8th Grade

Spring 2022 Lesson Plans

Vanderbilt Student Volunteers for Science

https://studentorg.vanderbilt.edu/vsvs/

VOLUNTEER INFORMATION

Team Member Contact Information

Name:____ Phone Number:_________________________

Name:____ Phone Number:_________________________

Name:____ Phone Number:_________________________

Name:____ Phone Number:_________________________

Teacher/School Contact Information

School Name: ____ Time in Classroom: ______________________

Teacher's Name: _____________________________________ Phone Number: __________________________

VSVS INFORMATION

VSVS Educational Coordinator:

Paige Ellenberger 615-343-4379

paige.ellenberger@vanderbilt.edu **VSVS Office:** Stevenson 5234

Co-Presidents:	Molly Friedman	molly.h.friedman@vanderbilt.edu
	Alex Ruemmler	alex.k.ruemmler@vanderbilt.edu
Secretaries:	Doah Shin	doah.e.shin@vanderbilt.edu
	Neeraj Namburu	neeraj.s.namburu@vanderbilt.edu

Vanderbilt Protection of Minors Policy: As required by the Protection of Minors Policy, VSVS will keep track of the attendance – who goes out when and where.
https://www4.vanderbilt.edu/riskmanagement/Policy_FINAL%20-%20risk%20management%20v2.pdf

Before You Go:

The lessons are online at: https://studentorg.vanderbilt.edu/vsvs/lessons/

- Email the teacher prior to the first lesson.
- Set a deadline time for your team. This means if a team member doesn't show up by this time, you will have to start the lesson without them.
- Don't drop out from your group. If you have problems, email Paige or one of the co-presidents, and we will work to help you. Don't let down the kids or the group!
- If your group has any problems, let us know ASAP.

Picking up the Kit:

- Kits are picked up and used for lessons in the VSVS Lab, Stevenson Center 5234.
- The VSVS Lab is open 8:30am – 4:00pm (earlier if you need dry ice or liquid N_2).
- Assign at least one member of your team to pick up the kit each week.
- Kits should be picked up at least 30 minutes before your classroom time.
- If you are scheduled to teach at 8am, pick up the kit the day before.
- There are two 20 minute parking spots in the loading dock behind Stevenson Center. Please do not use the handicap spaces – you will get a ticket.

Just relax and have fun!

February						
SUN	MON	TUES	WED	THU	FRI	SAT
	31 Applications Close	1	2	3	4	5
6	7	8	9 Team Leader Training 4-5 PM	10	11 Next Steps Lesson #1 2-3 PM	12
13 Team Leader Training 4-5 PM	14 5th/7th Grade Training Sessions	15 5th/7th Grade Training Sessions	16 5th/7th Grade Training Sessions	17 5th/7th Grade Training Sessions	18	19
20	21 6th/8th Grade Training Sessions	22 6th/8th Grade Training Sessions	23 6th/8th Grade Training Sessions	24 6th/8th Grade Training Sessions	25	26
27	28 First week of lessons					

March						
SUN	MON	TUES	WED	THU	FRI	SAT
	28 First week of lessons	1 First week of lessons	2 First week of lessons	3 First week of lessons	4	5
6	7 **No Lessons** VU Spring Break	8 **No Lessons** VU Spring Break	9 **No Lessons** VU Spring Break	10 **No Lessons** VU Spring Break	11	12
13	14 **No Lessons** MNPS Spring Break	15 **No Lessons** MNPS Spring Break	16 **No Lessons** MNPS Spring Break	17 **No Lessons** MNPS Spring Break	18 Next Steps Lesson #2 2-3 PM	19
20	21 Second week of lessons	22 Second week of lessons	23 Second week of lessons	24 Second week of lessons	25	26
27	28	29	30	31		

April						
SUN	MON	TUES	WED	THU	FRI	SAT
				31	1	2
3	4 Third week of lessons	5 Third week of lessons	6 Third week of lessons	7 Third week of lessons	8 Next Steps Lesson #3 2-3 PM	9
10	11 Fourth week of lessons	12 Fourth week of lessons	13 Fourth week of lessons	14 Fourth week of lessons	15	16
17	18 Lesson make-up week 1	19 Lesson make-up week 1	20 Lesson make-up week 1	21 Lesson make-up week 1	22	23
24	25	26	27	28	29	30

CLASSROOM ETIQUETTE

Follow Metro Schools' Dress Code!

- No miniskirts, shorts, or tank tops.
- Tuck in shirts if you can.
- Please dress appropriately.

Metro student standard attire guideline:
http://jtmoorems.mnps.org/pages/JohnTrotwoodMooreMiddle/About_Our_School/8998762518461552450/Dress_Code

COLLEGE Q&A SESSION

VSVS members should be candid about their experiences and emphasize the role of hard work and a solid body of coursework in high school as a means to get to college.

- Email the teacher prior to the first lesson.
  - They may want to have the students write down questions prior to your lesson.
  - They may also want to have a role in facilitating the discussion.
- Finish the experiment of the day and open up the floor to the students.
- Remind them of your years and majors and ask if they have specific questions about college life.
- If they are shy, start by explaining things that are different in college.
  - Choosing your own schedule, dorm life, extracurricular activities, etc.
  - Emphasize the hardworking attitude.

The following are some sample questions (posed by students):

- When is bedtime in college? Does your mom still have to wake you up in college?
- How much does college cost?
- What do you eat in college and can you eat in class in college?
- How much homework do you have in college?

Volunteer FAQ

➔ What is VSVS?

VSVS stands for Vanderbilt Student Volunteers for Science. Members of this organization volunteer to teach hands-on science lessons to 5th-8th grade classrooms in the Metro Nashville School District.

➔ How often are lessons?

Each team teaches 1 lesson per week for 4 consecutive weeks throughout a semester.

➔ What is the time commitment?

Relatively low! Depending on your position, you'll attend between 1-3 training sessions at the beginning of the semester, and each of the 4 lessons take about 1.5 hours (30 minutes to run through each lesson beforehand and 1 hour to teach it).

➔ Who will I be teaching with?

All volunteers are put into groups of up to 3 (based on availability) and assigned to a classroom.
If you have friends that you'd like to be partnered with, be sure to have one group member fill out a separate Partner Application so you can be appropriately matched!

➔ Where will I be teaching?

Your team will be teaching your students over some virtual platform from the same room. VSVS will reserve a room where your team can meet. Social distancing rules and sanitation protocols will be enforced.

➔ What are the lesson dates?

At the beginning of each semester, we send out a group assignment email that contains all of the relevant information for your group. It will have your teachers name and contact information, as well as the names and contact for all of your group members, and the date/time of your lessons.

➔ What if I need to quit VSVS?

If you can no longer fulfill your commitment to VSVS, please reply to one of the emails we've sent you ASAP and let us know so that we can adjust accordingly.

➔ Can graduate students participate in VSVS?

Yes -- you can either join as a regular volunteer and be assigned to a team and classroom OR you can serve as a floating volunteer (that is, if your schedule is very irregular but you know that you'll be available for at least a few of our weeks!). Just note which option you'd like in your application!

For additional questions, feel free to contact the VSVS Educational Coordinator at paige.ellenberger@vanderbilt.edu.

DIRECTIONS TO SCHOOLS

H.G. HILL MIDDLE SCHOOL: 150 DAVIDSON RD **615-353-2020**
HG Hill School will be on the right across the railroad lines.

HEAD MAGNET SCHOOL: 1830 JO JOHNSON AVE **615-329-8160**
The parking lot on the left to the Johnston Ave.

J.T. MOORE MIDDLE SCHOOL: 4425 GRANNY WHITE PIKE **615-298-8095**
From Lone Oak, the parking lot is on the right, and the entrance into the school faces Lone Oak, but is closer to Granny White.

MEIGS MIDDLE SCHOOL: 713 RAMSEY STREET **615-271-3222**
Going down Ramsey Street, Meigs is on the left.

ROSE PARK MAGNET SCHOOL: 1025 9th AVE SOUTH **615-291-6405**
The school is located on the left and the parking is opposite the school, or behind it (preferred).

WEST END MIDDLE SCHOOL: 3529 WEST END AVE **615-298-8425**
Parking is beside the soccer field, or anywhere you can find a place. Enter through the side door.

EAST NASHVILLE MAGNET MIDDLE SCHOOL: 2000 GREENWOODAVE **615-262-6670**

MARGARET ALLEN MIDDLE SCHOOL: 500 SPENCE LN **615-291-6385**
From West End down Broadway, take 1-40E to exit 212 Rundle Ave. Left on Elm Hill to Spence Lane.

VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE
http://studentorg.vanderbilt.edu/vsvs

Rock Cycle

Mini Lesson
Spring 2022
Adapted from work by the Warner Park Nature Center

GOAL: The students will identify factors that cause rocks to break down and change through numerous pathways in the rock cycle.
Introduces/reinforces TASS: 8.ESS2.3 Describe the relationship between the processes and forces that create igneous, sedimentary, and metamorphic rocks.

VSVSer LESSON OUTLINE

______ **I. Introduction**
a. Explain the rock cycle in terms of igneous, sedimentary, and metamorphic rocks and their starting materials.

______ **II. Rock Cycle Game**
a. Explain the rules and concept of the game that illustrates the general scheme of the rock cycle.
b. Play the game! Students roll dice to determine how they (acting as rocks) will move through the rock cycle.
c. Discuss the results of the game.
d. Identify and correct misconceptions about the rock cycle.

______ **III. Model Drawing**
a. Using their experience playing the game, students will draw a new and improved model of the rock cycle.

______ **IV. Observations and Explanations**
a. Students can volunteer to share their models with the class.

USE THE PPT AND/OR VIDEO ON WEBSITE TO VISUALIZE THE MATERIALS USED IN EACH SECTION BEFORE TEACHING THIS LESSON.

1. In the car ride, read through this quiz together as a team. Make sure each team member has read the lesson and has a fundamental understanding of the material.

1. What are the 3 major types of rocks and how are they formed? *Answer in section 1b.*
2. What are the relationships between each pair of rock types? For example, can sedimentary rocks form igneous rocks and vice versa. *Answer in section 1b.*
3. What are fossils and how do they relate to the rock cycle? *Fossils are preserved remains of organisms. They are formed when sediments cover and fill the organism. Therefore, sedimentary rocks can contain fossils.*

Full materials list:

- 8 sets five large dice (1 for each group)
- 8 sets igneous rocks (1 for each group)
- 8 sets sedimentary rocks (1 for each group)
- 8 sets metamorphic rocks (1 for each group)
- 8 containers “magma” (1 for each group)
- 8 containers sediment (1 for each group)

- 1 poster with rocks in different layers of Earth
- 32 copies Concept Map Sheet
- 32 copies Observation Sheet
- 1 instructor set rocks
- 1 simple rock cycle poster (laminated)

I. Introduction

a. **Why is the science in this lesson important?** The rock cycle is the continual cycle of transitions of rocks between the 3 main types of rocks. Rock cycles help in dating and understanding the change of earth through time. For example, Pangea and fossils. The rock cycle also produces soil (vital for life) and helps locate energy sources (oil) and building materials (granite, marble).

b. **Explain the rock cycle.** (Refer to the poster of rocks within different layers of Earth during this section.)
   - Rocks are the most common material on Earth. They are naturally occurring aggregates of one or more minerals. Based on how they are formed, there are three types of rocks; igneous, sedimentary, and metamorphic rocks.
   - When other rock types and organic remains such as shells or bone break apart from erosion, they (now called sediment) are transported by rivers and streams into lakes and oceans. As sediment builds up it is compressed and heated in the Earth eventually creating a sedimentary rock.
   - When magma from volcanoes cools it turns into an igneous rock.
   - Metamorphic rocks are created when other kids of rocks are subjected to very high heat and pressure (but not quite enough heat to melt the rock – then it would become igneous!).

c. **Show examples of each type of rock.** Remove the instructor set of rocks from the kit and show students the examples of each type of rock. Pass each rock around the classroom and allow students to touch and observe each one. You may choose to do this while you talk about each type of rock.

d. **Diagram creation.** Have students draw a diagram of the rock cycle on their concept map template (don't explain the intricacies or give them additional information at this point – you *want* to draw out any misconceptions they may have!).

Unpacking the kit and Set-Up:
1. Organize students in groups of 4.
2. Remove all items from kit box.
3. Pass out one set of large dice and one of each igneous rock, sedimentary rock, metamorphic rock sets and one container each "magma" and sediment to each group.

II. Rock Cycle Game

a. **Explain** to students that they will now participate in a game that illustrates the general scheme of the rock cycle through visualization and movement.

b. **Game.** (Approximately 15 min.)

   i. **Step #1 –** Pass out 1 observation sheet to each student.

   ii. **Step #2 –** Place students in groups of 4 each and have each group start at a different step in the rock cycle.

   iii. **Step #3 –** Explain that each die contains a different step in the rock cycle (magma, sediment, igneous rock, metamorphic rock, sedimentary rock) and that they are all rocks about to go through the rock cycle!

   iv. **Step #4 –** Instruct all students to draw a star in the top of the step they are starting on (you will assign each group a different step of the rock cycle and instruct them to place a star in this bubble).

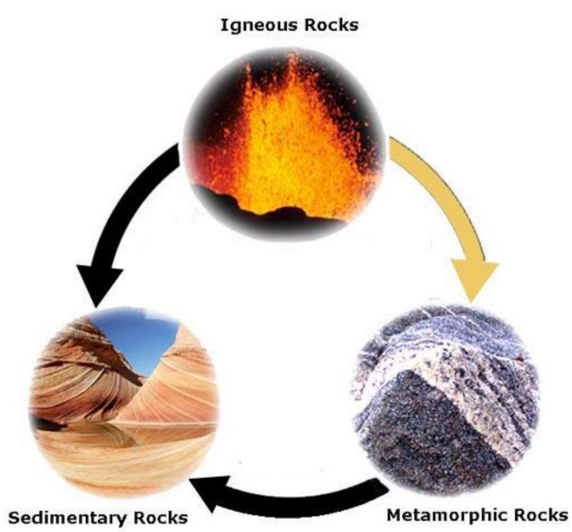
   v. **Step #5 –** Have students roll the word cube associated with the step they are in (one person at a time) to determine what will happen to them.

   vi. **Step #6 –** Instruct students to place a tally mark in the circle of the step they are on if the cube told them to "stay in this state" and to draw an arrow from the step they were in to the new state if the cube told them to "turn into" something.

   vii. **Steps #7-18 –** Have students repeat steps 5-6 to complete 5 full "rotations" being sure to record what happens (either with a tally or an arrow) each time. Don't allow students to take more than 2 minutes or so to pass the word cube around and roll each time (timing them on your phone or on a smartboard when available is a great way to motivate students to stay engaged and work quickly!).

c. **Discussion.** Ask students what they noticed as they worked through the rock cycle. Did they move through the cycle as they expected? Does their observation sheet look like their original concept map? *Many students will find that their original drawing of the rock cycle is flawed. Most will probably see that it is too simple (if their teacher hasn't "spoiled" it already!).*

d. **Misconceptions.** Explain to students that many people develop a misconception when learning about the rock cycle. Show students simple rock cycle poster (below and printed/laminated in kit) and explain that many people leave out the sediment and magma and oversi … complicated and that rocks can t … n just a circle).



III. Model Drawing. (Approximately 5-10 minutes)

- **a.** Have students draw a new and improved model of the rock cycle on the second section on their concept map sheet. Walk through the classroom and make note of whether or not students are including <u>all five</u> materials in the rock cycle (they should!). Students may have questions about how their arrows should look while they are drawing, if this is the case direct them back to their observation sheet (<u>do not</u> outright tell them which way the lines should go, this <u>should</u> make them think critically!).

IV. Observations and Explanations.

- **a. Sharing.** Allow 3-5 students to share their models with the class. Note that while many of the models may look similar, they are not exactly the same because each "rock" (student) in the classroom had a different experience and the rock cycle is complicated! It doesn't flow in a nice even circle step-by-step!

VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE
http://studentorg.vanderbilt.edu/vsvs

Igneous Rocks

Spring 2022

Goal: To introduce students to the types of igneous rocks, how they form, and what minerals combine to form them.
Introduces/reinforces TASS: 8.ESS2.3 Describe the relationship between the processes and forces that create igneous, sedimentary, and metamorphic rocks.

VSVSer Lesson Plan

_______ **I. Introduction – What are Igneous Rocks?**
- **A.** Definitions – How are igneous rocks formed?
- **B.** Lava versus Magma

_______ **II. Examining Igneous Rocks**
- **A.** Intrusive vs. Extrusive Igneous Rocks
- **B.** Basaltic vs. Granitic Rocks
- **C.** Minerals of Igneous Rocks
- **D.** Examining Pegmatite

_______ **III. Where do these Igneous Rocks come from?**

_______ **IV. Examining Volcanic Rock**
- **A.** Stratovolcanoes vs. Shield Volcanoes
- **B.** Special Types of Volcanic Rock

LOOK AT THE VIDEO BEFORE YOU GO OUT TO YOUR CLASSROOM
https://studentorg.vanderbilt.edu/vsvs/lessons/
USE THE PPT AND VIDEO TO VISUALIZE THE MATERIALS USED IN EACH SECTION

Divide class into 16 pairs. Hand out an Igneous Rock observation sheet to each student.

Unpacking the Kit:

VSVSers do this while 1 person is giving the Introduction. Note that students are put into pairs and should have their pencils ready

For Part II: Examining Igneous Rocks
16 Plastic Cases containing one set of Igneous Rocks, 1 set of minerals and 1 piece of pegmatite.
32 Magnify Glasses

For Part IIB, IIC and IID and Part III: 16 laminated mats for igneous rocks and 16 Venn diagrams.

For Part IV. Examining Volcanic Rocks
16 Volcano diagrams in sheet protectors
Deep plastic box with lid containing:1 Margarine container, 2 Lids (1 with multiple small holes and 1 with no holes), 16oz of water, Small plastic plate, Small dropper bottle of detergent, Small container of dry ice, A pair of tongs, 2 goggles for VSVSers

For Part B. Special Types of Volcanic Rock
1 clear 16oz cup, 8 Plastic Cases containing two sets of Volcanic Rocks (2 pairs of students will share the case), 16 magnifying glasses from Part III

I. Introduction – What are Igneous Rocks?

Why is the science in this lesson important?

Igneous rocks are a rich source of minerals and ores Minerals are vital to our everyday lives: for example, minerals are an important component of iPhones, computer chips, and magnets. New processes are currently being developed to allow us to more efficiently extract the minerals that we are currently using, as well as extract completely new materials. Careers involving innovation in the mining and metallurgy industries are extremely important in ensuring that humans use our limited supply of resources sustainably.

Learning Goals: Students understand that igneous rocks are formed above and below the earth's surface by cooling melted rock.

Write the following vocabulary on the board: **magma, lava, intrusive igneous rock, extrusive igneous rock, granitic, basaltic, intermediate, mineral, shield volcano, stratovolcano, volcanic rock**

A. Definitions – How are igneous rocks formed?

There are 3 types of rocks - sedimentary, metamorphic and igneous. This lesson focuses on igneous rocks.

Ask students if they know how igneous rocks are formed and what they are formed from.

- Igneous rocks form when the melted rock material from the Earth cools.
- Cooling and hardening of melted rock material can occur on or underneath Earth's surface.

B. Lava Versus Magma

- Tell them that melted rock material is called **magma** when it is ***underneath*** the Earth's surface. Igneous rocks made from **magma** form ***underneath*** the Earth's surface and are called **intrusive igneous rocks**
- When the melted material is ***on or above*** the Earth's surface, it is called **lava**. Igneous rocks formed from **lava** form ***on or above*** the Earth's surface and are called **extrusive igneous rocks.**

Tell the students that they will:

- Look at different samples of igneous rocks
- Look for visible differences between **intrusive** and **extrusive** igneous rocks
- Learn about some of the different **minerals** that make up **igneous rocks**
- Examine some different types of volcanic rocks and relate them to the type of volcano they come from.

II. Examining Igneous Rocks

Learning Goals: Students identify the differences between different types of igneous rocks and how minerals impact the qualities of each igneous rock type.

Materials:

17 Plastic Cases with one set of Igneous Rocks, 1 set of minerals and 1 piece of pegmatite.
32 Magnifying Glasses

A. Intrusive Versus Extrusive Igneous Rocks

Hand out igneous rock, minerals and pegmatite box to each pair and a magnifying glass to each student. Tell students to remove the rocks (A-F) from the box. Leave the minerals and pegmatite in the box.

Your Notes:

____

____

____

- Scientists can classify rocks as *fine-grained* or *coarse-grained*. Coarse-grained rocks have large crystals of different minerals, and fine-grained rocks have very small crystals that are difficult to see.
- **Extrusive igneous rocks** cool and harden much more quickly since they form at the Earth's surface where the temperature is cooler. Since they cool quickly there is not as much time for large, visible crystals to form. **Extrusive rocks are fine grained**
- **Intrusive igneous rocks** form deep within the Earth where they cool much more slowly because the temperature is higher. Crystals have more time to grow larger. **Intrusive rocks are coarse grained.**

Tell students to sort the rocks into 2 sets - fine and coarse grained.

Ask students what rocks are fine grained and which are coarse grained.

A, B, C have no crystals and are fine-grained. D, E, F have large crystals and are coarse-grained.

B. Basaltic Versus Granitic Rocks

- The color of a rock depends on the elements in the minerals in the rock.
- **Granitic (also called Felsic)** rocks are light-colored because they contain minerals that have more silicon, sodium, aluminum and potassium (don't emphasize elements, focus on the color).
  - Granite is the most common granitic rock.
- **Basaltic (also called Mafic)** rocks are dark-colored and contain minerals that have more calcium, iron and magnesium.
  - Basalt (*buh-salt)* is the most common Basaltic rock.

Tell students to sort the rocks into 2 sets - light-colored and dark-colored.

They might have trouble classifying rocks B and E. Tell the students that these rocks are called **intermediate** because they are made from a mix of Granitic and Basaltic lava.

Ask students which rocks they think are Granitic *(A and D),* Basaltic *(C and F).*

Pass out the laminated mats for igneous rocks AND the Venn diagram (1 per pair).

	Basaltic/Mafic Igneous Rocks	Intermediate Igneous Rocks	Granitic/Felsic Igneous Rocks
Extrusive Igneous Rocks Formed **above** Earth's surface from **lava**	Basalt **(BUH-SALT)** C	Andesite **(AND-UH-SIGHT)** B	Rhyolite **(RYE-OH-LIGHT)** A
Intrusive Igneous Rocks Formed **below** Earth's surface from **magma**	Gabbro **(GAB-ROW)** F	Diorite **(DIE-OH-RIGHT)** E	Granite **(GRAN-IT)** D

Refer to the images as you talk about key terms below

Tell students to place the rocks on the chart, matching the letters to the corresponding spaces.

Walk around and help them to do this as needed.

Explain that:

- The top row contains **Extrusive Igneous Rocks** that formed from **lava** on the **Earth's surface.** These rocks are fine-grained.
- The bottom row of rocks contains **Intrusive Igneous Rocks** that formed from **magma below the Earth's surface**. These rocks are coarser grained ("speckled"). Students may or may not know that the "specks" are crystals of minerals.

Your Notes:

- The color gradually gets lighter from left to right.
- The rocks in the blue column are lighter in color and are Granitic
- The rocks in the red column are darker and are Basaltic.

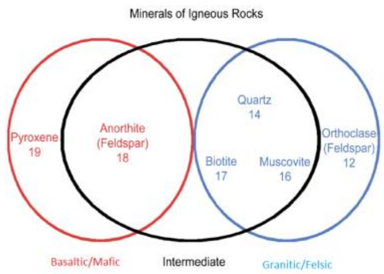
Tell students that the reason for the difference in colors will be more obvious after they have examined the minerals that make up the rocks.

C. Minerals of Igneous Rocks

Learning Goal: Students remember that minerals are the building blocks of rocks

Tell students to place the Venn diagram below the igneous rock mat.

Have the students place the minerals on the diagram, matching the numbers to the corresponding spaces. Remind students that **minerals** are the building blocks of rocks. The igneous rocks are different combinations of these minerals.



The colored circles/ovals in the Venn Diagram correspond to the three columns in the table:

- Any mineral in the blue circle can be found in a granitic/felsic rock.
- Any mineral in the black circle can be found in an intermediate rock.
- Any mineral in the red circle can be found in a basaltic/mafic rock.
- Minerals in overlapping ovals can be found in both corresponding rock types

***Ask students*:**

- What difference do they see in the colors of the minerals?
  The color gradually gets lighter from left to right.
- What is the relationship between the color in the minerals and rocks?
  The color of the rock depends on the minerals that make up the rock. The minerals that make up the basaltic rocks tend to be darker than those that make up the granitic rocks. Intermediate rocks are made from some granitic minerals and some basaltic minerals.

D. Examining Pegmatite

Tell students to look at the large-grained igneous rocks (D, E and F) and the pegmatite (H) with the magnifying glasses to observe the minerals in them.
Note: The name **Pegmatite** refers to an igneous rock with especially large mineral crystals. It does not have a specific mineral composition.

Walk through the minerals of the pegmatite with the students:

Using the minerals placed on the Venn diagram as a reference, ask students if they can see: *Orthoclase feldspar, quartz, muscovite, and biotite.*

Note: If the samples have a salmon/pink colored mineral, point out to students that it is a type of orthoclase feldspar (12) that has impurities that makes it pink instead of the white mineral they have in front of them.

Tell students that other minerals are present but that we have listed only the largest/easiest to see.

Your Notes:

____

____

____

Based on the minerals listed, ask the students:

Is the pegmatite intrusive or extrusive? *Intrusive because it has large crystals*

Is the pegmatite granitic, intermediate, or basaltic? *Granitic because it's made of the minerals that are found in granitic rocks. It may also be lighter in color.*

III. Where do these Igneous Rocks come from?

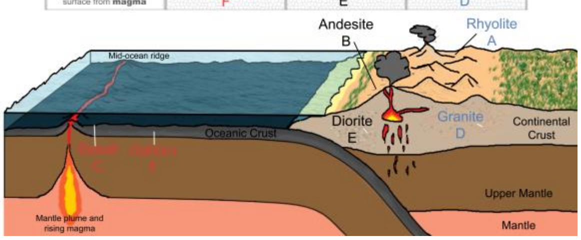
Learning Goals: Students identify the source of different igneous rock types.

Have the students place the rocks on their labels on the landscape diagram below the chart.

Tell students to notice where these rocks are forming.

- Darker basaltic rocks form from cooling of lava or magma from the ocean splitting apart at rifts, also called mid-ocean ridges.
- Lighter granitic rocks form from violent eruptions of volcanoes on land.

	Basaltic/Mafic Igneous Rocks	Intermediate Igneous Rocks	Granitic/Felsic Igneous Rocks
Extrusive Igneous Rocks Formed **above** Earth's surface from **lava**	Basalt C	Andesite B	Rhyolite A
Intrusive Igneous Rocks Formed **below** Earth's surface from **magma**	Gabbro F	Diorite E	Granite D



Ask the students to put their rocks and minerals back in their boxes so that VSVS volunteers can collect the boxes and the mats while setting up for the next part of the lesson.
VSVS volunteers MUST look at every box before they remove them from the table, to make sure all materials have been put back.

IV. Examining Volcanic Rocks

Learning Goals: Students observe demonstrations to understand how shield and stratovolcanoes can produce igneous rock.

Pass out one volcano diagram to each pair.

Ask the students if they know the difference between a **<u>shield volcano</u>** and a **<u>stratovolcano</u>** (also known as **Cinder Cone volcanoes).**
Shield volcanoes *are broad volcanoes that have slow moving lava flows.*
Stratovolcanoes *are tall, steep volcanoes that erupt explosively.*

Tell students to look at the Volcano diagram handout and explain the difference between the 2 volcanoes

SHIELD VOLCANOES:

- Are named because they look like upside down shields.
- Are spread out over a wide area and are almost continuously erupting.

Your Notes:

____

____

____

- Form as lava flows in all directions, cools, and builds up in layers over time.
- Can be found in Hawaii. Lava from Kilauea Volcano was in the news in 2015, as it flowed towards a shopping center.
- Tend to have **basaltic** lava, which flows easily.

STRATOVOLCANOES (Cinder Cone volcanoes):
- Are usually very tall and very steep.
- Erupt explosively all at once, sending out clouds of hot ash and gases as well as flows of lava.
- Mt. St. Helens and Vesuvius – the volcano that destroyed Pompeii – are both stratovolcanoes.
- Stratovolcanoes tend to have **granitic** lava, which flows slowly.

Additional Information for VSVS members:
Stratovolcanoes are more explosive in nature and deadlier. They are often found on shores because of plates moving underneath the Earth's surface. These volcanoes are very dangerous because of ash clouds and pyroclastic flows that form when they erupt. Ash clouds can form a glassy layer inside the lungs, which end up suffocating the victim. Pyroclastic flows are extremely fast and large clouds of hot gas whose temperature can reach up to 300°F and can travel at speeds of 200 miles per hour.

A. Demonstration - Stratovolcanoes vs. Shield Volcanoes
Materials:

Deep plastic box with lid containing:

1	Margarine container
2	Lids – 1 with multiple small holes and 1 with no holes
16oz	water
1	Small plastic plate
1	Small dropper bottle of detergent
1	Small container of dry ice
1	Pair of tongs

SAFETY GUIDELINES:
1. **VSVS VOLUNTEERS MUST WEAR SAFETY GOGGLES WHILE DOING THIS DEMONSTRATION.**
2. **KEEP THE MARGARINE CONTAINER IN THE BOX FOR THE STRATOVOLCANO DEMONSTRATION.**
3. **USE THE TONGS TO HANDLE DRY ICE**

Tell students that we will be demonstrating shield volcano and stratovolcano eruptions.

For the shield volcano:
1. Take the margarine container out of the box and place it on the small plastic plate so that the students can see the demonstration better.
2. Fill the margarine container 2/3 of the way full with water.
3. Add one squirt of laundry detergent to the water.
4. Using the tongs, drop 2 pieces of dry ice into the container.
5. Quickly place the lid *with multiple small holes* on top of the container, making sure to press it on fully.

Your Notes:

The mixture should start to slowly ooze out of the holes in the lid. Explain that this is similar to how lava in a shield volcano eruption slowly leaves the volcano and slowly flows down around all sides.

For the stratovolcano:

1. Put the margarine container back in the deep plastic box.
2. Make sure the margarine container is 2/3 full of water.
3. Using the tongs, drop 2 pieces of dry ice into the container.
4. Quickly place the lid *without holes* on top of the container, making sure to press it on fully.
5. Step back and watch the lid first bulge and then fly off.

Point out that lid bulges as gas builds up inside the margarine container– this didn't happen with the shield volcano.
This is similar to how gas builds up in a stratovolcano just before it explosively erupts, sending material (and lava) outwards in all directions, just as the lid violently flew off.

Repeat the demonstrations, making sure to point out the slow oozing of the shield volcano demo and the **lid bulging** before the eruption in the stratovolcano demo.

B. Special Types of Volcanic Rock

Materials:

1 clear 16oz cup
8 Plastic Cases with two sets of Volcanic Rocks - (Box #4 – 2 pairs of students will share the case)
16 magnifying glasses from Part III

Pass out the cases of volcanic rocks labeled (M-T). Each group of four should get one case that contains two sets of rocks.

Tell students that these are special kinds of igneous rocks called **volcanic rocks** because they come from volcanoes. **All of the rocks in the cases come from stratovolcanoes.**

Have students work with their partner to make observations about each rock.
As they make observations, they should fill in the chart on the back of their observation sheets.
If time is short, discuss the differences between the rocks as a class and take notes on the board.

While the students are working, walk around and engage them in conversation about what they are observing and make sure that they are recording their observations on their observation sheet.
After a few minutes, have the students stop working, and ask them about their observations.

- Pronounce the name of each rock
- Ask them what they observed or what they think makes the rock unique
- Mention some (**not all**) of the fun facts provided for each rock below.

Your Notes:

Volcanic Rock Fun Facts:

M. Vesicular Basalt (***veh-sick-you-ler buh-salt***)

- This rock is made of the same minerals as the basalt we looked at earlier.
- The word *vesicular* means it has small cavities or air pockets because the gas didn't escape before the rock cooled.

N. Scoria (***skur-ree-uh***)

- It is made from lava that had a lot of gases trapped inside.
- These gases form large bubbles in the lava which remain as **holes or cavities** in the solid rock.

O. Pumice (***pum-iss***)

- When lava is extremely rich in gases, it can begin frothing or foaming.
- When this **foam is violently ejected** from the volcano and **solidifies**, pumice is formed.
- Pumice will **float on water**.
- Pumice is commonly used as scouring stones or in exfoliating creams.

Show students that pumice will float – use the 16 oz cup, add water, and add a piece of pumice.

P. Obsidian (***ub-sid-dee-in***)

- Obsidian is also known as **volcanic glass**, and has a **smooth, glassy appearance**.
- It is formed when lava from a volcano **flows into water** (a lake or ocean), which causes it to cool so quickly that **no mineral crystals can form**.
- The red streaks tell us **how the lava was flowing** when it cooled.
- In the past, obsidian was used to make arrowheads and other tools.

R&T. Ash Tuff (*ash tough*) & Vitric Tuff (*vit-trick tough*)

- Volcanic tuff is rock formed when **debris** from an explosive volcano piles up and is later **compressed into a solid rock**.
- Sample **R** is called ash tuff because it is mainly composed of **volcanic ash** pressed together to form a solid rock.
- The word *vitric* means glassy, and vitric tuff is made up of bits of volcanic glass (obsidian).

CLEAN UP:

1. **Collect all volcanic rocks and put into cases in their labeled positions.**
2. **Collect the volcano diagrams and the magnifying glasses.**
3. **Empty the liquid from the margarine container.**

Lesson written by: Pat Tellinghuisen, Program Coordinator of VSVS 1998-2018, Vanderbilt University
Courtney Luckabaugh, Lab Manager of VSVS, Vanderbilt University
Edited by: Kyle H. Broach, VSVS Training Committee, Vanderbilt University
Lucas Loffredo, VSVS Training Committee, Vanderbilt University
Megan Covington, VSVS President, Vanderbilt University
Reference: Chernicoff, S., & Whitney, D. (2007). *Geology: An Introduction to Physical Geology.* Upper Saddle River, New Jersey: Pear

Your Notes:

___

___

___

Igneous Rock Observation Sheet Answers

I. Introduction – What are Igneous Rocks? – Circle your answer

1. (Sedimentary, metamorphic, ***igneous***) rocks form when melted rock material cools.

2. Igneous rocks formed from lava form *on or above* the Earth's surface are called (intrusive, ***extrusive***) igneous rocks.

3. Igneous rocks formed from magma *underneath* the Earth's surface are called (***intrusive***, extrusive) igneous rocks.

II. Examining Igneous Rocks

4. Which kind of rock – granitic or basaltic – tends to be light in color? ***Granitic***

5. In your chart, what differences do you notice between the extrusive igneous rocks in the top row and the intrusive igneous rocks in the bottom row? ***The extrusive igneous rocks in the top row are fine-grained, whereas the intrusive igneous rocks in the bottom row are speckled/have visible crystals.***

6. Circle your answer: The color of an igneous rock is determined by (where it forms, ***what minerals it is made of***, the temperature of the lava around it).

7. What minerals do you observe in the pegmatite sample? ***Orthoclase feldspar, quartz, muscovite, and biotite***

8. Do you think pegmatite is intrusive or extrusive? Why? ***Intrusive because it has large crystals***

IV. Examining Volcanic Rock

For the chart, possible answers include the appearances of the rocks, how shiny they are, how heavy they are (pumice should be very light, for example), or anything else observable about the rock

VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE
http://studentorg.vanderbilt.edu/vsvs

Stratigraphy

Spring 2022

Goal: To introduce students to the geological time scale, fossils, sedimentary rock columns, index fossils, and column correlation methods.
Introduces/reinforces TASS: 8.LS4.1 Analyze and interpret data for patterns in the fossil record that document the existence diversity, extinction, and change in life forms throughout Earth's history.

VSVSer	Lesson Outline:
	I. Sedimentary Rock Layers/Columns
_______	A. Sedimentary Rocks
_______	B. Creating a Model of Sedimentary Layers
_______	C. Explaining the Column
_______	D. Index Fossils and Radioactive Dating
_______	E. Finding the Ages of the Layers in Our Column
_______	**II. Stratigraphy (Correlating Columns)**
_______	**IIB. Correlating Stratigraphic Columns**
_______	**III. Timeline of the Earth**

LOOK AT THE VIDEO BEFORE YOU GO OUT TO YOUR CLASSROOM (https://studentorg.vanderbilt.edu/vsvs/lessons/)
USE THE PPT AND VIDEO TO VISUALIZE THE MATERIALS USED IN EACH SECTION.

1. Before the lesson:

In the car ride, read through this quiz together as a team. Make sure each team member has read the lesson and has a fundamental understanding of the material.

Stratigraphy Lesson Quiz

1. How do sedimentary rocks form? *formed from sediments deposited in oceans, lakes or rivers*
2. What is the age of a fossil relative to the rock in which it is found? *relatively the same age*
3. Which layer in a stratigraphic column is the oldest? *the bottom*
4. Explain how you can compare two different stratigraphic columns from different parts of the world. *the columns can be correlated using index fossils*
5. Give an example of an index fossil and explain why it is useful. *Trilobites are commonly used as index fossils to determine the age of certain landmarks. They are great for determining the movement of plate tectonics.*

2. During the Lesson:

Here are some fun facts for the lesson

1. Nashville sits in a valley surrounded by limestone layers. Fossils can be seen embedded in the limestone.
2. Evidence for the asteroid that killed the dinosaurs is seen in various stratigraphic columns. There is a worldwide layer of iridium dating back to the time when the dinosaurs were wiped out. Iridium is more common in meteorites than it is on Earth.

3. Trilobites are commonly used as index fossils to determine the age of certain landmarks. They are great for determining the movement of plate tectonics. Scientists today are still unsure of why the trilobites went extinct.

Unpacking the Kit – What you will need for each section:

IB. Creating a Model of Sedimentary Layer

For demonstration:

1 box containing materials for demonstrating the layering:
1 plate, 1 column container, 1 bottle of water
Jars 1-5 of sand, with different colors of sand representing different types of sedimentary rock and different stones representing fossils:

For students:

10 plates, 10 column containers (jars containing water), 10 bags containing jars of sand (to represent different types of rocks and fossils):

- Jar 1: White sand containing black rocks
- Jar 2: Orange sand containing white rocks
- Jar 3: Black sand
- Jar 4: White sand containing white rocks
- Jar 5: Tan sand containing white rocks and tan/red rocks

36 observation sheets
20 Handouts with Column Diagram,

ID. Index Fossils and Radioactive Dating

10 models of rock layers/fossils encased in boxes

IIA. Stratigraphy (Correlating Columns)

20 sets of colored stratigraphic columns (National Park Sequences)

IIB. Correlating Stratigraphic Columns

20 sets of 3 stratigraphic sequences

For Part III. Timeline of the Earth

1 cylinder containing the string timeline

I. Sedimentary Rock Layers/Columns

Learning Goals:

- **Students understand how sedimentary rocks are formed.**
- **Students experiment with forming sedimentary layers and understand that fossils are deposited at the same time the as the sediment.**
- **Students understand that sediments are deposited in <u>horizontal</u> layers**
- **Students understand that older layers are at the bottom in a sedimentary layer, while younger layers are at the top**

Why is the science in this lesson important?

An understanding of stratigraphy is useful for understanding when and how life originated on Earth, as well as for studying evolution and historical changes in Earth's ecosystems. Potential careers that benefit from an understanding of stratigraphy include paleontologists, archaeologists, and soil scientists.

A. Reviewing Sedimentary Rocks

Your Notes:

____

____

____

- Q. Ask students what they know about sedimentary rocks. If these answers aren't given, go over them briefly:
  - Most sedimentary rocks are formed from sediments deposited in oceans, lakes or rivers.
  - Sediments form layers that pile on top of each other, which compress over time to create rock.
  - Types of sedimentary rock include sandstone, limestone, and shale.

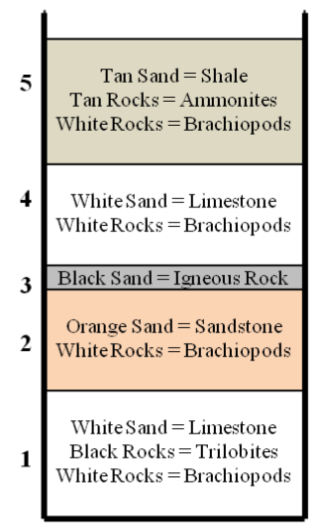
- Q. Ask for a show of hands of which students have seen rock layers on the sides of the highway while driving around Nashville – this is sedimentary rock! Ask if anyone knows what type of rock this is.
  - *Limestone*
- Tell students that we are going to create a model of sedimentary rock layers.

B. Creating a Model of Sedimentary Layers

- Set up at the front of the class the apparatus to create the sedimentary rock column demonstration

  Materials for VSVS demo

  1 plate
  1 column container
  1 bottle of water
  1 set of numbered jars of sand, with different colors of sand representing different types of sedimentary rock and different stones representing fossils:
  - Jar 1: White sand containing black and white stones.
  - Jar 2: Orange sand containing white stones.
  - Jar 3: Black sand.
  - Jar 4: White sand containing white stones.
  - Jar 5: Tan sand containing white and tan/red stones.



Materials for students, per group:

1 plate, 1 column containers (jars containing water), 1 set of jars of sand (1-5, to represent different types of rocks):

36 observation sheets
20 Handouts with Column Diagram,

- One VSVS member should draw a large diagram on the board to represent the column, based on the diagram on this page.
  - Do not draw the entire finished diagram. Start with the open-top rectangle representing the column (bolder lines). As each jar of sand is added, draw the layer line and write the color of the sand and rocks.
- The other VSVS members should hand out the columns (jar), jars of sand, water, and plates (1 per group of students).

  Put the column on the plate to catch spills.

- Demonstrate how to create the column and have the students do each layer after you do.
  1. Pour the container of water into the column, reminding students that sedimentary rocks form when sediments settle out of water and form layers.

  2. Explain to students that we are using different colors of sand to represent different types of sedimentary rock, and different color stones to represent fossils. **Point out that the fossils (stones) get deposited at the same time as the sand and rocks.**

Your Notes:

___

___

___

3. Pour all of the sand and rocks from container #1 into the column. Wait until each layer settles (~30 seconds) before pouring the next layer. Make sure students are adding the jars of sand to the column in the correct order (#1 first ...)
4. When settled, pour all of container #2's contents into the column and wait for it to settle. Then container #3's contents, and so forth until all 5 containers are used. Make sure to update the drawing on the board as new layers are added.

C. Explaining the Column

- Q. Ask students to describe what happened when they poured each layer of sand.
  - *Sand settles through the water to make a flat layer at the bottom of the column.*
  - This is similar to sediment settling out of water to form layers; over millions of years the sediment is compressed and turns into rock.
  - Explain that sediment is deposited in horizontal layers, and it stays that way unless something disturbs it.
  - Have students answer Question 1 on their observation sheet.
    1. *Sediments settle and form rocks in* ***___horizontal_****layers.*

  - **Fossils are deposited at the same time the rock material is deposited. Therefore, the ages of the fossil and rock in which it is found are the same.**
  - Have students answer Question 2 on their observation sheet.
    2. *What is the age of a fossil relative to the rock in which it is found?* ***The same_***

- Tell students to imagine that the process of creating their sand columns took millions of years to occur.
- Tell students that different rock layers represent different periods of time.
  - Q. Ask students which layer is the oldest in the column.
    - *The bottom layer; it was deposited first and other layers were deposited on top of it.*
  - Q. Ask students which layer is the youngest in the column.
    - *The top layer; it was deposited last, on top of all other layers.*
  - How old are the middle layers? *(You can't tell for sure! But they are older than the top layer and younger than the bottom layer.)*
  - Have students answer Question 3 on their observation sheet.
    #3. Older layers are ***__at the bottom_*** *in a column of sedimentary layers, while younger layers* ***__are at the top__.***
  - Fossils succeed each other in a definite order – the oldest fossils in a series of layers will be in the lowest layer.

D. Index Fossils and Radioactive Dating

Learning goals:
- **Students observe a model of a stratigraphic column that includes fossils.**
- **Students correlate the model with the sedimentary column that they created.**
- **Students learn what an index fossil is and realize that in the model, the ammonites and trilobites are index fossils. Index fossils are used for dating rock layers.**
- **Students learn that radioactive elements are used for dating rock layers.**

Your Notes:

___

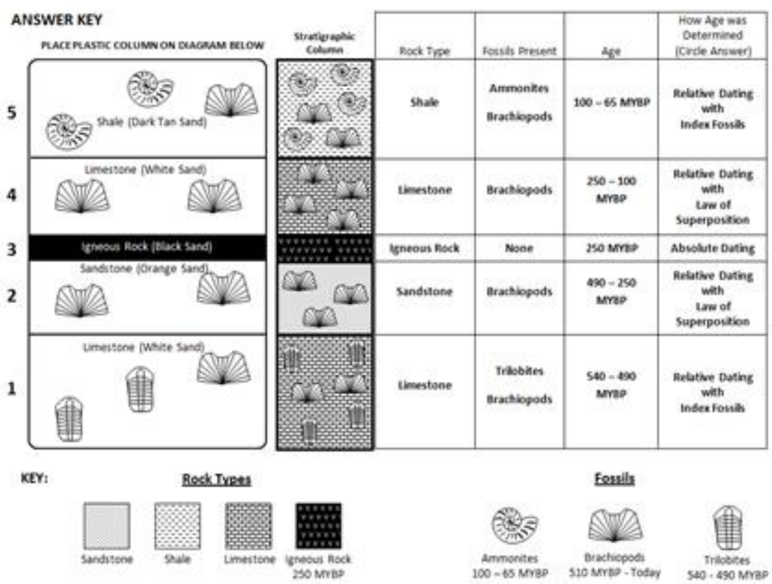
___

___

Pass out 1 model of rock layers/fossils encased in boxes plus the “Column Analysis” worksheet to each group of students. Have them hold the model beside their sand column and tell them that the model has the same pattern of layers from the sand column. The fossils in the box model are real and are represented by different colored pebbles in their columns

- Explain that the second column (called **Stratigraphic Column**) on the worksheet is the way geologists would represent such a column and that the key on the bottom of the page shows what each symbol means.

- Tell students names of type of rock and fossils in each layer.
  - *Top layer: ammonites and brachiopods in shale*
  - *Bottom layer: trilobites in limestone*
  - *Middle layers 2 and 4: brachiopods in limestone or sandstone*
  - *Middle #3: Igneous rocks*
- Tell students that fossils are often incorporated into sedimentary rocks. The sediment that buries them later forms into rocks with the fossils inside.



Using Index Fossils to find the Age of Rock Layers

- Tell students that in real sedimentary rocks, some fossils are found in many layers, while some are found in only one layer.
  - Q. Ask students which type of fossil, one found in many layers or one found in only one layer, would be more useful for identifying the age of a rock layer. (A tough question – give them hints and walk them to the answer if necessary!)

    A. *Fossils found only in one rock layer can be used for identifying the age of the rock layer. If a fossil is found in many different layers, the age of the layers can’t be identified using fossils.*

- Tell students that fossils that are only found in one layer, can be used for identification/rock dating purposes. These fossils are called **index fossils**.
- Have the students answer Question 4 on their observation sheet.

Your Notes:

___

___

___

*#4. __**Index fossils**__are fossils found in only 1 layer of sedimentary rock and can be used for identification/rock dating purposes.*

- Q. Ask students which fossil(s) in their column would be considered index fossils, and which would not be considered index fossil(s)

  A. Ammonites and trilobites are only found in one layer, so they would be considered index fossils; brachiopods are found in all layers, so the brachiopod is not an index fossil.

Using Absolute Dating with Radioactive Elements to find the Age of Rock Layers

Tell students to look at layer # 3 in their column – the thin black layer.

A. When there is a dark, skinny layer in a sedimentary rock column, it is usually the result of lava or volcanic ash interrupting a sedimentary rock layer – it is an igneous rock, not a sedimentary rock.

B. Igneous rocks contain radioactive elements like uranium, rubidium, thorium, and potassium – scientists can use these elements to determine the exact age of these rocks.

E. Finding the Ages of the Layers in our Column

Learning Goals: Students will determine the ages of the layers in the model.

- Tell students they are now going to use their model to determine the ages of the "rock" layers. As they go through the column, layer-by-layer, point out what rock types and fossils are represented in the columns. The answers for the rock types and fossils are already given on the worksheet. The students will be asked to determine the ages (relative or absolute) of each layer.

A. The black layer (third layer from the top) is an <u>igneous rock</u>.

How can we find the age of this layer?

*By using **absolute dating** with radioactive elements.*

In this hypothetical case, we will say that this layer is **250 million** years old.

Tell students to enter this data on their worksheet.

- Ask students how an igneous rock might get into a sedimentary layer?
  - Answers should include **volcanic ash** settling out many miles away from an erupting volcano, **lava flows** above ground, or **magma** intruding into rock layers below the surface.

For VSVS Information only:

Most igneous rocks can be dated radiometrically because they contain unstable radioactive elements that decay.

Carbon-14, uranium-238, rubidium-87, thorium, potassium are the most common (isotopic) elements studied.

Igneous rocks can be given a **numerical age** by radiometric dating methods.

Two layers contain index fossils. Which layers are these?

The tan layer (on top) and the white layer on the bottom both contain fossils that aren't found in any other layers. *Ammonites and Trilobites are index fossils and scientists know how old they are (over a range of time).*

So how can we find the ages of these layers?

Your Notes:

___

___

___

Ammonites (in the tan layer on top) lived from 100 million years ago until 65 million years ago – this is the range in which this rock was deposited in.

Tell students to enter this data for the top layer (100-65 MY old, and circle Relative dating with index fossils).

Trilobites (in the white layer on bottom) lived from 540 million years ago until 490 million years ago – this is the range in which this rock was deposited in.

Tell students to enter this data for the bottom layer (540 - 490 MY old, and circle Relative dating with index fossils).

How do we find the dates the other two layers were deposited in?

Relative dating.

We know that the white layer second from the top must have been deposited between the top layer (100 million years ago) and the third layer (250 million years ago)

The orange layer (fourth from the top) must have been deposited between the bottom layer (490 million years ago) and the third layer (250 million years ago).

Tell students to enter this data for layers 2 and 4.

II. Stratigraphy (Correlating Columns)

Learning Goals:
Students look at real life example of stratigraphic columns in 3 National Parks
Students learn how geologists can correlate sedimentary layers many miles apart.

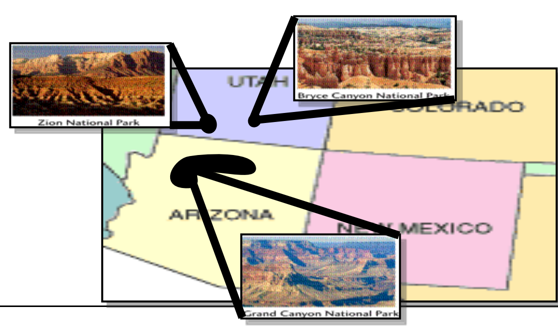
- Tell students that sedimentary rock layers often stretch across entire continents. Sometimes these layers are connected; however, often layers have been removed in some locations by erosion, and some are buried under other layers and can't be seen by us yet.

A. National Park Rock Sequences

- Pass out a set of colored stratigraphic columns (paper-clipped together) to students.

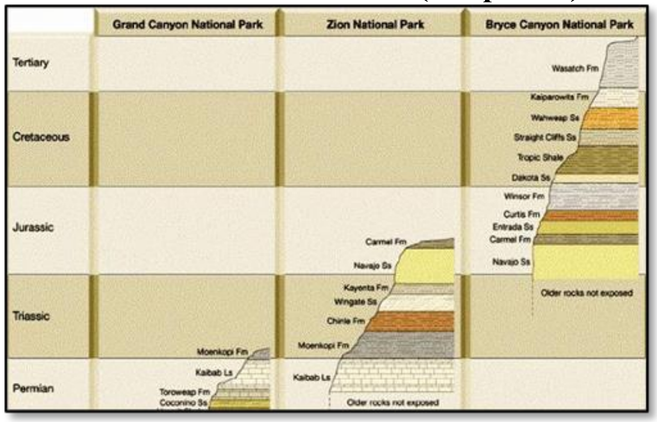
- Tell students that these columns represent actual sedimentary layers taken from the National Parks (Graphic A); they have been cut from the stratigraphic columns in Graphic B, on Handout #1.)
  - Have students separate the columns and put them at their correct National Park locations on the map (Graphic A) in Handout #1. Tell them that although erosion has affected each location differently, they all still show some of the same layers. Have the students put them in stratigraphic order, then place them on the map.
  - Point out that columns can correlate over large distances.
  - Have them put the complete, paper-clipped columns back together and collect them from the students.

Map of National Parks (Graphic A)



Your Notes:

National Park Correlations (Graphic B)



B. Correlating Stratigraphic Columns

- Pass out the set of 3 stratigraphic sequences to each student. Tell students to imagine that these are 3 sequences of rocks found in different places around the US.
    - Tell students to find in sequences A and B at least 2 layers whose index fossils and rock types match.
    - Emphasize that the depth of the layers does not have to be the same.
    - Students should place the sequences side-by-side with matching layers touching.
    - Have them repeat the process with sequences B and C.
    - This can get tricky, so VSVS members should walk around and help students with the task.

- Pass out the longer laminated strip (1 per pair) and tell the students that this geological column is the one they have just compiled from their short sequences. This can tell us a lot more about the geologic history of the earth than the individual columns can.
- Q. Which short strip has the oldest rocks exposed and how do we know?
    - *Location A, because it contains the oldest fossils and has the bottom layers in the geological columns.*
    - These layers still exist at locations B and C, they just haven't been exposed yet.
- Q. Which short strip has the youngest rocks exposed and how do we know?
    - *Location C, because it has the top layers in the geological column.*
    - These layers are missing at locations A and B because of erosion.

VSVS members should collect the columns and answer any questions the students have.

III. Timeline of the Earth (If time permits – do as much as time allows)

Learning Goals: Students can "see" the time scale of earth's history from a model.

A. Introduction

- Q. Ask the class if anyone knows how old the earth is.

Your Notes:

____

____

____

- *4.6 billion years old, or 4600 million years old. Write the number out in full on the board so they understand how much time this is (4,600,000,000).*

- Tell students that the timeline of earth's history is called the geologic time scale. We will show them a rope that represents, to scale, this timeline.
- It is divided into 4 major periods called eons, which are further divided into eras. The boundaries between geological times correlate with major changes on earth.

B. Time Scale Model

Tell students to look at the timeline on the observation sheet

- Hold up the time scale model (the cylinder) with just a small piece of string pulled out so that all students can see it. Tell students:
  - The string represents the timeline of the earth's history – the complete geologic time scale over its entire duration of 4.6 billion years.
  - The string is divided into the 4 eons, and the last eon is divided into eras.

Note – the string is 19 feet long, so make sure you have enough room to "spread".

  - One VSVS member or student volunteer will hold the string and another will hold the container and walk to the right while removing each eon and stopping when a knot is reached.
  - A VSVS member will describe each eon to the students, while another writes the information regarding each eon and era on the board as they are introduced.
  - The string must be kept taught in a straight line so that the students get the concept of the length of time taken for each eon.
- **Hadeon Eon**
  - Pull the first (<u>camouflage-colored</u>) section of the string out, and stop as soon as you get to the first knot (between color changes). Tell students:
  - This is the **Hadeon Eon**, from 4.6-3.8 billion years ago.
  - No living organisms during this time, but the oldest known rocks existed (found in the Canadian Rocky Mountains).

Eon:	Hadean Eon	Archean Eon	Proterozoic Eon	Phanerozoic Eon
Years:	4.6-3.8 billion years ago	3.8-2.5 billion years ago	2.5 billion years ago - 540 million years ago	540 million years ago - now
Major Events:	Oldest earth rocks form	Single-cell organisms evolve	Multi-cell organisms evolve	Advanced organisms like plants, mammals, and fish

Era:	Paleozoic Era	Mesozoic Era	Cenozoic Era
Dominant Organisms:	Invertebrates (trilobites, crinoids, ammonites, brachiopods)	Dinosaurs, birds	Mammals

Archean Eon

- Pull the second (<u>tan</u>) segment of the string until the second knot is reached. Tell students:
  - This is the **Archean Eon**, from 3.8-2.5 billion years ago.
  - The first single-cellular organisms lived during this time (fossils found in Australia).

Proterozoic Eon

- Pull the third (<u>white</u>) segment of the string until the third knot is reached. Tell students:
  - This is the **Proterozoic Eon**, from 2.5 billion years ago to 540 million years ago.
  - The first multi-cellular organisms lived during this time (fossils found in Michigan)

Phanerozoic Eon,

Your Notes:

____

____

____

- Pull out and display the black end of the string. Tell students:
    - This is the **Phanerozoic Eon**, from 540 million years ago to now.
    - Plants, fish, and animals came to exist as we know them today during this time.
    - This last eon is subdivided into 3 smaller time intervals called **eras**.

C. Looking at the Phanerozoic Eon Timeline

- Tell students to look at the Phanerozoic Eon time line. Focus students' attention on the black (Phanerozoic Eon) section of the rope.
    - The different colors (pink, green and yellow) show the different **eras**. The colored string twisted around the black cord corresponds with these eras on the placemat.
    - The organisms shown lived and thrived on earth during the time periods their boxes overlap with; both fossil and living pictures are displayed.

- Tell students that each era ends with the extinction of a large amount of animals on earth.
    - Q. Ask students if they know what extinction means.
        - *When the last remaining members of a species have died out.*

- Point to the pink section of the timescale, and identify it as the **Paleozoic Era**. Tell students:
    - Simple animals called invertebrates dominated the earth in this era. Pictures of different types of invertebrates (trilobites, ammonites, crinoids, and brachiopods) can be seen on the timeline; point them out to the students**. Emphasize that the earliest trilobite is an index fossil.**
    - Early fish, land plants, and reptiles develop but are not common yet.
    - 90% of all species of animals went extinct at the end of this era. (Emphasize to students the magnitude of this extinction – tell them to imagine 90% of animals on earth dying.) (If students ask why – scientists are still investigating!)

- Point to the green section of the timescale, and identify it as the **Mesozoic Era**. Tell students:
    - Dinosaurs and other reptiles dominated the earth in this era.
    - Small mammals, birds, flowering plants, and flies also were common
    - 50% of all species of animals went extinct at the end of this era. (If students ask why, tell them that most scientists agree that it was due to impact of a large meteorite near Mexico.)
    - **The later ammonites are index fossils**

- Point to the yellow section of the time scale as the **Cenozoic Era**. Tell students:
    - This era continues up until today
      Mammals dominate the earth in this era.
    - Q. Ask students if they've thought about how long humans have existed in the geologic time scale. *Humans have only existed in the very last knot of the rope (the dangling skeleton). This is an extremely short time in the history of the earth.*

Lesson written by: Pat Tellinghuisen, Program Coordinator of VSVS1998-2018, Vanderbilt University
Courtney Luckabaugh, Lab Manager of VSVS, Vanderbilt University
Edited by: Kyle Broach, VSVS Training Committee, Vanderbilt University
Lucas Loffredo, VSVS Training Committee, Vanderbilt University
We gratefully acknowledge the assistance of Dr. Molly Miller, Professor Emeritus of Earth & Environmental Sciences, Vanderbilt University.
Reference:Chernicoff, S., & Whitney, D. (2007). *Geology: An Introduction to Physical Geology.* Upper Saddle River, New Jersey: Pearson

Your Notes:

<u>Stratigraphy - Answers - Observation Sheet</u>

1. Sediments settle and form rocks in _**horizonta**l__________________ layers.

2. What is the age of a fossil relative to the rock in which it is found? **The same**.__________

3.Older layers are **at the bottom** in a column of sedimentary layers, while younger layers **are at the top.**

4.. **__Index fossils__** are fossils found in only 1 layer of sedimentary rock that is used for identification/rock dating purpose

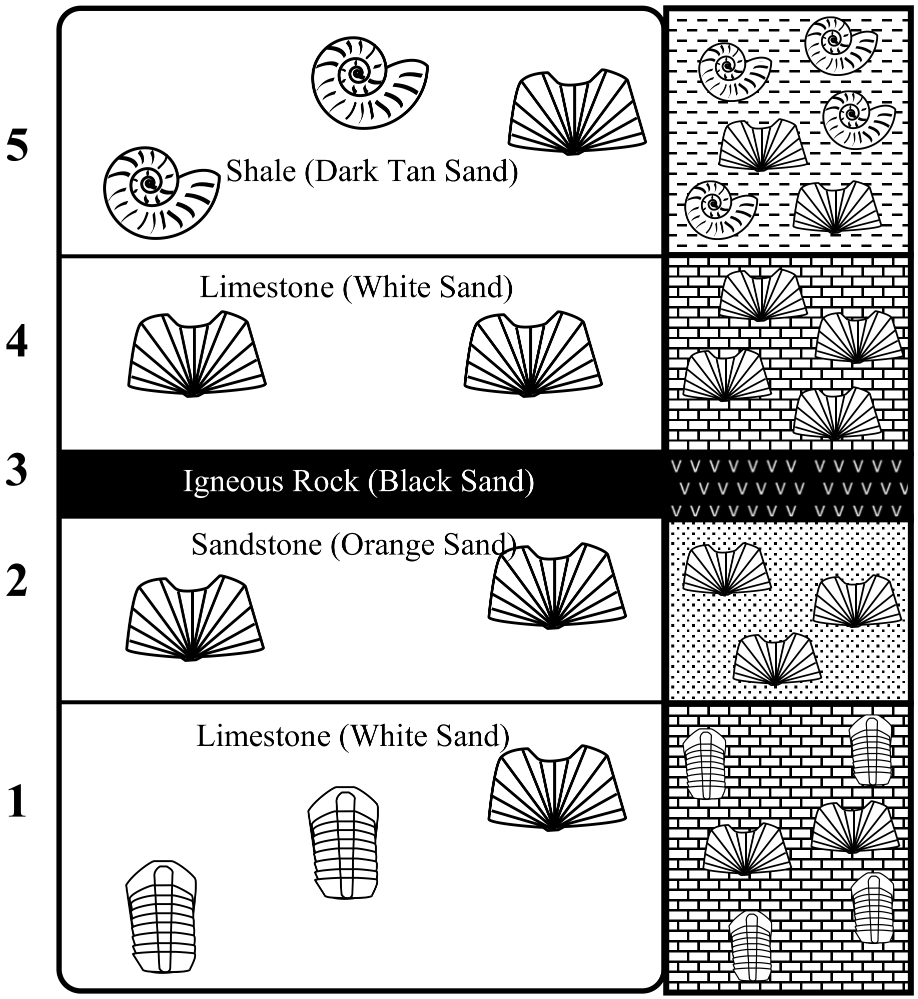
Eon:	**Hadean Eon**	**Archean Eon**	**Proterozoic Eon**	**Phanerozoic Eon**
Years:	4.6-3.8 billion years ago	3.8-2.5 billion years ago	2.5 billion years ago - 540 million years ago	540 million years ago - now
Major Events:	Oldest earth rocks form	Single-cell organisms evolve	Multi-cell organisms evolve	Advanced organisms like plants, mammals, and fish

Era:	**Paleozoic Era**	**Mesozoic Era**	**Cenozoic Era**
Dominant Organisms:	Invertebrates (trilobites, crinoids, ammonites, brachiopods)	Dinosaurs, birds	Mammals

ANSWER KEY

PLACE PLASTIC COLUMN ON DIAGRAM BELOW

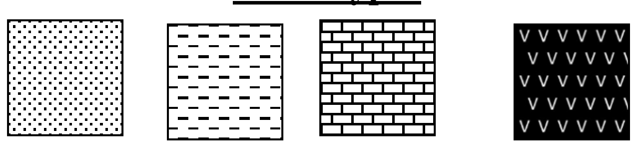
Stratigraphic Column



Rock Type	Fossils Present	Age	How Age was Determined (Circle Answer)
Shale	Ammonites Brachiopods	100 – 65 MYBP	Relative Dating with Index Fossils
Limestone	Brachiopods	250 – 100 MYBP	Relative Dating
Igneous Rock	None	250 MYBP	Absolute Dating
Sandstone	Brachiopods	490 – 250 MYBP	Relative Dating
Limestone	Trilobites Brachiopods	540 – 490 MYBP	Relative Dating with Index Fossils

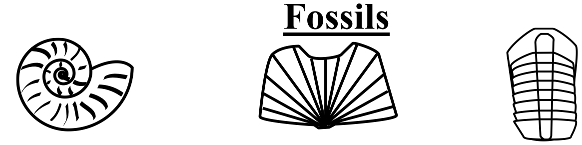
KEY:

Rock Types



Sandstone | Shale | Limestone | Igneous Rock 250 MYBP

Fossils



Ammonites 100 – 65 MYBP | Brachiopods 510 MYBP - Today

VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE
http://studentorg.vanderbilt.edu/vsvs

Vacuums and Air Pressure

Spring 2022

Goals: To introduce students to atmospheric pressure and vacuums
Introduces/reinforces TASS: 8.PS2.5 Evaluate and interpret that for every force exerted on an object there is an equal force exerted in the opposite direction.

VSVSer Lesson Plan

______ **I. Introduction to Air Pressure**

A. What is the Atmosphere?
B. What is Air Pressure?
- Activity: Water in a jar held upside-down remains inside when covered by a card.

C. Atmospheric Mat: How can we Prove Air Pressure Exists?
- Activity: Pressure acting on a mat prevents it from being picked up in the center.

______ **II. What is a Vacuum?**

A. Investigating the Action of a Vacuum Pump: How does a Vacuum Pump Work?
- Activity: The force required to pull a piston increases as more air is removed.

B. Does Air have Mass?
- Activity: The mass of a jar previously held under vacuum increases when air enters it.

C. Demonstration: How Much Air is Being Removed from the Bell Jar?
- Activity: Water rushes into a jar held under vacuum because no air is inside that jar.

______ **III. What Happens when Air Pressure is Decreased?**

A. Balloon in Jar: Pressure is All About Balancing the Inside and the Outside!
- Activity: A deflated balloon inflates when placed in a vacuum.

B. Marshmallow: How are Marshmallow Bubbles like Balloons?
- Activity: A marshmallow expands when placed in a vacuum.

C. The Suction Cup (Optional)
- Activity: Removing atmospheric pressure causes suction cups to fall.

______ **IV. Use Magdeburg Hemispheres to Illustrate Air Pressure (Optional)**
- Activity: Atmospheric pressure acting outside a hemisphere holds it in place.

______ **V. Review**

Materials
1 Atmospheric mat
1 bag containing 15 Madgeberg hemispheres – change if can to increase from 10-15
11 plastic bags with a 1bell jar, syringe and tubing (10 for students, 1 for VSVS members
1 bag containing 10 balloons, slightly inflated (about 3-4 cm in diameter). The balloon should easy to put into bell jar
1 bag containing 10 large marshmallows
1 bag containing 10 suction cups
1 plastic container with 10 scales
1 tub about 3L, large enough to immerse bell jar into it
3L water to fill above container
1 plastic box containing:
  1 jar (2oz) and 1 laminated card
  100 mL water in bottle
16 handouts
32 observation sheets

1 box of goggles (for all to wear)

Before the Lesson: In the car ride, read through this quiz together as a team. Make sure each team member has read the lesson and has a fundamental understanding of the material.

Lesson Quiz

1. How does the atmosphere cause atmospheric pressure? *Air pressure is caused by the weight of the air molecules above. Even tiny air molecules have some weight, and the huge numbers of air molecules that make up the layers of our atmosphere collectively have a great deal of weight, which presses down on whatever is below.*
2. If you squeeze a marshmallow, the pressure from your hand crushes it. Why does air pressure not crush humans? *pressure is being applied equally in all directions outside and inside our bodies*
3. What is the purpose of a check valve? *it's basically a one-way valve, in which the flow can run freely one way, but if the flow turns the valve will close to protect the piping, other valves, pumps etc.*
4. True or False: The inside of a deflated balloon is completely empty. *False*
5. Why does a deflated balloon inflate when it is placed in a vacuum? *When air outside the balloon is removed, it doesn't push as hard on the balloon but the inside air is still pushing out at full strength. As we remove more and more air, the balloon expands to nearly fill the chamber.*

Divide students into groups of 3-4 (there are 10 sets of bell jars).

Unpacking the Kit

I.B What is Air Pressure?

Pass out student handouts and observation sheets.

1 plastic box containing:

- 1 jar (2oz) and 1 laminated card
- 100 mL water in bottle

I.C. Atmospheric Mat

1 Atmospheric mat

II. What is a Vacuum?

A. Investigating the Action of a Vacuum Pump

Distribute the bell jar apparatus – there are 10 per class (plus one for VSVS members to use), so divide students into groups of 3-4. D

Distribute goggles to all students.

B. Does Air have Mass?

Distribute the10 scales to groups.

C. Demonstration: How Much Air is Being Removed from the Bell Jar?

1 tub large enough to immerse bell jar into it

3L water to fill above container

Fill the plastic tub with water

III. What Happens when Air Pressure is Decreased?

A. **Balloon in Jar**

Pass out 10 slightly inflated balloons

B. **Marshmallow**

Pass out 10marshmallows

C. **Suction Cup (optional, time permitting)**

Pass out 10 suction cups

Your Notes:

____

____

____

IV. Use Magdeburg Hemispheres to Illustrate Air Pressure (Optional)
Distribute 15 Madgeberg hemispheres

Students and volunteers must wear goggles at all times

I. Introduction

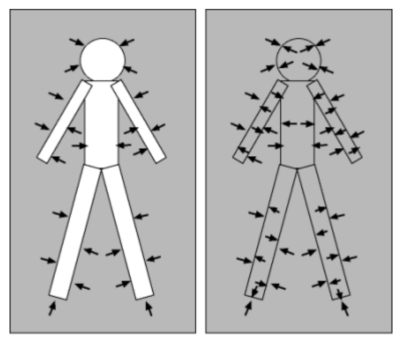
Learning Goals:
Students understand that gases in the atmosphere create an atmospheric pressure that acts in all directions.
Students understand that vacuums decrease pressure within an enclosed region. Students understand that air, which consists of elemental and small molecular gases, has mass.
Students understand that pressure acts both within and outside a region, and that these two forces must be in balance. Students can conceptualize that decreases in pressure cause increases in volume.

A. What is the Atmosphere?

Our planet is wrapped in a blanket of air called the atmosphere. The atmosphere is a thin layer of gases as well as liquid and solid particles.
Ask students if they know what gases are in the atmosphere? – Nitrogen, Oxygen, carbon dioxide, argon plus very small amounts of “trace” gases.
What are other particles in the atmosphere? Water vapor, dust, smoke, chemicals….

B. What is Air Pressure?

Gravity acts on the air
All of these gases and particles have mass. The weight of the air above earth presses down on us - we call this atmospheric pressure.
Can you feel the atmosphere? Why don’t we get crushed?
Because at the same time as the atmosphere is pushing down on us, pressure is being applied equally in all directions outside and inside our bodies.



Demonstration:

Materials: 1 plastic box containing jar of water plus card
Fill the glass jar with water and cover it with a card. Hold jar over plastic box. Invert jar (slowly) while holding on to card. Carefully remove hand from card.
The card remains “attached” to the jar, and the water stays in the jar.
Atmospheric pressure keeps the card in place

Your Notes:
____
____
____

C. Atmospheric Mat

If you can't feel the atmosphere, how do you know it is there?
Demonstration:
Place the mat on a **flat-topped** desk or table. Move it around the table to show students that it is not glued down.
Pick it up by its edge. Easy!
Ask a volunteer, or the teacher, or another VSVS member to try to pull the mat up, using the hook.

Put it down again and lift it by the hook. Impossible!
Release the hook, and lift it by the edge again to show that it is not stuck at all.

Attach it to a free-standing object (a stool, book,….) and demonstrate that you can lift the object

Explanation:
The mat is held down by atmospheric pressure, which is approximately 15 pounds per square inch.
The area of the mat is about 100 square inches (10.5 x10.5).
A quick calculation leads to a total pressure of over 1500 lbs pushing down on the mat (assuming no air at all is under the mat).
Note - Imperfections in the rubber can lead to bumps and leaks, breaking the seal.

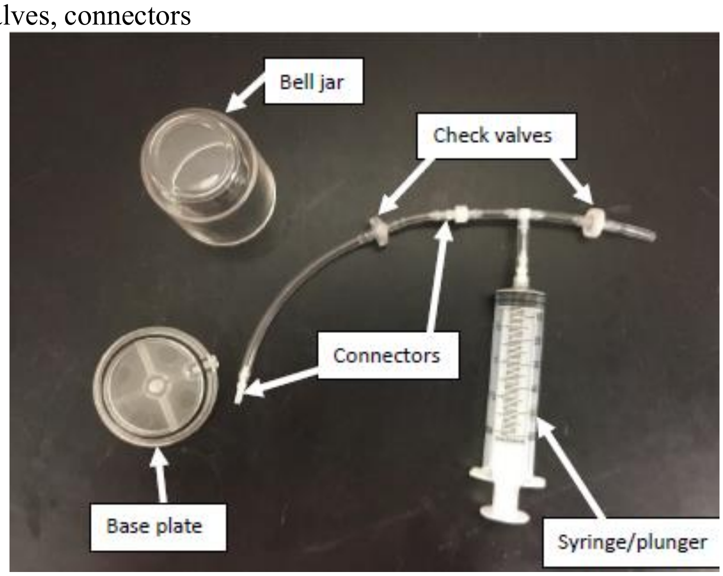
The Atmospheric Mat is unique in that you don't need to apply any force to make it work.
(Suction cups, for example, also stay put because of atmospheric pressure, but the way they are applied may make it seem like they adhere to the surface, rather than being pushed there from outside.)

II. What is a Vacuum?

A. Investigating the Action of a Vacuum Pump

Distribute the bell jar apparatus – there are 10 per class, so divide students into groups of 3-4.

Show students the handout of the apparatus. Point out the parts: a bell jar and its base, syringe/plunger, tubing with 2 check valves, connectors



1. **Ask** students what is in the bell jar? *Air is present - nothing is not the correct answer.*

Your Notes:

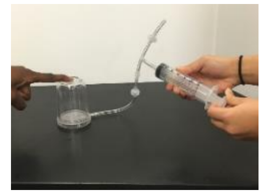
___

___

___

2. Have one team member pull the syringe to the top. Team members take turns listening to the "short" tubing end while the piston is pushed back in. They will hear air coming out.
Point out the check valves. The check valves will allow air to flow in one direction but not in the other. See diagram.

3. Tell one person in each group to push down on the bell jar to make certain that the bell jar is pressing against the "O" ring. Another student should pull the syringe out to the 60 mark.



Ask students where does the air come from that fills the syringe?
The air comes from the bell jar (so there is now less air than in the bell jar than before).
How hard was it to pull out the piston? (*Not very*).

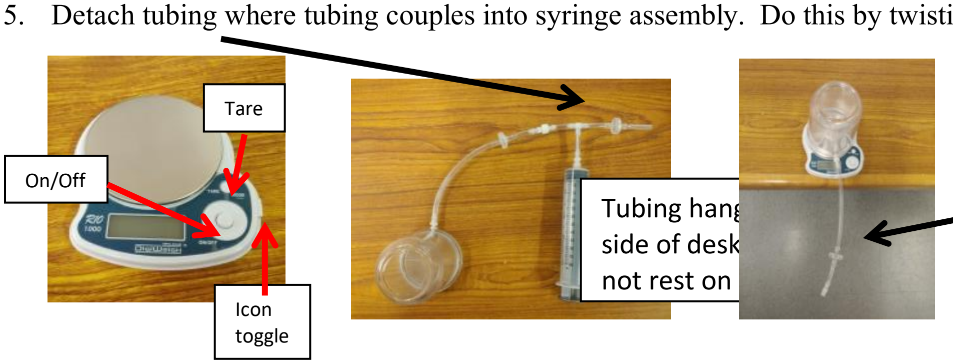
4. Let go of the piston and watch what happens. Now push the piston all the way back into the syringe. Where did the air go (hint – listen for the sound of moving air at the end of the open tube*). Air moves out of the open end at point E.*
5. Repeat the following steps five times in rapid succession:
    a. Pull the piston out to the 60ml mark;
    b. Let go of the piston, and see what happens;
    c. Push the piston all the way in.

Ask students: what happened to the amount of force required to pull out the piston? (*The force needed increased.)*
Explain why. (Less air pressure inside the jar, which used to initially helped push the piston out)

6. Repeat the steps in #5 another 10 -15 more times until it is very difficult to pull the piston out.
7. What has happened towards the end of the pull/pushes? What is in the bell jar now? (*Very little air will be in the jar = partial vacuum)*

8. Tell students to keep the vacuum in the jar for the next experiment.

B. Does Air have Mass?
1. Tell students to place the scale on flat surface, remove any protective cover, and turn it on.
2. Press the on/off button to switch on and wait until "0.00" is shown on the screen. .
3. Make sure it is zeroed by pressing the button labelled T,- this is called taring.
4. The icon in the screen should read "g". If it does not, toggle the "mode" button (on the side) until it does. There are other icons – oz, ozt and ct. We want to measure the mass of the bell jar plus its air in grams.
5. Detach tubing where tubing couples into syringe assembly. Do this by twisting gently.

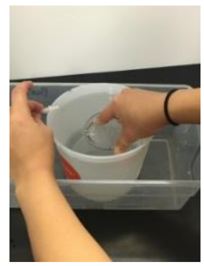


Your Notes:
____
____
____

6. Place bell jar apparatus with this remaining small piece of tubing on the scale. Place the scale close to the edge of the table, the tubing can hang over the edge (you do not want the tubing to rest on the table.)
7. Mass the above set-up. and record the value.
8. Remove the tubing from the bell jar so that the air rushes in.
9. Replace the tubing and mass the apparatus again.

Was there any difference? (In the VSVS lab, *we found it about .1-.3 g lighter*)

Demonstration: How much air is being removed from the bell jar?



Fill the plastic tub with water.
Repeat the procedure for evacuating the jar: pull the piston of the syringe to the 60 ml mark and push it all the way back in. Do this 24 times in rapid succession.
Detach tubing where D tubing couples into syringe assembly. Do this by twisting gently.
HOLD THE BELL JAR UPSIDE DOWN and immerse it in the bucket of water. While the jar is immersed, detach the tubing from the bell jar. Water will fill the chamber. CAREFULLY lift the bell jar out, keeping the jar and its bottom intact. Turn upright and show students how much water and air is in the jar.

D. What Happens when Air Pressure is Decreased?

What happens to the volume of an object when the pressure is changed?

VSVS Information only: Use the equation PV=nRT If you decrease the pressure, the volume will increase.

Ask students if they have noticed what happens to a plastic bottle if it is carried up to a higher altitude (such as going up a mountain)?

As air pressure decreases, the density of the contents decreases as well. The plastic bottle may feel "tighter" as the gas expands.
On the other hand, a plastic bottle will look "crushed" if it is taken from high altitude (lower air pressure) to sea level where the pressure is greater.

A. Balloon in Jar:

Show students the slightly inflated balloon (about 3-4 cm in diameter). The balloon should be tight.
Ask students to hypothesize what will happen to the volume of the air in the balloon if the pressure is decreased?
Tell students to place the balloon in the bell jar and make sure that no part of the balloon touches the black O-ring of the bell jar.
Tell one person in each group to push down on the bell jar to make certain that the bell jar is pressing against the "O" ring. Another student should pull the syringe out to the 60 mark and start pumping the piston:

What happens to the balloon after a few pumps? *It grows larger.*

Your Notes:

____

____

____

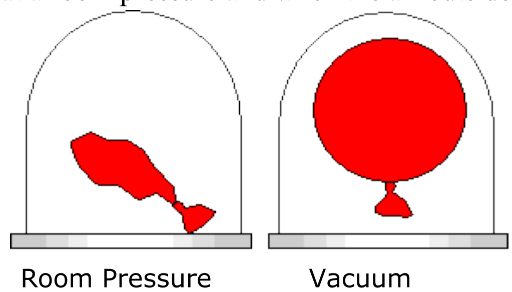
Why? *The pump removed air surrounding the balloon that had been pressing inward. The air inside the balloon wants to stay at the same pressure as the air around it. The air inside the balloon is still pressing outward, so the balloon expands.*

What do you think will happen when the chamber is re-pressurize?

Loosen the end connected to the bell jar. What do you hear, and what happens to the balloon*? Air moves back into the bell jar and crushes the balloon.*

Explanation:

If you put a partly blown up balloon in a bell jar and then pump out the air from the bell jar the balloon will slowly expand. This is because the air inside the balloon is at a room pressure and when the air outside the balloon is removed there is a bigger pressure difference between the inside and outside of the balloon. The balloon therefore expands to balance this difference.



This is how our lungs fill with air. A muscle called the diaphragm contracts downward to increase the space in your chest. As volume increases, pressure decreases. Imagine the balloons represent your lungs. Since there is now less pressure pushing against your lungs, they begin to expand as outside air rushes inside.

B. **Marshmallow** . Repeat with a marshmallow. Predict what will happen. Marshmallows have small bubbles of air trapped inside them. These bubbles are at atmospheric pressure. When the air inside the container is sucked out the pressure is reduced. The air bubbles inside the marshmallows are therefore at a much higher pressure than the air surrounding the marshmallows, so those bubbles push outwards, causing the marshmallows to expand. When air is let back into the container, the surrounding pressure increases again, and the marshmallows deflate back to their normal size.

Note that the marshmallow now looks funky.

Some of the gas inside the marshmallow was also drawn out of the chamber so there is now less air in the marshmallows than before. What happens if you try it again with the same marshmallow?

VSVS Information only: This illustrates <u>Boyle's Law</u> (as the pressure on a gas decreases, its volume increases).

C. The suction cup – optional if time permits

Stick the suction cup firmly to the stop of the bell jar.

a. Why does the suction cup stick to the jar? *Atmospheric pressure of 15lb per square inch pushes on the suction cup (and us)*

b. What do think will happen when some of the pressure is removed?

Your Notes:

____

____

____

Pull the piston of the syringe to the 60 ml mark and push it all the way back in.
Repeat until something happens to the suction cup.
The suction cup eventually falls off because the pump has removed the outside pressure that held the cup on the surface.

IV. Optional – If Time Permits Use Magdeburg Hemispheres to Illustrate Air Pressure

Background Information:

Historically, the Magdeburg hemisphere is a pair of copper hemispheres that can be sealed together, by applying grease around the rim, then connected to a vacuum pump so as to create a near "perfect vacuum" inside of the sealed sphere. In this vacuumed-out state, the pressure of the weight of surrounding atmosphere, (piled upwards of 62-miles above the sphere), acts to hold the spheres together tightly with great force by pressing inward on the outer casing.
The Magdeburg hemispheres were invented by German engineer Otto Guericke who became mayor of Magdeburg (hence the name), from 1646 to 1676.

Activity:

1. Each student /pair will use one half a hemisphere.
2. Tell students to press the hemisphere down onto a flat desk top and then try to lift it up.

Explanation:

When the hemisphere is pressed against a flat surface, most of the gas molecules in the air are forced out. There are a lot of air molecules on the outside of the hemisphere. This results in the atmospheric pressure being much greater on the outside, so that it pushes the hemisphere down and forms a seal with the surface.

Lesson ideas taken from Educational Innovations “Bell Jar and Vacuum Pump Set”

Lesson written by
Pat Tellinghuisen, VSVS Program Coordinator 1998-2018, Vanderbilt University
James Dohm, Undergraduate student, Vanderbilt University
Significant edits by Zach Ullmann, Frank Cai, Vincent Huang, Undergraduate students, Vanderbilt University

https://www.youtube.com/watch?v=Ssqi-CkysvQ

Your Notes:
____
____
____

Vacuums and Air Pressure Observation sheet = Answers

Part 1 – What is Atmospheric Pressure?

In both the water jar and atmospheric mat experiments, what force caused the results we observed? ***atmospheric pressure***
In which direction does this force point? ***all directions***

Part 2 – What is a Vacuum?

The Bell Jar

(a) As you pull-out the piston, what are you removing from the bell jar? ***air***

(b) [Circle the correct *italicized* answers]. Over time, the piston becomes (***harder***) to pull-out.
This happens because, over time, the air pressure inside the bell jar (***decreases,***) while the atmospheric pressure (***remains the same***).

(c) We made a vacuum inside the bell jar. This means the air pressure inside the bell jar was (***less than***) the atmospheric pressure pushing on the outside of the jar.

(d) When the vacuum is released from the bell jar, what happens to the jar's mass? Why? **The bell jar's mass *increases because air rushes inside the jar once the vacuum is released. This shows that air has mass.***

(e) In the last demonstration, the amount of water that entered the bell jar was equal to the amount of ***air*** that was removed from the bell jar.

Part 3 – What Happens when Air Pressure Decreases?

A & B The Balloon and Marshmallow

As air is taken out of the bell jar, the pressure in the jar drops. What happens to the balloon and marshmallow?
The balloon and marshmallow ***inflate***

C.The Suction Cup (If Time Permits)
What force causes suction cups to stick to walls? ***atmospheric pressure***

IV. The Magdeburg Hemisphere (If Time Permits)

Do you think the Magdeburg hemisphere would work if we used it on a bumpy surface, like sandpaper, instead of a flat surface? Why or why not? ***The Magdeburg hemisphere would not work. On a bumpy surface, the hemisphere would not be able to form a tight seal with the ground. Air from the atmosphere could then enter the hemisphere, resulting in atmospheric pressure within the hemisphere.***