

atmosphere

thermosphere

stratosphere

troposphere

mesosphere

exosphere

STEM ACTIVITY:

Where in the Air Classroom
Activity Educator Guide

OVERVIEW

In this lesson, students learn about the layers of the atmosphere as well as what things can be found in each layer.

Objectives

Students will be able to:

- Identify the layers of the atmosphere, including their location relative to the other layers
- Determine in which layer of the atmosphere different objects can be found

Standards

Next Generation Science Standards

Disciplinary Core Ideas

- MS-ESS2 Earth's systems

Crosscutting Concepts

- Systems and system models

Science and Engineering Practices

- Developing and using models

Preparation

- Print out a worksheet for each student and enough informational sheets so each student will get a copy of the sheet describing their group's object.
- The object descriptions in the informational sheets vary in complexity, allowing reading variation for students.

Materials

- Worksheet – one per student
- Informational sheets – one per group or student

Other Resources

“Earth's Atmospheric Layers” diagram, available at:
https://www.nasa.gov/mission_pages/sunearth/science/atmosphere-layers2.html

Steps

1. Use a warm-up or other method to teach (or review) the layers of the atmosphere. A search of the internet will provide you with many possible activities or videos that can be used to engage students. This information can be presented in conjunction with Earth's other spheres (cryosphere, hydrosphere, biosphere, etc.).
2. Divide the students into groups of two or three. Or, depending on class size and composition, students can work as individuals instead of in small groups.
3. Assign each group an object to research and become "experts" on. Give each member of the group a copy of the informational sheet (in the student guide) which describes their object. Groups can be assigned a second object if they complete the first one. Alternatively, students can access the student guide digitally.
4. Part 1 of the worksheet helps students gather information about their assigned object, which will then be shared with the class. This part of the worksheet should be completed by the student groups as they read the informational sheet(s) assigned to their group.
5. To complete part 2 of the worksheet, each group presents the researched information for their object. As the information is shared, other students in the class should fill in this information on their own worksheet.
6. Once completed, part 2 of the worksheet provides students with the necessary information to complete the atmospheric diagram (part 3 of the worksheet).
7. Students should individually complete part 3 of the worksheet using the information shared with them.

ANSWER KEY

“Where in the Air?” Student Worksheet

PART 1

Answers will vary

PART 2

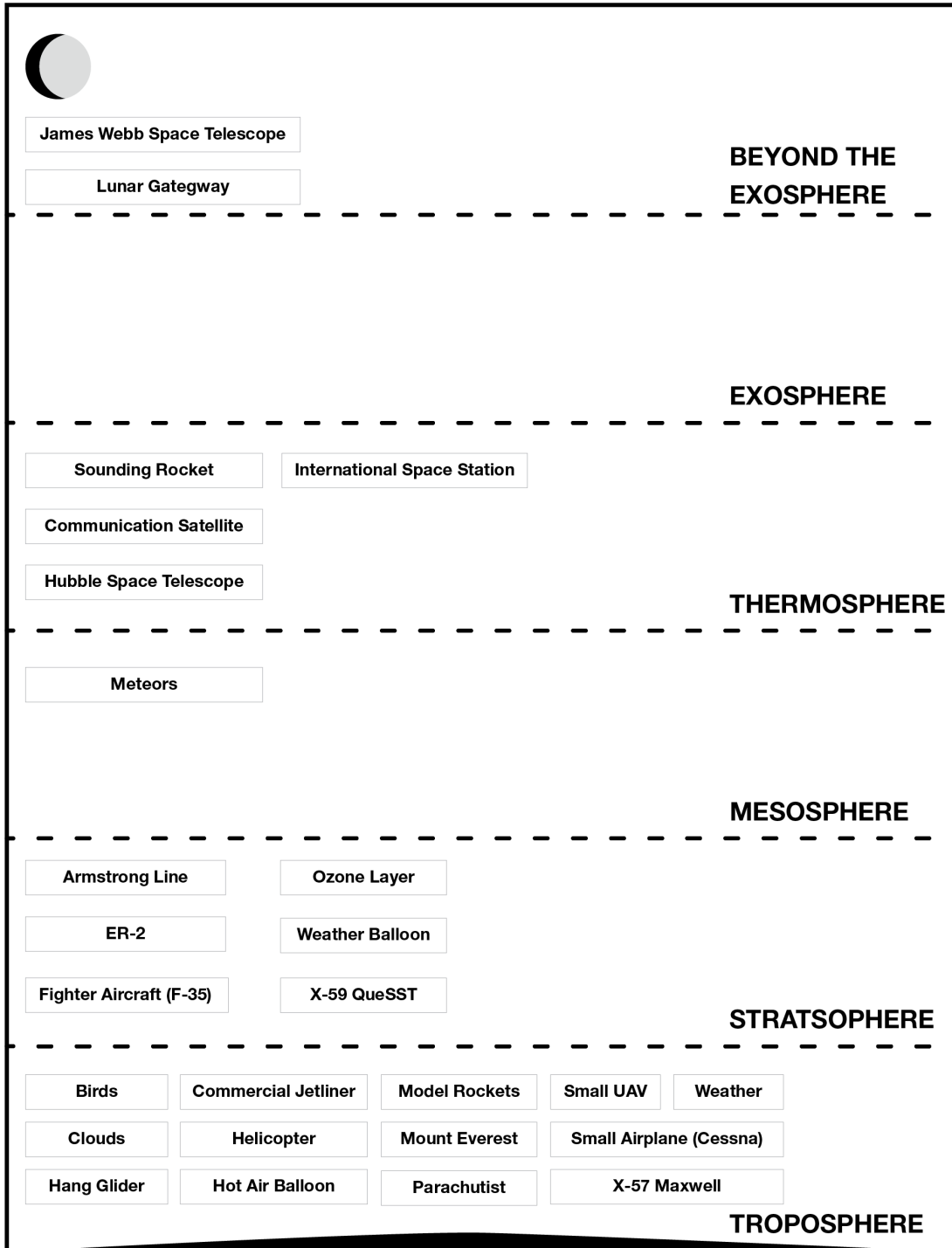
Now that you know about one object found in Earth’s atmosphere, it’s time to learn about other objects. Other groups have been busy learning about these other objects. As they share information about their object, write down what they teach you. Make sure you also fill in the information about your object! There may be some objects on the list that are not covered.

OBJECT	ALTITUDE	LAYER OF THE ATMOSPHERE	EXPLAIN ABOUT THE OBJECT – WHAT IS IT? WHAT IS ITS FUNCTION? (etc.)
1. Armstrong Line	62,000 ft (19 km)	Stratosphere	It’s the altitude at which liquids boil at human body temperature. A full pressure suit is needed at this height
2. Birds	500-29,000 ft (0.15–8.8 km)	Troposphere	Birds fly at different altitudes depending on their size and destination.
3. Clouds	0-60,000 ft (0–18 km)	Troposphere & Lower Stratosphere	Clouds are masses of liquid/solid water floating in the air. Different types are at different altitudes.
4. Commercial Jetliner	32,000–39,000 ft (9.8–11.4 km)	Troposphere	They carry passengers and cargo over long distances. They fly high enough that oxygen is needed.
5. Communication Satellite	100–22,000 miles (160–36,000 km)	Thermosphere & Exosphere	They receive, amplify, and transmit electronic signals to allow communication over long distances.
6. ER-2	65,000–70,000 ft (20–21 km)	Stratosphere	They serve as platforms for high altitude science missions because they can fly slow and high.
7. Fighter Aircraft (F-35)	60,000 ft (18 km)	Stratosphere	They are very fast and maneuverable. Pilots need g-suits because of the forces they feel.
8. Hang Glider	12,000–15,000 ft (3.7–4.6 km)	Troposphere	They are non-powered aircraft that allow people to glide over fairly long distances.
9. Helicopter	0–25,000 ft (0–7.6 km)	Troposphere	They use rotating wings, called rotors, to create lift. They can takeoff and land vertically.
10. Hot Air Balloon	1,200–2,000 ft (0.4–0.6 km)	Troposphere	They are inflated with hot air, which is less dense than cool air, causing them to rise and carry passengers.
11. Hubble Space Telescope	340 miles (450 km)	Thermosphere	This powerful telescope is in orbit around the Earth and observes objects in space.

OBJECT	ALTITUDE	LAYER OF THE ATMOSPHERE	EXPLAIN ABOUT THE OBJECT— WHAT IS IT? WHAT IS ITS FUNCTION? (etc.)
12. International Space Station	250 miles (400 km)	Thermosphere	This manned space station conducts scientific research while orbiting Earth.
13. James Webb Space Telescope	930,000 miles (1,500,000 km)	Beyond Exosphere	Scheduled to launch in 2021, this telescope will be able to see very distant objects in space.
14. Lunar Gateway	239,000 miles (384,000 km)	Beyond Exosphere	The Gateway will be in orbit around the Moon and will be used as a stopping off point for missions to the Moon's surface.
15. Meteors (Shooting Stars)	40–60 miles (65–97 km)	Mesosphere	Meteors are meteoroids (small pieces of asteroids or comets) entering Earth's atmosphere.
16. Model Rockets	190–1,000 ft (0.06–0.3 km)	Troposphere	They are small rockets that individuals can build and launch.
17. Mount Everest	29,029 ft (8.8 km)	Troposphere	This is the highest point on Earth's surface.
18. Ozone Layer	10–30 miles (15–50 km)	Stratosphere	Located in the stratosphere, this layer absorbs some of the Sun's dangerous ultraviolet rays.
19. Parachutist	13,000 ft (4 km)	Troposphere	High-altitude parachutists have reached heights of 135,908 ft (41.1 km) which is in the mesosphere. Parachutes slow the fall of people and objects due to air resistance.
20. Small Airplane (Cessna)	2,500–9,500 ft (0.8–2.9 km)	Troposphere	These small planes carry only a few passengers at a time.
21. Small UAV	400 ft (0.1 km)	Troposphere	Drones and other small UAVs fly below 400 ft and can perform many different functions such as package delivery and aerial photography.
22. Sounding Rocket	75 miles (12 km)	Thermosphere	These rockets don't reach orbit and are designed to carry science experiments.
23. Weather	0–9 miles (0–14 km)	Troposphere	Weather is a condition in the atmosphere at a certain place and time.
24. Weather Balloon	25 miles (40 km)	Stratosphere	After being launched, they collect weather data as they rise. They eventually pop and come back down.
25. X-57 Maxwell	8,000–14,000 ft (2.4–4.3 km)	Troposphere	This battery powered plane was designed by NASA to test the viability of electric propulsion.
26. X-59 QueSST	55,000 ft (16.8 km)	Stratosphere	This NASA plane will be used to test if planes can break the sound barrier without making a loud, damaging sonic boom.

PART 3

On the following atmospheric diagram, label each layer of the atmosphere in the blanks. Then, enter the name of each of the objects you learned about from your classmates. Make sure each object is in the correct layer of the atmosphere. If time permits, draw a picture for each object.



LAYER OF THE ATMOSPHERE INFORMATION SHEETS

LEVEL	ALTITUDE
Troposphere	Sea level to 5 miles (8 kilometers)—varies with weather and seasons
<ul style="list-style-type: none"> • The most complex of the atmosphere's layers because it is a system that involves many different variables, all of which affect conditions <ul style="list-style-type: none"> – Temperatures fluctuate due to seasons, weather, and the uneven heating and cooling of Earth's surface <ul style="list-style-type: none"> – Air temperature declines with an increase in altitude – Temperature, pressure, and air density are interconnected • All water vapor in the atmosphere is within the troposphere • The height of the troposphere changes with the weather and seasons; it stretches higher in the summer and lower in the winter • Composed of nitrogen (78 percent), oxygen (21 percent), and small concentrations of other trace gases • As altitude increases, the pressure decreases due to a lessening of gravity's pull and lessening of the amount of air that pushes down from above • The densest layer of the atmosphere <ul style="list-style-type: none"> – Approximately 75 percent of the mass of the atmosphere is in the troposphere – At sea level, the atmospheric pressure is 14.7 pounds per square inch 	
WHAT OBJECTS ARE FOUND HERE? <ul style="list-style-type: none"> A. Birds B. Clouds C. Commercial Jetliner D. Hang Glider E. Helicopter F. Hot Air Balloon G. Model Rocket H. Mount Everest I. Parachutist J. Small Airplane (Cessna) K. Small Unmanned Aerial Vehicle (UAV) L. Weather M. X-57 Maxwell 	HOW FAR FROM EARTH'S SURFACE ARE THEY? <ul style="list-style-type: none"> A. 500 feet (0.2 kilometers) B. 0–20,000 feet (0–6 kilometers) C. 32,000–39,000 feet (9.8–11.4 kilometers) D. 5,000–10,000 feet (1.5–3 kilometers) E. 11,000 feet (3.4 kilometers) F. 2,000 feet (0.6 kilometers) G. 1,000 feet (0.3 kilometers) H. 29,029 feet (8.8 kilometers) I. 13,000 feet (4 kilometers) J. 9,500 feet (2.9 kilometers) K. 400 feet (0.1 kilometers) L. Throughout the troposphere M. 8,000–14,000 feet (2.4–4.3 kilometers)

LEVEL	ALTITUDE
Stratosphere	5–31 miles (8–50 kilometers)
<ul style="list-style-type: none"> • Contains the ozone layer (31,600–105,600 feet or 6–20 miles), part of Earth’s atmosphere that contains relatively high concentrations of ozone <ul style="list-style-type: none"> – This layer absorbs some of the Sun’s ultraviolet-B rays, preventing them from reaching Earth’s surface • Temperatures rise as the altitude increases due to the radiation absorbed by the ozone layer • Very stable atmospheric conditions; lacks air turbulence • Almost completely free of clouds or other forms of weather 	
WHAT OBJECTS ARE FOUND HERE? A. Armstrong Limit B. ER-2 C. Fighter Aircraft (F-35) D. Ozone Layer E. Weather Balloon F. X-59 QueSST	HOW FAR FROM EARTH’S SURFACE ARE THEY? A. 62,000 feet (19 kilometers) B. 70,000 feet (21.3 kilometers) C. 60,000 feet (18 kilometers) D. 10–30 miles (24–48 kilometers) E. 25 miles (40 kilometers) F. 55,000 feet (16.8 kilometers)

LEVEL	ALTITUDE
Mesosphere	31–53 miles (50–85 kilometers)
<ul style="list-style-type: none"> • Temperatures drop as altitude increases (as cold as -100°C or -148°F) • The coldest temperatures in any layer of the atmosphere (colder than Antarctica’s lowest recorded temperature) • Meteors often burn up while passing through this layer • Not much is known about this layer 	
WHAT OBJECTS ARE FOUND HERE? A. Meteors (Shooting Stars)	HOW FAR FROM EARTH’S SURFACE ARE THEY? A. 40–60 miles (64–97 kilometers)

LEVEL	ALTITUDE
Thermosphere	53–372 miles (85–600 kilometers)
<ul style="list-style-type: none"> • Very little air in this layer • Hottest layer—temperatures reach well beyond 1000°C <ul style="list-style-type: none"> – The few air molecules that are present receive extraordinary amounts energy from the Sun, causing the layer to heat to incredibly high temperatures – A person would feel cold here because the low air pressure means there are very few air molecules to transfer heat • The transition to space is at approximately an altitude of 62 miles (100 kilometers) 	
<p>WHAT OBJECTS ARE FOUND HERE?</p> <ul style="list-style-type: none"> A. Hubble Space Telescope B. International Space Station C. Sounding Rocket D. Communication Satellites 	<p>HOW FAR FROM EARTH'S SURFACE ARE THEY?</p> <ul style="list-style-type: none"> A. 40–60 miles (64–97 kilometers) B. 250 miles (400 kilometers) C. Up to 75 miles (120 kilometers) D. 100–22,000 miles (160–36,000 kilometers)

LEVEL	ALTITUDE
Exosphere	372–6200 miles (600–10,000 kilometers)
<ul style="list-style-type: none"> • Hydrogen and helium are present in extremely low densities • Air molecules are constantly escaping Earth's gravity into space • Contains free-moving particles that may migrate into and out of the magnetosphere • Not all scientists consider the exosphere part of the atmosphere 	
<p>WHAT OBJECTS ARE FOUND HERE?</p> <ul style="list-style-type: none"> A. Spacecraft leaving the Earth for the Moon B. Distant planets pass through this layer 	<p>HOW FAR FROM EARTH'S SURFACE ARE THEY?</p>

LEVEL	ALTITUDE
Beyond the Exosphere	372 miles (600 kilometers)
<ul style="list-style-type: none"> • Space! • In reality, there is not a distinct line, since the atmosphere becomes thinner the further it is from Earth's surface (at this altitude, it is generally agreed that you are in space) 	
WHAT OBJECTS ARE FOUND HERE? A. James Webb Space Telescope B. Lunar Gateway	HOW FAR FROM EARTH'S SURFACE ARE THEY? A. 930, 000 miles (1.5 million kilometers) B. Orbiting Moon—239,000 miles (384,000 kilometers)

National Aeronautics and Space Administration

Headquarters

300 E Street SW
Washington, DC 20546

www.nasa.gov