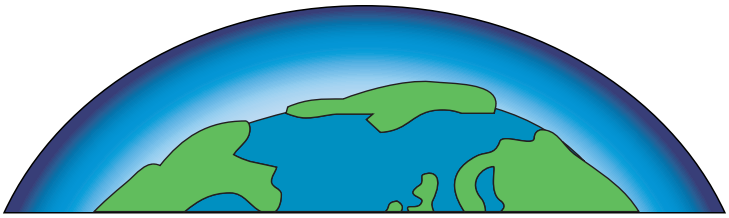


Lesson 7: Nitrogen: The Effects from Properties versus Amount

Students explore the benefits to life of an inert gas (nitrogen).

Main Concept: Nitrogen, like other substances, can have an effect on life because of its unique properties and because of the amount of it in the environment, which contributes to air pressure necessary for life functions.

Scientific Question: How do the properties of nitrogen and its amount in the atmosphere affect life on Earth?

Objectives	Standards
• Students will explain how nitrogen's properties affect life on Earth • Students will explain how the amount of nitrogen in the atmosphere affects life on Earth. • Students will explain the difference between effects due to the properties of a gas and effects due to the amount of a gas.	**Addresses**: 2061: 4D (6-8) #6 NSES: B (5-8) #1.2 ISTE: 3, 5

Assessment	Abstract of Lesson
Responses to Astro Journal questions.	Students model nitrogen gas bonds to explore nitrogen's non-reactive property. Students then explore the role of the large amount of nitrogen in the atmosphere and research nitrogen's benefits to life.

Prerequisite Concepts	Major Concepts
• Humans need oxygen, carbon dioxide, nitrogen, ozone, and water vapor in certain quantities. (Atmosphere Lesson 1) • Properties of a gas describe unique characteristics of a gas. (Atmosphere Lesson 1) • Gases do not have a fixed shape or volume, allowing molecules to move freely. (Astronomy Lesson 4) • A chemical change or reaction occurs when molecules change or transform by combining with other substances, interchanging atoms with another molecule, or by breaking down into separate atoms. (Atmosphere Lesson 4) • Reactive gases, like oxygen, tend to react. (Atmosphere Lesson 6) • About 100 different elements have been identified…out of which everything is made. (2061: 4D (6-8) #5)	• Nitrogen gas has strong bonds, so it does not easily break apart to form new molecules, making it a stable molecule and inert gas. • Because nitrogen is inert, it can compose a large percentage of our atmosphere without causing negative effects to life and, thus largely contributes to the air pressure on Earth necessary to support our bodies. • Nitrogen is a fundamental building block for proteins, which are essential for life.

Suggested Timeline (45-minute periods):
Day 1 Engage, Explore and Explain Sections
Day 2 Extend Section
Day 3 Evaluate Section (15 minutes)

Materials and Equipment:
- Gas Reference Chart
- Chemical Diagram Sheet
- A class set of Astro Journal Lesson 7
- 1 balloon
- A pile of books for each pair of students
- Computers with Internet connection
- A class set of Nitrogen and Life Reading

Preparation:
- Gather materials.
- Duplicate Astro Journal and Nitrogen and Life Reading.
- Prepare chart paper with the major concept of the lesson to post at the end of the lesson.

Differentiation:

Accommodations
For students who may have special needs:
- Have them work with a partner on the Astro Journal writing or report orally to the teacher.

Advanced Extensions
For students who have mastered this concept:
- Research and report on inert and reactive gases. What causes the bonds of inert gases to be so strong? What causes reactive gases to want to react?
- Research and report on the nitrogen cycle. If nitrogen is inert, how do we get it out of our atmosphere so that plants and animals can use it? What chemical reactions occur in this process?

Engage (approximately 10 minutes)

1. **Review properties of a gas (Atmosphere Lesson 1); atoms as unique building blocks (Atmosphere Lesson 2); and greenhouse gases, oxygen, and ozone as examples (Atmosphere Lessons 3, 5 and 6).**
   - Question: What are some properties of a gas that might make it different from another gas?
   - *Answer: Properties of a gas might include mass, reactivity, and the types of bonds between atoms that make up the gas molecules.*

   - Question: So when we say properties of a gas, what do we mean?
   - *Answer: Properties of a gas describe characteristics of a gas that are unique to that gas.*

   - Question: What is it about each gas that gives it its unique properties?
   - *Answer: Each gas is composed of different atoms or building blocks. Atoms of any element are alike but are different from atoms of other elements.*

   - Question: Why are the properties of a gas important to understand?
   - *Answer: The unique properties of a gas may be important to human survival.*

   - Question: What is an example of a gas that has a unique property that is important to human survival?
   - *Answer: Greenhouse gases, like carbon dioxide and water vapor, absorb heat and play a role in determining our surface temperature. Oxygen is reactive, which allows it to combine with sugars that can then be carried throughout the body to provide energy to our cells. Oxygen's reactivity also allows fires to burn, which we rely on for warmth, light, and to cook our food. Ozone's unique properties allow it to block ultraviolet radiation from the Sun.*

2. **Review chemical reactions and reactive gases (Atmosphere Lesson 4).**
   - Question: What are the ways that gases can transform or react?
   - *Answer: The atoms that make up a gas can combine with other molecules, interchange with the atoms of another molecule, or can break down into separate atoms.*

   - Question: What do we call substances that tend to transform in these ways?
   - *Answer: We say that they are reactive.*

3. **Bridge to this lesson and introduce the purpose and Scientific Question.**
   - Say: Today we're going to look at the unique properties of nitrogen and how nitrogen is important to human survival. The Scientific Question we will explore is:
     - How do the properties of nitrogen and its amount in the atmosphere affect life on Earth?

   - Question: What do you already know about nitrogen, either from previous experience or from the Atmospheric Science Training module?
   - *Answers may include: Nitrogen makes up 78% of our atmosphere. The effects of too little nitrogen on life were that plants and animals died.*

   - Have students look at the Gas Reference Chart.

- Question: When you look at the amounts of each gas in the atmosphere, how does nitrogen compare to the others?
- *Answer: There is significantly more nitrogen than any other gas.*

- Question: What does this tell you about nitrogen's properties?
- *Answer: (Allow students to discuss their ideas about this.)*

- Question: Could we survive if we had 78% carbon dioxide in our atmosphere? Why? Could we survive if we had 78% oxygen in our atmosphere? Why? So what unique property does nitrogen have that allows us to have so much of it in the atmosphere?
- *Answer: Too much carbon dioxide would trap too much heat increasing temperatures and harming life. Too much oxygen would cause fires because oxygen is highly reactive. (Accept all ideas about nitrogen's unique properties.)*

- Say: In the next activity, we'll look at the unique properties of nitrogen that allow us to have so much of it in our atmosphere and why this is important to human survival.

Explore (approximately 20 minutes)

1. Lead Modeling Nitrogen: Effects from Properties Activity.

- Review nitrogen on the Chemical Diagram Sheet.

- Question: How many bonds does nitrogen tend to form?
- *Answer: It tends to form three bonds.*

- Have students work in pairs to model a single nitrogen atom. Two students stand shoulder to shoulder. One holds out two hands to "bond" while the other holds out one.

- Once students have formed nitrogen atoms, have them pair up with other nitrogen atoms to form single nitrogen molecules of nitrogen gas.

- Have two students form a hydrogen gas molecule, by facing each other and holding one hand to form a single bond.

- Have two other students form an oxygen gas molecule, by facing each other and holding two hands to form two bonds.

- Question: Observing these three gases, which would you say has the strongest bonds? Why?
- *Answer: Nitrogen gas has the strongest bonds, because it has the most bonds.*

- Question: Do you think nitrogen gas will react easily with other substances? Why?
- *Answer: No, nitrogen will not react easily, because its bonds are stronger.*

- Question: How does this compare to oxygen?
- *Answer: Oxygen is reactive, so it tends to transform and change often. Nitrogen tends to maintain the same molecule.*

Note to Teacher: You may wish to act this out with students, by having those acting as hydrogen gas and oxygen gas transform into water vapor, while nitrogen gas stays in its same form.

- Explain to students that nitrogen atoms tend to form nitrogen gas (at Earth-normal conditions), whereas most other molecules tend to change or react. Gases (like nitrogen) that tend to form strong bonds that don't break apart easily are called "inert gases."

- Question: Thinking back to the questions we discussed before, could humans tolerate high quantities of reactive gases like oxygen in our atmosphere? Explain.
- *Answer: Humans could not survive with large percentages of other reactive gases, because the gases tend to form new molecules causing changes that could be poisonous or explosive.*

- Question: So what unique property does nitrogen have that allows us to have so much of it in the atmosphere?
- *Answer: Nitrogen is an inert gas, meaning it does not easily break apart and form new molecules. It is a stable gas.*

- Have students summarize their learning about the properties of nitrogen in their Astro Journals.

Explain (approximately 15 minutes)

1. Guide Air Pressure: Effects from Amounts Activity.

- Review Gas Reference Sheet, focusing on the percentage of nitrogen in the atmosphere.
  - Question: So, we seem to have a lot of nitrogen in our atmosphere. What possible use might we have for so much of a gas that doesn't seem to do much except take up space?
  - *Answer: (Allow students to discuss their ideas.)*

- Have students predict in their Astro Journals: Why is the amount of nitrogen important to human survival?

- Connect back to prior knowledge of gases.
  - Question: In Astronomy what did we learn about the difference in the movement between solids, liquids, and gases?
  - *Answer: We learned that gas molecules move freely and quickly with a lot of energy.*

- Demonstrate air pressure.
  - Blow up a balloon.

  - Question: Why does the balloon expand?
  - *Answer: The molecules of air are moving and pressing against the skin of the balloon.*

  - Explain that pressure is the result of the movement of molecules pressing against a container of some kind or against some other matter.

  - Question: In the air, what are the molecules of the different gases running into?
  - *Answer: Gas molecules are running into other gas molecules and the physical features of Earth.*

  - Have students work in partners. Have one student start to pile books on the arms of the other student.

  - Question: As you add more books, what happens?
  - *Answer: Adding more books adds mass to the pile on the arms. As the mass increases, the attraction of gravity increases and the pile is pulled toward the center of Earth.*

  - Question: What does this mean for air and air pressure?
  - *Answer: The molecules of the different gases in the air are pulled down toward the center of the Earth by gravity, and they create pressure.*

- Discuss air pressure's benefit to human life.
  - Question: Where is the pressure the greatest?
  - *Answer: At Earth's surface.*
  - Question: What happens to air pressure as you move up from Earth's surface?
  - *Answer: It lessens.*
  - Question: When air pressure lessens, what do you think happens to the gases.
  - *Answer: They tend to spread out more.*
  - Question: So, how does air pressure affect us?
  - *Answer: Air pressure pushes against us and helps us keep our form.*
  - Question: You can think of air pressure like a brick on a sponge. What happens to the sponge with a brick on it?
  - *Answer: It is squished down.*
  - Question: What happens if you remove the brick?
  - *Answer: The sponge expands to fill the space that is left.*
  - Question: Are there any gases in your body?
  - *Answer: Yes. There is air (oxygen and carbon dioxide) in blood, tissue, lungs, stomach, and other organs.*
  - Question: So, without so much air pressure, what might happen to our bodies?
  - *Answer: Gases in our bodies would spread out and "boil off", as they try to fill the void. The air in our lungs would rush out. The gases in our body would expand and cause us to be bloated, and our blood vessels would burst. Over time, we would die.*
  - Question: What must astronauts do to prevent this, when they are in space?
  - *Answer: They must wear pressurized suits.*
  - Question: Do all living things need the same amount of pressure to survive? Explain.
  - *Answer: Different forms of life have different pressure requirements. For example, a jellyfish and other deep sea creatures need more pressure than humans to keep its form. Water provides that pressure to help jellyfish keep their form. Octopuses can survive under a wide range of pressures, because they don't have gases in their bodies.*
  - Question: Is there an upper limit to the amount of pressure humans can stand? Give an example.
  - *Answer: Yes. When humans go in the deep sea, we need specially pressurized suits or submarines to prevent us from being squashed.*
  - Question: Another important effect of decreasing pressure is on water. With a decrease in pressure and increase in space, the water molecules will want to spread out to fill the space. What happens when water molecules become more spread out?
  - *Answer: When water molecules are more spread out, they become a gas.*
  - Question: When pressure is decreased a certain amount, water molecules will then spread out to fill the void, changing from a solid or liquid to a gas. Why might this be important to life?
  - *Answer: We need liquid water to survive, so if we don't have enough air pressure, liquid water could evaporate and leave us with little or no liquid water.*
- Have students summarize their learning about air pressure in their Astro Journals.

Note to Teacher: You may want to have students complete their Astro Journals as homework or at the beginning of the next class period.

Extend/Apply (approximately 45 minutes)

1. **Guide students in researching other ways that nitrogen is important to human survival.**
   - Question: So, what have we learned so far about nitrogen?
   - *Answer: Nitrogen forms strong bonds, causing it to be inert. Since it is so stable, we can survive with a large percentage of nitrogen in the atmosphere. In fact, we need to have a large percentage of it in the atmosphere so that we have enough air pressure to support our bodies and to keep water in a liquid state.*

   - Question: What other role might nitrogen play in supporting human survival or life in general?
   - *Answer: (Allow students to discuss ideas.)*

   - Have students conduct research on nitrogen on the Internet to see what information they can find about the importance of nitrogen for life.
     - Web sites: Have students try key words such as: "nitrogen", "nitrogen cycle" or "nitrogen and biology" at a search engine or directory for kids such as:
       - Yahooligans http://www.yahooligans.com
       - ithaki for Kids http://www.ithaki.net/kids
       - KidsClick http://sunsite.berkeley.edu/KidsClick!/
       - Ask Jeeves for Kids http://www.ajkids.com

     - The following encyclopedia Web sites can also be useful:
       - Columbia Encyclopedia http://www.encyclopedia.com
       - Microsoft Encarta http:// encarta.msn.com

     - A fairly good description of the nitrogen cycle can be found at:
       - http://www.geog.ouc.bc.ca/physgeog/contents/9s.html
       - http://helios.bto.ed.ac.uk/bto/microbes/nitrogen.htm

2. **Have students read the Nitrogen and Life Reading about nitrogen in proteins and other biological processes. Have them answer the following question in their Astro Journals: Why is nitrogen important to life?**

3. **Discuss nitrogen's role in proteins and other biological processes.**
   - Question: What did you learn about nitrogen's role in supporting life?
   - *Answer: Nitrogen is extremely important in living things. It forms the building blocks of proteins. We need proteins because they make up our skin and hair. Proteins also help us digest food. We get our nitrogen from plants, and plants get it from bacteria in the soil. Our atmosphere provides life with the nitrogen it needs.*

Evaluate (approximately 15 minutes)

1. **Have students complete their conclusions in their Astro Journals.**

2. **Discuss students' responses to ensure they have mastered the major concepts.**
   - Question: Why is nitrogen important to human survival?
   - *Answer: Nitrogen is inert, so it is a stable gas that we can have a lot of in the atmosphere without it negatively affecting life. We need an inert gas to contribute to air pressure, which is needed to support our bodies. Nitrogen also makes up proteins, which make up our skin and hair and help us to digest food.*

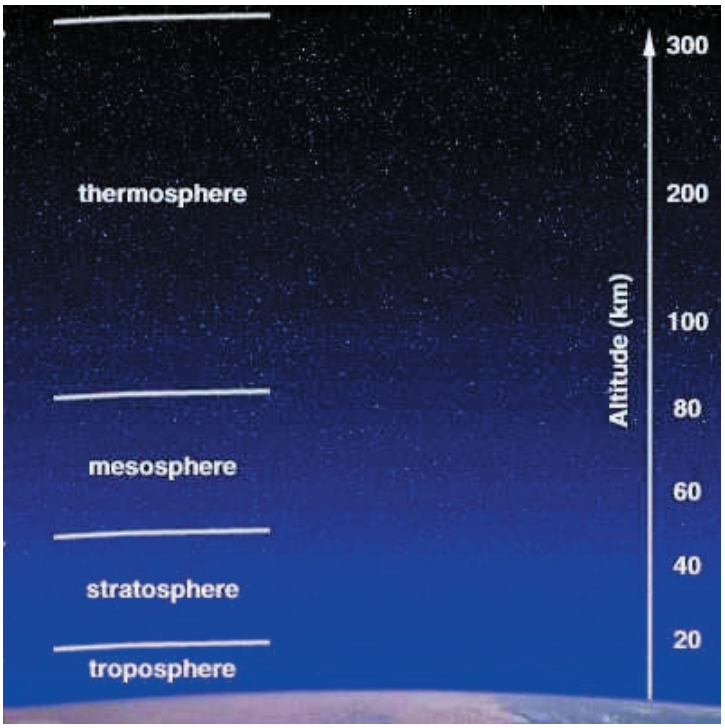
   - Question: Which effects of nitrogen are a result of its unique properties, and which are a result of the amount of nitrogen in the atmosphere?
   - *Answer: One of nitrogen's properties is that it has strong bonds, which makes it inert. The amount of nitrogen in our atmosphere contributes to the air pressure on Earth.*

3. **Collect students' Astro Journals and evaluate them to ensure that they have each mastered the major concepts:**
   - Nitrogen has strong bonds, so it does not easily break apart to form new molecules, making it an inert gas.
   - Because nitrogen is inert, it can compose a large percentage of our atmosphere without causing negative effects to life and thus, largely contributes to the air pressure on Earth necessary to support our bodies.
   - Nitrogen is a fundamental building block for proteins, which are essential for life.

4. **Bridge to next lesson.**
   - Say: Today we learned about the unique properties that nitrogen has and how those unique properties are important to human survival. We also discussed how molecules can break apart and form new molecules. In the next lesson we'll apply all that we've learned about each of the gases and how they are important to human survival; we'll also assess locations in our Solar System for their ability (or inability) to support humans' atmospheric needs.

   Note to Teacher: After each lesson, consider posting the main concept of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the "conceptual flow" and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding.

Gas Reference Chart



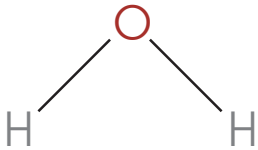
Gases	Location in the atmosphere	Amount in the Earth's atmosphere
Carbon dioxide (CO_2)	troposphere	0.035%
Water vapor (H_2O)	troposphere	1 to 4%
Oxygen (O_2)	troposphere	21%
Ozone (O_3)	stratosphere	300 Dobson Units
Nitrogen (N_2)	troposphere	78%
Methane (CH_4)	troposphere	0.0002%
Argon (Ar)	troposphere	0.9%
Neon (Ne)	troposphere	0.002%
Helium (He)	troposphere	0.0005%
Krypton (Kr)	troposphere	0.0001%
Hydrogen (H_2)	troposphere	0.00005%

Chemical Diagrams Sheet

Carbon Dioxide (CO_2)

Hydrogen Gas (H_2)

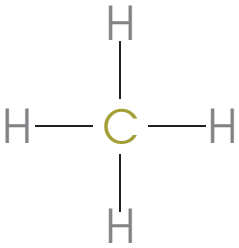
Oxygen Gas (O_2)



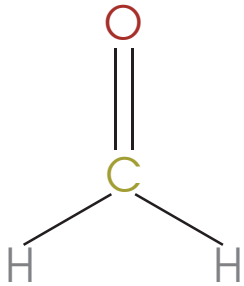
Water (H_2O)

Ozone Gas (O_3)

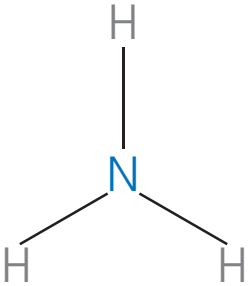
Nitrogen Gas (N_2)



Methane (CH_4)



Formaldehyde (CH_2O)



Ammonia (NH_3)

Astro Journal Lesson 7: Nitrogen

Name:

Class/Period:

Date:

Modeling Nitrogen: Effects from Properties

1. Explain how the properties of nitrogen (specifically the way it bonds with other molecules) make it a substance that does not react easily with other substances.

Air Pressure: Effects from Amounts

1. Prediction: Why is the amount of nitrogen important to human survival?

2. Results: Why is the amount of nitrogen important to human survival?

Astro Journal Lesson 7: Nitrogen

Class/Period:

Name:

Date:

Nitrogen and Life

1. Why is nitrogen important to humans and life in general?

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_____

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2. How can the effects of the properties of a substance differ from the effects of the amount of a substance? Use nitrogen as an example, and include illustrations to support your ideas.

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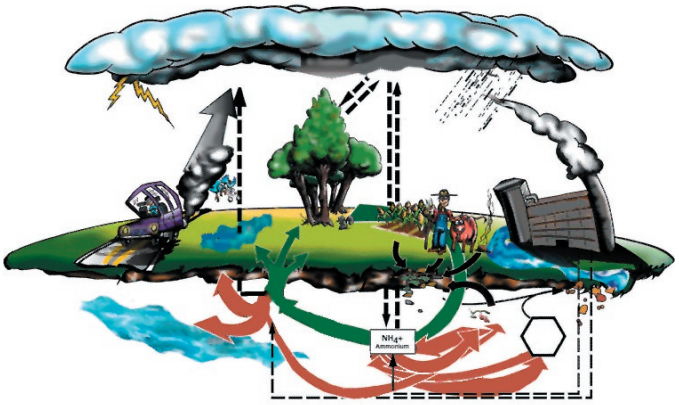
Nitrogen Reading



The Nitrogen Cycle

Nitrogen gas, N_2, is by far the most abundant gas in Earth's **atmosphere**. It makes up 78.1% of Earth's air by volume. Both nitrogen's properties and its amount in Earth's atmosphere play important roles in maintaining life on Earth.

Nitrogen is considered to be an **inert** gas. This means it does not easily react with other substances to form new substances. Most of the nitrogen in the atmosphere simply stays in the atmosphere. One of the reasons for this stability is an important property of nitrogen. The element nitrogen has three bonding slots. When two nitrogen atoms attach to each other, the three **bonds** are strong and difficult to break.

Despite this difficulty, nitrogen is an essential element for life. It is used to build the rungs of the ladder of DNA and RNA and is used in many substances that life either requires or creates. Certain **bacteria** can take nitrogen from the atmosphere and use it to make important substances. This process is called 'fixing'. These substances are passed to plants and then animals that use the substances for themselves. Without these nitrogen- fixing bacteria, life as we know it would not be possible. The movement of nitrogen from the atmosphere through bacteria to plants and then animals is called the **Nitrogen Cycle**. It is one of the most important cycles for life on Earth.

There is far more nitrogen in Earth's atmosphere than could ever be used by plants and animals. Yet it is still important that there is so much nitrogen in the atmosphere. The reason is that while individual gas **molecules** are small and do not weigh much, all the gases combined have a great **mass** and a great weight. Because of this mass and weight, there is a specific air **pressure**. As various gas molecules move around, they bump into other gas molecules. This air pressure is highest at sea level, where the weight of the gases presses down the most. As one moves up from sea level, the pressure becomes less. Eventually, the pressure becomes so low that people cannot breathe. This is why mountain climbers on Mt. Everest need to bring tanks of oxygen with them. There is oxygen up there, but the air pressure is so low that a person cannot get enough oxygen through regular breathing. This is also why airplanes that fly very high need to carry oxygen with them.

Due to the decrease in air pressure, we need oxygen masks when we fly at high altitudes.

Without the significant amount of nitrogen in the atmosphere, air pressure at sea level would not be enough for people to breathe. Since there is so much of it, it is fortunate that nitrogen is not very **reactive**. If a reactive gas such as oxygen replaced the nitrogen in the atmosphere, Earth would be much less likely to support life. In this way, both nitrogen's properties and the amount of it help maintain life on Earth.