Thunderstorms

Essential Standard 2.5

Understand the structure of and processes within our atmosphere.

Learning Objective 2.5.3

Explain how cyclonic storms form based on the interaction of air masses.

I Can Statements

At the end of this lesson, you should be able to say, with confidence:

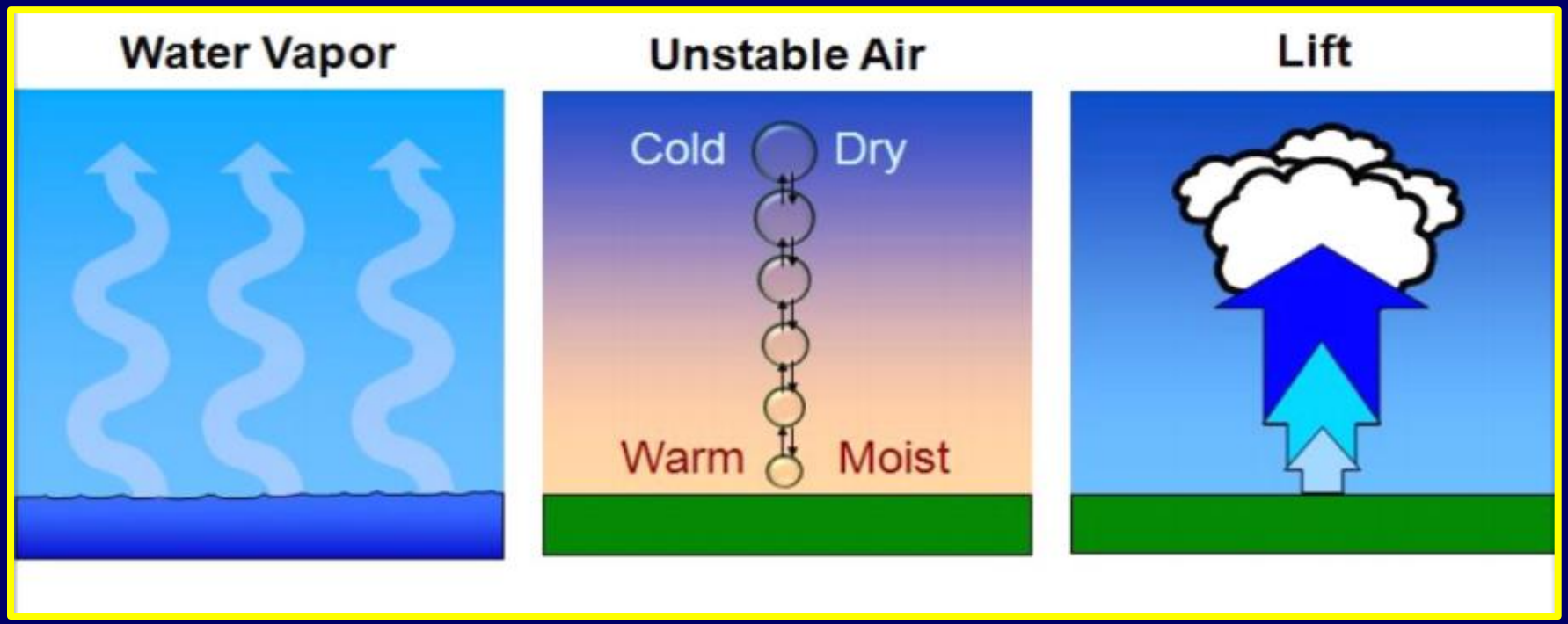
- I can explain how moisture, unstable air, and uplift are three conditions needed for the formation of thunderstorms.
- I can explain how lightning, thunder, and thunderstorms are formed.

Thunderstorms

When a storm contains thunder and lightning, it's considered to be a thunderstorm.

Three Ingredients

The three most important ingredients for thunderstorms are moisture, unstable air, and a source for lift.

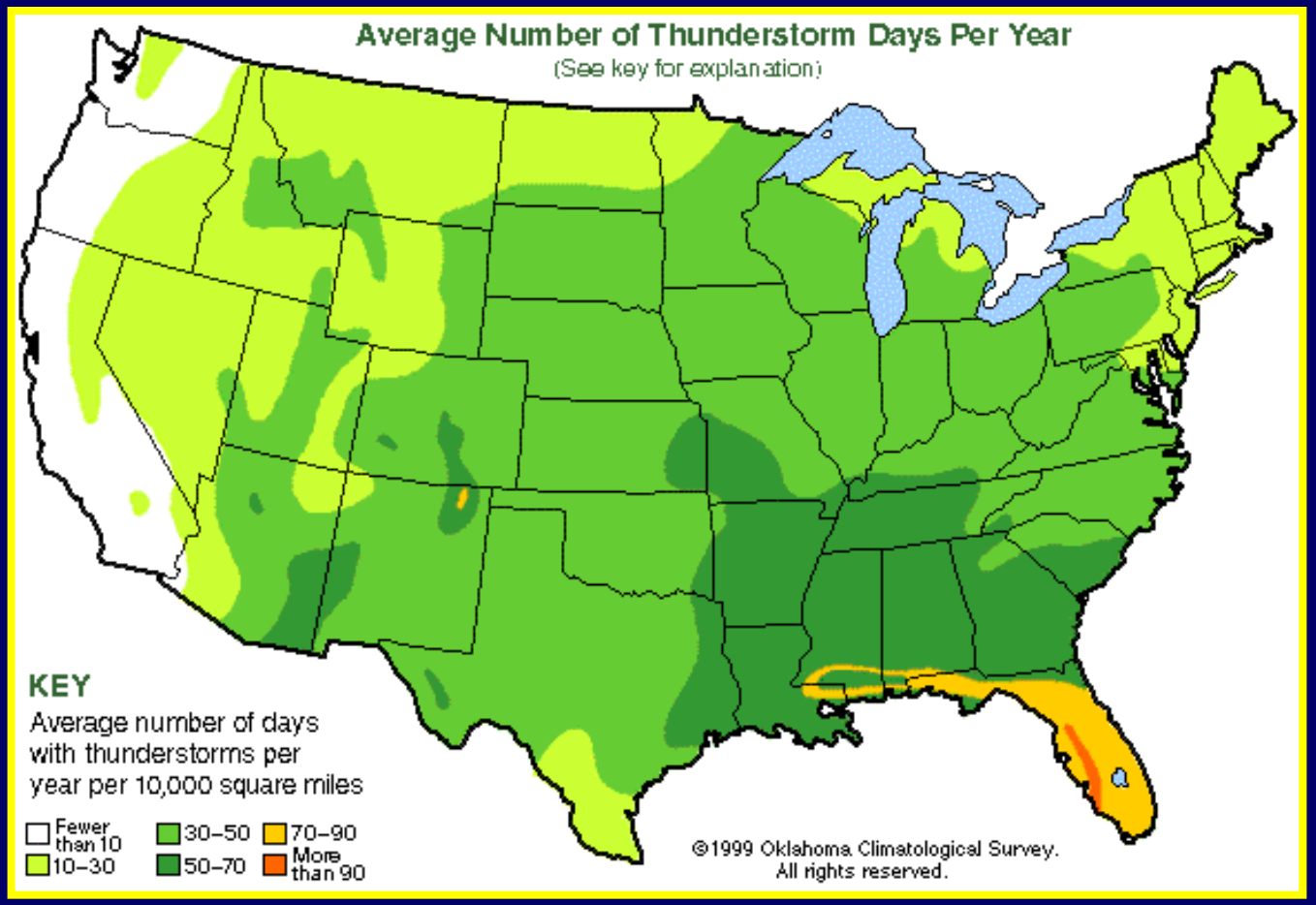


Moisture

Moisture is usually provided as air flows over warm, ocean waters or large lakes.

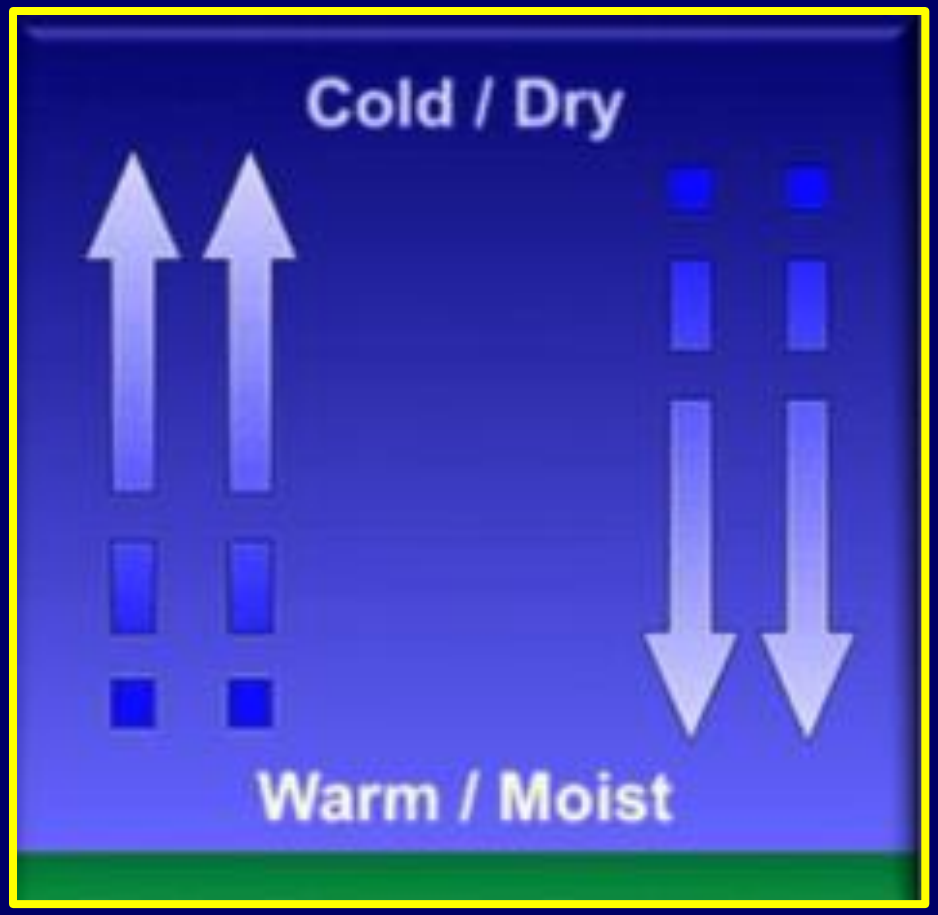
Frequency Due to Moisture

Notice that Florida and the southeast have the highest number of thunderstorms each year.



Unstable Air

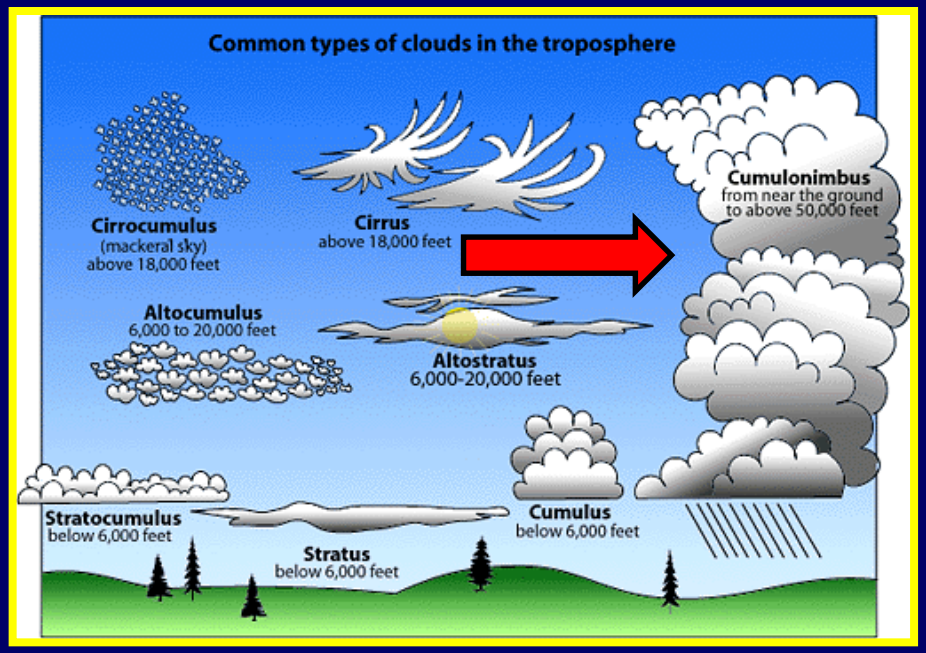
Unstable air occurs when warm moist, air continues to rise and cold dry, air continues to sink.



This usually occurs on warm, humid days.

Cumulonimbus Clouds

When warm, moist air rises, some of the air begins to cool and condense, resulting in the formation of clouds.



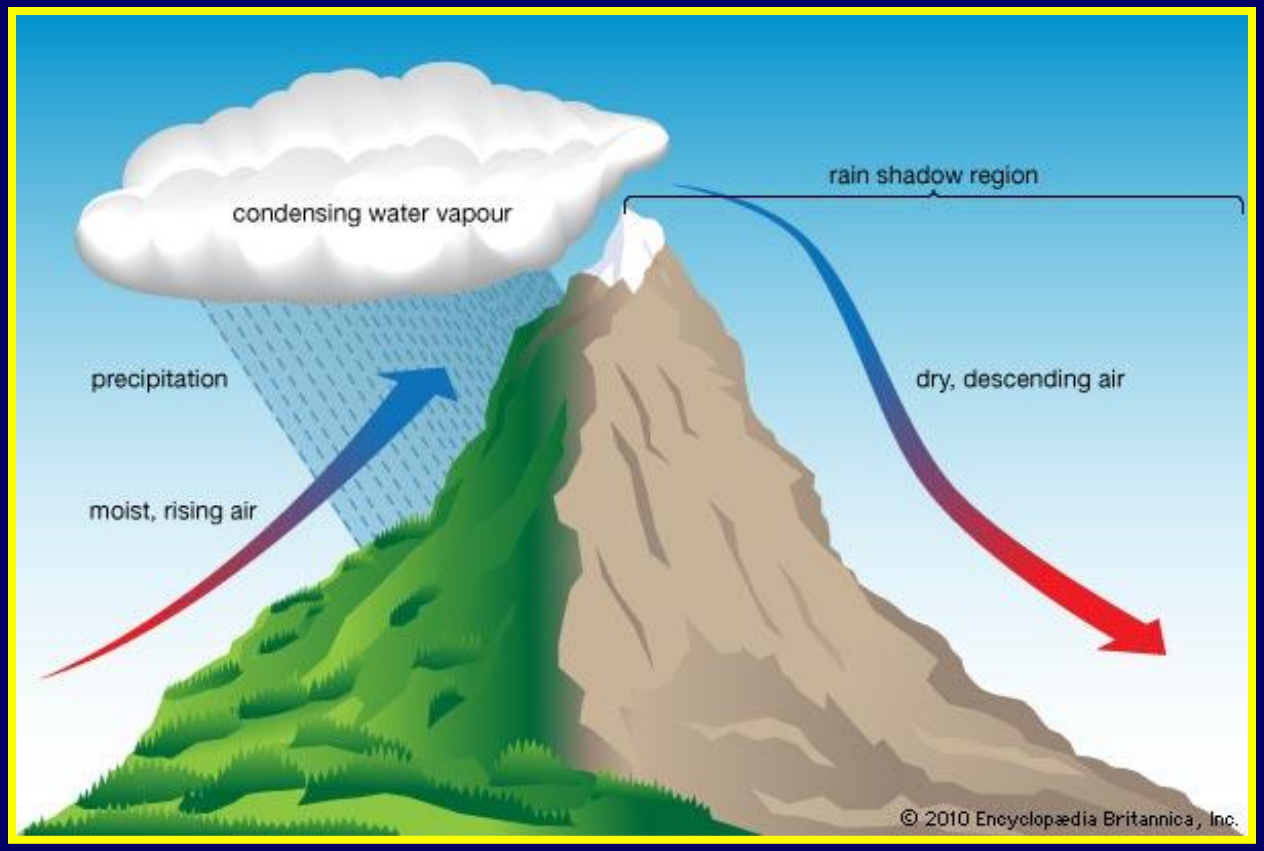
As even more warm, moist air rises, extremely tall clouds, called cumulonimbus clouds, are formed.

Lift

While warm, moist air will rise on its own due to convection, certain conditions that help provide even more lift to the warm, moist air, will create greater chances for thunderstorms to occur.

Mountains → Lift

When warm, moist air is forced upward as it approaches a mountain, the warm air condenses, resulting in precipitation and thunderstorms.



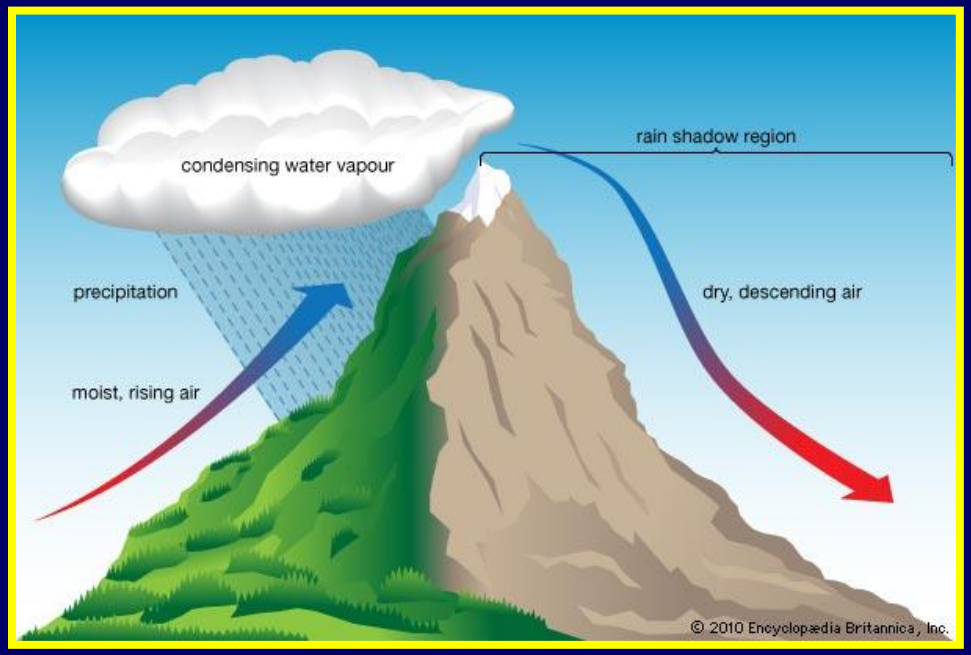
Mountain Thunderstorms

The lift mountains provide to help form thunderstorms is why thunderstorms are so common in the mountains.

This also explains why there are a series of deserts in the western portion of California and in Nevada.

Rain Shadow Effect

As the warm, moist air rises over the mountain, all the moisture is released, resulting in dry descending air.



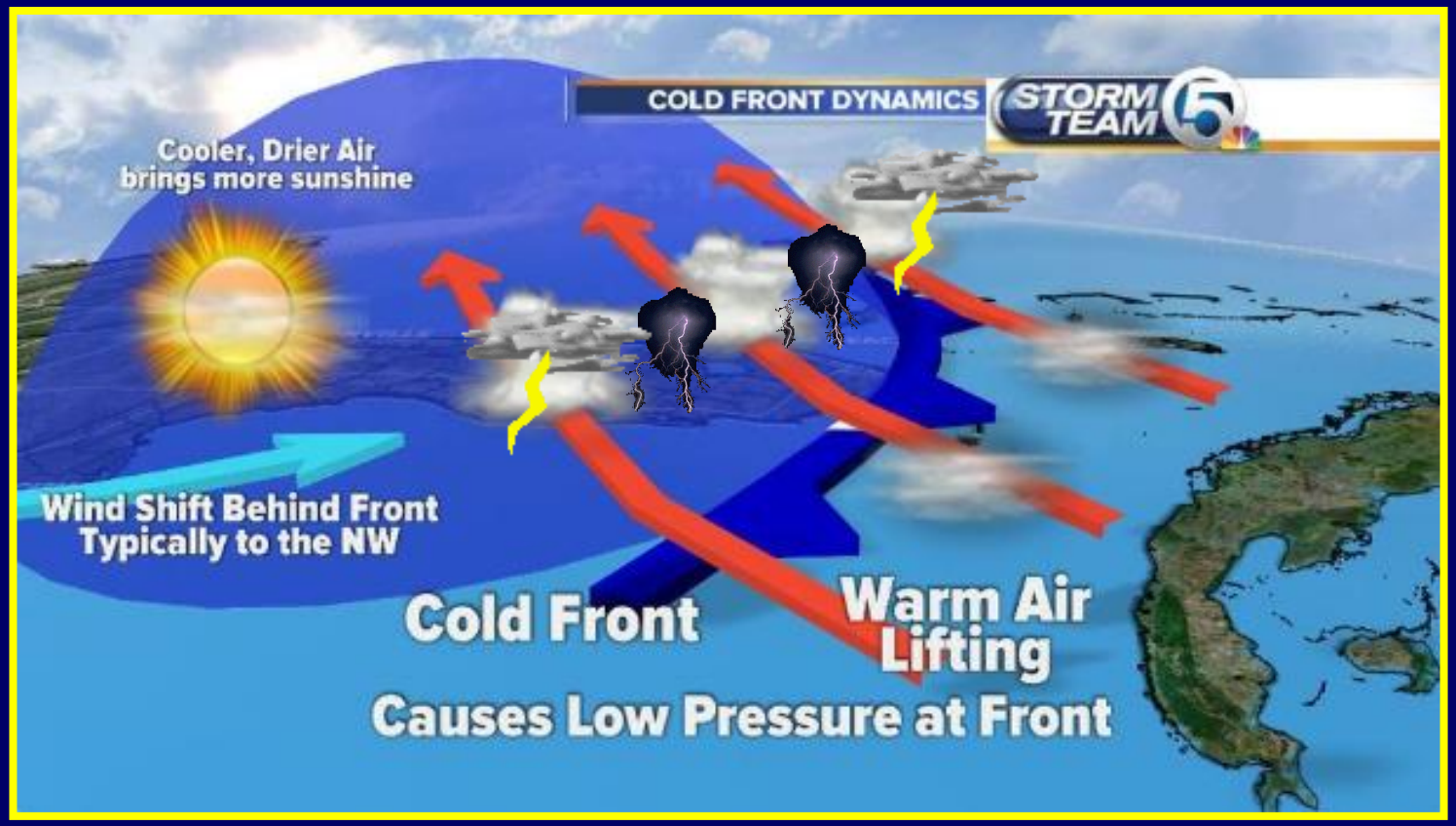
This is called the rain shadow effect and results in desert conditions on the other side of the mountain.

Fronts → Lift

Another source of lift occurs when a cold air mass pushes a warm air mass higher into the air.

Frontal Thunderstorms

Frontal thunderstorms usually occur when cold fronts are moving in, which is why it is often cooler after a thunderstorm.



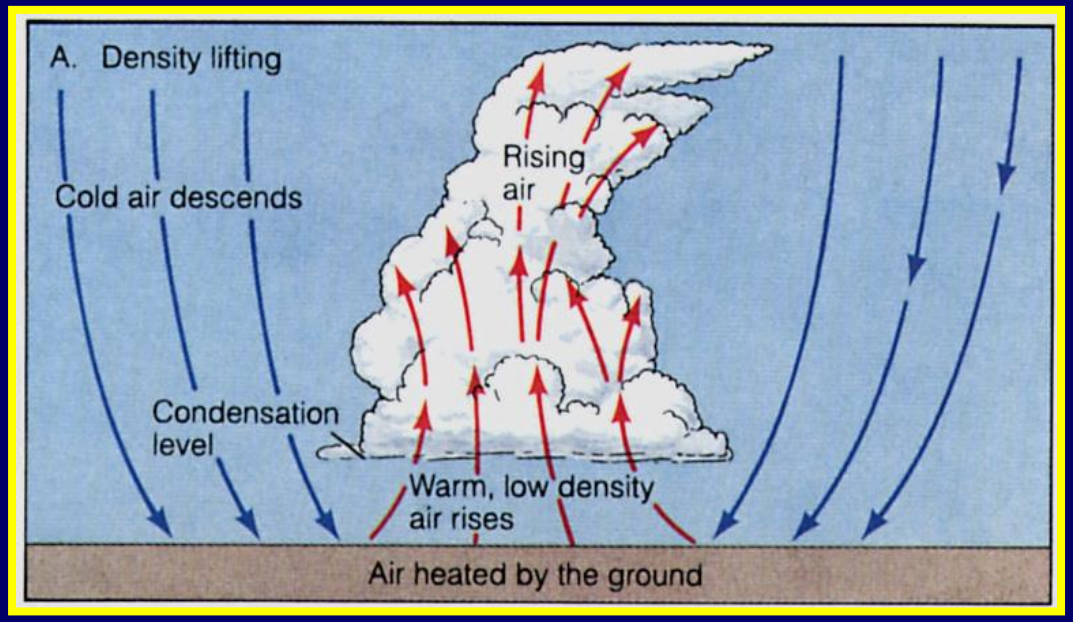
Rising Air Mass → Lift

Thunderstorms can also occur when a warm air mass rises due to localized convection on a hot, humid, sunny day.

Radiation, from the Sun heats the ground, which then heats the air above it by conduction.

Air Mass Thunderstorms

The warm, moist air then begins to rise by convection, creating a warm updraft.

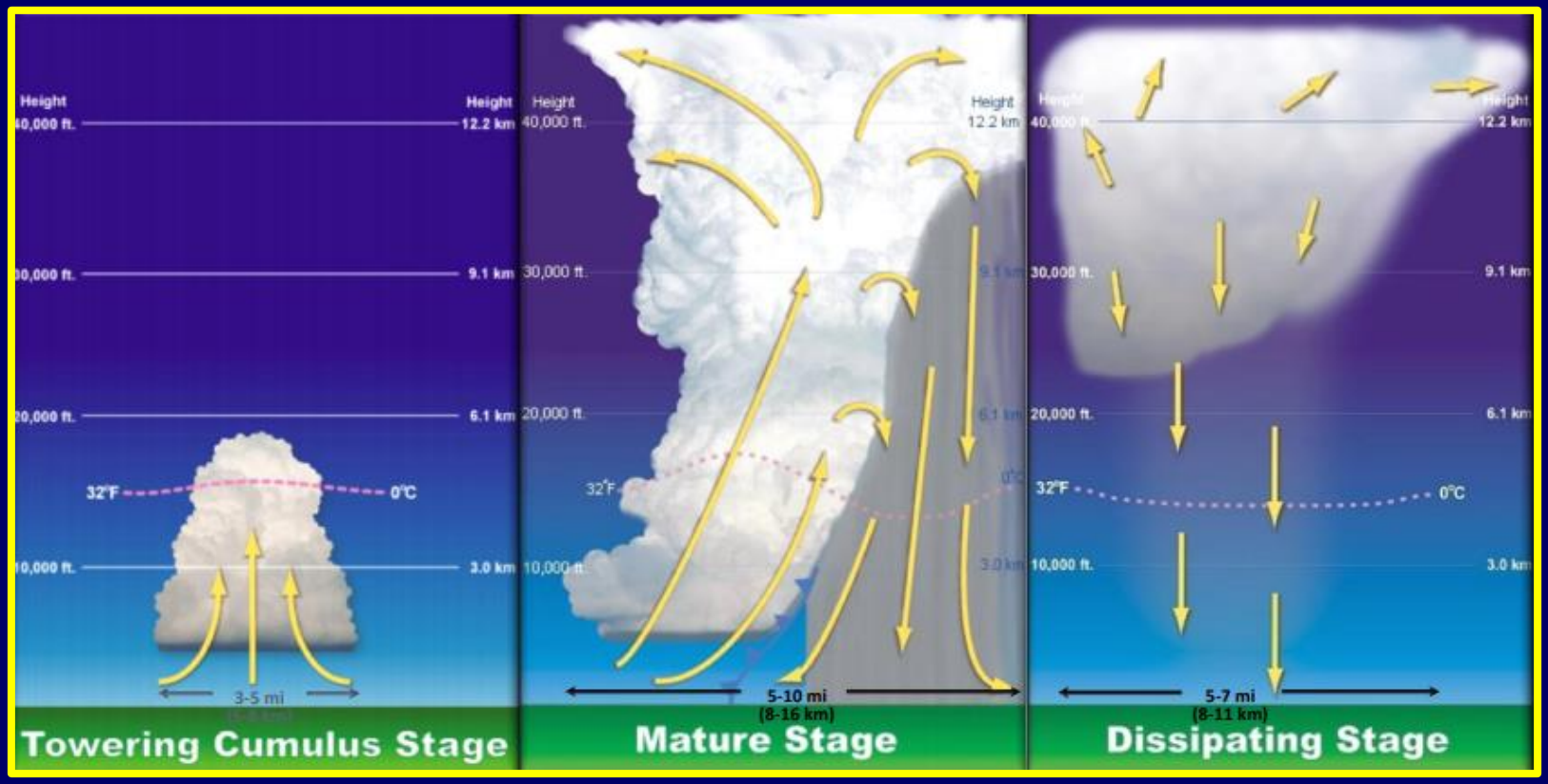


Eventually, with height, the air begins to cool and the water vapor condenses to form clouds.

After enough water droplets have collected in the clouds, it falls to Earth as rain, creating a cool downdraft.

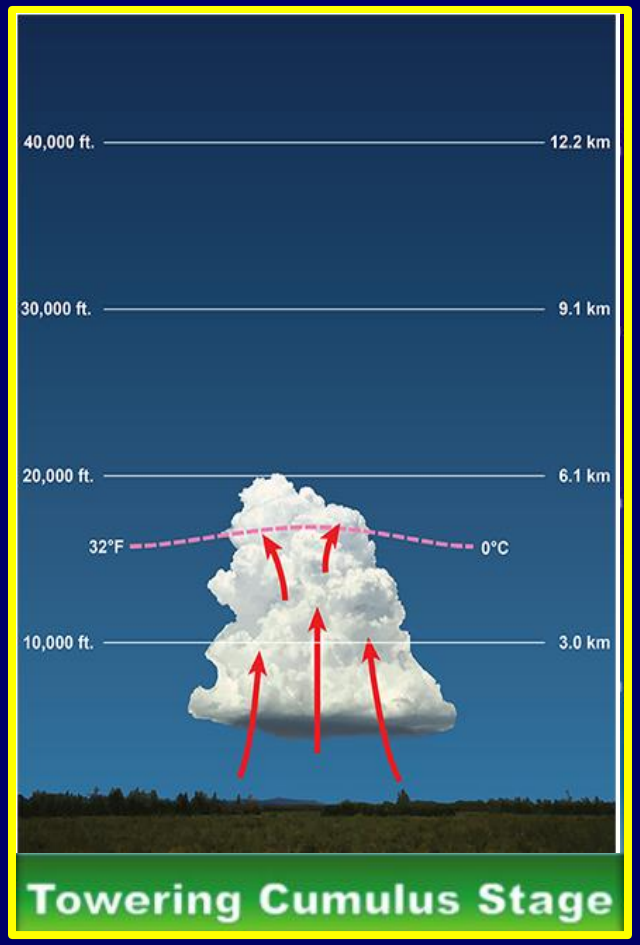
Thunderstorm Life Cycle

Thunderstorms tend to go through three different stages: Towering Cumulus Stage; Mature Stage; and Dissipating Stage.



Towering Cumulus Stage

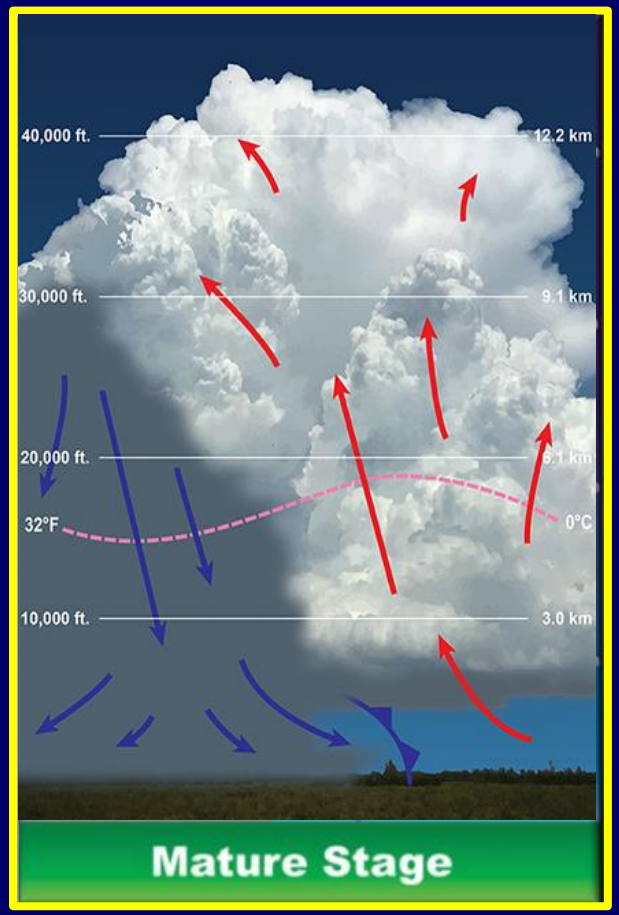
During the towering cumulus stage, the cloud begins to grow vertically, around reaching 20,000 feet.



At this point, the cloud is dominated by strong updrafts.

Mature Stage

During the mature stage, the cloud can reach heights between 40,000 and 60,000 feet.

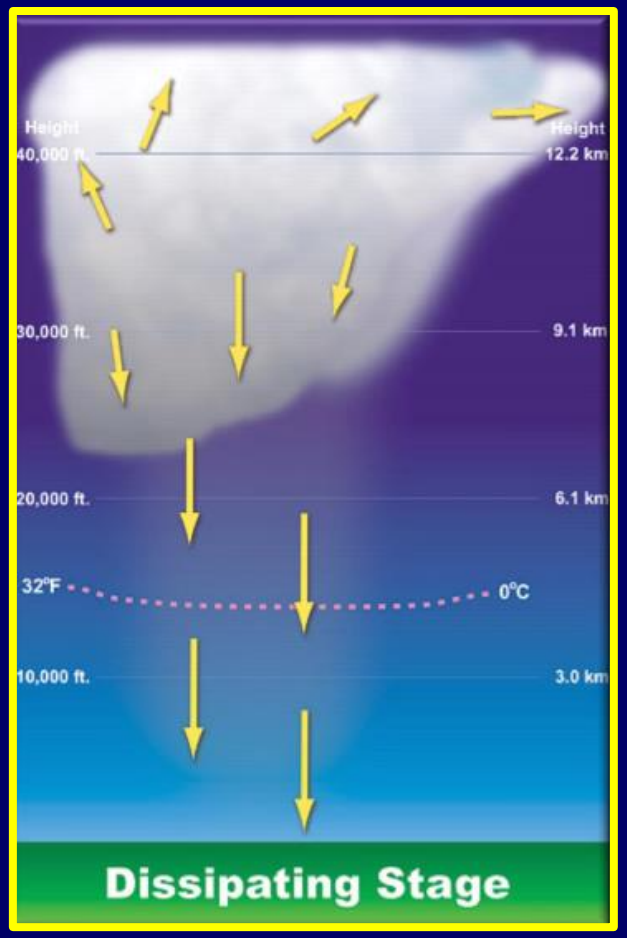


At this point, strong updrafts and strong downdrafts coexist.

This is the most dangerous stage of a thunderstorm, when large hail, damaging winds, or flash floods may occur.

Dissipating Stage

During the dissipating stage, the downdraft cuts off the updraft.

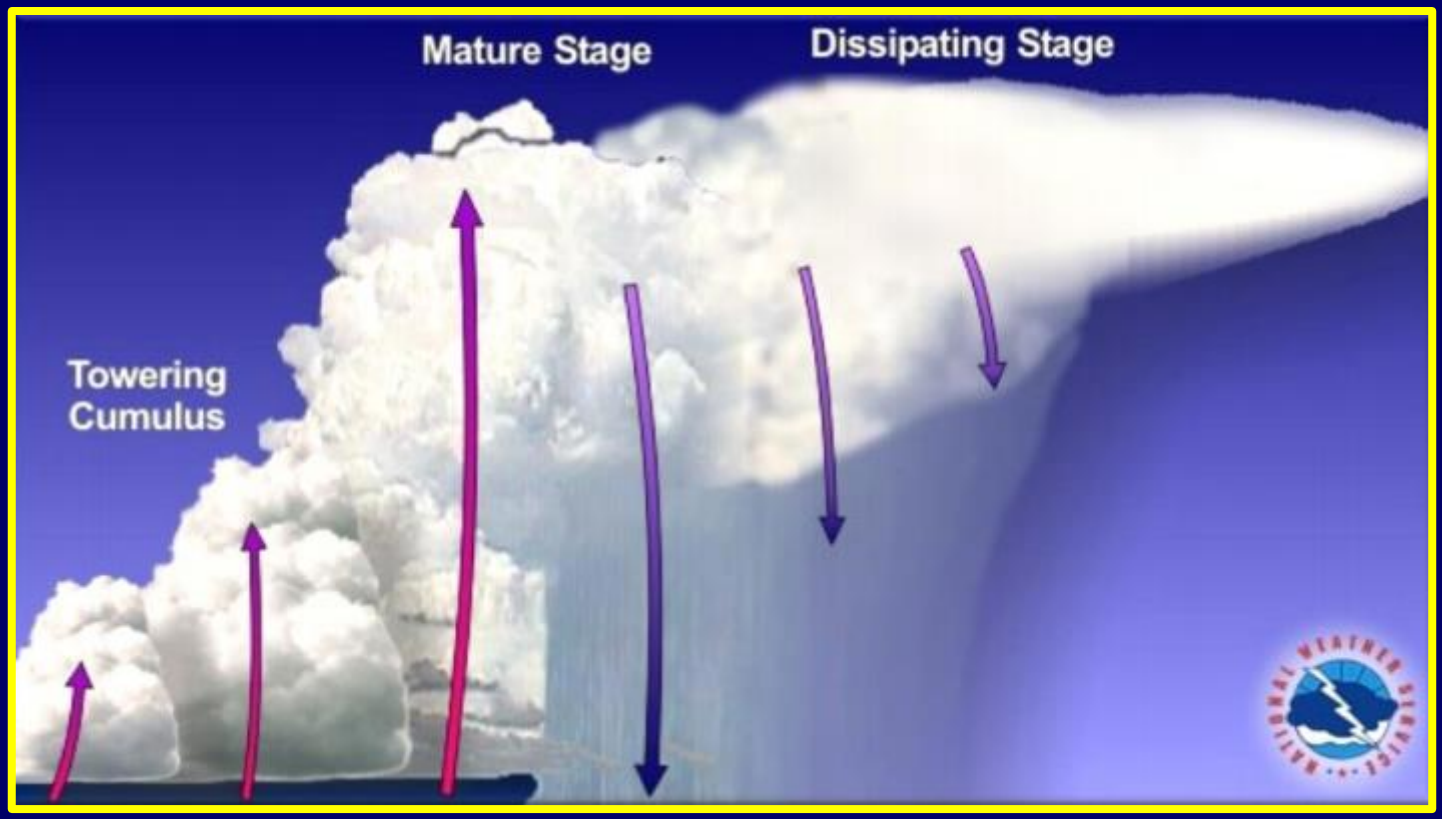


With no additional warm, moist air, the storm runs out of energy and weakens.

Light rain and weak winds may remain for a while, before clearing.

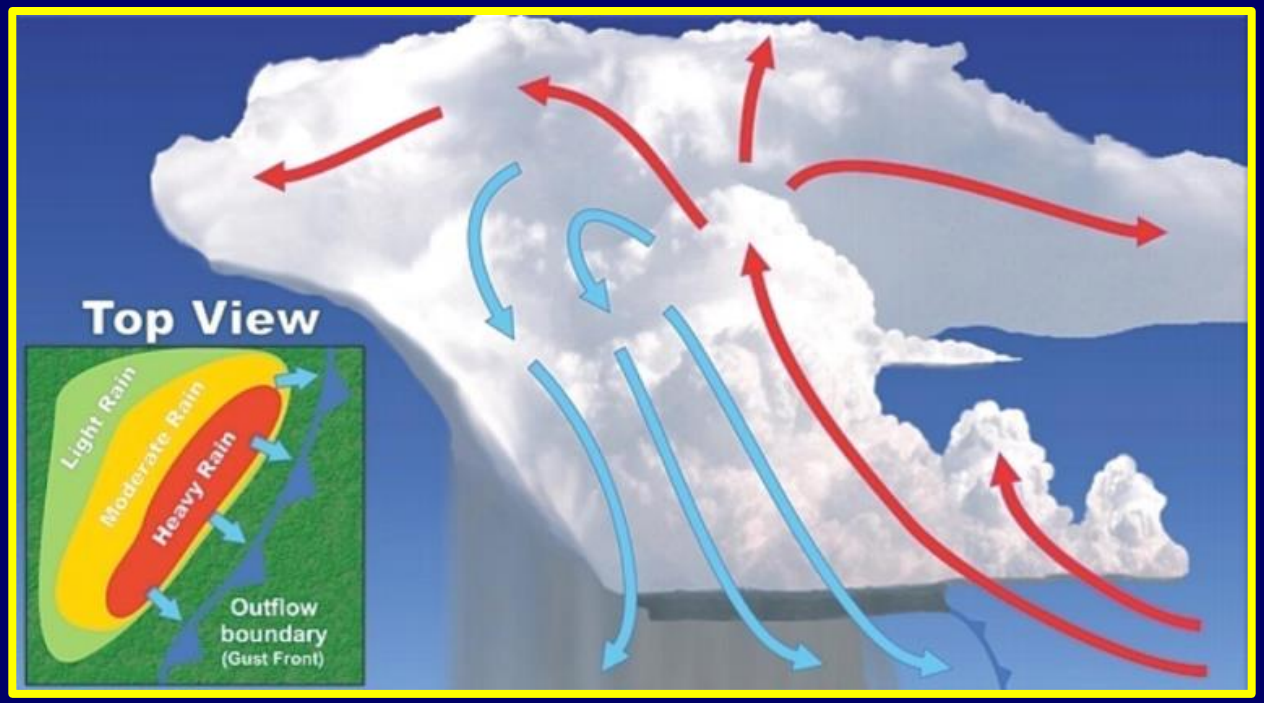
Multi-Cell Cluster

Thunderstorms usually form in clusters with numerous cells, in various forms of development, merging together.



Multi-Cell Squall Line

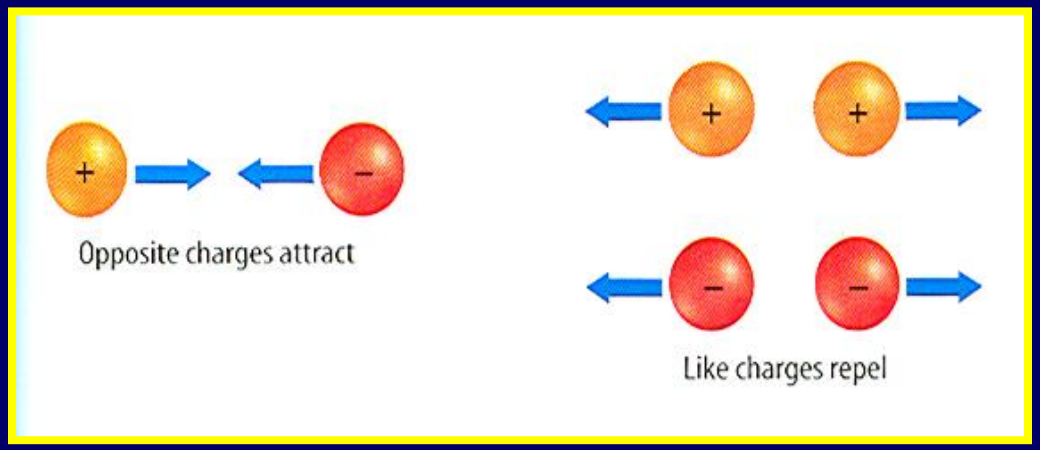
Sometimes thunderstorms will form in a line which can extend laterally for hundreds of miles.



These squall lines can persist for many hours and produce damaging winds and hail.

Lightning

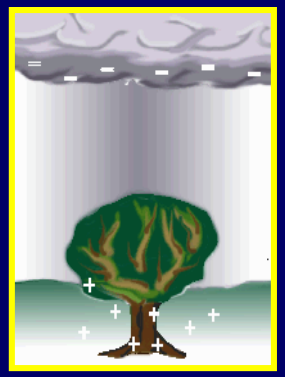
The combination of updrafts and downdrafts, in thunderstorms, cause water molecules to rub against each other, creating static electricity.



Static electricity is the accumulation of excess positive and negative charges.

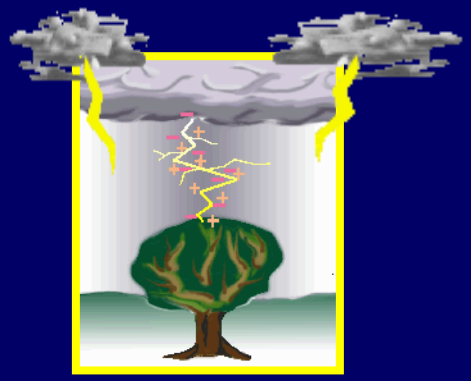
Electrical charges exert a force on each other, opposite charges attract and like charges repel.

Lightning



In a storm cloud, the negative charges collect at the bottom of the cloud and attract positive charges to the surface of the ground.

When the attraction force becomes strong enough, the negative and positive charges rush towards each other.



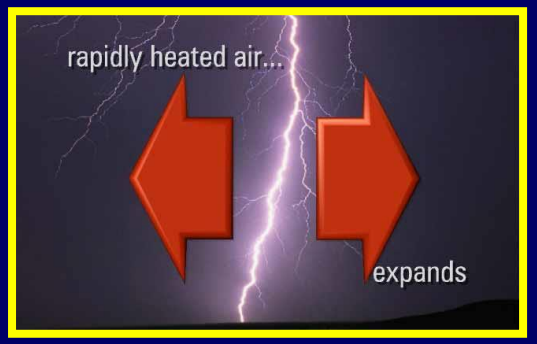
When the charges meet, a spark or lightning is generated.

Lightning in Slow Motion

Notice the lightning travels from the air, first, and then the ground. When the two meet, that's when we see the spark.

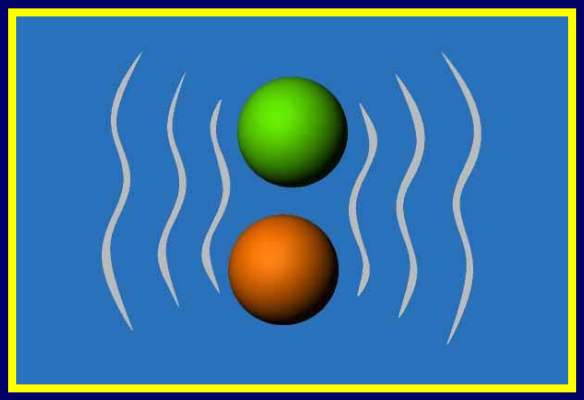
Thunder

Lightning can reach temperatures as high as 50,000 ^{0} F.



The rapid heating of air causes the air molecules to expand.

Within a fraction of a second, the air molecules then begin to cool and contract.



The rapid expansion and contraction of air molecules creates sound waves that we hear as thunder.

The End