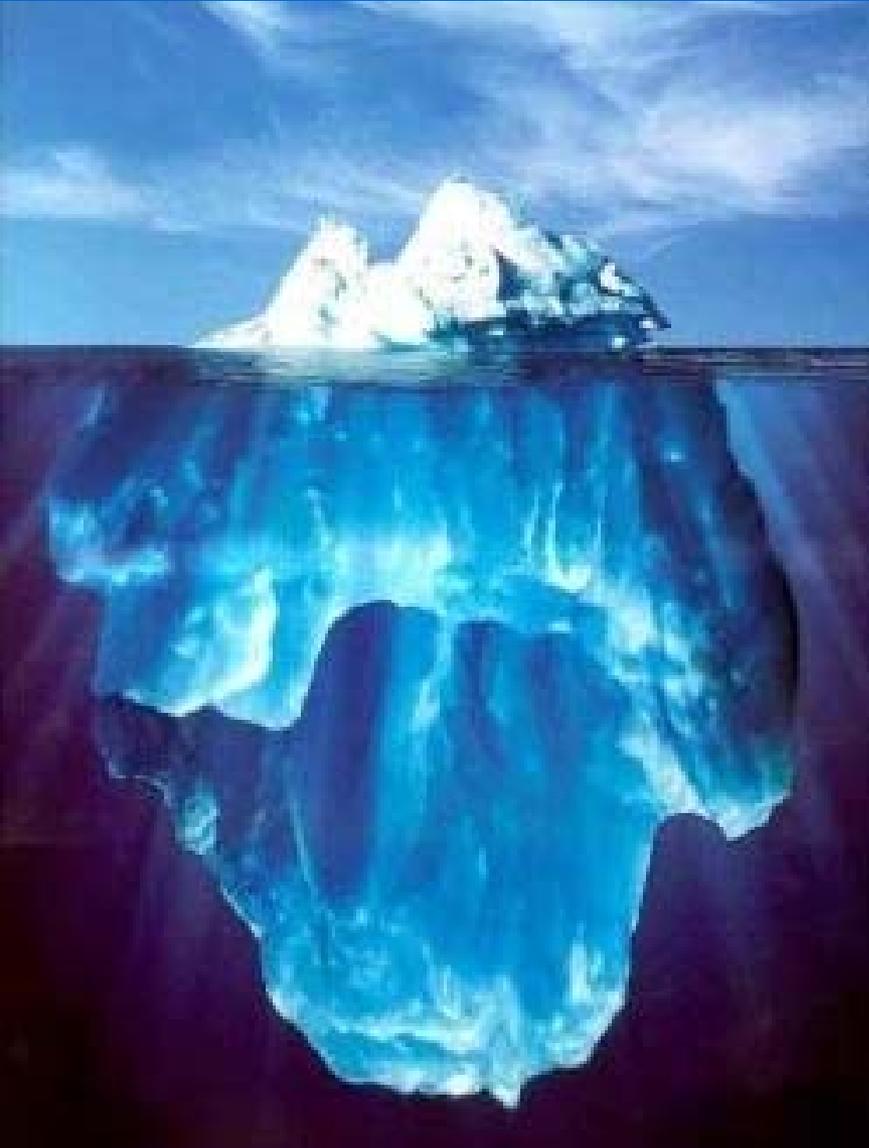


Self Study Physical Science Refresher

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1. Three phases of matter: Solids, Liquids and Gases
2. The effect of heat and pressure on the phases of matter
 - a) expanding and contracting
3. Changing Phase
4. Chemical properties of natural gas



Section 1

Three Phases of Matter: Solids, Liquids and Gases

Properties of the three phases: solid, liquid and gas.



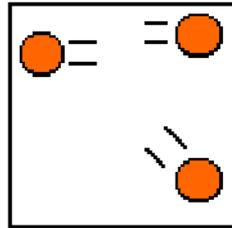
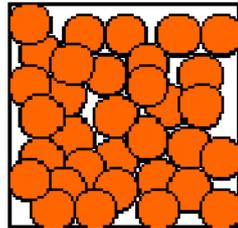
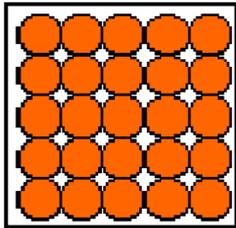
SOLIDS



LIQUIDS



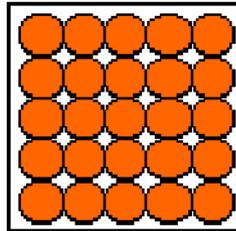
GASES



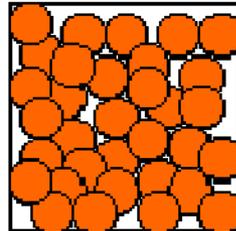
Matter is found in three phases: solid, liquid and gas.

The best way to understand how each phase behaves is to look at what's going on at the molecular level.

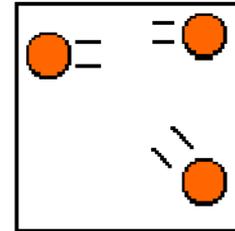
Properties of the three phases: **solid**, liquid and gas.



SOLIDS



LIQUIDS



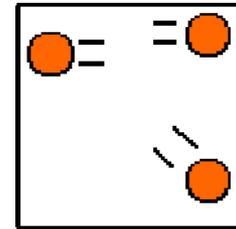
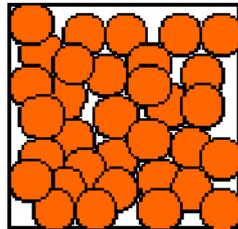
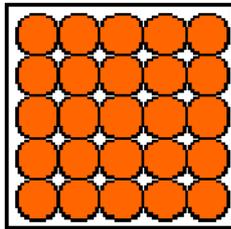
GASES

In solids, the molecules are rigid and packed together.

There is very little space between molecules, so adding pressure does not change the volume.

The molecules are locked into place—they don't slide around, so solids hold their shape, regardless of the container.

Properties of the three phases: solid, **liquid** and gas.



SOLIDS

LIQUIDS

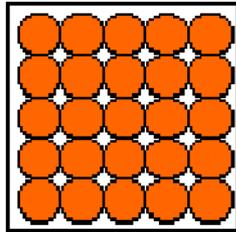
GASES

In liquids, the molecules are close together, but not locked into place.

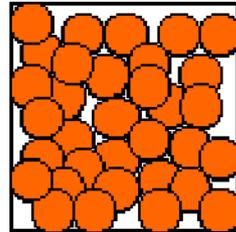
Pressure does not change the volume very much, because there is not much space between the molecules.

The molecules can slide freely, allowing liquids to take the shape of a container. (Pour a liquid into a cup and it takes the shape of the cup.)

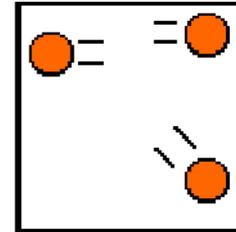
Properties of the three phases: solid, liquid and **gas**.



SOLIDS



LIQUIDS



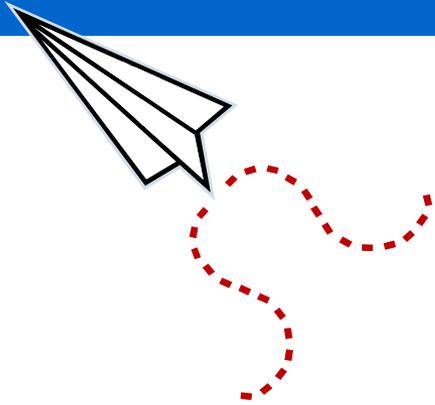
GASES

Gas molecules move freely.

There is a lot of empty space between molecules, so adding pressure decreases the volume.

Since the molecules move freely, they can fill the shape of their containers.

Note: You might hear the term vapor. Vapor and gas mean the same thing.



Fast Fact

Density is a measure of how much matter is in a given volume. It is expressed as weight/volume (e.g. , pounds per gallon or pounds per cubic foot).

For example:

- A gallon of water weighs 8 pounds
- A gallon of oil weighs 7.2 pounds

So water has a greater density than oil.



Trick Question!



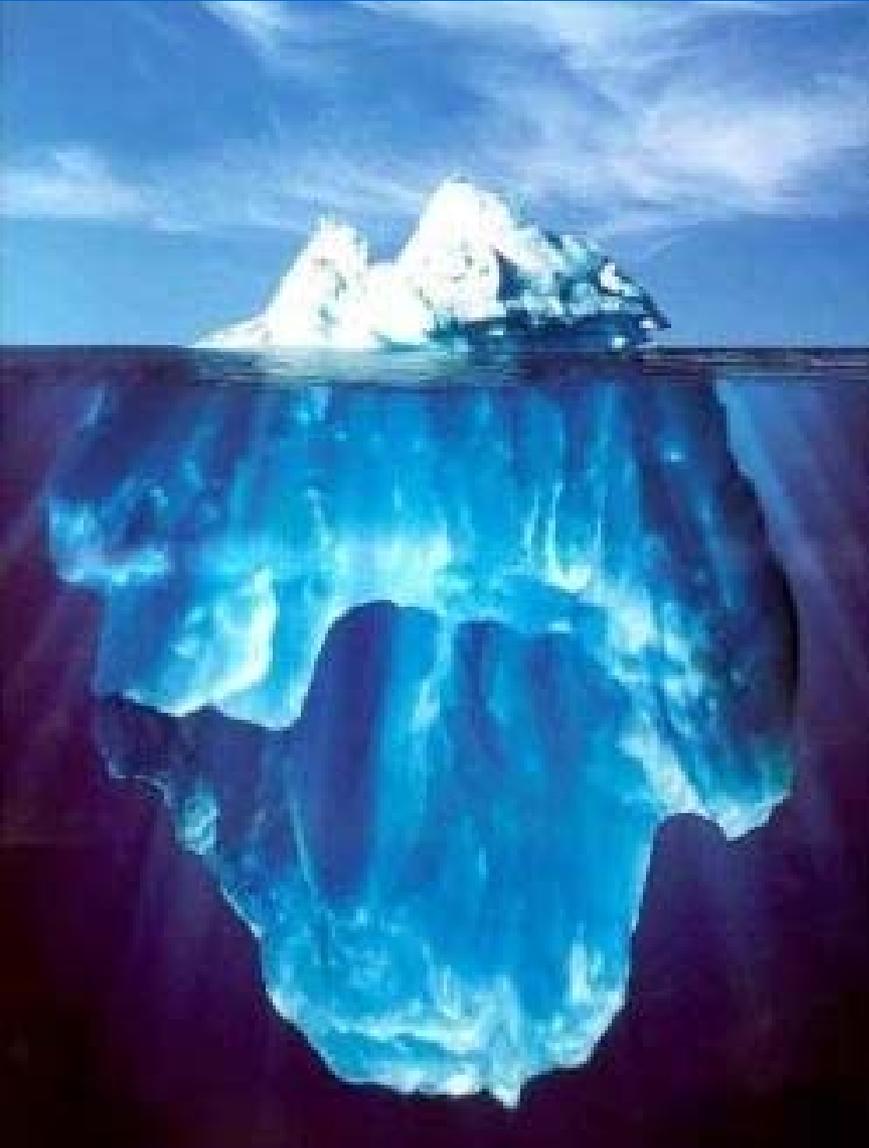
Which weighs more: a pound of feathers or a pound of lead?

Trick Question!



Answer: They both weigh the same—**one pound**.

Feathers, however, are much less dense than lead. You would need a large volume of feathers, but just a small volume of lead to make up a pound.



Section 2

The Effect of Pressure and Temperature on Matter

Temperature and Volume--Metals



Most substances expand when heated, as shown with this metal ball and ring.

1 Ball goes through ring.



2 Heat ball.



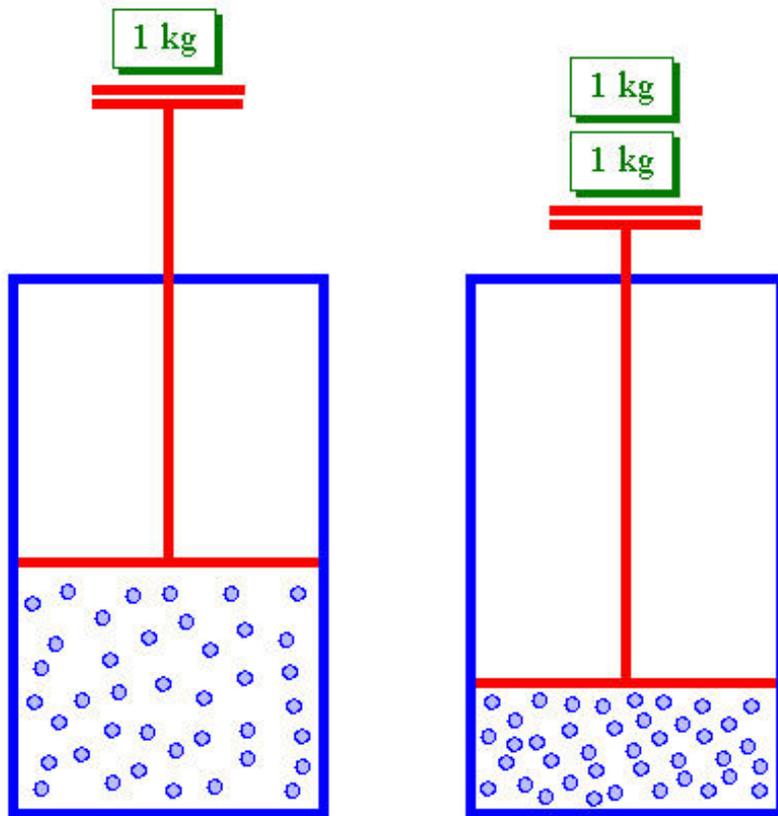
3 Heated ball has expanded, no longer goes through the ring.

Temperature and Volume--Liquids



As liquids are heated they expand. This property explains how thermometers work. As the heat increases, the water in the tube expands and marks a higher temperature.

Temperature, Volume and Pressure--Gases



Gases change volume due to changes in pressure.

When the pressure is increased, the volume of a gas decreases, if the temperature remains the same.

Ideal Gas Law

The relationship between temperature, volume and pressure is described in the ideal gas law.

$$PV = nRT$$

The Pressure (**P**)
x the (**V**)

= the number of atoms (**n**)
x a constant (**R**)
x the temperature (**T**).

Ideal Gas Law

$$PV = nRT$$

Changing any one of the conditions brings changes to other conditions.

What this means in practical terms is, changes to pressure, temperature and volume are related. We have already seen that changing the pressure changes the volume—but what happens if we change the pressure but keep the volume constant?

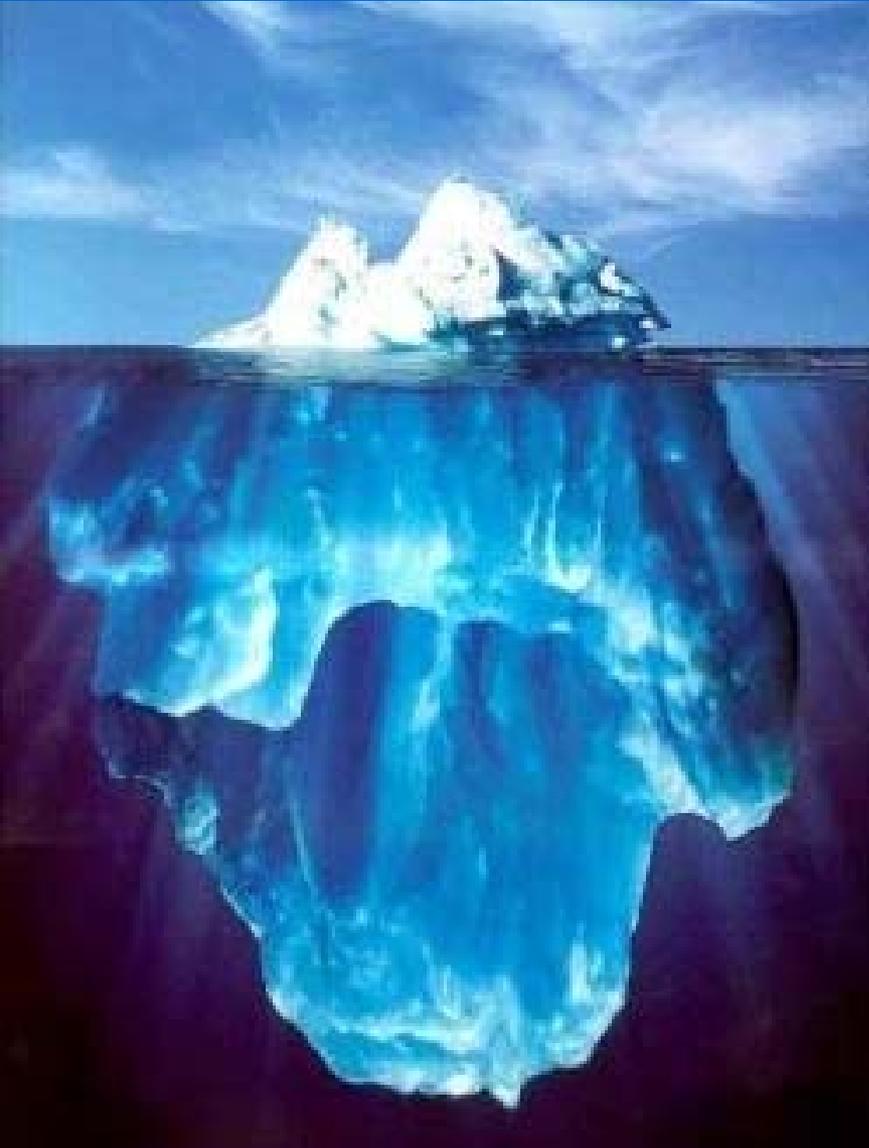
Ideal Gas Law



The image shows the Ideal Gas Law equation $PV = nRT$ written in large, colorful, hand-drawn letters. The letter 'P' is blue, 'V' is green, '=' is pink, 'n' is orange, 'R' is pink, and 'T' is red. Two blue arrows point downwards towards the 'P' and 'T' respectively.

If we reduce the pressure and keep the volume constant, the temperature goes down.

This is the principle behind refrigeration. Compressed gas goes through an expansion valve and its temperature drops.



Section 3

Phase Changes

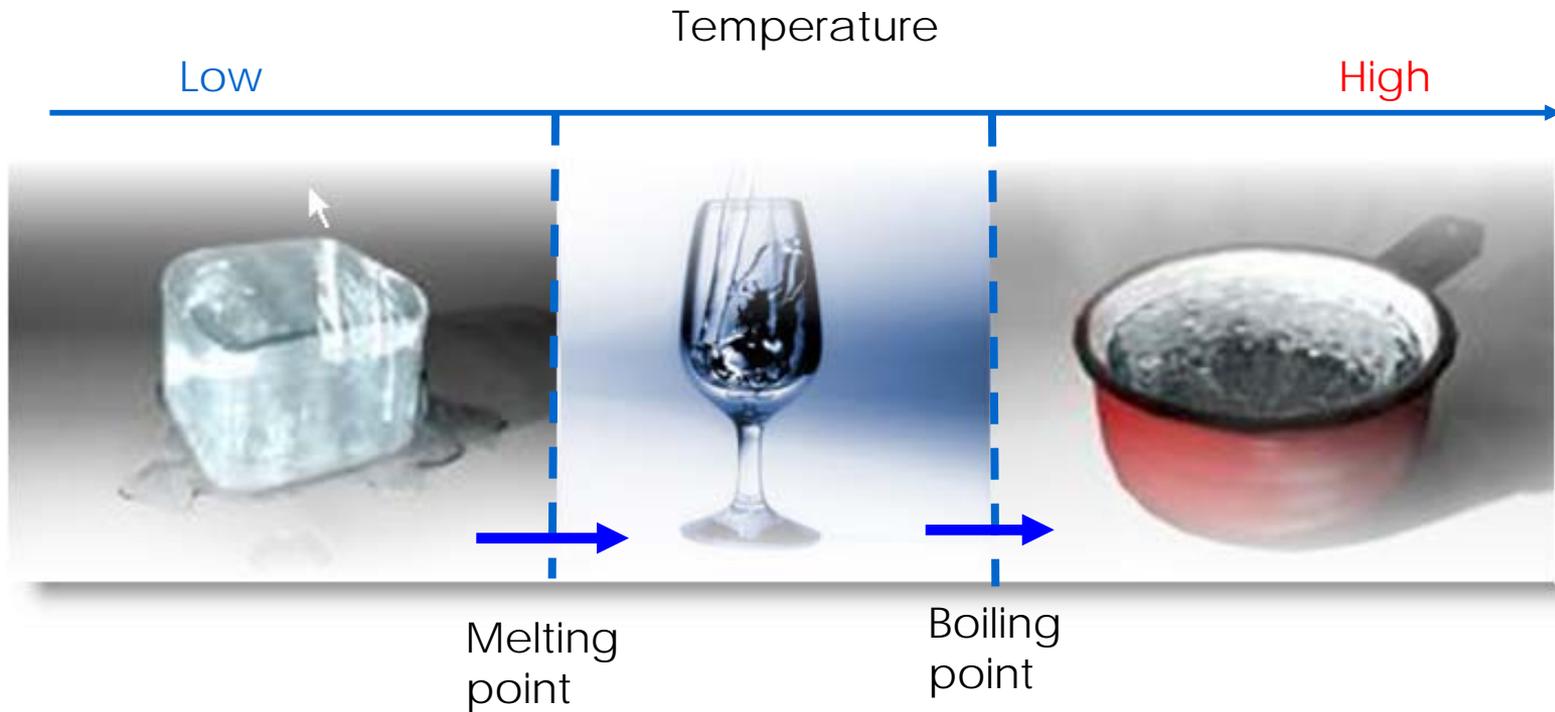
Phase Changes



Most substances can be solid, liquid or gas, depending on the temperature and pressure.

For example, water can be a solid (ice), a liquid (water), or a gas (steam).

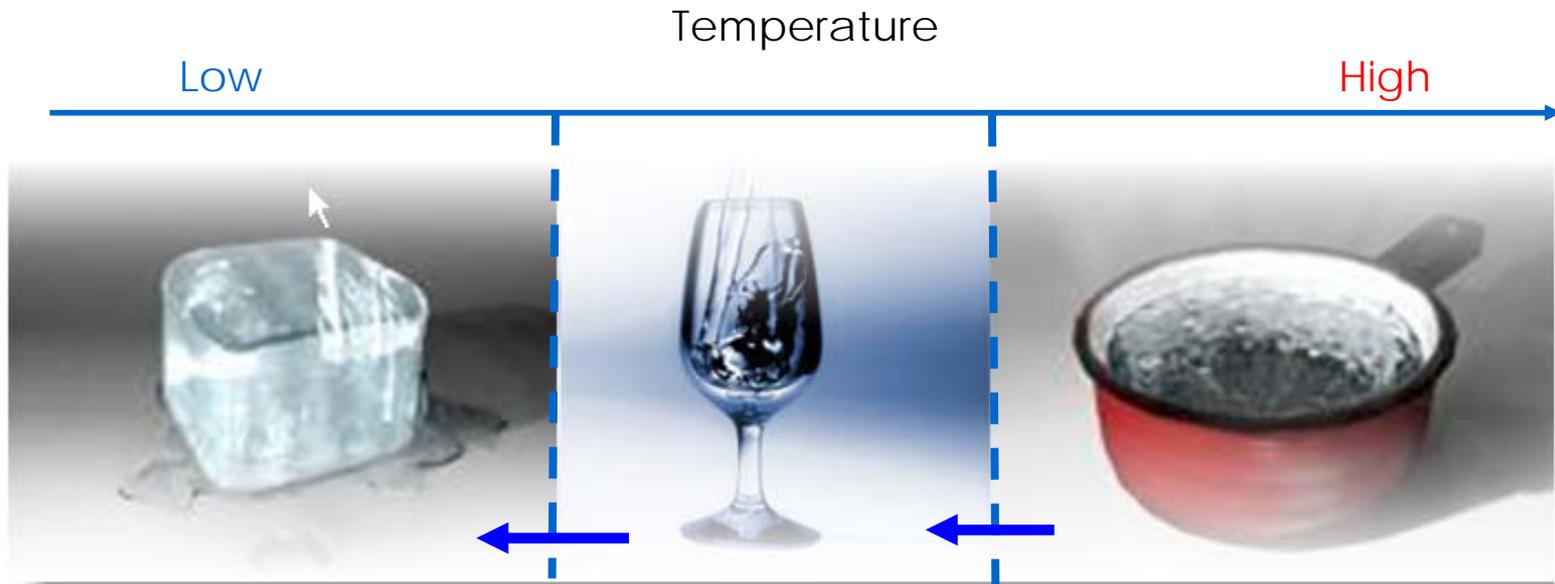
Melting and Boiling point



At normal pressure, the temperature at which:

- A solid changes to a liquid is the **melting point**.
- A liquid changes to a gas is the **boiling point**

Melting and Boiling point



Melting point is also the freezing point.

Boiling point—also the condensation point

Going the other way—a gas changes to a liquid at the condensation point. A liquid changes to a solid at the freezing point.

Generally, the melting point and freezing point are the same, just as the boiling point and condensation point are the same.

Fast Fact

Temperature

Low

High



The melting point (and the freezing point) of water is 32°F

The boiling point (and condensation point) of water is 212°F

Liquefied Natural Gas

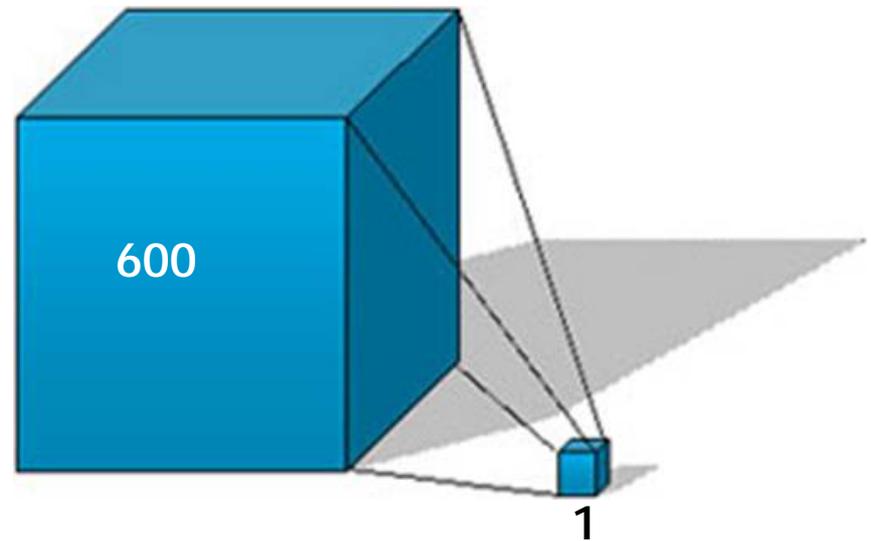


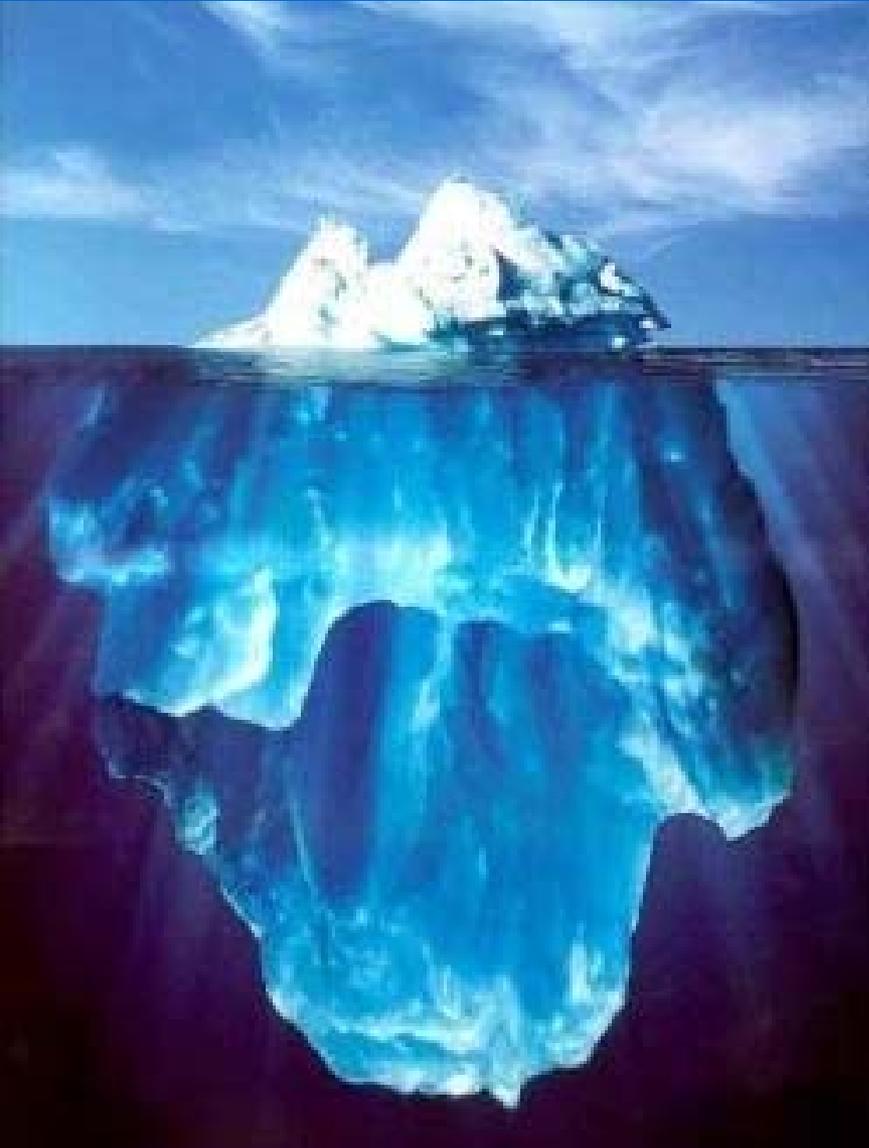
The condensation point of natural gas is -256°F . This means that natural gas, when cooled to -256°F , changes to a liquid.

We refer to temperatures this cold as **cryogenic**.

Storing LNG

- As a liquid, natural gas shrinks to 600 times less than its original volume, making it easier to store.

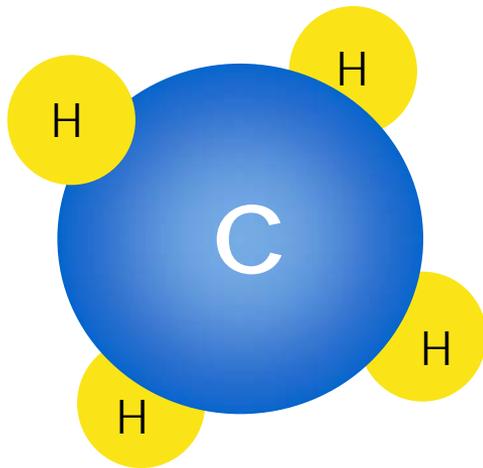




Section 4

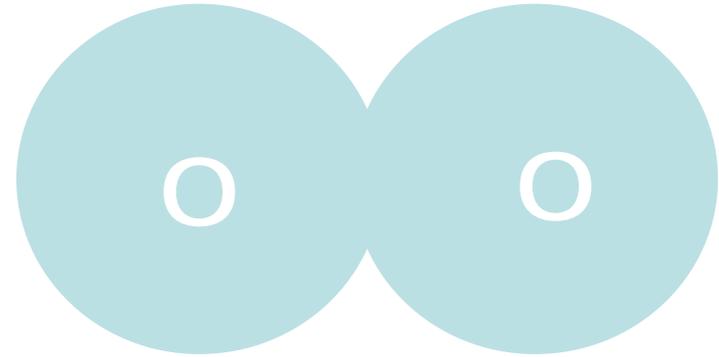
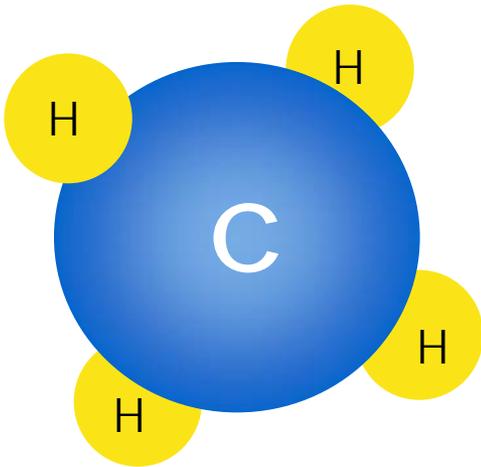
Chemical Properties of Natural Gas

What is Natural Gas?



- In its purest form, natural gas is almost pure methane.
- Methane is a molecule made up of one carbon atom and four hydrogen atoms, and is referred to as CH₄.

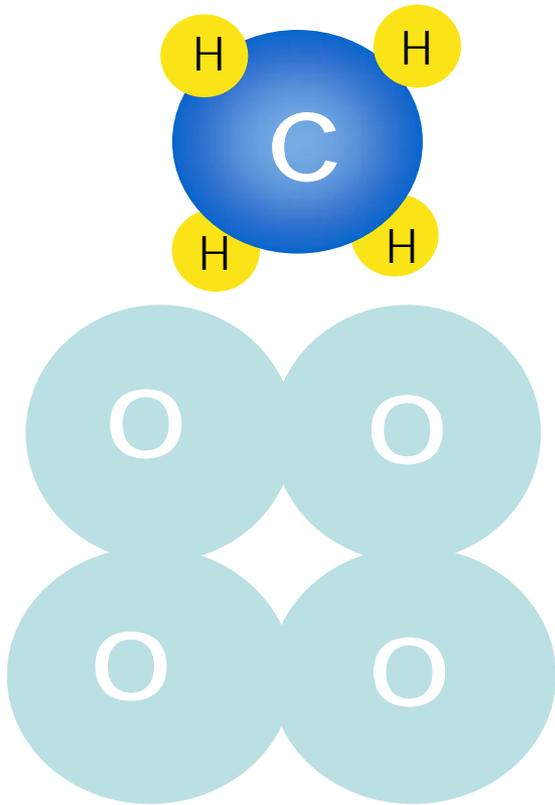
How Does Natural Gas Burn?



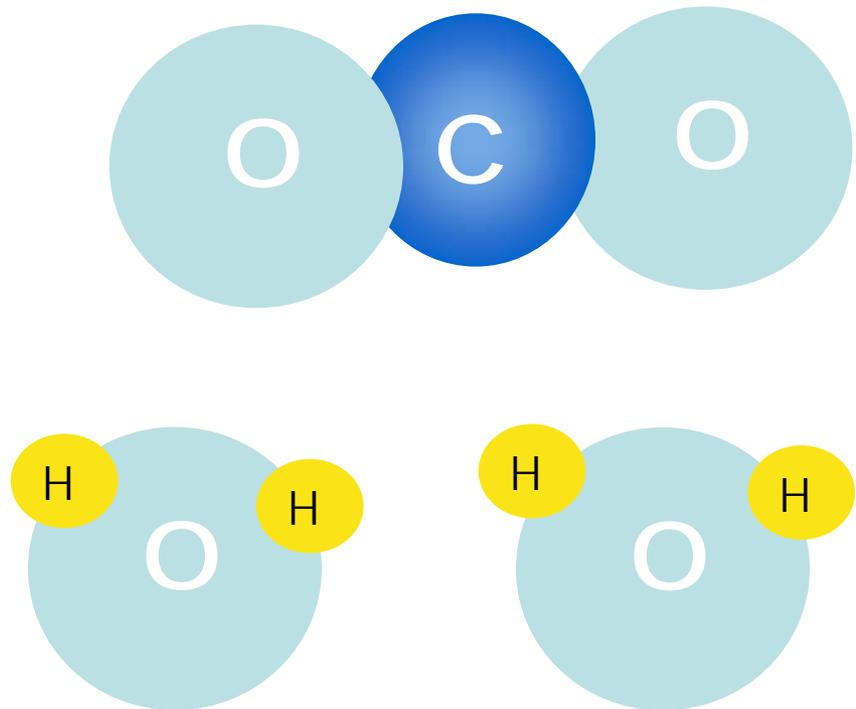
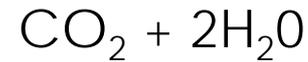
- Chemically, combustion, or burning, is when a substance combines with oxygen (found in the air as O₂).
- For combustion to occur, you need
 - fuel (such as methane),
 - oxygen, and
 - heat.

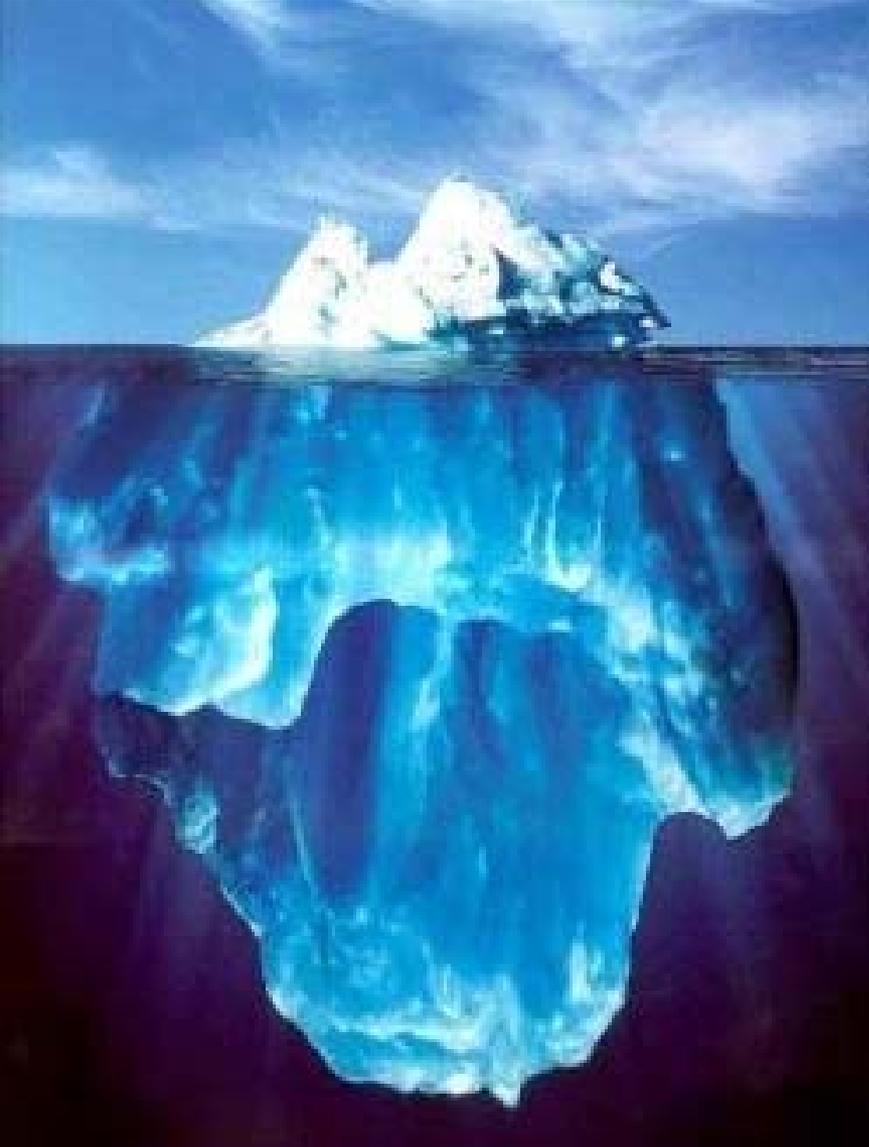
How Does Natural Gas Burn?

Before- One gas molecule and two oxygen molecules $\text{CH}_4 + 2\text{O}_2$



After – One carbon dioxide molecule and two water molecules



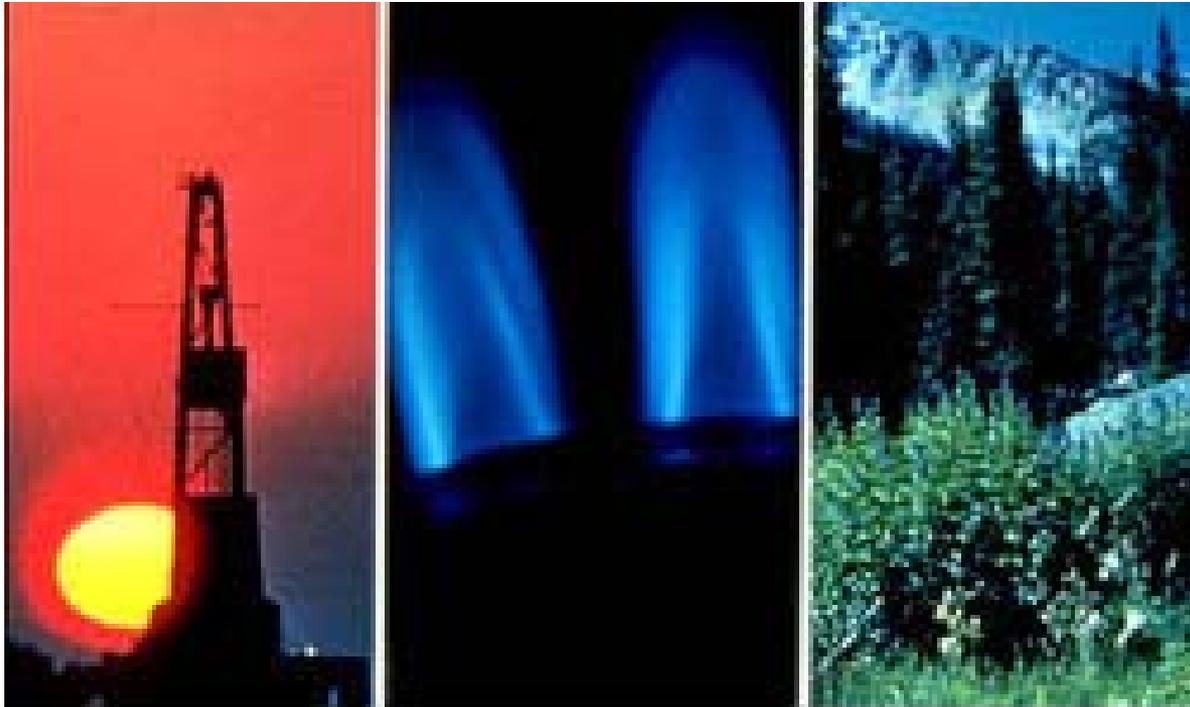


Summary

You have now completed the physical science refresher presentation. You have reviewed:

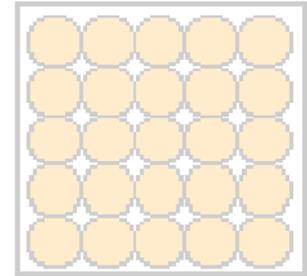
1. Three phases of matter: Solids, Liquids and Gases
2. The effect of heat and pressure on the phases of matter
3. Phase Changes
4. Chemical properties of natural gas

Check your understanding by taking the Quiz.



Self Study Physical Science Refresher
PRACTICE QUIZ

1. Match the phase of matter to the description.



Phase

Description

Solid

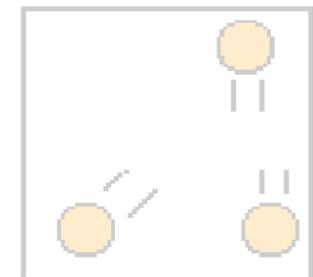
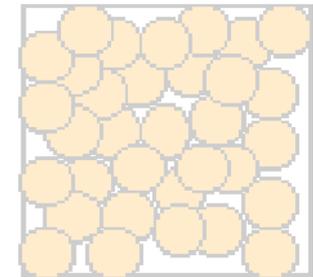
a. Molecules are close together but slide freely

Liquid

b. Freely-moving molecules fill their container

Gas

c. Molecules are packed together; holds its own shape

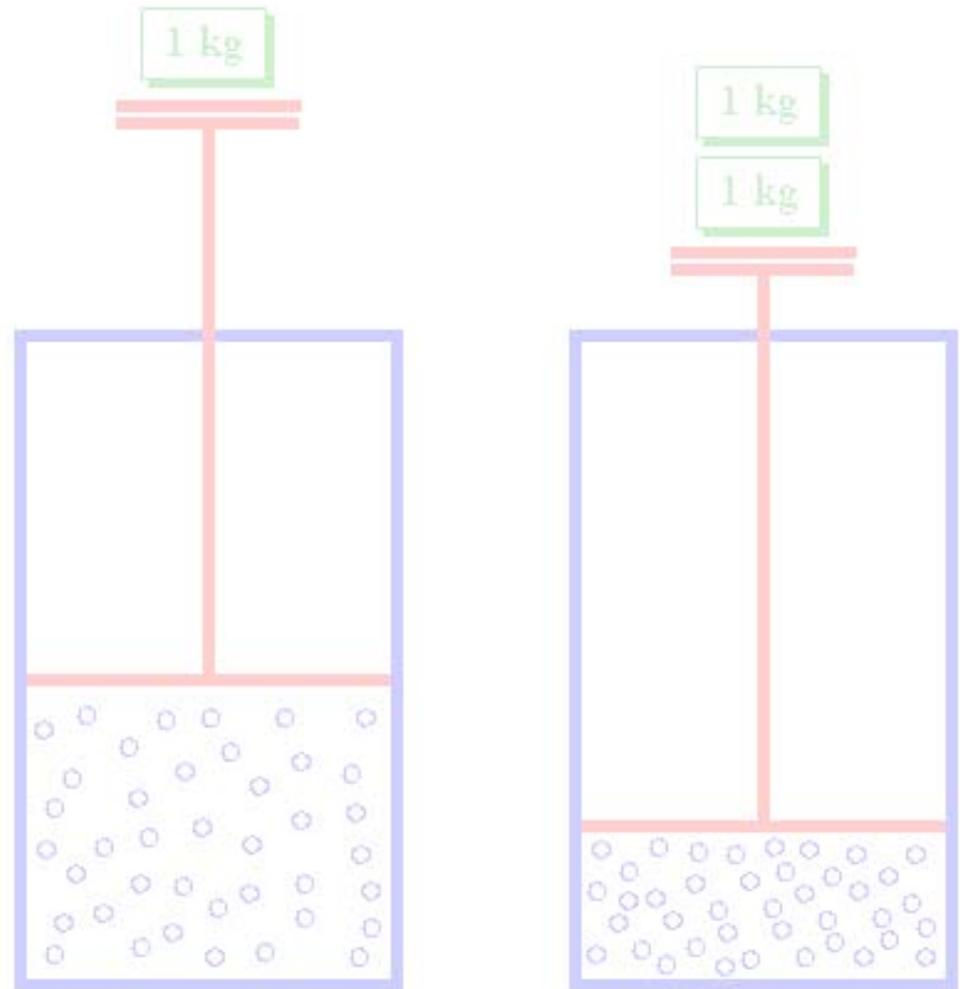


2. *In this phase of matter, changing the pressure changes the volume.*

a. Solid

b. Liquid

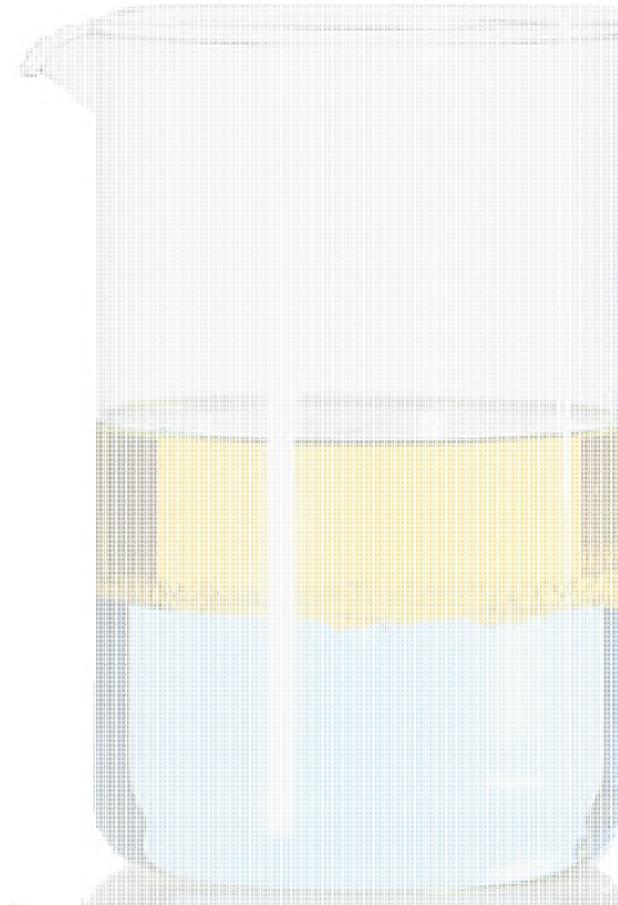
c. Gas



3. *If 5 ounces of water are poured into an 8 ounce glass, what is the volume of the water in the glass?*

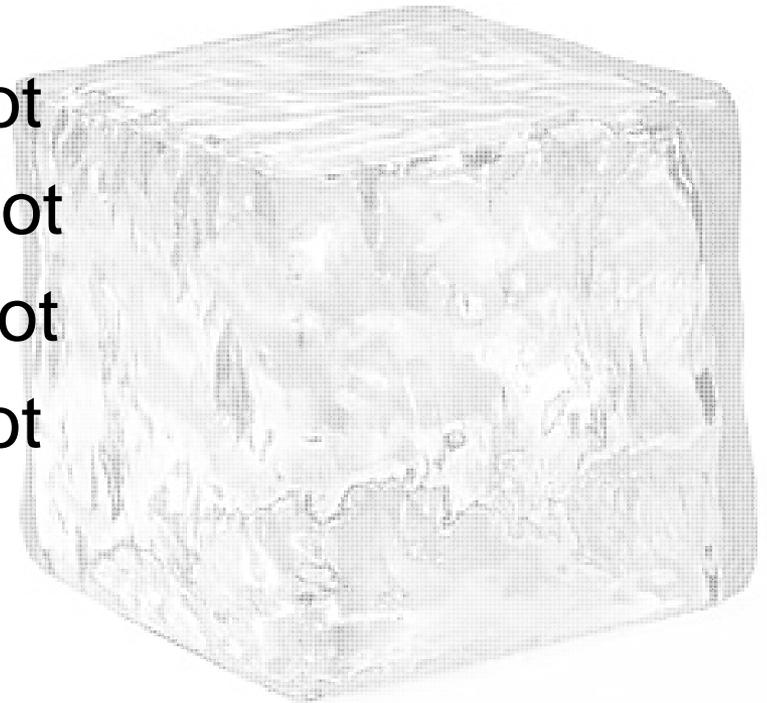
a. 5 ounces

b. 8 ounces



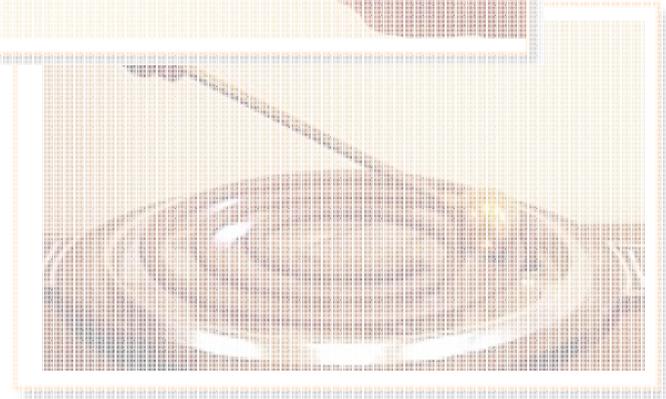
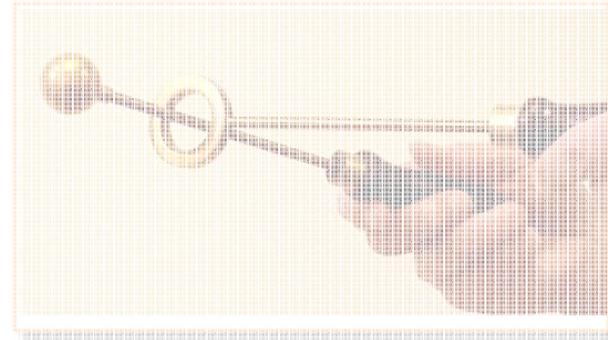
4. *What is the density of a block of ice that has a volume of 4 cubic feet and a weight of 228 pounds?*

- a. 57 pounds per cubic foot
- b. 228 pounds per cubic foot
- c. 114 pounds per cubic foot
- d. 7.2 pounds per cubic foot



5. *Most substances expand when they are heated.*

- a. True
- b. False



6. *When the pressure on a gas increases, its volume _____.*

- a. Increases
- b. Decreases
- c. Stays the same



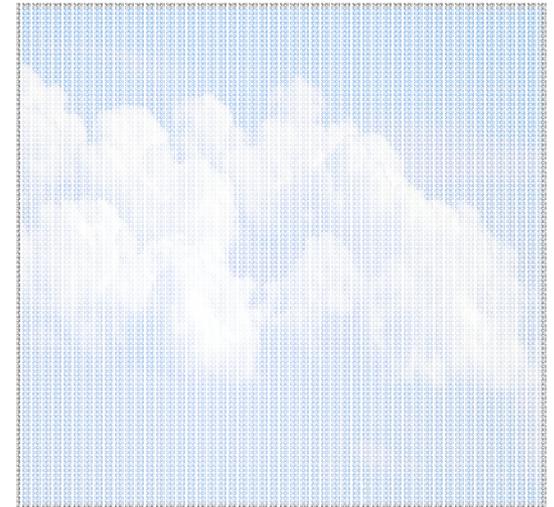
7. *Reducing the pressure of a gas while keeping the volume constant warms the gas.*

- a. True
- b. False



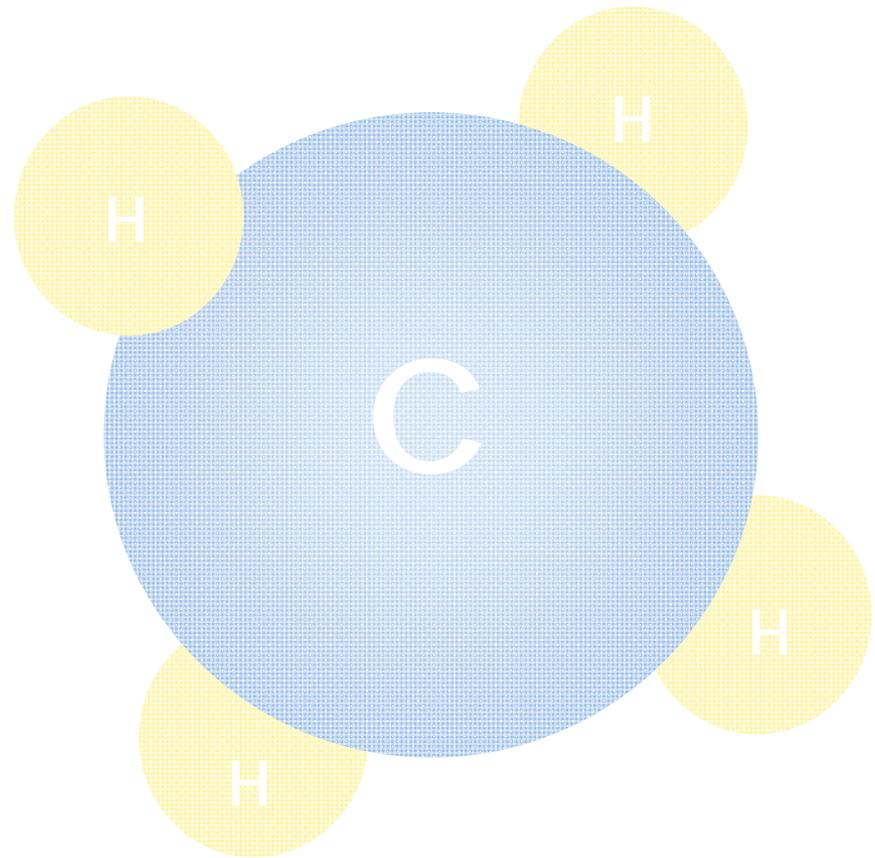
8. *The boiling point of natural gas is -256 degrees F. At -260 degrees F, at normal pressure, natural gas is a _____.*

- a. Solid
- b. Liquid
- c. Gas



9. *In its purest form, natural gas is almost pure methane.*

- a. True
- b. False



10. Complete combustion of natural gas forms (check all that apply):

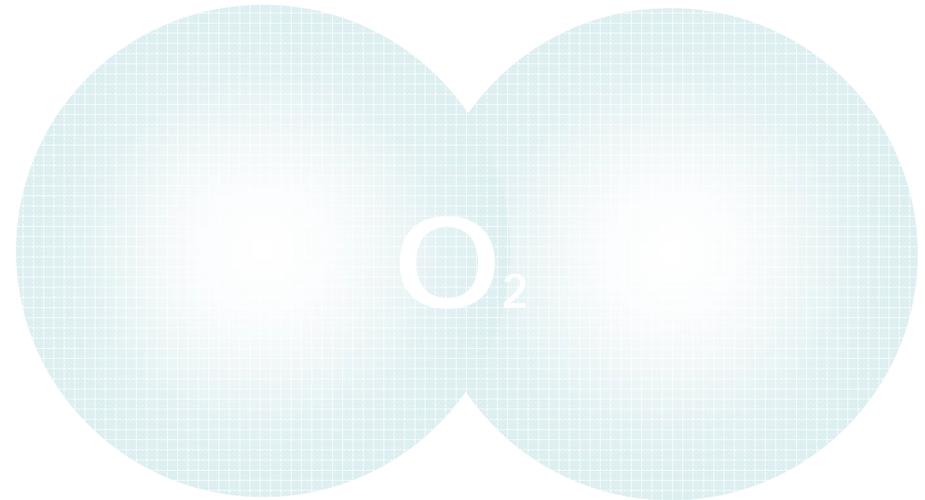
a. Oxygen

b. Methane

c. Carbon dioxide

d. Water

e. Hydrogen



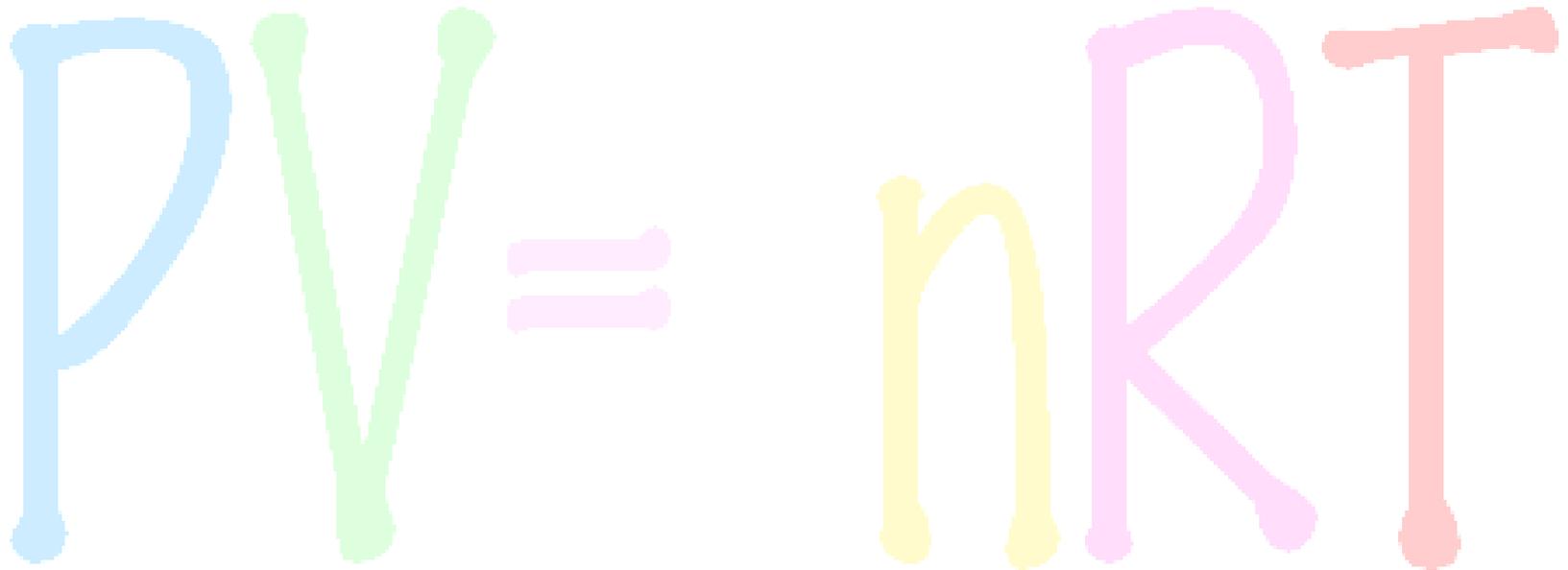
11. *Extremely cold temperatures are called _____.*

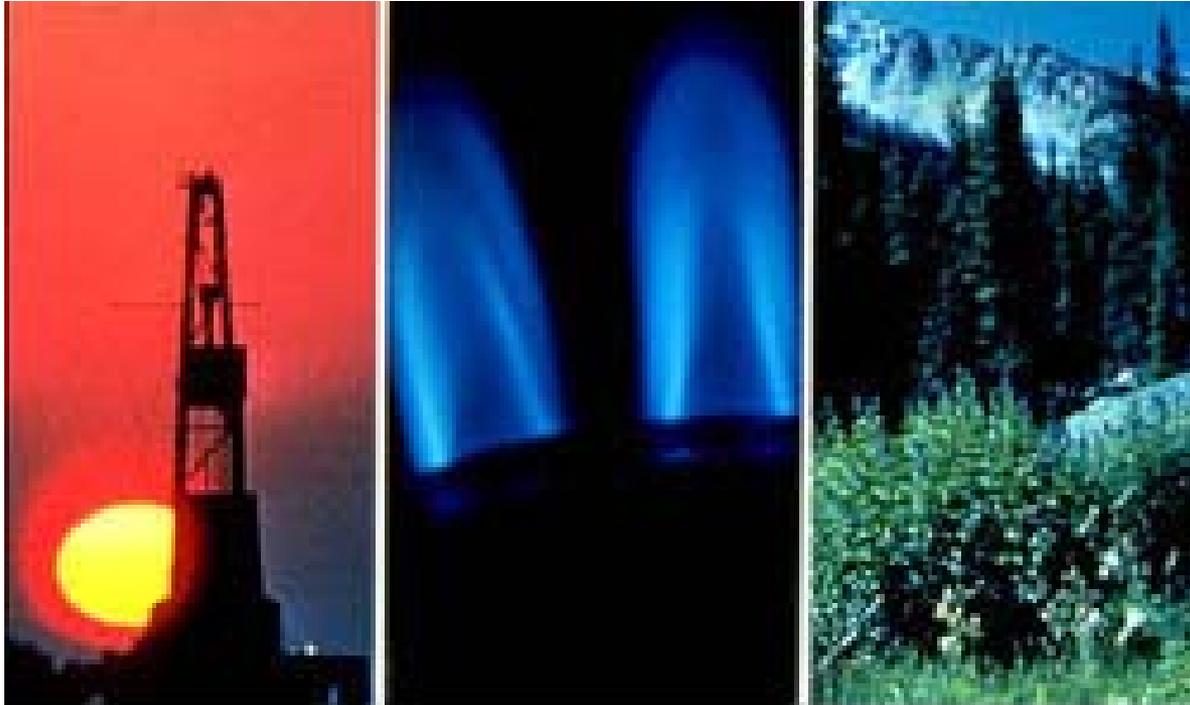


12. *The temperature at which a liquid becomes a gas is called the _____.*



13. *The Ideal Gas Law describes the relationship between _____, _____ and _____.*





Self Study Physical Science Refresher

PRACTICE QUIZ

Answer Key

1. Solid → c. Molecules are packed together; holds its own shape
Liquid → a. Molecules are close together but slide freely
Gas → b. Freely-moving molecules fill their container
2. c
3. a
4. a
5. a
6. b
7. b
8. b
9. a
10. c and d
11. Cryogenic
12. Boiling point
13. Pressure, temperature and volume