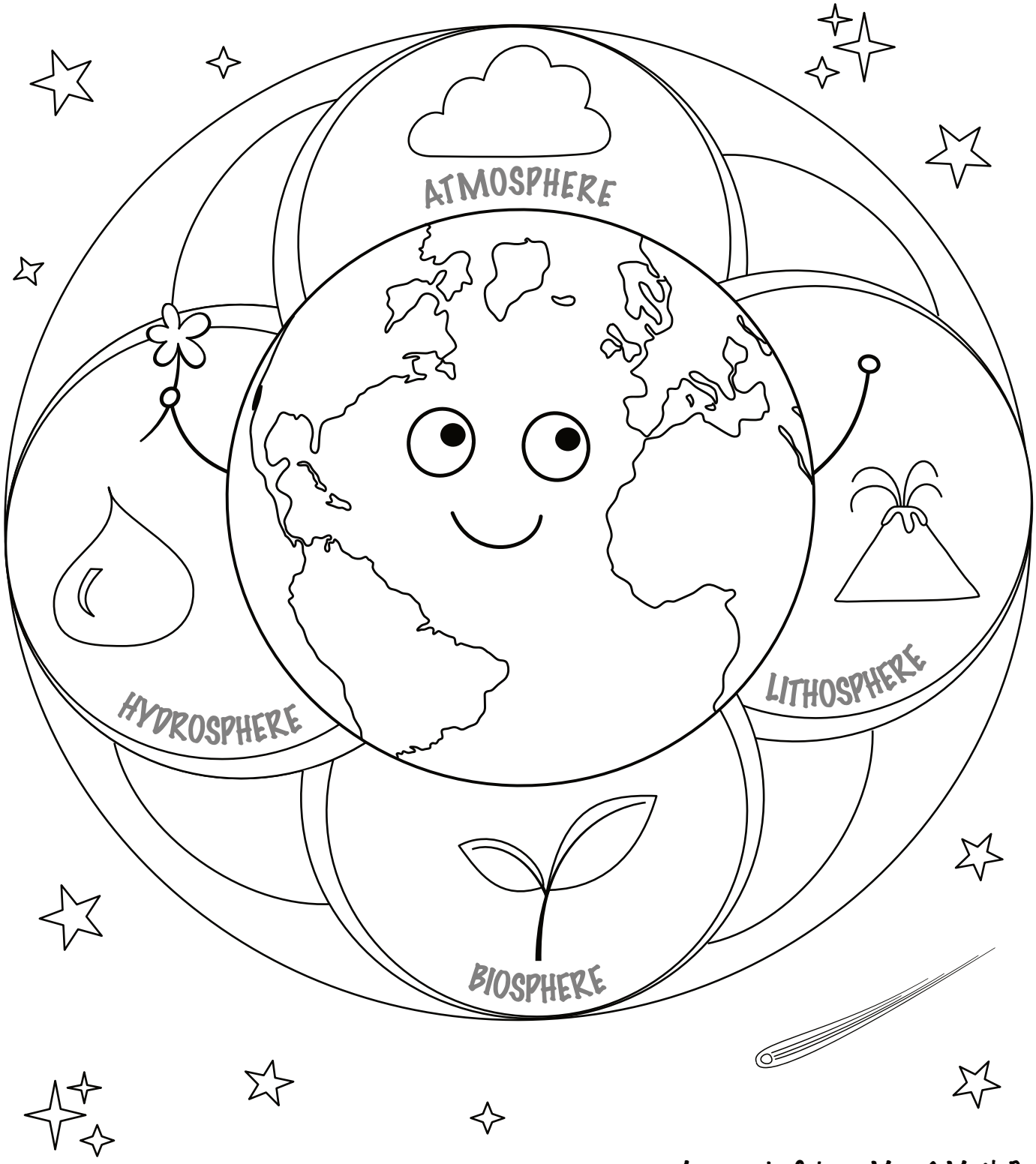
Earth Science

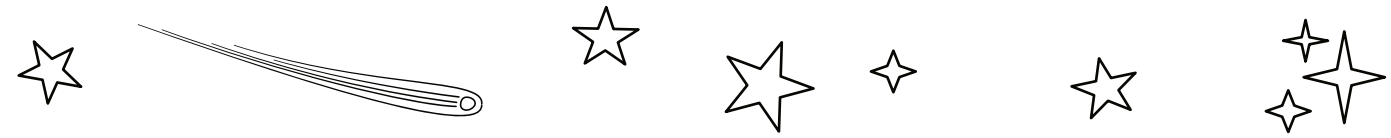


A course by Science Mom & Math Dad

EARTH SCIENCE

~ SPRING 2021 ~

	Date	Topic	NGSS *(if applicable)*	Page(s)
Week 0	Monday, Jan 11-Friday, Jan 15	Watch the welcome video or join one of our meetups for a face-to-face orientation!		
Week 1	*Monday, Jan 18*	*Holiday - no class*		
	Wednesday, Jan 20	What are you breathing?		7-8
	Friday, Jan 22	***Art Project: Layers of the atmosphere***		9-12
Week 2	Monday, Jan 25	Could you live in a cloud?		14-15
	Wednesday, Jan 27	Predicting weather	4-PS3-1	16-17
	Friday, Jan 29	***Science Activity: How do planes fly?***	4-PS3-3	18-21
Week 3	*Monday, Feb 1*	Severe storms		22-23
	Wednesday, Feb 3	Global weather patterns		
	Friday, Feb 5	Gameshow review		
Week 4	Monday, Feb 8	Rainforest biomes	4-LS1-2, 5-ESS3-2	
	Wednesday, Feb 10	Desert biomes	4-LS1-2, 5-ESS3-2	
	Friday, Feb 12	***Art Project: Climate Zone Quadramas***		
Week 5	*Monday, Feb 15*	*Holiday - no class*		
	Wednesday, Feb 17	What caused the ice ages?		
	Friday, Feb 19	***Science Activity: Mason Jar Biomes***		
Week 6	Monday, Feb 22	The ozone hole		
	Wednesday, Feb 24	Fossil fuels		
	Friday, Feb 26	Gameshow review		
Week 7	Monday, Mar 1	The story of CO_2		
	Wednesday, Mar 3	The future of climate change		
	Friday, Mar 5	***Science Activity: spaghetti bridge***	3-5-ETS1-1	
Week 8	Monday, Mar 8	Where do planets come from?	5-ESS1-1	
	Wednesday, Mar 10	Earth's structure	5-ESS1-2, 5-PS2-1	
	Friday, Mar 12	***Art Project: Layers of Earth***		
Week 9	Monday, Mar 15	How do volcanoes work?		
	Wednesday, Mar 17	Erosion and weathering	4-ESS2-1	
	Friday, Mar 19	Gameshow review		
Week 10	Monday, Mar 22	Sedimentary rocks		
	Wednesday, Mar 24	Geologic time		
	Friday, Mar 26	***Science Activity: Candy Rock Cycle***	*4-ESS2-1*	

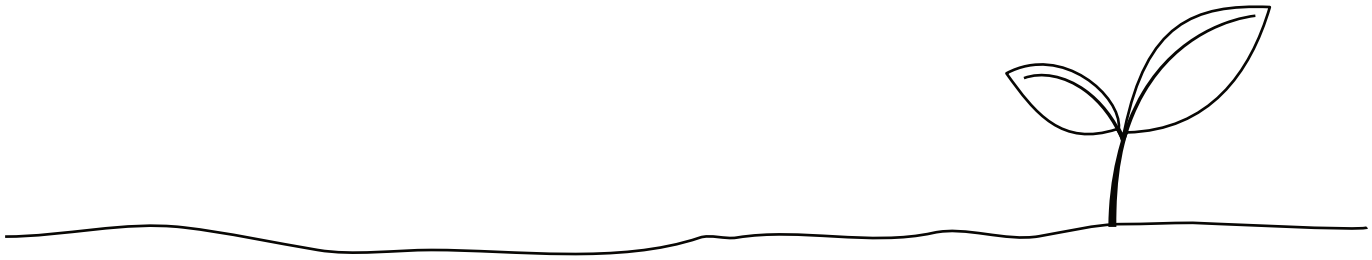


	Date	Topic	NGSS (if applicable)	Page(s)
Week 11	*Monday, Mar 29*	Spring Break		
	Wednesday, Mar 31			
	Friday, Apr 2			
Week 12	Monday, Apr 5	Fossils		
	Wednesday, Apr 7	How to identify rocks		
	Friday, Apr 9	***Art Project: Lunar Art***		
Week 13	Monday, Apr 12	What if we didn't have a moon?		
	Wednesday, Apr 14	Where's the water?	5-ESS2-2	
	Friday, Apr 16	***Science Activity: Waves***	4-PS4-1,	
Week 14	Monday, Apr 19	Ocean currents		
	Wednesday, Apr 21	You're grounded!		
	Friday, Apr 23	Gameshow Review		
Week 15	Monday, Apr 26	How rivers work		
	Wednesday, Apr 28	Lakes: the good, the weird, and the salty		
	Friday, Apr 30	***Art Project: Watershed Map***	4-ESS2-2	
Week 16	Monday, May 3	Earthy ecosystems	5-ESS2-1	
	Wednesday, May 5	Live on Mars (or Venus!)	5-ESS2-1	
	Friday, May 7	Gameshow review		

Class is taught live on the above dates at 10:00-10:45 a.m. Pacific / 1:00-1:45 p.m. Eastern time on the Science Mom YouTube channel. The livestreams are only accessible to registered attendees and scholarship recipients. The replays and recordings of the lessons are freely available and can can be found at https://science.mom/earthscience.

There are 5 art projects and 5 hands-on science activities that can be completed throughout this course. A complete supply list is available on the following page.

Have questions? Contact jenny@science.mom



Supply List for Friday Projects:

January 22 - Layers of Atmosphere

- Paper
- Art supplies for coloring (any type)
- Printed template (optional - found in the appendix of these notes)

January 29 - How do Planes Fly?

- Roll of tissue paper
- 3 ping pong balls
- 2 pencils OR a ruler OR another long straight object
- 4 Balloons
- String or yarn
- Paper “helicopter” toy (instructions in the appendix)
- A paper airplane (instructions in the appendix)
- Hair dryer (can substitute a straw if no hairdryer is available)

February 12 - Climate Zone Quadramas

- Cardstock
- Crayons or markers for coloring
- Scissors
- Gluestick or tape
- Printed template (found in the appendix)

Feb 19 - Mason Jar Biomes

- 2 mason jars and lids
- 1 disk of compressed coconut fiber OR 2 cups of potting soil
- ½ cup Gravel
- Food scraps from the kitchen
- 1 bright light that can be placed over one of the jars
- Small seeds such as Clover, alfalfa, or thyme

March 5 - Spaghetti Bridge

- A box of spaghetti noodles (can substitute angel hair and other long noodles also work)
- Tape OR Marshmallows
- A cup
- String or yarn
- A unit of weight such as coins, beans, or marbles

March 12 - Layers of Earth

- Paper
- Art supplies for coloring (any type)
- Printed template (optional - found in the appendix of these notes)

March 26 - Candy Rock Cycle

- Skittles or other round candy with a marking on one side (m&ms are a good substitute)
- Starbursts or other chewy candy that has different colors and will soften when warm
- Paper towel or plate
- Sidewalk chalk

April 9 - Moon Phases

- Cardstock
- A white crayon
- Watercolors or markers
- Printed template (found in the appendix)
- Sidewalk chalk

April 16 - Waves

- 1 lightweight blanket or sheet
- 3 pingpong balls
- 1 slinky

April 30 - Watershed Map

- Crayons or markers
- Printed Template (found in the appendix)

PLEASE NOTE: THE SUPPLY LIST IS SUBJECT TO CHANGE! SOME ADJUSTMENTS MAY BE MADE BEFORE THE FINALIZED LIST IS POSTED.

Why Earth Science?

Why study Earth Science? Well, Earth is the only place in our solar system where we find **living things**. The animals, plants, fungi, and single-celled organisms that call Earth home have one important thing in common; they each live in and depend on these four spheres:

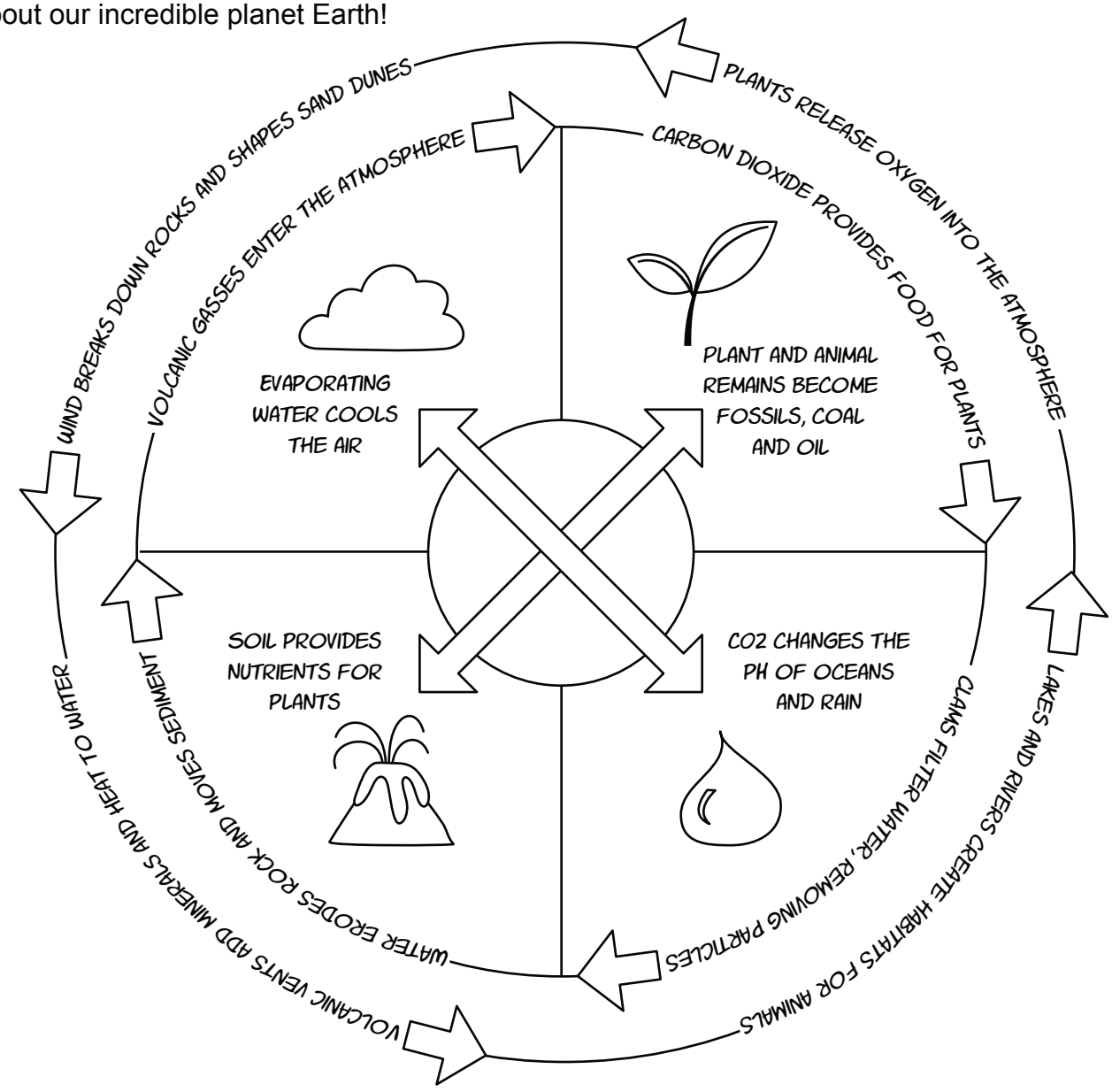

Atmosphere: all the air surrounding our planet


Lithosphere: all the rocks! The crust of our planet


Biosphere: all the living things on planet Earth


Hydrosphere: The water on, under, and above the surface of our planet

Each of these spheres interacts with the others in fascinating ways, and the study of these spheres and their interactions is called *Earth Science*. In this course, we're going to focus our attention on the atmosphere, lithosphere, and hydrosphere. We can't wait to show you more about our incredible planet Earth!



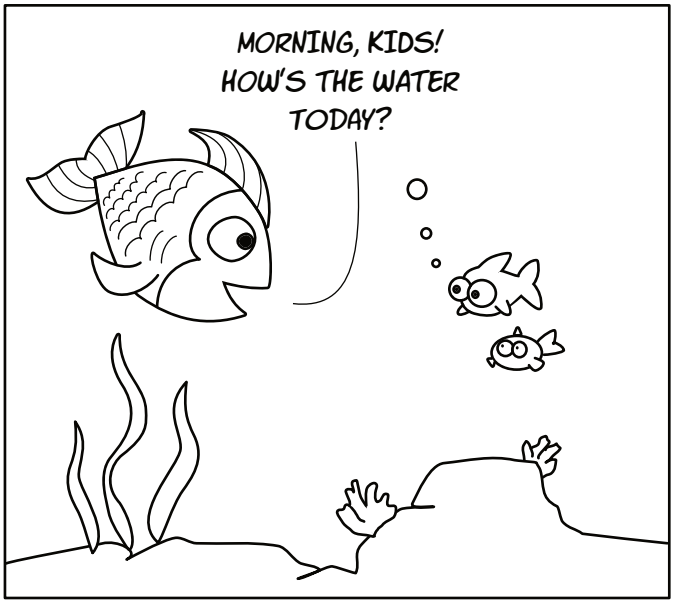
Part One:

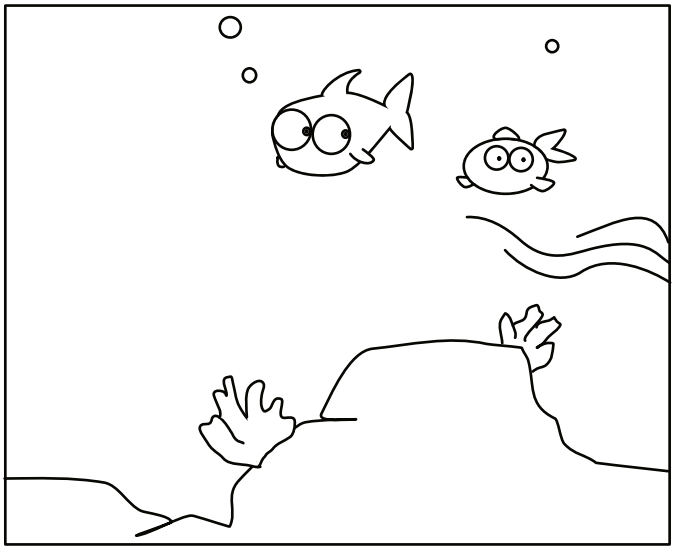
The ATMOSPHERE

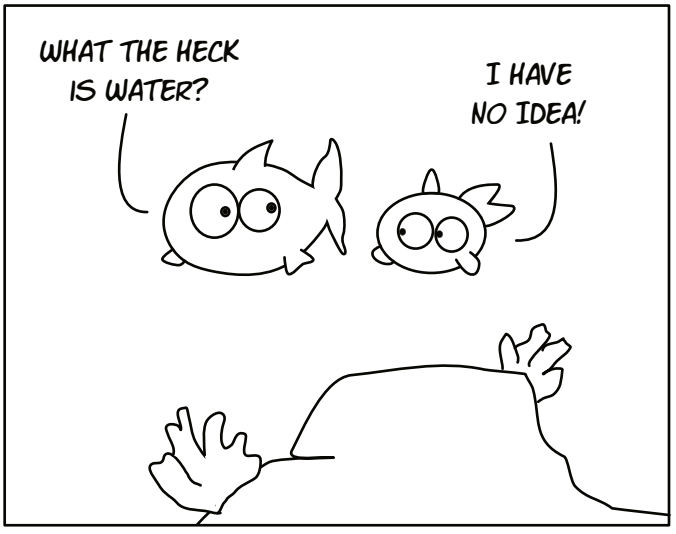
Have you ever felt sorry for a fish because it's trapped in a pond and can't walk around on land? Well, we live in air just like fish live in water, only we're too heavy to swim!

Just like a fish can't live without water, we can't live without air, which is a mixture of gases. The layer of gases surrounding a planet is called its atmosphere. Our atmosphere is important for more than breathing. It protects us from radiation, cycles nutrients and heat, and is the source of all our food.

Over the next several weeks, we'll learn exactly what it is that we're breathing and why it's so important for food, climate, weather, and life!







QUICK FACTS:

THE ATMOSPHERE IS MADE OF:

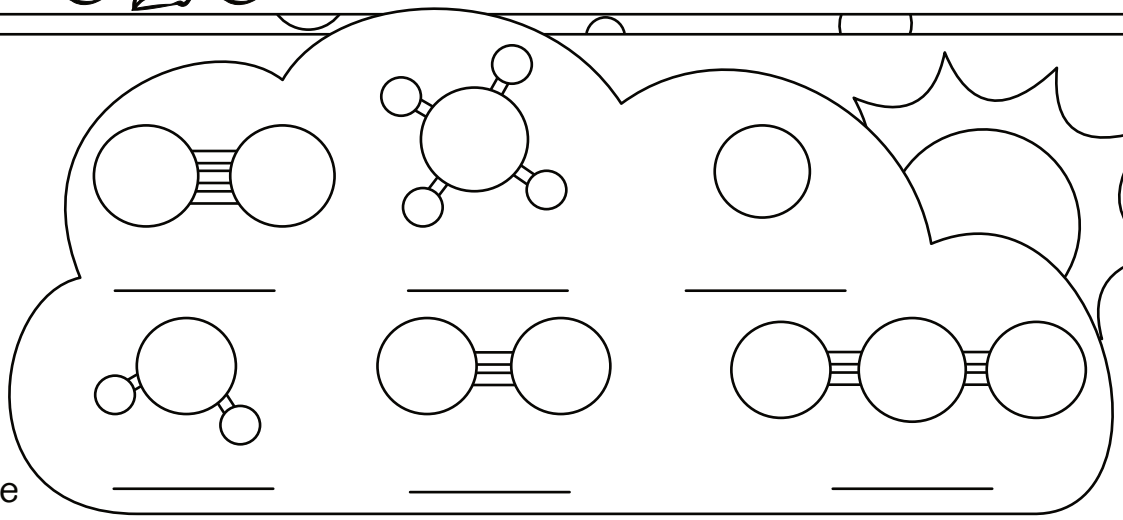
Nitrogen: 78%
Oxygen: 20.9%
Argon: 0.9%
Carbon Dioxide: 0.04%
Helium: 0.0005%
Methane: 0.0001%
Ozone: 0.00006%

At any given time there is a significant amount of ***water vapor*** in the air too. But since the amount of water is constantly changing, it isn't included in percentages of atmospheric gasses.

THE LAYERS ARE:

Troposphere: 1-12 km (1-7 miles)
Stratosphere: 12-50 km (7-31 miles)
Mesosphere: 50-80 km (31-50 miles)
Thermosphere: 80-700 km (50-440 miles)
Exosphere: 700-1,000 km (440-6,200 miles)

GASES of the ATMOSPHERE



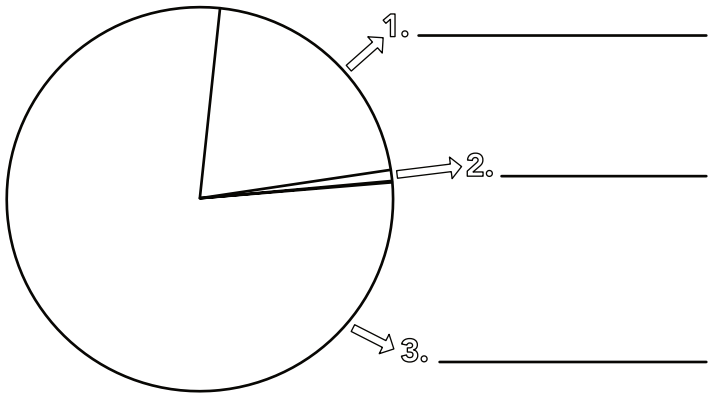
Chemical Formula

Name

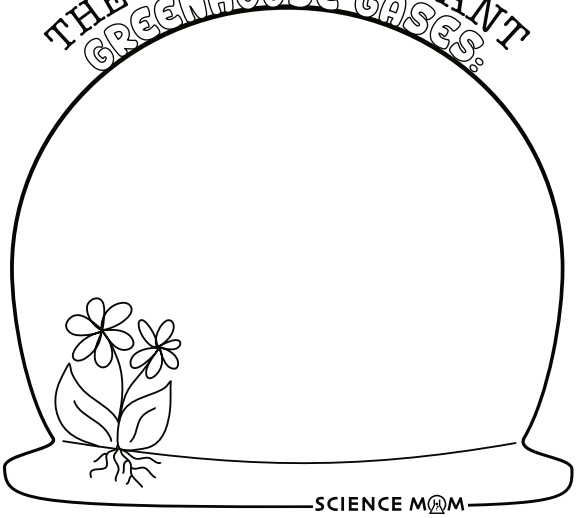
YOUR NOTES

Ar Argon	CH_4 Methane	O_2 Oxygen
CO_2 Carbon Dioxide	N_2 Nitrogen	H_2O Water Vapor

The 3 most abundant gases in the atmosphere:

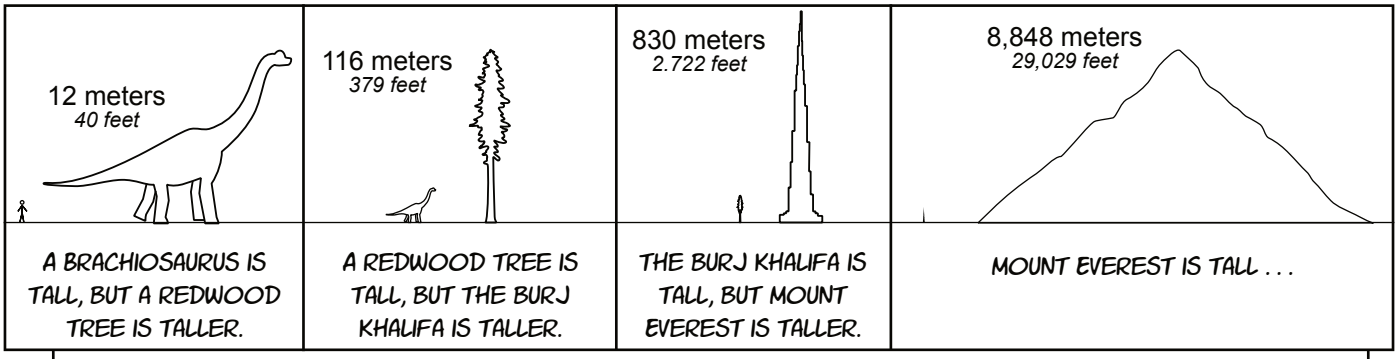


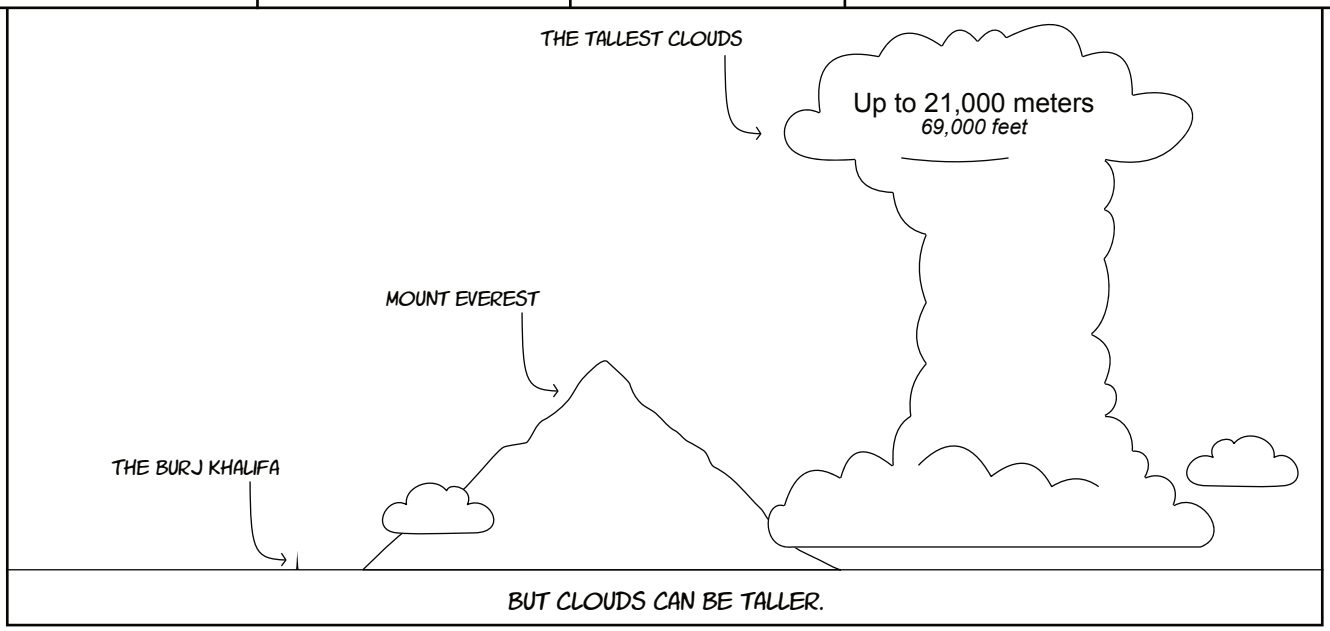
THE MOST IMPORTANT GREENHOUSE GASES:



How TALL is the atmosphere?

Compared to how tall we are, the atmosphere is incredibly tall!
Compared to how thick the Earth is, it's rather small.





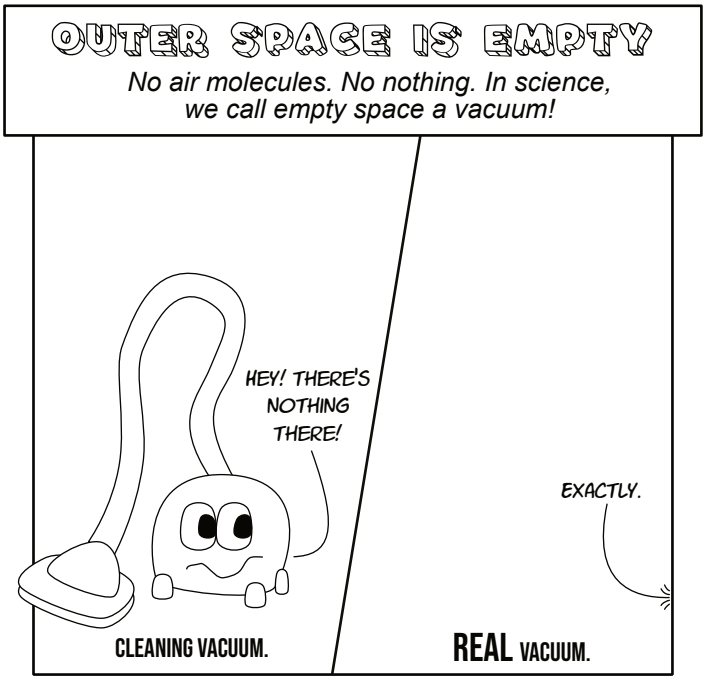
It's difficult to measure *exactly* where the atmosphere ends and outer space begins because the atmosphere doesn't have a "lid" or cap on top. The air just keeps getting thinner and thinner, until it's so thin that it acts and looks much like the emptiness of outer space.

The lowest layer of the atmosphere is called the *troposphere*. It's the warmest part of our atmosphere and where all our weather occurs.

The next layer is defined by the ozone layer, which protect our planet from harmful radiation. We call it the *stratosphere*.

The third layer is the *mesosphere*. When meteors enter our atmosphere and burn up, creating shooting stars, they are doing it in this layer.

The *thermosphere* and *exosphere* are the next two layers. The air molecules in these layers are so far apart, being in these layers feels similar to visiting the vacuum of outer space.



LAYERS of the ATMOSPHERE

500 km

90 km

50 km

40 km

30 km

OZONE LAYER

20 km

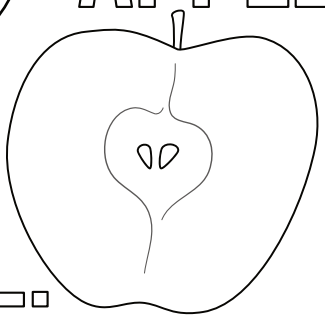
10 km

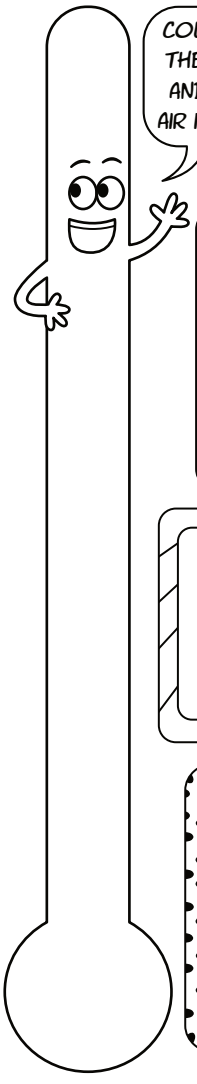
8 km

5 km

If our EARTH were the size of an APPLE

The **ATMOSPHERE** would only be as thick as THE PEEL.





When _____ enter the atmosphere they burn up, creating shooting stars. This happens in the _____.

Ozone is O_3 a molecule that absorbs harmful UV light. The ozone layer is in the _____.

All of our breathable air is in the _____. People can adapt to live anywhere from sea level to ___ km above sea level.

Layers of the ATMOSPHERE ART PROJECT

BUILD THE LAYERS, COLOR THEM WITH LETTER ART, OR BOTH. YOU CHOOSE WHICH PROJECT YOU WANT TO DO!

1 *Build the Layers*

Choose something for your "unit" and make sure you have at least 9 of them. It could be anything! Beans, pencils, pieces of licorice, lego blocks, books, or pieces of paper that are cut to be the same size.

Place 1 unit down for the troposphere.

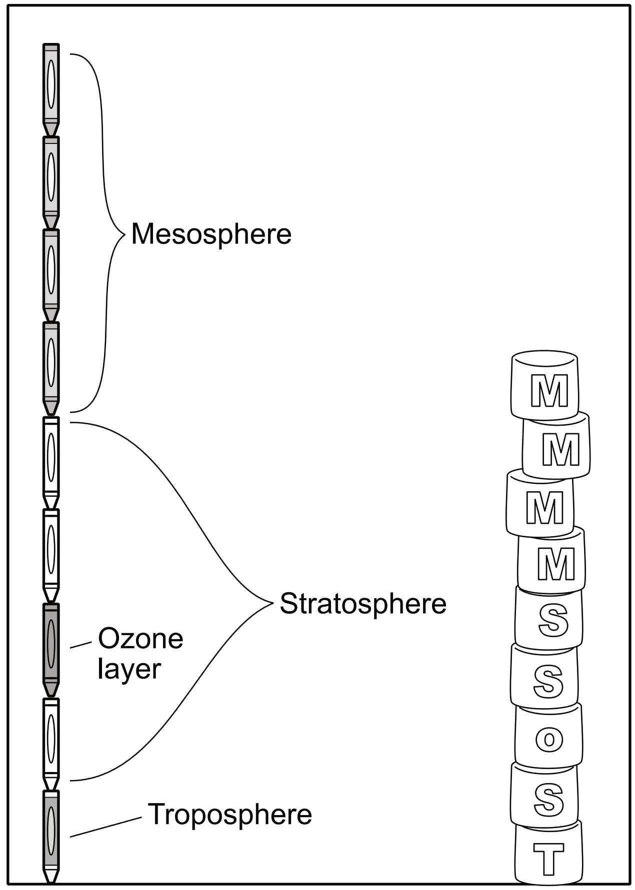
Place 4 units down for the stratosphere. The second of these units represents the ozone layer!

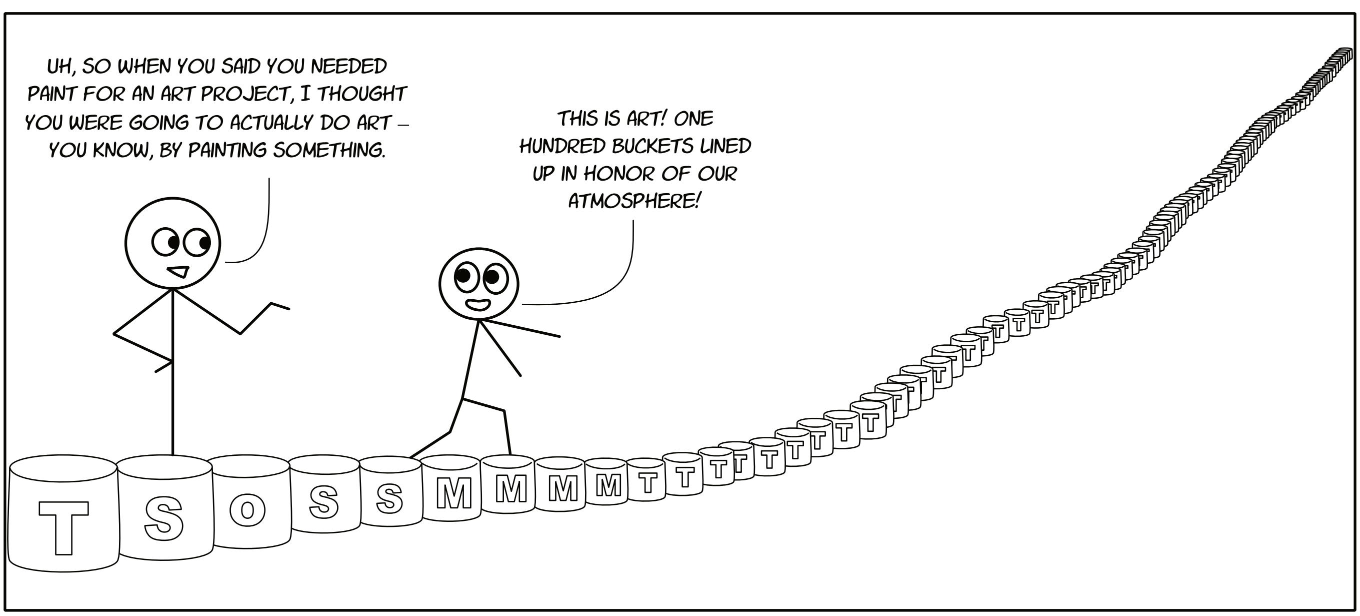
Place 4 more units down for the mesosphere*

Your atmosphere model is complete!.... - or is it? Figuring out where the atmosphere ends and outer space begins can be tricky, because the air just keeps getting thinner, and thinner, and thinner.

In the thermosphere and exosphere, there's more than a *kilometer* of space between air molecules. Since these layers act and feel a lot like the emptiness of outer space, sometimes they aren't included when we talk about the layers of the atmosphere.

If you'd like to include them in your model, you'll need FOURTY ONE additional units for the thermosphere and FIFTY more for the exosphere!





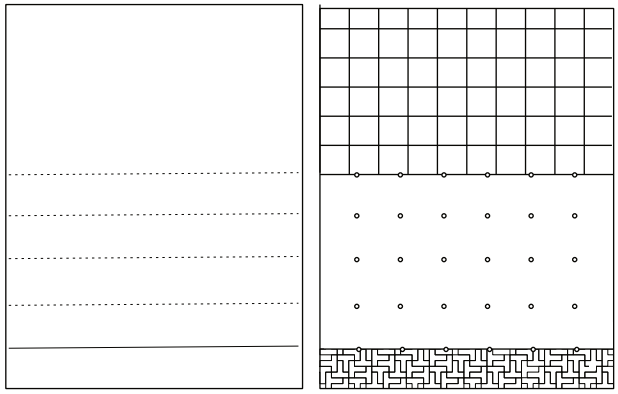
Layers of the ATMOSPHERE ART PROJECT

(2) *Art with Letters*

Print the Layers of Atmosphere template from the appendix OR create your own using a ruler by starting at the bottom and marking straight lines across the paper at approximately the following heights:

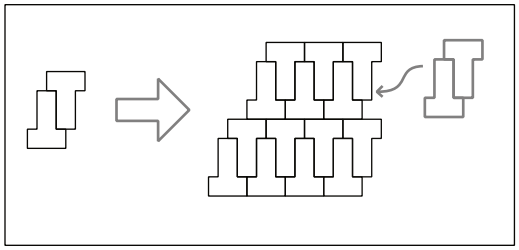
Draw 4 more lines (lightly) every 3.3 cm or 1¼ inches above the first line (these are the stratosphere. The ozone layer will be between the 1st and 2nd of these lines)

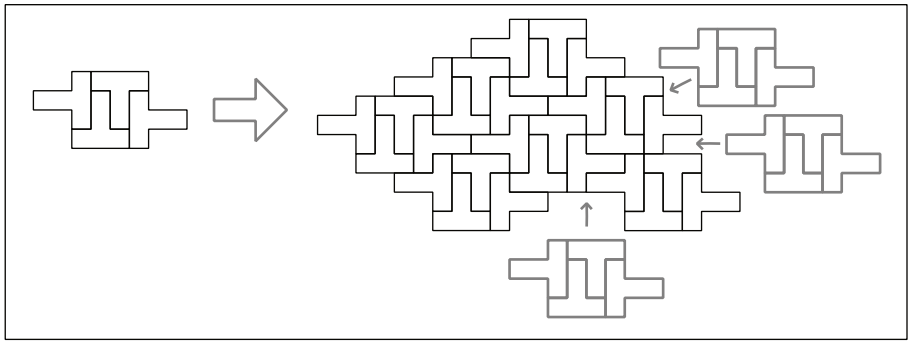
3.3 cm/1¼ in from bottom (represents top boundary of troposphere)



TROPOSPHERE LAYER

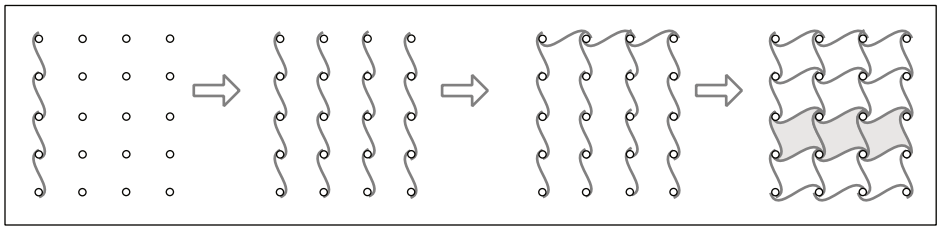
The troposphere layer in the template is decorated with a *tessellation* of the letter T. A tessellation is a repeating pattern with no overlaps and no gaps. You can make your own by repeating this basic shape of 2 letters, or 4 letters:

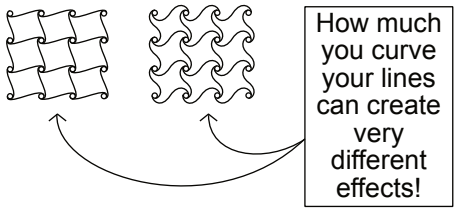




STRATOSPHERE LAYER

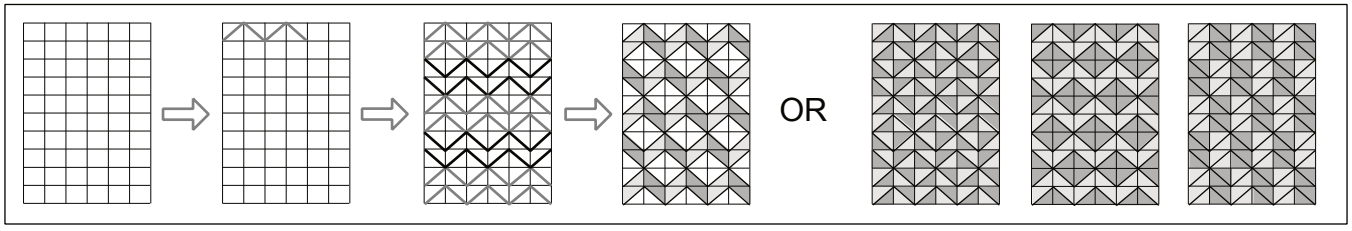
Make a grid of dots or circles on the 4 parallel lines and then connect the dots with the letter s. Then color the second row a different color for the ozone layer!





MESOSPHERE LAYER

Make a grid of parallel lines and then draw the letter M in between them, connecting the corners. If you shift every two lines over, then you'll end up with a pattern that can be shaded to look three dimensional! This is rather appropriate, since the air molecules in the mesosphere are spread VERY far apart. Of course, you can color yours any way you'd like!



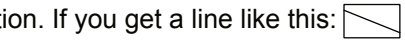
This page is optional.

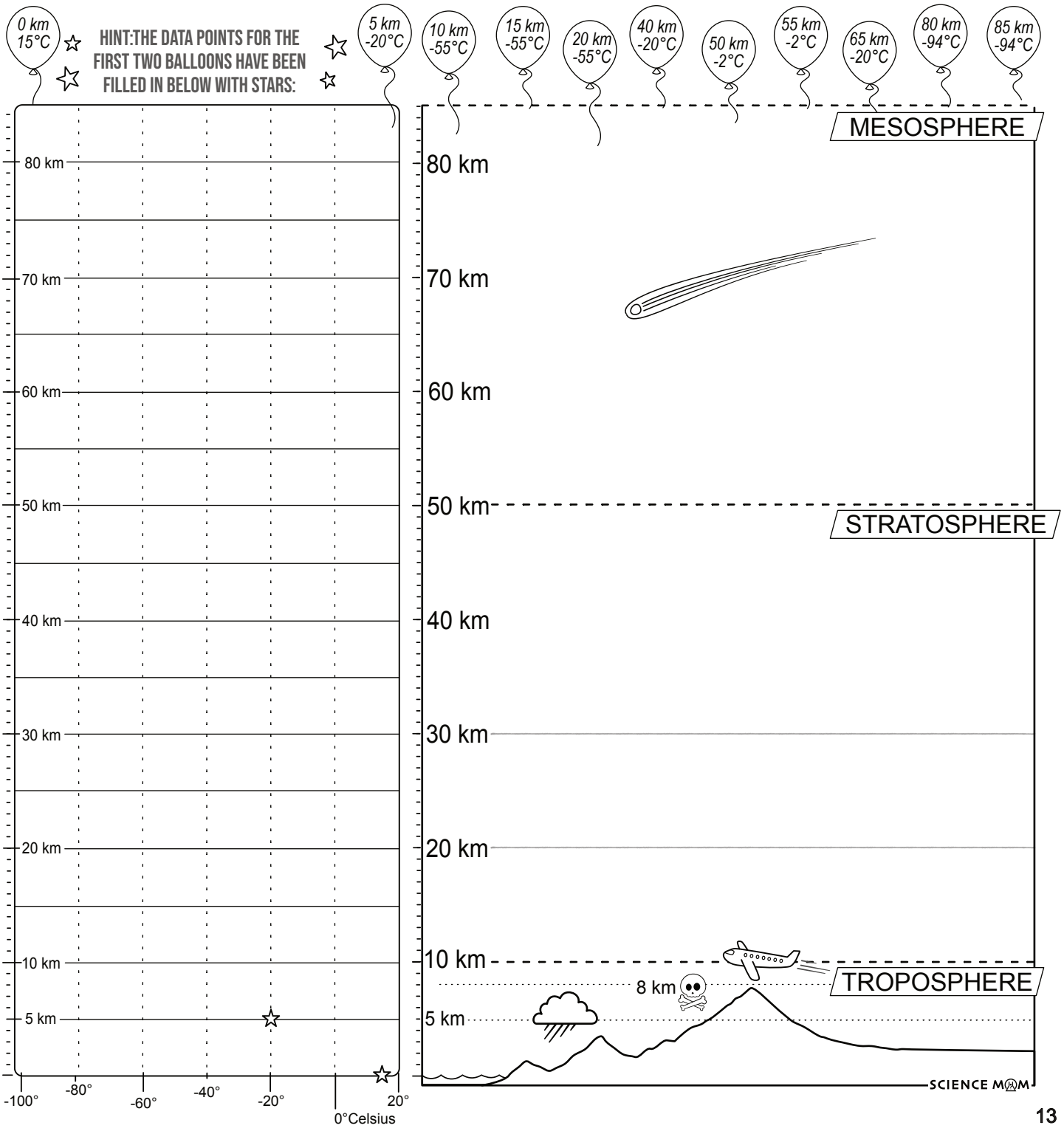
YOU CAN SKIP IT!

COMPLETELY OPTIONAL!

IT CONTAINS THE ANSWER TO WHY THE ATMOSPHERE EVEN HAS LAYERS!

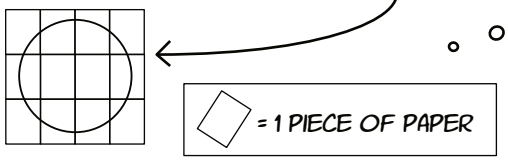
Graph the temperature of the atmosphere

Hot air rises, so you might think that the air would keep getting warmer and warmer the higher you go. But don't forget that outer space is really cold! Each of the balloons below has a measurement. Put these data points on the graph and draw a line between them to discover how temperature changes with elevation. If you get a line like this:  that means the air is getting colder the higher you go. If the line looks like this:  then the air is getting warmer with higher elevation.



How clouds are made

Most clouds are made of incredibly small droplets of water. These droplets are between 0.001 mm and 0.05 mm in size. Raindrops are 0.05 mm and larger, which is MUCH bigger than a water droplet. If the circles you see all around these words were water droplets, then THIS would be the size of a raindrop. To draw a raindrop at this scale, you'd need 12 pieces of paper!



FILL IN THE BLANKS USING THESE WORDS:

gas	water	humidity	precipitation
float	condenses	merge	vapor

When water evaporates it turns into a _____ called _____ _____. The amount of water vapor in the air is called _____. When water _____ it changes from a gas into a liquid. Clouds are made from water droplets so small that they can _____ in air. If enough water droplets collide with each other, they can _____ to form a raindrop. Raindrops are too heavy to float, so they fall from the sky. This is called _____.

THE WATER CYCLE SONG

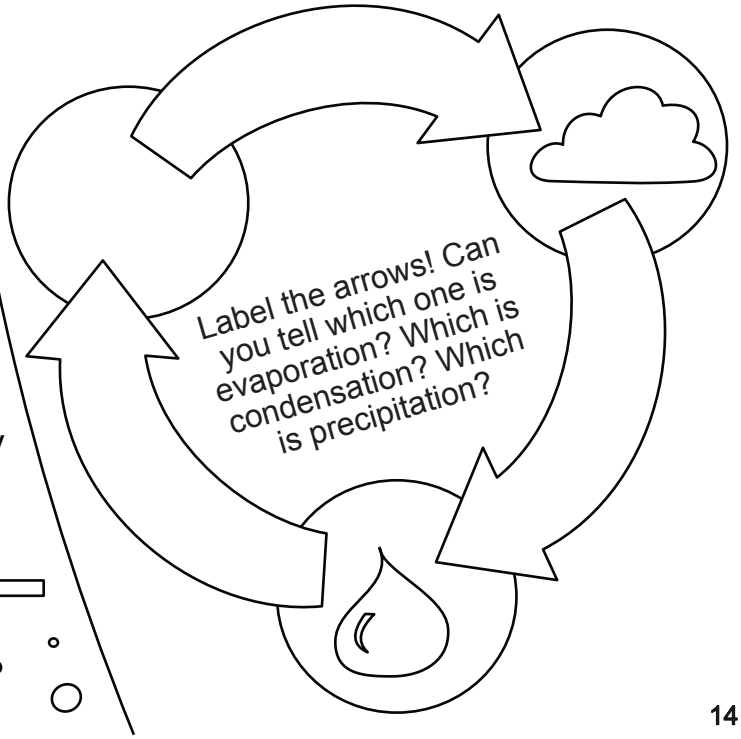
Sung to the tune of La Cucaracha. Best when performed with hand actions!

Evaporation,
Raise hands in a wavy motion
Condensation,
Clap hands together up high
Precipitation's when it rains,
Bring hands down low
The water goes round
Move hands in a circle
From cloud to wet ground
Move hands from high to low
That's the water cycle song!
Clap three times when done!

CLOUD IN A BOTTLE DEMONSTRATION

Will the cloud appear or disappear?

Increasing the pressure makes the cloud _____.
Decreasing the pressure makes the cloud _____.

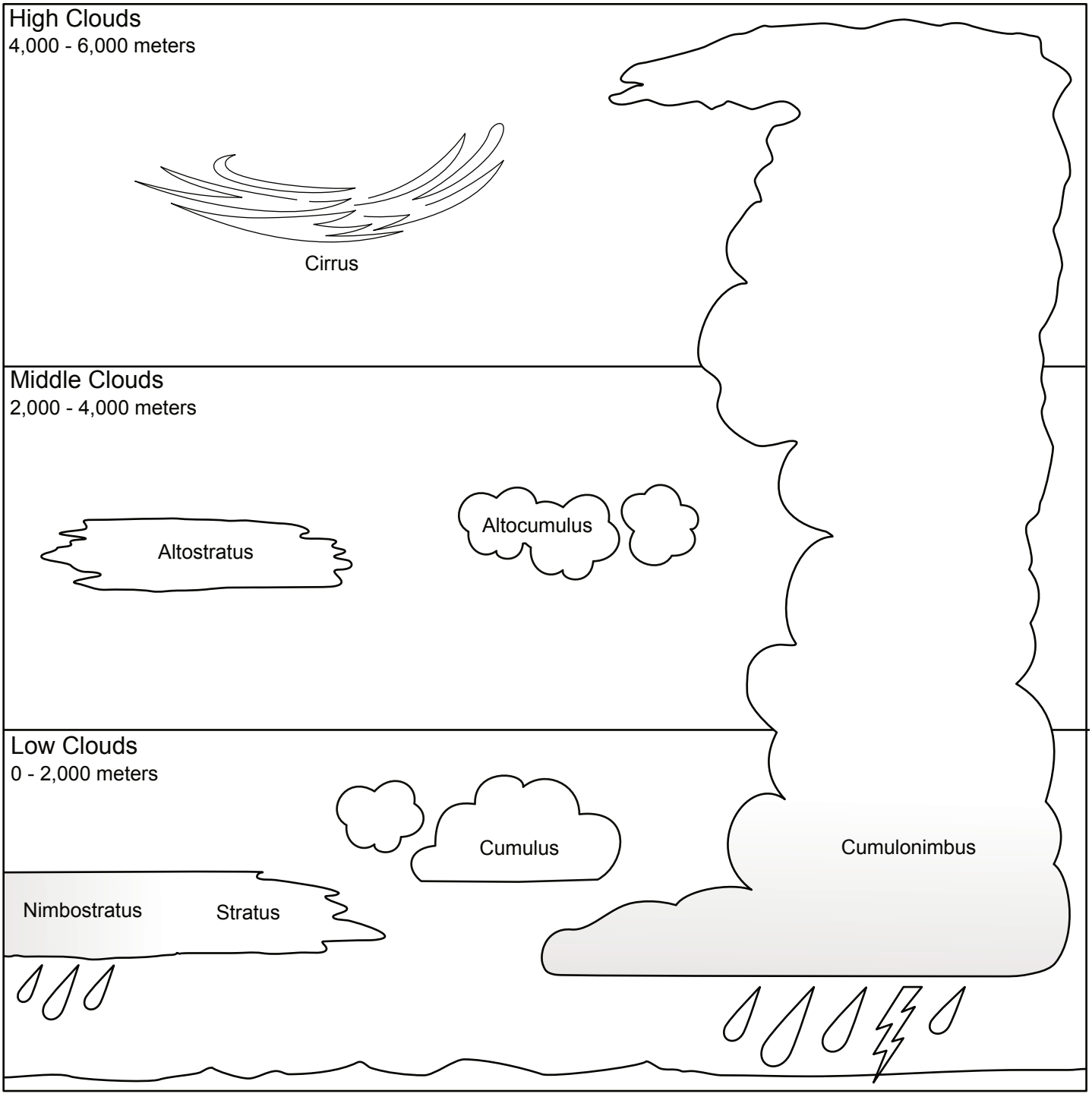


Types of clouds

CAN YOU USE THE CLUES FROM THE PICTURE BELOW TO FILL IN THE BLANKS USING THESE WORDS?

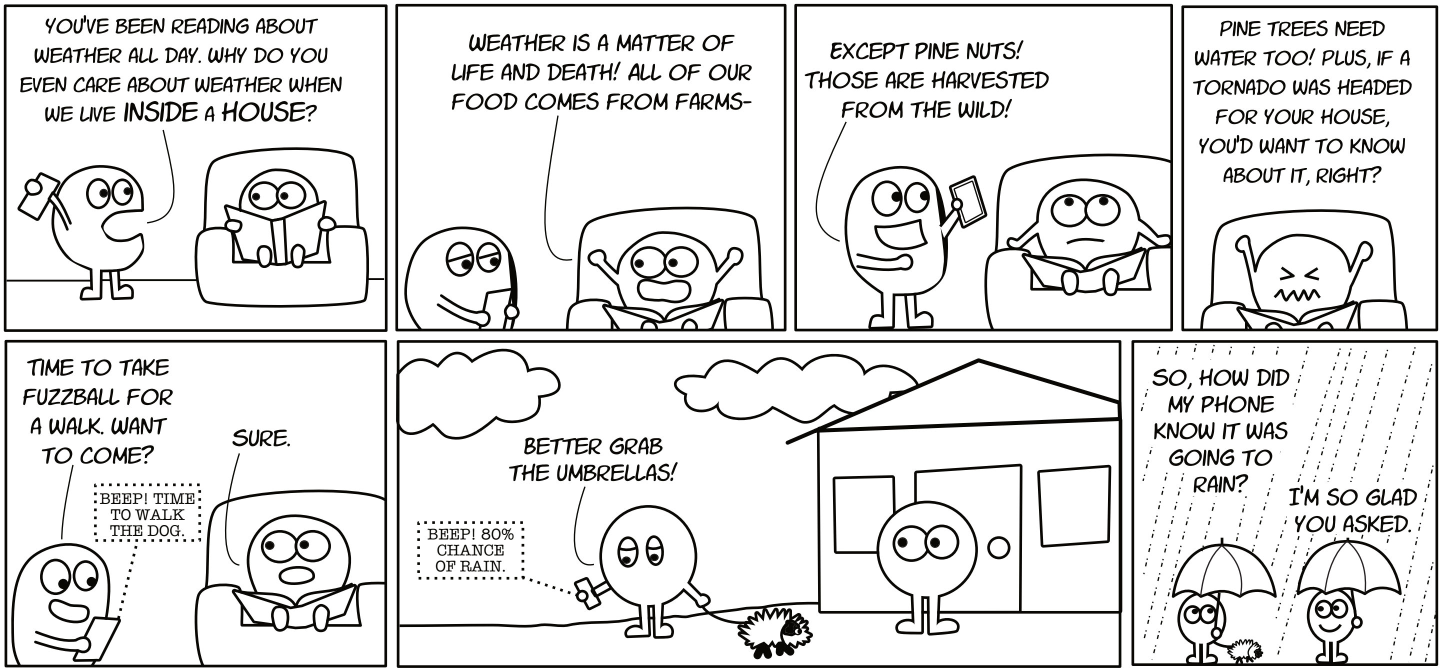
stratus	cumulus	
nimbo	alto	cirrus

The names of clouds come from latin root words. In latin, the word _____ means rain. _____ means a heap or pile. _____ means to extend, spread out, or cover with a layer. _____ means high or upper air, and the word _____ means a lock of hair or a tuft of horsehair.



About the Weather

Two Globs and a Dog - *by Science Mom*



YOUR DOODLE SPACE

Draw your favorite type of weather below, then see if a family member or friend can guess what it is! Is their favorite kind of weather the same as yours?

Your notes: ______________________________

____

____

____

____

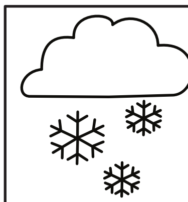
____

____

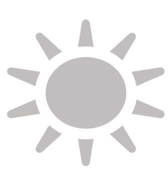
____

What types of measurements will you find with which type of weather? Take a guess by checking the boxes here, then spend some time observing the weather forecast and see if you notice a pattern!

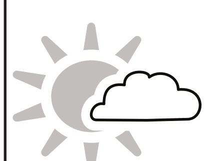
- ☐ *HIGH PRESSURE*
- ☐ *LOW PRESSURE*
- ☐ *HIGH HUMIDITY*
- ☐ *LOW HUMIDITY*



- ☐ *HIGH PRESSURE*
- ☐ *LOW PRESSURE*
- ☐ *HIGH HUMIDITY*
- ☐ *LOW HUMIDITY*



- ☐ *HIGH PRESSURE*
- ☐ *LOW PRESSURE*
- ☐ *HIGH HUMIDITY*
- ☐ *LOW HUMIDITY*



- ☐ *HIGH PRESSURE*
- ☐ *LOW PRESSURE*
- ☐ *HIGH HUMIDITY*
- ☐ *LOW HUMIDITY*

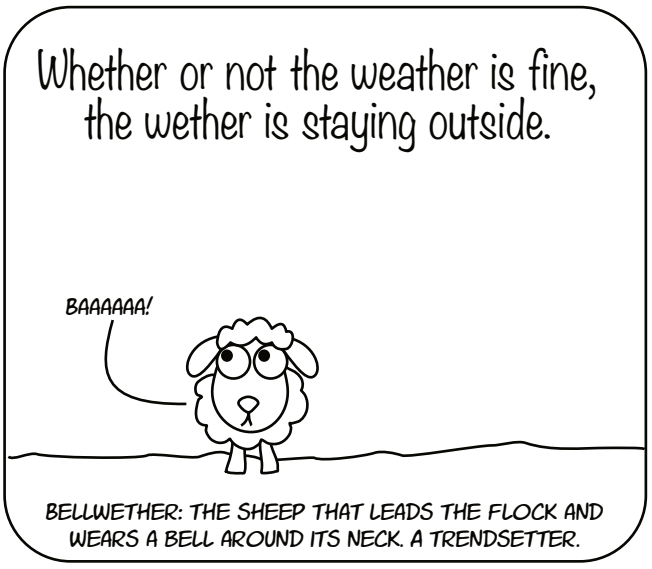
Making a Forecast

To predict the weather, you need to know where the wind is blowing from and what it's bringing with it. Scientists who study weather (meteorologists) make their predictions by measuring the cloud cover, temperature, humidity, barometric pressure, and wind.

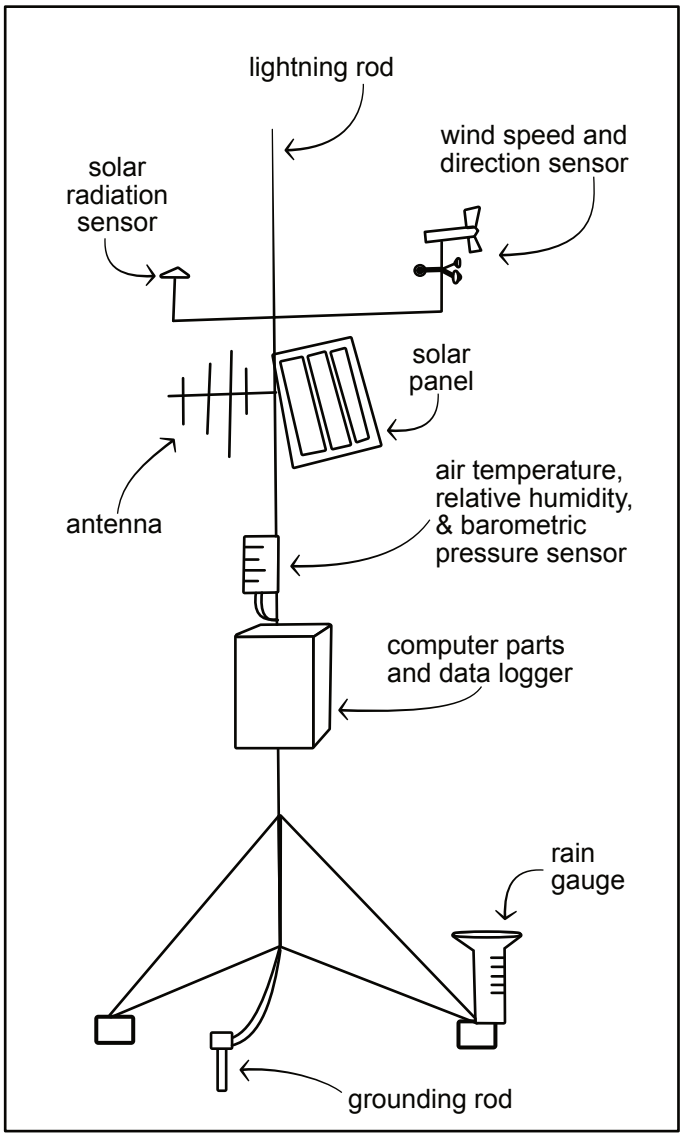
If they gather this information for a large enough area, then they can use models to predict the weather for the next 10 days. But how do you measure the temperature over 500 miles of desert, or the wind that's blowing over an entire prairie?

There are two important ways scientists gather the information they need to predict the weather: from weather stations and satellites.

Then, once they have all of their data, they use computer models to predict what weather will happen next.



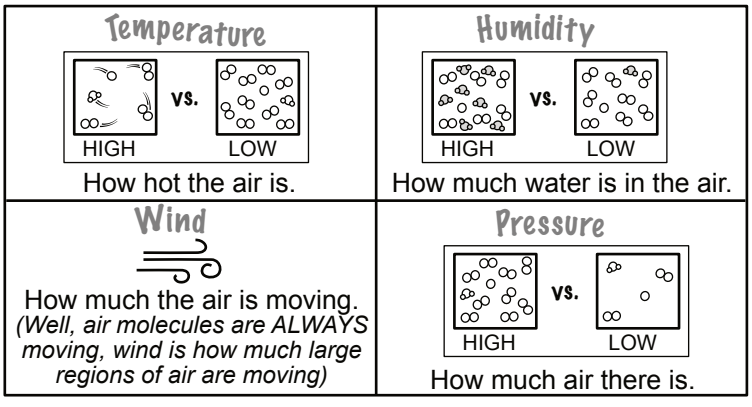
A MODERN WEATHER STATION



FILL IN THE BLANKS USING THESE WORDS:

thermometer	anemometer	meter
barometer	hygrometer	

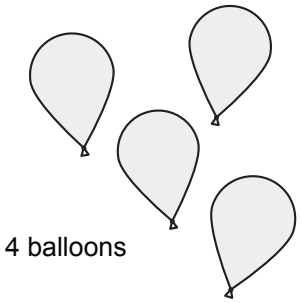
An _____ measures wind speed and direction. Air pressure is measured using a _____. To measure the temperature, use a _____. To measure humidity, a _____ is the tool you'll need. You might have noticed that each of these tools contain the word _____ which means "to measure." A good weather station will have all of these instruments, plus measure cloud cover and rainfall!

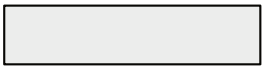


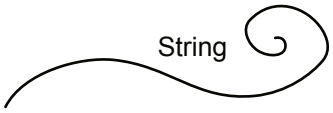
Hands-on Activity

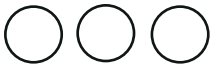
HOW DO AIRPLANES FLY?

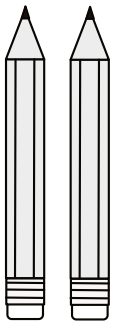
MATERIALS:

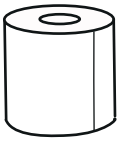

4 balloons


Tape

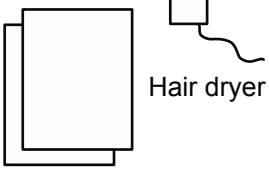

String


3 Ping Pong balls


2 pencils/something on which to tie the balloons


Roll of toilet paper


Paper clip


Hair dryer

2 sheets of paper

Does air have weight?

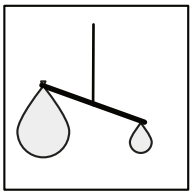
1: Attach 2 empty balloons to the pencil with tape
2: Suspend the pencil from string so that it is balanced
3: Carefully remove one balloon, blow it up and reattach it in the same place
4: Circle your prediction
5: Draw what happened

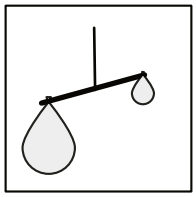
How did your predictions differ from your results?

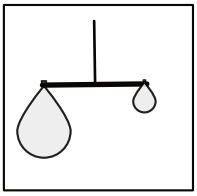
_____

_____

Will the inflated balloon be...


Lighter?


Heavier?


Weigh the same?

Draw what you see!

What does wind do?

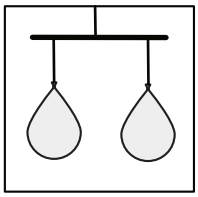
1: Use the balloons from your previous experiment again, but blow up both of them
2: Attach string to each
3: Suspend the balloons so they are about ten cm (4 inches) apart
4: Circle your prediction
5: Blow air between the balloons and observe how they move!
6: Draw your results

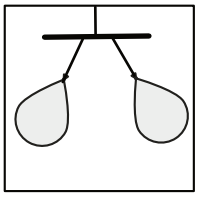
How did your predictions differ from your results?

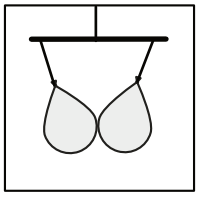
_____

_____

When the wind blows, will the balloons...


Stay the same?

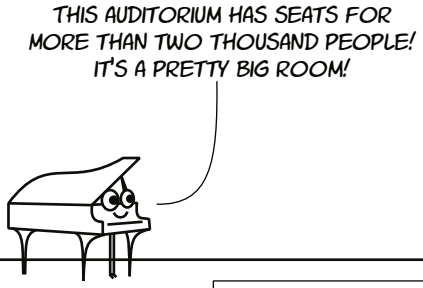

Push apart?


Push together?

Draw what you see!

YOUR DOODLE SPACE

If there is only a piano in Carnegie Hall, is the room empty? Nope. The room is full of air! But ***how much does the air weigh?*** *Write down a guess below. Then draw the kind of music you'd play if you got to perform!*



HOW MUCH DOES THE AIR WEIGH? YOUR GUESS:

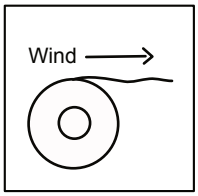
THE ACTUAL AMOUNT:

Tissue Trouble

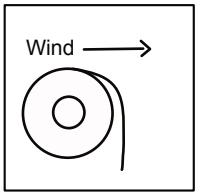
1: Circle your prediction
2: Hold a tissue roll so that it will unravel away from you
3: Use your breath to blow over the top of the roll
4: Draw your results
5: (Optional) Try it with the hair dryer!

How did your predictions differ from your results?

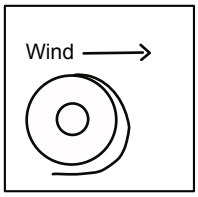
When you blow over the top of a tissue roll, will it...



Lift up?



Stay the same?



Curve around?

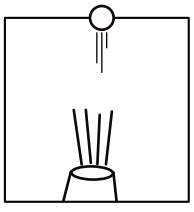
Draw what you see!

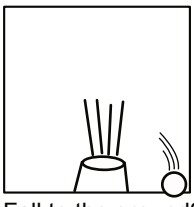
Ping Pong Ball + Hair Dryer

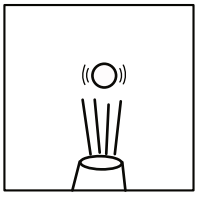
1: Circle your prediction
2: Plug in your hair dryer and turn it on
3: Carefully place your ball a few inches Above the air stream and let go.
WARNING: Air from a hair dryer can get very hot! If your hair dryer has a "cool shot" button, use it! If it does not have a cool button, be sure not to leave it on too long and don't touch the top of the dryer because it will get hot!
4: Observe how the ball behaves
5: Draw what happened

How did your predictions differ from your results?

When you put a ping pong ball over a hair dryer, will it...


Shoot into the air?


Fall to the ground?


Hover in place?

Draw what you see!

Air at an angle

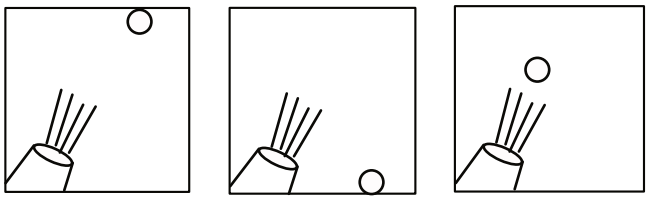
1: Circle your prediction
2: Plug in your hair dryer and turn it on
3: Carefully place your ball over the air stream. ***WARNING: Air from a hair dryer can get very hot! If your hair dryer has a "cool shot" button, use it! If it does not have a "cool air" button, be sure not to leave it on too long and don't touch the top of the dryer.***
4: What happens when you gently tip the dryer to the side?
5: Draw what happened

Did your predictions differ from your results?

_____

_____

If the hair dryer is tipped, will the ball...



Shoot into the air? Fall to the ground? Continue hovering?

Draw what you see!

Two or three at once!

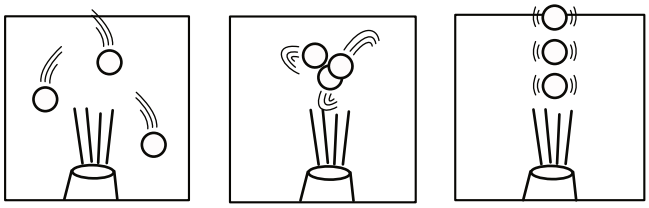
1: Circle your prediction
2: Dent one of the ping pong balls by gently stepping or pushing on it
3: Plug in your hair dryer and turn it on
4: Carefully place your ball over the air stream ***WARNING: Air from a hair dryer can get very hot! If your hair dryer has a "cool shot" button, use it! If it does not have a "cool air" button, be sure not to leave it on too long and don't touch the top of the dryer, it will be hot!***
5: Draw what happened

Did your predictions differ from your results?

_____

_____

If multiple balls are in the air, will they ...



Fall to the ground? Do a crazy dance? Hover in place?

Draw what you see!

A Dented Ping Pong Ball

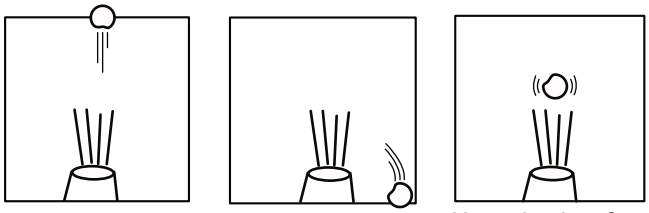
1: Circle your prediction
2: Dent one of the ping pong balls by gently stepping or pushing on it
3: Plug in your hair dryer and turn it on
4: Carefully place your ball over the air stream ***WARNING: Air can get very hot! If your hair dryer has a "cool shot" button, use it! If it does not have a "cool air" button, be sure not to leave it on too long and don't touch the top of the dryer because it will be hot!***
5: Draw what happened

Did your predictions differ from your results?

_____

_____

If a ping ball is dented, will it ...



Shoot into the air? Fall to the ground? Hover in place?

Draw what you see!

Flying Balloons?

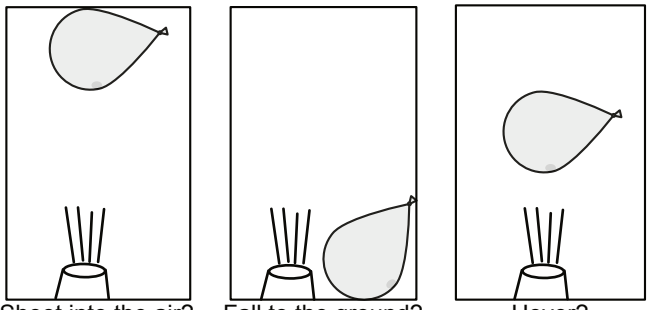
1: Circle your prediction
2: Place a penny, raisin, or peanut in a balloon and then inflate the balloon and tie it off
3: Carefully turn on the hair dryer and place the balloon over the air stream. ***WARNING: Air from a hair dryer can get very hot and hot air will pop the balloon! If your hair dryer has a "cool shot" button, use it! If it does not have a "cool air" button, be sure not to leave it on too long and don't touch the top of the dryer.***
4: Draw what happened

Did your predictions differ from your results?

_____

_____

If a balloon with weight is placed over a dryer, will it...



Shoot into the air? Fall to the ground? Hover?

Draw what you see!

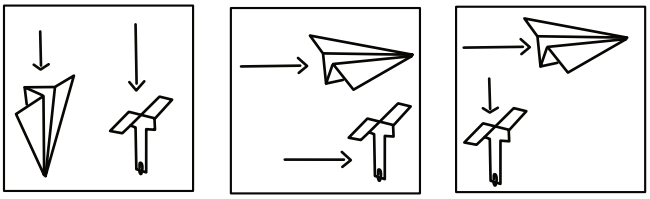
Helicopter vs Plane

1: Build your helicopter and plane. See appendix if you would like directions
2: Circle your prediction
3: Toss your helicopter and plane from a height
4: How do their flight patterns differ?
5: Draw your results

Did your predictions differ from your results?

_____

When both are dropped will they...



Fall? Glide? Differ?

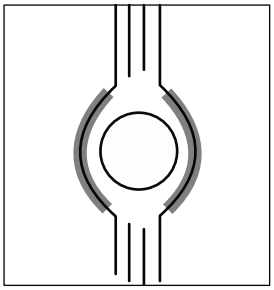
Draw what you see!

NOTES ABOUT LIFT AND PRESSURE

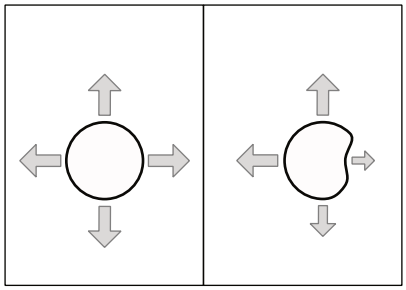
_____

_____

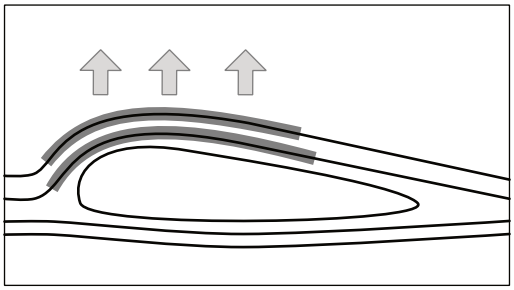
_____



When fast moving air meets the ping pong ball, it **speeds up** to go around the ball.



Faster air = lower pressure. The lower pressure pulls evenly in all directions on a round ball, but unevenly on a dented ball.

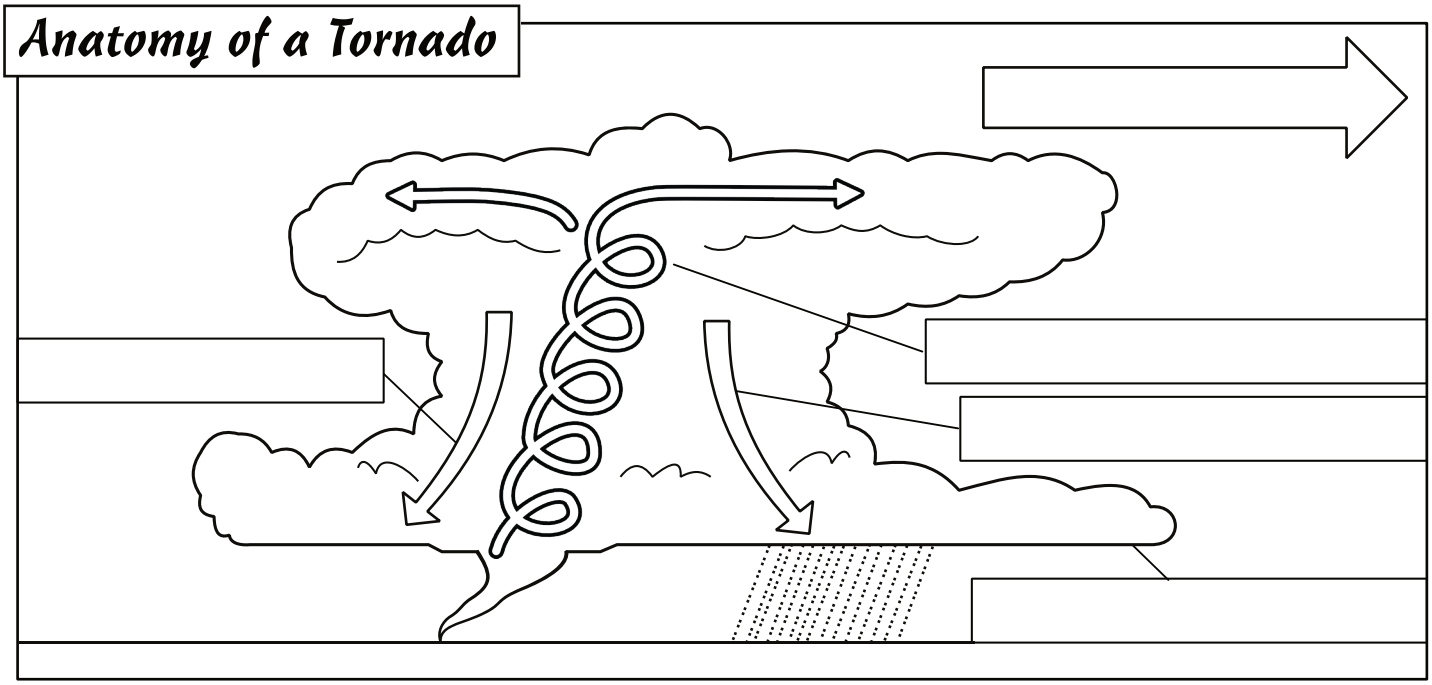


Air moves faster over the curved surface of a wing, and the low pressure provides lift.

SEVERE STORMS

ALL ABOUT TORNADOS + HURRICANES / TYPHOONS

Anatomy of a Tornado

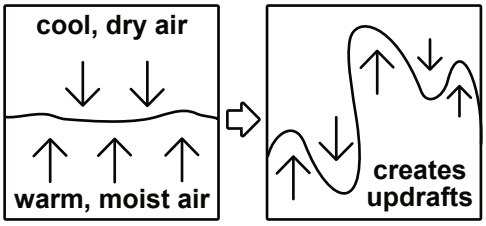


FILL IN THE LABELS ABOVE USING THESE WORDS:

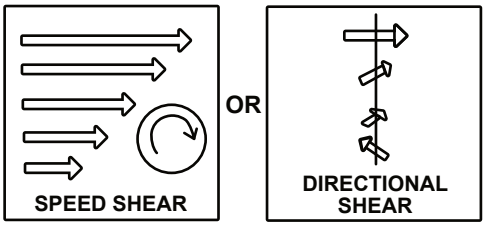
STORM DIRECTION | MESOCYCLONE | FORWARD FLANK DOWNDRAFT | SHELF CLOUD | REAR FLANK DOWNDRAFT

THE THREE MAIN INGREDIENTS OF A TORNADO

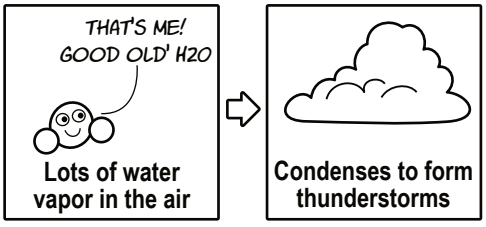
1. INSTABILITY



2. WIND SHEAR

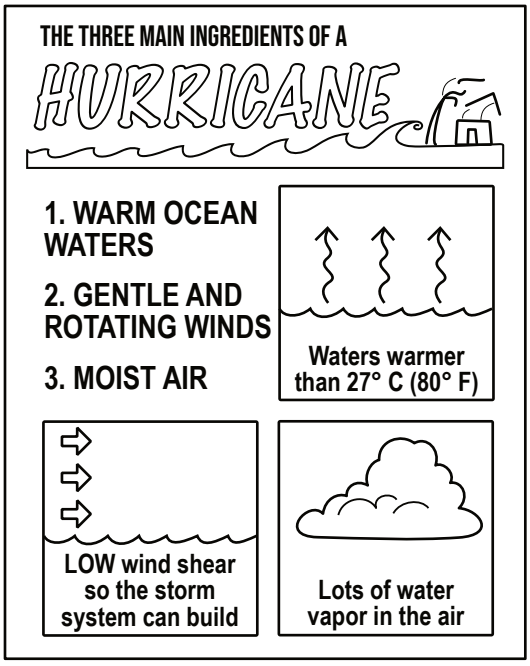


3. MOISTURE

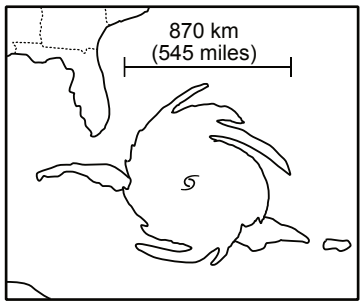


Your notes:

Your notes:



Tropical Cyclones are usually called HURRICANES if they form in the Atlantic or Northeastern Pacific, and TYPHOONS if they occur in the Northwest/ South Pacific. They are huge storm systems, ranging from 100 to 2,000 kilometers across!



THE SAFFIR-SIMPSON SCALE

Describes how severe a storm is expected to be.

63-118 km/h	119-153 km/h	154-177 km/h	178-208 km/h	209-251 km/h	252+ km/h
34-73 mph	74-95 mph	96-110 mph	111-129 mph	130-156 mph	157+ mph
TROPICAL STORM	1	2	3	4	5
	HURRICANE				

Anatomy of a Hurricane