Rock Cycle Game and Data Analysis

Goal: Students use mathematical analysis to deepen their understanding of rock cycle stages and geologic time**.**

Objectives
Knowledge: The development of a rock can occur and change in a multitude of ways and does not follow a set path.
Skills: Students develop mathematic skills of solving multistep problems and converting fractions to decimals. Students will use probability thinking to understand the likelihood of an outcome.
Values: Students appreciate the rock cycle and the large expanses of time over which rocks form.

Grade: 5th

Special Safety: This activity can be conducted indoors or outside. If setting up outside, check the area for safety hazards (holes, bare root/branches).

VA Standards addressed:
Rock Cycle Game. Math (2016) 5.15 Science (2018) 5.8
Rock Cycle Analysis. Math (2016) 5.2, 5.5 Science (2018) 5.8

Materials:

Game

- Set of 5 game stations (igneous, magma, sediment, sedimentary, and metamorphic) (Appendix A)
- Set of 5 game dice (Appendix B)
- Starting dice (1)
- Five colors of beads (we chose to use color to code the beads to the stations: red for magma, black for igneous, purple for metamorphic, green for sedimentary, yellow for sediment); each bead color placed in a small container
- Fuzzy sticks/chenille sticks (one per student)
- Student data sheets (one per student) (Appendix C)
- Pencils & clipboards (one per student)

Analysis

- Rock Cycle Game Data Analysis Sheet (one per student) (Appendix D)
- Pencils (one per student)
- Clipboards (one per student)

Setup:

- Create five game stations, one for each of the five dice (note: stations and dice refer to Virginia rocks; modify to correlate with your local geology)
- Set up the five game stations with corresponding dice and beads in a rough circle (the size depends on how much you want the students to move around).
- Determine how you wish students to work:
    - in assigned groups or self-selected groups of a set size
    - in self-selected groups of varying sizes (including independent) but no more than four.

(Students can work in groups or individually. Decide what is best for your students.)The game and analysis datasheets are set up for 12 rounds. If you wish to change the number of rounds, the data sheet may need to be modified.

Instructional Strategy (Game):

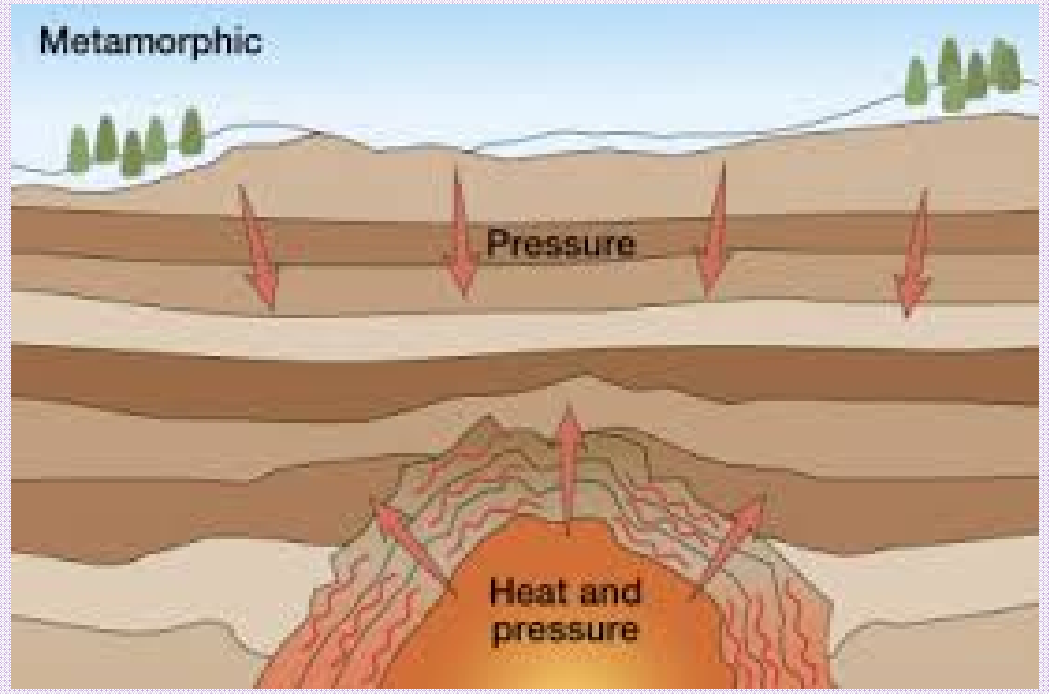
1. Give each student a fuzzy stick, explain its purpose (to record their rock cycle journeys). Model how to create a loop on one end of the stick so that beads will not fall off.
2. Tell students the basic gameplay instructions:
    a. Game begins with a roll of the start dice, directing students to a station.
    b. Upon arrival at a station, students place a bead on the fuzzy stick, and record the station **name** on the datasheet. (ex: Sedimentary)
    c. They then roll the dice, and record on their datasheets (Appendix C) the **length of time** the die side indicates spent in that state of the rock cycle and the **reason** for doing so before moving to the next. (For example, one side of the sedimentary die reads: compacted for 10,000 years.) MATH 5.15
    d. They then move to the next station (or stay if the die indicates so). Repeat b and c until they have 12 beads on their fuzzy stick.
3. As students play their way through 12 rounds of the game, circulate around to check for the following:
    a. Many of the dice have very limited outcomes based on the realities of the rock cycle. Background info on the rock cycle can be found at http://imnh.isu.edu/digitalatlas/geo/basics/diagrams.htm For example, sediment can only move to sedimentary or stay at sediment. As a result, students may experience some frustration. If this occurs, tell students that you are 'changing geologic history' and send them to another station on the die with a lower probability of rolling (in this example, send to Magma). SCI 5.7
    b. You also may want to engage in a discussion of how the probabilities reflect the realities of the rock cycle.
    c. Draw their attention to the possibilities on the dice, and the probability of moving to each station. (Number of "favorable" outcomes/number of possible outcomes). Use terms to describe the degree of likelihood of moving to a particular station (i.e., impossible, unlikely, equally likely, likely, and certain).
4. You may choose to differentiate by adjusting data collection/recording for your students reading/writing abilities as students may finish at different rates. Suggestions for evening out the ending time include permitting students to summarize the reason for being at the station but still record the time.

5. For groups who finish early:
    a. Compare datasheets with others in their group and make sure the data matches their string of beads.
    b. Ask students to consider the time their rock spent at each station. Instruct them to consider number placements (one, tens, and hundreds) and arrange the rock station times so that they can easily add up the number for a total length of time for the rock formation. They can record this on the back on their data sheet.

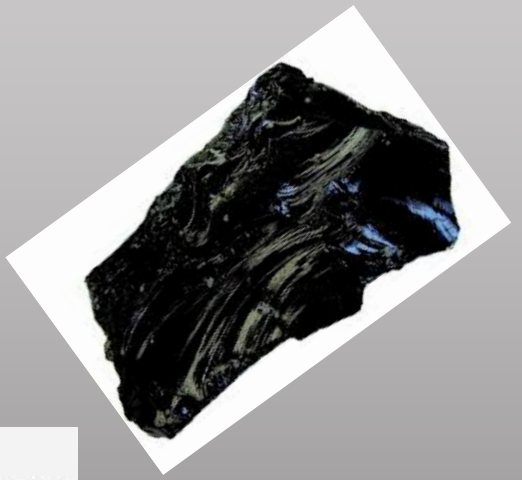
Instructional Strategy (Analysis):

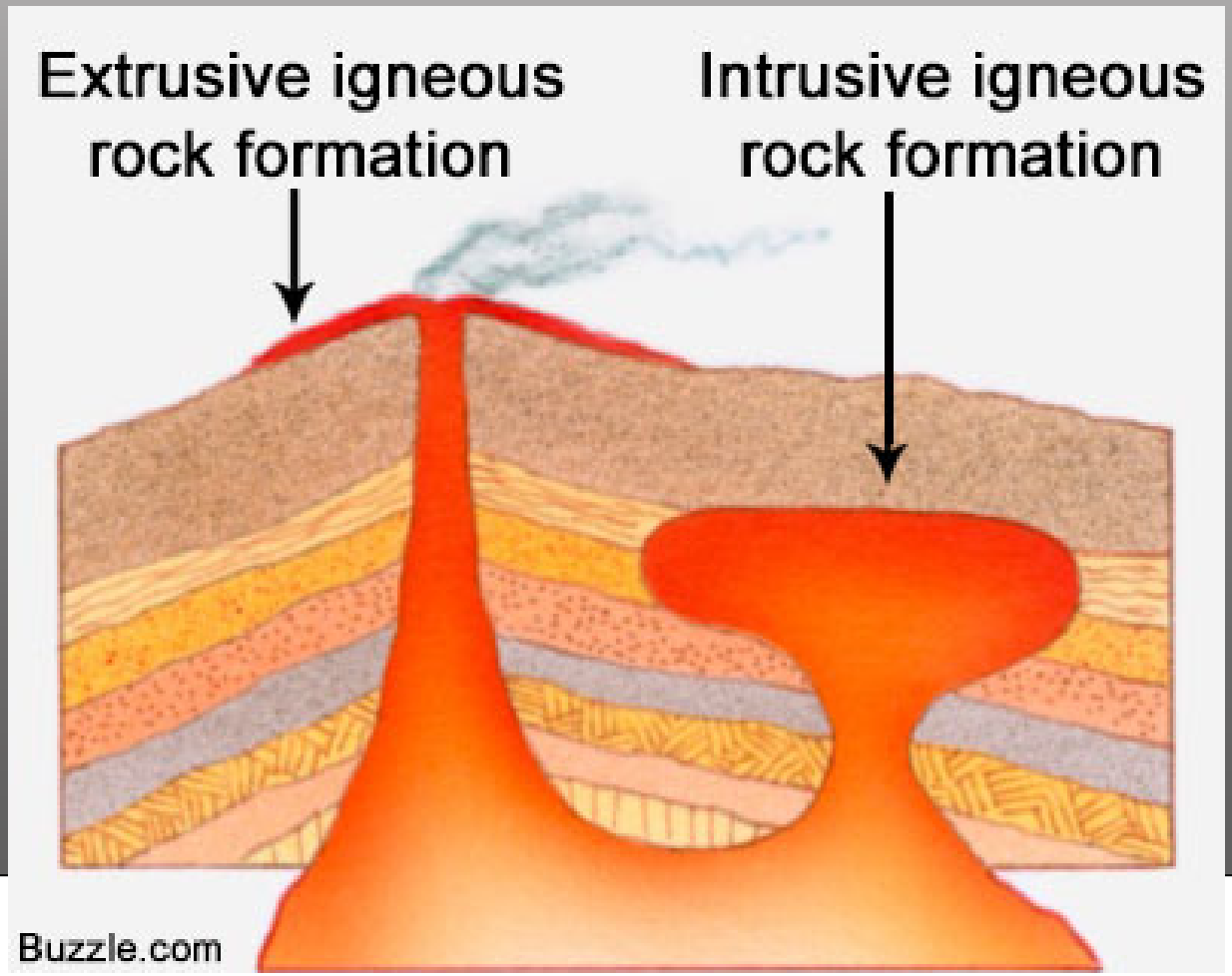
1. *Inquire*: Tell students: Now that you have taken on the role of a changing rock in the rock cycle activity, the next step is to analyze your results. MATH 5.5
2. Inform students they will use the Rock Cycle Data Analysis (Appendix D) sheet and their group's journey to analyze and consider their rock cycle. As necessary, point out the tasks on the datasheet:
    a. First, record your total number of stops (12).
    b. Find the factors of your total (the numbers that can be multiplied together to get your total number of stops. [e.g., 1,2,3,4, 6, 1])
    c. Determine how many stops you made at each of the 5 stations. (e.g., 4 at Sediment) SCI 5.7
    d. Calculate the fraction of the whole for each. Example: If you had 12 stops total, that is the denominator, and if 4 of them were at the Sediment station, the fraction will be 4/12.
    e. Use the list of factors to help simplify this fraction, if possible. Is there a number by which you can divide both the numerator and denominator?
    f. Convert your fraction to decimal. *Discuss ways to do this*: How can we convert/change this fraction into decimals? Assess if students need more guidance to convert from fractions to decimals.
    g. Be sure students double-check their work by adding up the column on the datasheet. The results should be very close to 1.
3. Students then use the circle/pie chart on the back of the datasheet to display the # of stops made at each station. This is an excellent opportunity to assess student understanding of data display and graph making. NOTES:
    a. Allow students to decide how to denote different rock cycle stations and number of stops. Some may use symbols and create a legend, some more shade certain areas, etc. This is an excellent opportunity for differentiation.
    b. Bar Graphs are emphasized in fifth grade VA Mathematics SOL. However, the circle graph is a more appropriate type of graph for displaying this data. Comparison to slicing a pizza is a good real world connection for displaying in a circle/pie graph.
4. As a class, compare each group's results. *Ask*: Did each group have the same fractions? Explain why or why not. Discuss how long it takes rocks to transition from one type to another.
5. *Explore*: Ask groups to share their pie charts and discuss the display features they used. All options students used are probably correct; however, some methods may communicate the data better (easier for a reader to interpret the data). Have students discuss the importance of graphs for communication and assess which methods are better. Be sure to guide the discussion to focus on the METHODS, rather than on the students that did the work.

Metamorphic

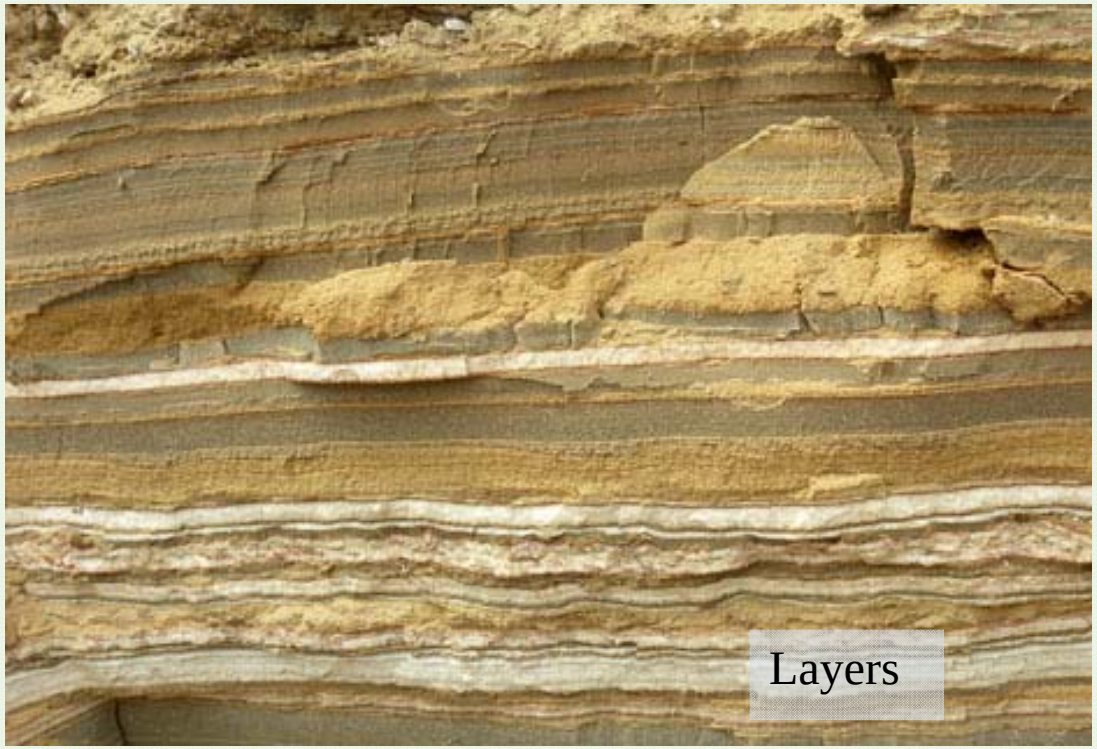


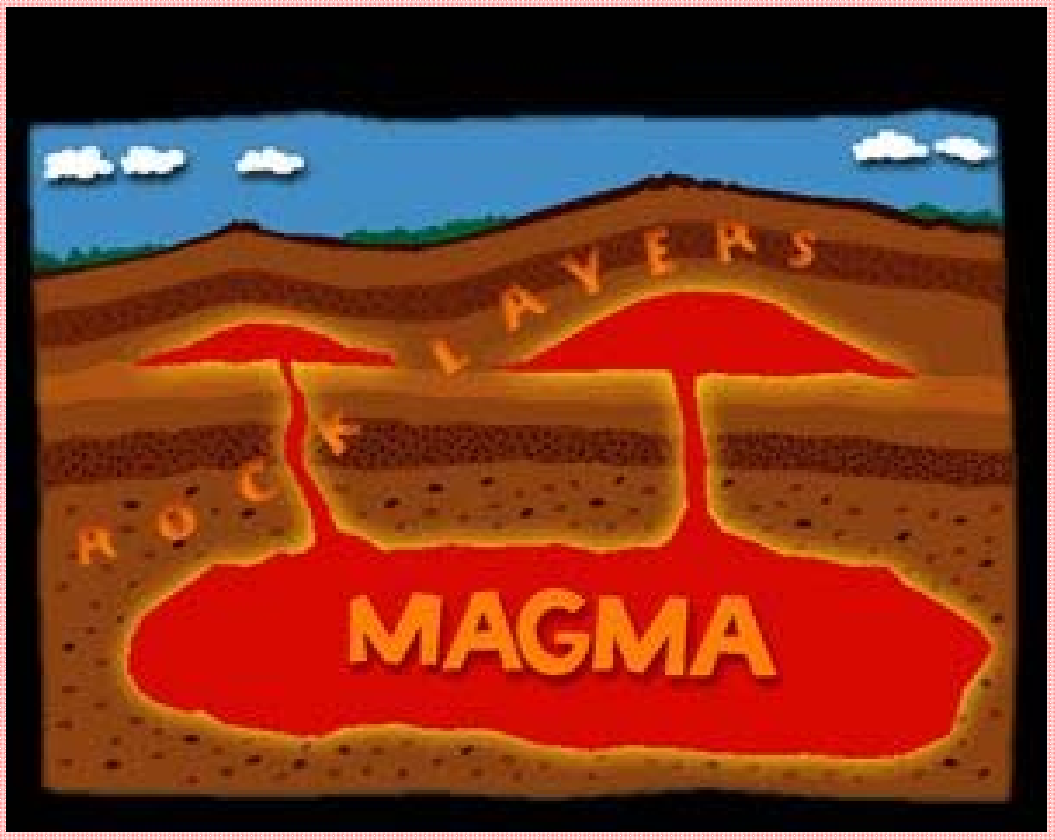
IGNEOUS




Extrusive igneous rock formation
Intrusive igneous rock formation
Buzzle.com

Sedimentary





Magma

Sediment

100 years

You remain as **SEDIMENT**.

Stay where you are; add another bead and roll again.

Sediment

100 years

You remain as **SEDIMENT**.

Stay where you are; add another bead and roll again.

Sediment

100 years

You remain as **SEDIMENT**.

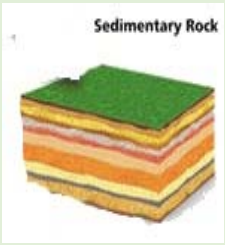
Stay where you are; add another bead and roll again.

Sediment

10,000 years

You get buried underneath additional layers of sediment and are compacted into coal.

Go to **SEDIMENTARY**.

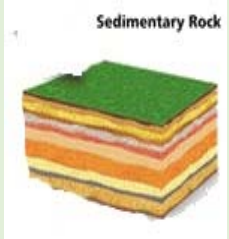


Sediment

10,000 years

You get buried underneath additional layers of sediment and are cemented into limestone.

Go to **SEDIMENTARY**.

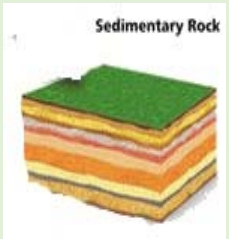


Sediment

10,000 years

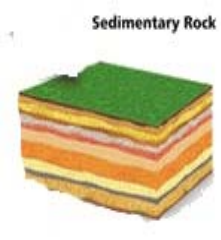
You get buried underneath additional layers of sediment and are compacted into sandstone.

Go to **SEDIMENTARY**.



10,000,000 years

You are buried beneath the ground and remain there.



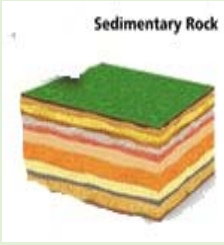
Stay at **SEDIMENTARY**; add another bead and roll again.

Sedimentary

10,000,000 years

You are buried beneath the ground and remain there.

Stay at **SEDIMENTARY**; add another bead and roll again.



1,000 years

You are exposed to the surface. Erosion breaks you off from your layers. You become sediment again.

Go to **SEDIMENT**.

Sedimentary

1,000 years

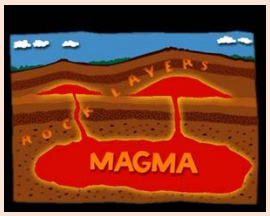
You are exposed to the surface. Erosion breaks you off from your layers. You become sediment again.

Go to **SEDIMENT**.

10,000 years

You are exposed to a nearby source of magma and melt.

Go to **MAGMA**.



Sedimentary

10,000 years

The tectonic plate you are on crashes into another tectonic plate. You are crushed by HUGE forces and become slate. Go to **METAMORPHIC**.

10,000,000 years

You are part of a pocket of magma near the surface, but the rock above is too thick to break through.

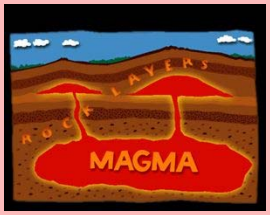
Stay at **MAGMA**;add another bead and

Magma

10,000,000 years

You are carried into the mantle.

Stay at **MAGMA**; add another bead and roll again.

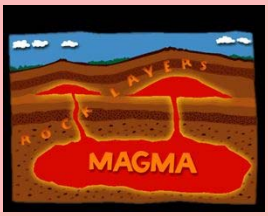


Magma

10,000,000 years

You are carried into the mantle.

Stay at **MAGMA**; add another bead and roll again.



100,000 years

You cool down quickly just below the surface. You are intrusive igneous diabase.

Go to **IGNEOUS**.

Magma

100,000 years

You reach the surface and cool rapidly. You are extrusive igneous metabasalt.

Go to **IGNEOUS**.

100,000 years

You cool down slowly before you ever reach the surface. You are intrusive igneous gabbro.

Go to **IGNEOUS**.

1,000,000 years

You remain buried underneath the ground.

Stay at **IGNEOUS**; add another bead and roll again.

Igneous

1,000,000 years

You remain buried underneath the ground.

Stay at **IGNEOUS**; add another bead and roll again.

1,000 years

You are exposed to the surface. Erosion breaks you off from the rest of the rock. You become sediment.

Go to **SEDIMENT**.

Igneous

10,000 years

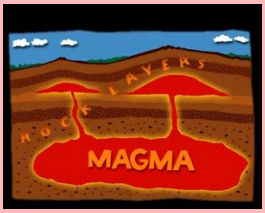
You are exposed to a nearby source of magma and melt.

Go to **MAGMA**

10,000 years

You are exposed to a nearby source of magma and melt.

Go to **MAGMA**.



Igneous

100,000 years

Your tectonic plate crashes into another and you are exposed to A LOT of pressure.

You change into charnockite.

Go to **METAMORPHIC**.

10,000,000 years

You remain buried in the crust.

Stay at **METAMORPHIC**; add another bead and roll again.

Metamorphic

100,000,000 years

You are exposed to more heat and pressure and become soapstone.

Stay at **METAMORPHIC**; add another bead and roll again.

Metamorphic

1,000 years

You are exposed to the surface. Erosion breaks you off from the rest of the rock. You become sediment.

Go to **SEDIMENT**.

Metamorphic

10,000,000 years

You remain buried in the crust.

Stay at **METAMORPHIC**; add another bead and roll again.

100,000,000 years

You are exposed to more heat and pressure and become phyllite.

Stay at **METAMORPHIC**; add another bead and roll again.

10,000 years

You are exposed to a nearby source of magma and melt.

Go to **MAGMA**.

Rock Cycle Student Data Sheet: Appendix C

Round #	Location in rock cycle	Years spent at this round	Reason for being here
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Each group member gets one fuzzy stick, making a loop at one end so beads do not fall off. When you arrive at a station, put a bead on your stick, then toss the cube and read what happens during the rock cycle. Share the writing responsibility in your group!

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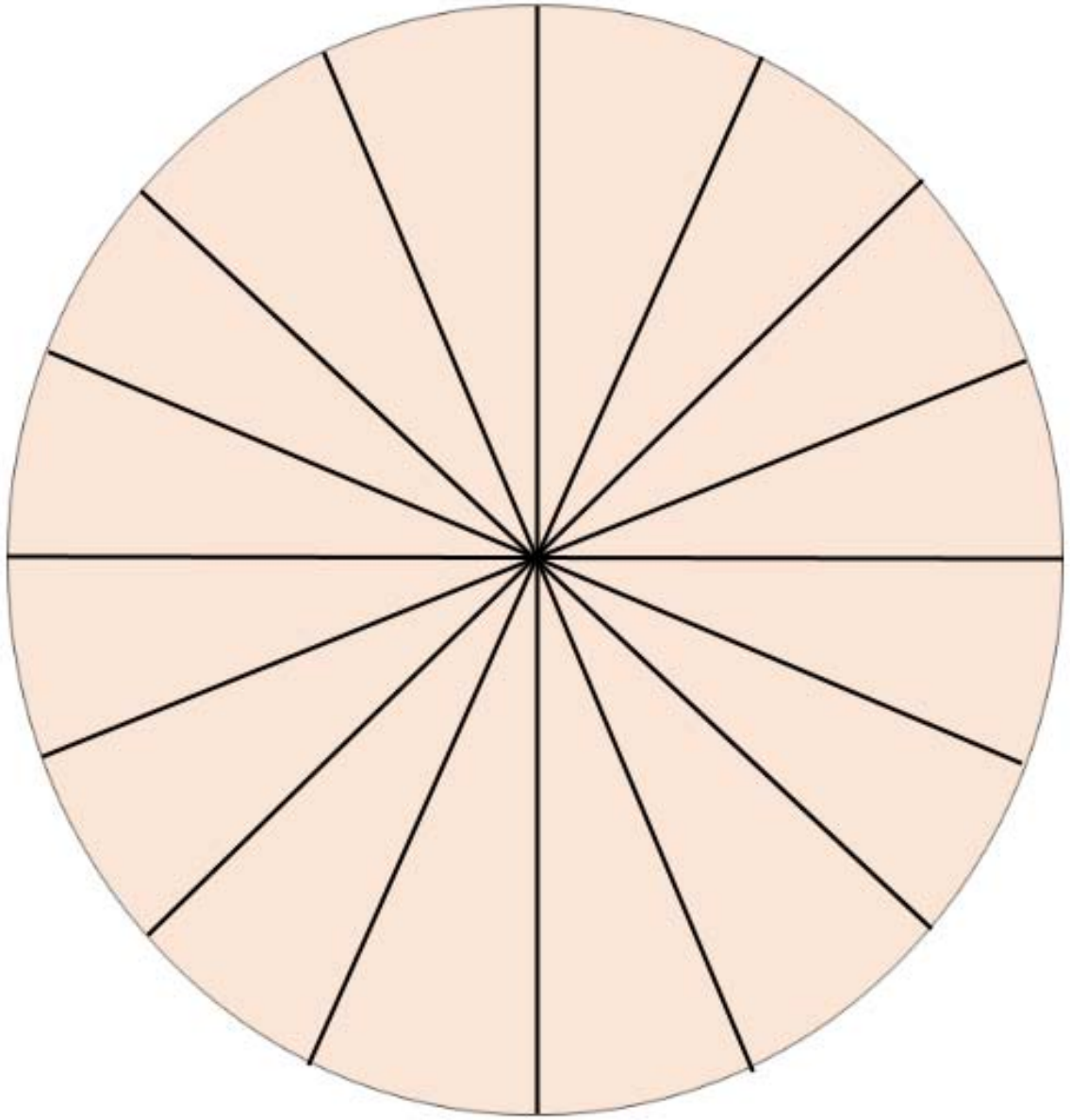
Rock Cycle Game Data Analysis (Appendix D)

- --What is the total # of stops made during your rock cycle journey? _____
- --Find the factors of this number: _____

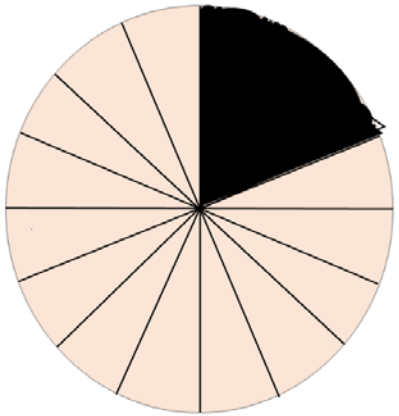
	How many of these stops were at:	What is the fraction of the whole that you were at this station?		Convert this to a decimal (round to the hundredths place)
			Can you simplify this fraction? If you can, write that fraction below.	
Sediment				
Sedimentary				
Metamorphic				
Igneous				
Magma				
Does it add up?				
Tips for adding up	Total # of stops = 12	Do these fractions add up to **12/12 ?**		Do these decimals add up to 1.00 (or very close to)?

Graph your
rock cycle journey.



EXAMPLE

3 _ 12	3 Sedimentary 12 stations



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