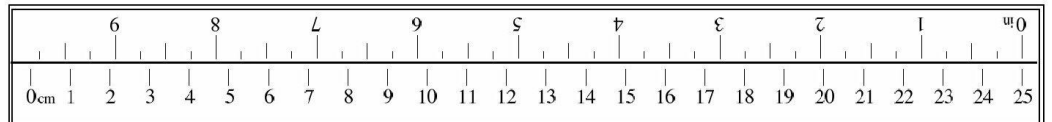
solid – matter that has a shape and size that does not easily change

1. TG pp. 13 – 14, look at Materials, Preparation and read “Background Information”.
2. TG pp. 15 – 17, Activity Sheet 1
 - A. Introduce blocks.
 - B. Discuss concepts of solid, shape and size.
 - C. Students explore shape and size.
 - D. Concept reinforcement. (see “Reinforcement”)

[Act. 1 Video](#)
[“How To”](#)



See “Connections”: TG p. 18
Science and Language Arts



Name _____

Activity Sheet 1

What Is a Solid?

1. Observe and measure each block. Record your measurements in the chart below.

on the table		
	wooden block	foam block
Shape		
Length of Side 1 (cm)		
Length of Side 2 (cm)		
Length of Side 3 (cm)		

2. Record your predictions.

- a. I predict the shape of each block will _____
- b. I predict the size of each block will _____

in the box		
	wooden block	foam block
Shape		
Length of Side 1 (cm)		
Length of Side 2 (cm)		
Length of Side 3 (cm)		

3. Think about when the blocks were moved from the table to the box.

- a. What happened to the shapes?

- b. What happened to the sizes?

Practice going to the library to check out books on solids.

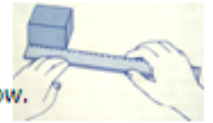
State of Matter © 2008 Delta Education

NAME: _____

What is a solid?

What is a Solid?

1. Observe and measure each block.
Record your measurements in the chart below.



On the Table		
	Wooden Block	Foam Block
Shape		
Length of Side 1		
Length of Side 2		
Length of Side 3		

2. Now make a prediction. When you place the blocks in the box will the shape and size of the blocks change or remain the same?

Circle One:

I predict the shape of the blocks will...	Change	Stay the Same
I predict the size of the blocks will...	Change	Stay the Same

3. Now measure each block as it sits in your box, and record your measurements.

In the Box		
	Wooden Block	Foam Block
Shape		
Length of Side 1		
Length of Side 2		
Length of Side 3		

Activity 1

1

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Solid Rule

Solid Rule: When put in a container a solid will take up the same SPACE and not change its SHAPE .

Act. 2: What is a liquid?

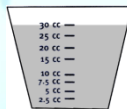
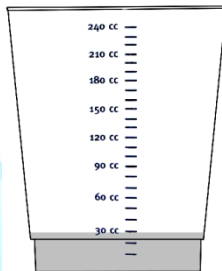
Vocabulary

cubic centimeters – cm^3 , cc, a measurement of how much space something takes up (length, width and height)

liquid – matter that easily changes shape but the volume stays the same

volume – how much space something takes up (length, width and height)

Act. 2 Video “How To”



1. TG pp. 19 – 20, look at Materials, Preparation and read “Background Information”.
2. TG pp. 21 – 24, Activity Sheet 2
 - A. Introduce a liquid.
 - B. Discuss concepts of volume (size, amount of space something takes up).
 - C. Introduce cubic centimeter. (?? – think about units)
 - D. Students explore volume (size) and shape of a liquid.
 - E. Reinforce concepts using another liquid.
 - F. Compare liquids and solids.

NOTE: You need to provide clear, plastic bottles for Act. 3 (16 oz min., 20oz. Ideal)

Liquid Rule

Liquid Rule: When put in a container a liquid will take up the same **SPACE** but may have a different **SHAPE**.

Act. 3: What is a gas?

Vocabulary

gas – matter that easily changes shape and volume

states of matter – the three basic conditions that matter can be in: solid, liquid, gas (we do not discuss the 4th state - plasma)

[Act. 3 Video](#)
[“How To”](#)



1. TG pp. 27 - 28, look at Materials, Preparation and read “Background Information”. **Note:** You will need to provide some clear, plastic bottles.
2. TG pp. 27 – 33, Activity Sheet 3A and 3B

Session I

A. Students explore “air”.

B. Discuss concept of a “gas”.

C. Apply concept of “taking up space” to the gas (air) in the bottle.

Session II

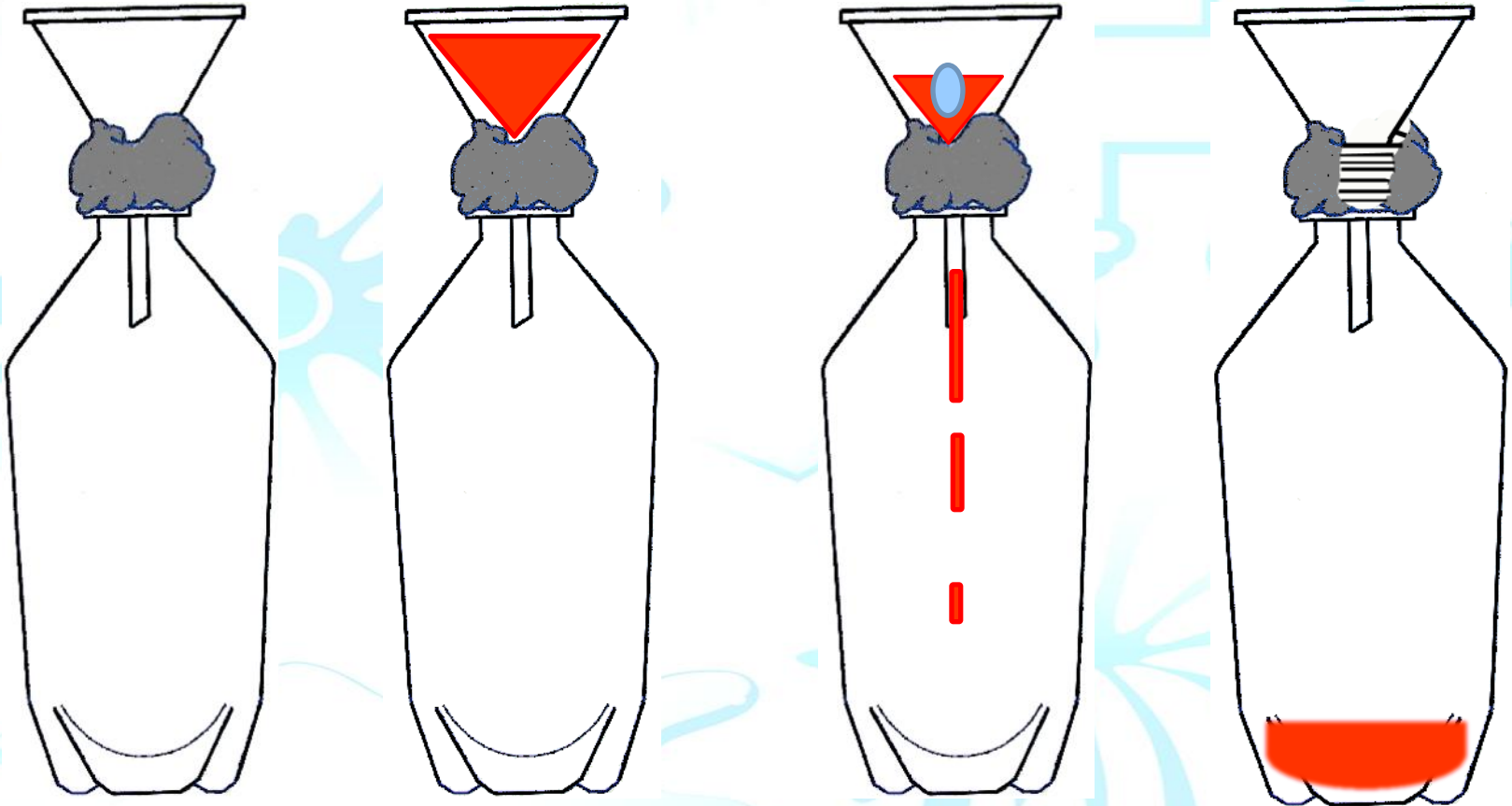
D. Students explore shape of a gas.

E. Reinforce concepts using a paper towel, cup, container and water. (see “Reinforcement”)

F. Compare liquids and solids.

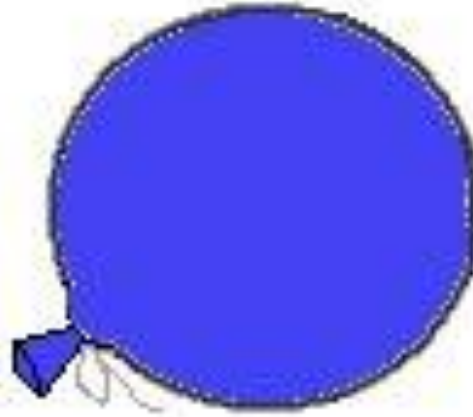
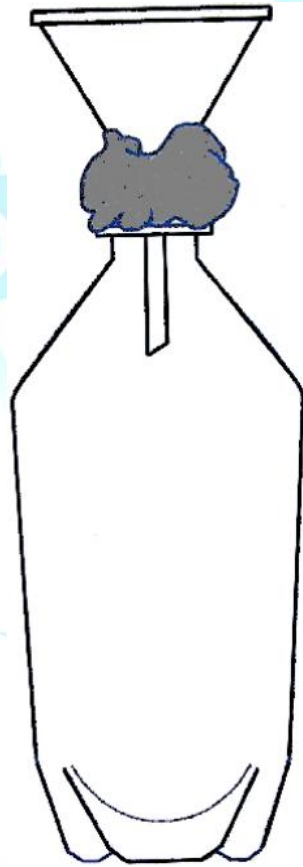
See “Connections”: TG p. 34
Science Extension

Gas Activity



Gases are matter: they take up space
The water cannot enter the bottle
unless some air leaves (evidence: air
bubbles leave - water enters).

Like liquids, gases easily take the shape of their container



Gas Rule

Gas Rule: When put in a container a gas will take up all of the SPACE. It will have the SHAPE of the container.

States = Phases

Teacher FYI:

The differences between phases or states of matter is the “energy of motion” of the particles of matter.

Solid – the particles are tightly packed with the least amount of motion. There are so many packed together in the same space that we can see the matter.

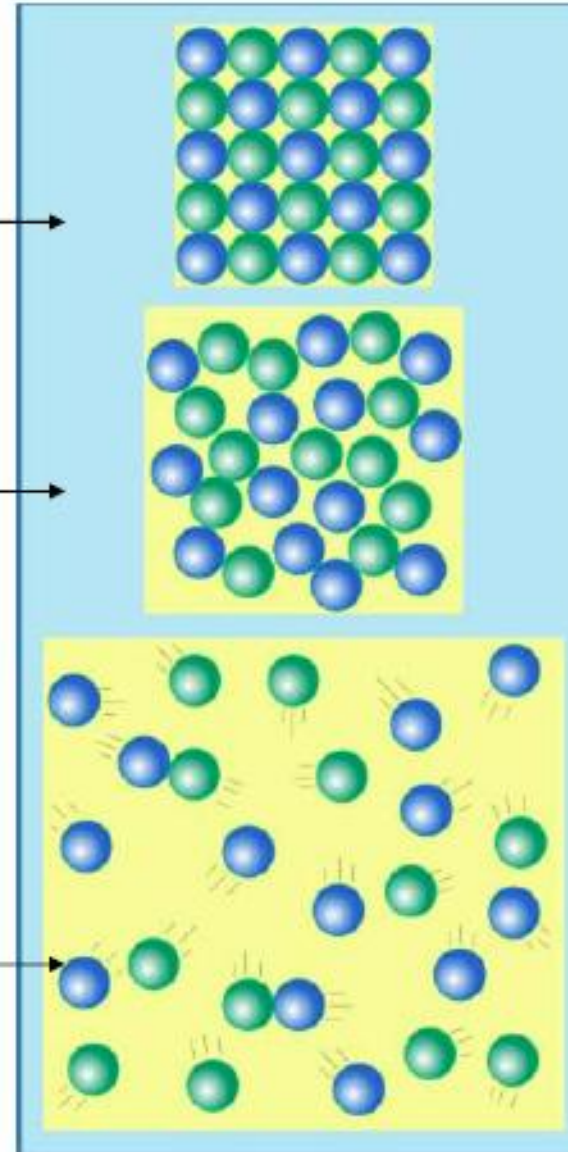
Liquid – the particles of matter have enough energy of motion to move (flow) around each other, less tightly packed. The particles are packed together enough that we can still see the matter.

Gases – the particles of matter have the greatest amount of motion for that type of matter. Particles are so spread out that we can not see the matter.

Solid

Liquid

Gas



Act. 4: What is “changing state” and what affects it?

Vocabulary

melting – changing a solid to a liquid by heating (adding energy)

variable –something that is made to be different in an experiment

[Act. 4 Video](#)
[“How To”](#)

Session I

1. TG pp. 35 - 36, look at Materials, Preparation and read “Background Information”.
2. TG pp. 27 – 33, Activity Sheet 4

- A. Discuss “state of matter” of ice.
- B. Discuss concept of changing state.
- C. Students examine “changing state”.

Session II

- D. Students use their observations to define “melting”.
- E. Students compare all the group’s results. The term “variable” is introduced.
- F. Reinforce concepts using “Changing States” chart and “Reinforcement” idea.

Solid to a liquid – for a change of state it is always the same “stuff”



See “Connections”: TG p. 40
Science and Social Studies

Act. 5: What can I do to change the speed of the melting of ice?

Vocabulary

insulation – material that can trap heat in or keep it out

insulator – a type of material through which air or heat cannot easily pass

[Act. 5 Video](#)
[“How To”](#)

Teacher FYI:

Adding energy – to change the state from a solid to a liquid you need to increase the energy of motion of the particles of matter. The usual forms of energy used to do this are radiant light energy and heat energy.

To slow the change (melting) you need to keep additional energy out (not keep the cold in).

1. TG pp. 41 - 42, look at Materials, Preparation and read “Background Information”.

2. TG pp. 43 - 48, Activity Sheet 5A and 5B

Session I

- A.** Review concept of “changing state”. Discuss role of heat in change of state.
- B.** Discuss ideas for speeding up melting.
- C.** Students explore variables that affect melting ice more quickly.

Session II

- D.** Introduce term “insulation” and “insulator”
- E.** Students explore variables that affect melting ice more slowly.

Session III

- F.** Students compare time and variables that affect melting ice more slowly.

See “Connections”: TG p. 50
Science and Health

Act. 6: What is a thermometer and how do I use it?

Vocabulary

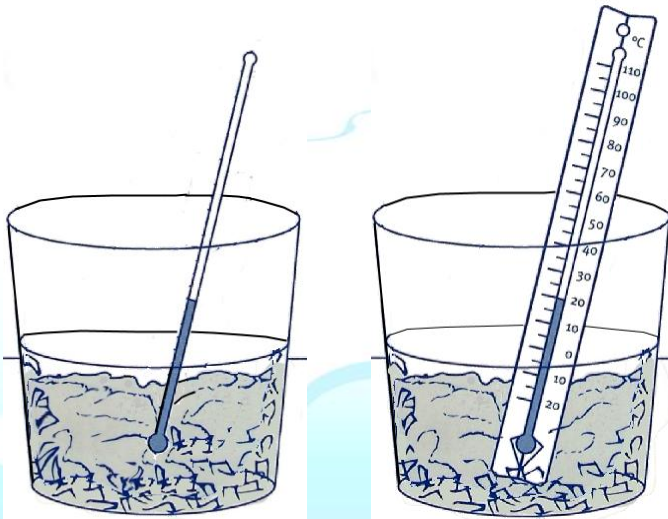
degrees Celsius – a unit scale for measuring temperature

temperature – a measurement of how much energy something has (how much heat energy)

thermometer – a tool used to measure temperature in degrees

Act. 6 Video “How To”

1. TG pp. 51 - 52, look at Materials, Preparation and read “Background Information”.
2. TG pp. 53 - 55, Activity Sheet 6
 - A. Pre-assess for understanding of what a “thermometer” is and its use.
 - B. Define “temperature”.
 - C. Students explore how the red liquid in a glass tube moves when it is heated and cooled.
 - D. Introduce the terms “degrees” and “Celsius”.
 - E. Students explore the movement of the liquid in a thermometer.
 - F. Students compare liquid movement and change in temperature.
 - G. Reinforce concepts (see “Reinforcement”)



Temperature

- Measures the amount of energy in matter (an object).
- Science definition: average kinetic energy (motion energy) of particles
- State of change is all about energy of motion (internal motion) of matter

- Measured using a thermometer
- Red liquid changes energy level until its energy level equals that of its surroundings
- Matter expands when it is heated so liquid spreads out (takes up more space)
- Matter contracts when it loses energy so liquid compacts (takes up less space)

Act. 7: What is the “melting point” of a substance? How do I measure it?

Vocabulary

butyl stearate – a substance whose melting and freezing point is about room temperature

melting point temperature– the temperature at which a solid changes to a liquid

[Act. 7 Video](#)
[“How To”](#)

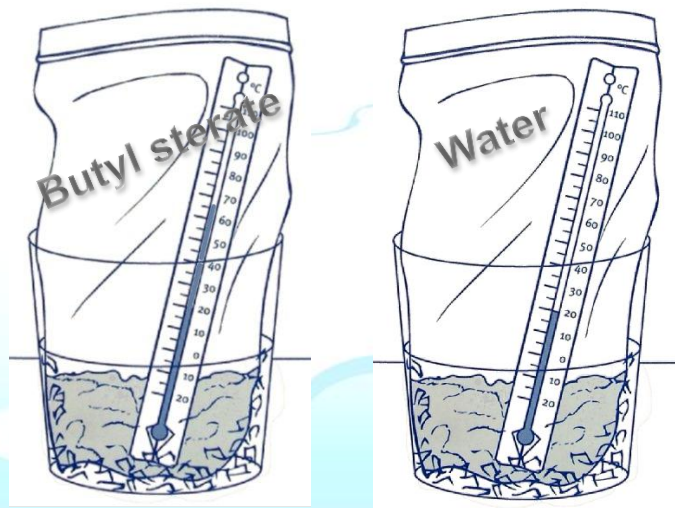
1. TG pp. 57 - 58, look at Materials, Preparation and read “Background Information”.
2. TG pp. 59 -62, Activity Sheet 7

- A. Review concepts of solid to a liquid (change state) and temperature.
- B. Students explore “melting point” by observing the temperature change of two solids – water and butyl stearate.

Note: Be careful not to puncture the bag when inserting the thermometer, especially the bag of butyl stearate.

C. Students compare the melting point of the two solids.

F. Reinforce the concept of a specific melting point for a certain type of matter. (See “Reinforcement”)



Measuring Melting (Point)


Name _____ Activity Sheet 7

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision. (The chemical used in this activity is butyl stearate.)


Measuring Melting Points

- Place one thermometer into the bag of ice. Place one thermometer into the bag of solid butyl stearate. Reseal the bags tightly.
- Place each bag in a tumbler of warm water.
- Read the thermometer every 3 or 4 minutes. Record the temperature and appearance of each substance in the chart below.

Reading	Ice		Butyl Stearate	
	Temperature (°C)	Appearance	Temperature (°C)	Appearance
1				
2				
3				
4				
5				
6				
7				
8				



Measuring Melting Points




Our Experiment:

- Place one thermometer into the bag of ice.
- Place one thermometer into the bag of solid butyl stearate.
- Reseal the bags tightly.
- Place each bag in a cup of warm water.
- Read the thermometer every 3 or 4 minutes. Record the temperature and appearance of each substance in the chart below.
- Record the temperature and appearance of the substance on the corresponding results chart.


Activity 7 31

NAME: _____ What is a melting point? _____

Results Charts

Reading 1: 

Ice	Butyl Stearate
Temperature: _____	Temperature: _____
Observation: _____	Observation: _____

Reading 2: 

Ice	Butyl Stearate
Temperature: _____	Temperature: _____
Observation: _____	Observation: _____

Activity 7 32 Our 2008

Act. 8: What do we call the process where a liquid changes to a gas?

Vocabulary

boiling point temperature – the temperature at which a liquid rapidly changes to a gas

evaporation – the process by which a liquid changes to a gas

water vapor – water in the gas state

Act. 8 Video “How To”

From Liquid to Gas

You and your partner will do an experiment to see how water changes from liquid to gas.



1. Label yours and your partner's 1-oz plastic cup with your names. Pour 10cc of water into each of the 1-oz cups.

2. Place one of your cups in sunlight or under a lamp. Place the other cup out of direct light. Leave the cups in the same place for 5 days.

1. TG pp. 65 - 66, look at Materials, Preparation and read “Background Information”.

2. TG pp. 67 - 71, Activity Sheet 8

A. Review concepts of change of state from solid to a liquid (melting) and that different matter has different melting temperatures.

B. Students explore “evaporation” by observing the disappearance of water from a cup.

C. Students explore the effect of temperature on evaporation.

D. Reinforce the relationship between evaporation and heating through a boiling water demonstration.

Liquid to Gas

Session II:

Define evaporation as the change from a liquid to a gas (energy needs to be added for this to happen)

Liquid water to gas water (water vapor), you can not see water vapor.



Demonstration using hot plate
increase energy input = increase speed of change of state

Measure Boiling Point Temperature using a boiling thermometer. (100°C or 212°F)

Boiling point temperature = energy level needed for a liquid to change to a gas as measured by temperature



Water Vapor

Air is a mixture of gases – like a bowl of trail mix is a mixture of solids such as: nuts, raisins, seeds ... you just can't see them.

Water in the gas state is still water – it does not become “air”, it is mixed in with all the gases that make up the air (nitrogen, oxygen, carbon dioxide ...)

Change of state – water as water vapor (a gas) is still water, this is different than the production of other gases which are a changed product from the liquid that is heated. For example: gasoline is heated to a point that the gasoline “burns”; changes to *different types* of gases (matter in the gas state).

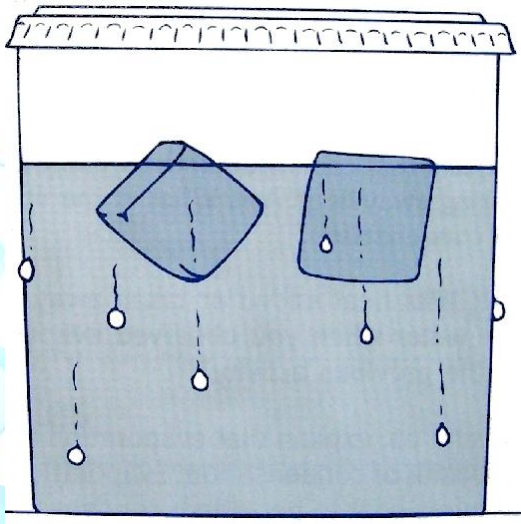
NOTE: different substances have different boiling point temperatures

Act. 9: What do we call the process where a gas changes to a liquid?

Vocabulary

condensation – the process by which a gas changes to a liquid

Act. 9 Video “How To”



1. TG pp. 73 - 74., look at Materials, Preparation and read “Background Information”.
2. TG pp. 74 - 78, Activity Sheet 9
 - A. Review concept that changing from a liquid to a gas is called evaporation
 - B. Students explore the change of state from a gas to a liquid and identify cooling as a causative factor. The term that describes this change, condensation, is introduced.
 - C. Students compare evaporation and condensation.
 - D. Reinforce the concept that the type of matter does not change when a change of state occurs.

Gas to Liquid



Define condensation as the change from a gas to a liquid (energy needs to be taken away for this to happen)

Gas water to liquid water, you can not see liquid water if it is in small quantities. Clouds are made up of condensed water on tiny pieces of air borne particles (dirt, dust, salt).

Note that, in our environment ,the range of temperatures allow for water vapor to change state to a liquid but not the other gases in the air.

For nitrogen gas to be a liquid the temperature must be lowered to -371° F.
For carbon dioxide gas to be a solid, as in dry ice, the temperature must be lowered below -109° F

Act. 10: What do we call the process where a liquid changes to a solid?

Vocabulary

freezing – removing energy from a liquid by lowering the temperature until it changes to a solid

[Act. 10 Video](#)
[“How To”](#)

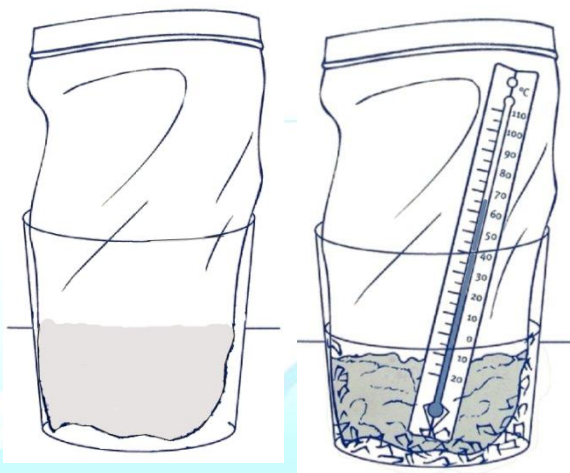
1. TG pp. 81 - 82., look at Materials, Preparation and read “Background Information”.
2. TG pp. 83 - 87, Activity Sheet 10

A. Review concept that changing from a gas to a liquid is called condensation.

B. Students explore the change of state from a liquid to a solid and identify cooling as a causative factor. The term that describes this change, freezing, is introduced.

C. Students compare freezing and melting.

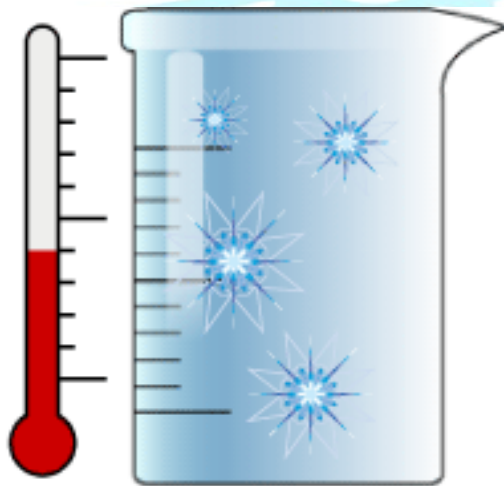
D. Reinforce the concept that the type of matter does not change when a change of state occurs.



Act. 11: What is the “freezing point” of a substance?

Vocabulary

freezing point temperature– the temperature at which a liquid changes to a solid



1. TG pp. 89 - 90., look at Materials, Preparation and read “Background Information”.
2. TG pp. 91 - 95, Activity Sheet 11
 - A. Review concept that changing from a liquid to a solid is called freezing.
 - B. Students explore the change of state from a liquid to a solid and measure the cooling by reading a thermometer.
 - C. Students compare the freezing temperatures of three different substances and conclude that not all substances freeze at the same temperature.
 - D. Reinforce the concept that the state that matter is in is affected by the temperature (amount of energy).

Act. 12: How is the ability of matter to change state important to us?

Students use what they have learned about states of matter to make a tasty treat.

This activity requires the use of salt and ice water to change liquids to a solid state. Conveying the concept of lowering the freezing point is not a learning objective. The main goal is to revisit the concept of change of state with materials that can be used in the classroom.

(FYI: Adding salt lowers the freezing point of the water so it can be colder, as a liquid, in the bucket)

You can also answer the above essential question by:

- making fruit juice popsicles
- talking about the weather and changes in forms of precipitation
- discussing the washing and/or drying of clothes, dishes, hair ...



Act. 13: Assessment

DSM Assessment:

Section 1 – Hands On

Section 2 – Visual Analysis

Section 3 – Critical Thinking

In addition to the assessment found in the Delta Science Module Teacher Guide, there are check points for you to adapt/adopt on the Grade 2 page of the Science Units– Grade Level Resources section of our website. There is a MS Word form so that you can edit it.