Name _____

Period _____ Date _____

NOTES ON THE POWELL EXPEDITION

As you watch the *River Song* video, write down

- Three interesting things about the Powell expedition.
- Three interesting things about the natural history of the Grand Canyon.

Powell Expedition	Grand Canyon
1. _____ _____ _____	1. _____ _____ _____
2. _____ _____ _____	2. _____ _____ _____
3. _____ _____ _____	3. _____ _____ _____

After reading *The Journal of John Wesley Powell*, record the following information.

Who were the expedition members?

Name	Description

List the kinds of food Powell took on the expedition.

List the equipment Powell took on the expedition.

If you were to make the same trip today down the Green and Colorado Rivers, what supplies and equipment would you take?

Write a short paragraph describing the type of person you think Powell was. Don't write a physical description. Describe his character, attitudes, and values. Use the information in the reading to help you make these inferences about Powell. Support your inferences with examples.

Name _____

Period _____ Date _____

GRAND CANYON FIELD-TRIP GUIDE

Stop 1: Multimedia Panoramic View—Pima Point

From the Visitor's Center,

- Go to the Expeditions Desk.
- Select the Grand Canyon Rim on the clipboard.
- On the map, click on the words "Pima Point."
- Use the navigation tool to look around.

At this stop you will look around a QuickTime virtual reality panoramic view from the rim of the Grand Canyon. You may see some other sights as well. Write down two or three questions about the Grand Canyon after you finish with the multimedia.

Information about Pima Point

Pima Point is one of the places along West Rim Drive where you can get a great view of the Colorado River flowing through the Grand Canyon. In the distance you can see the bathtub ring of the Coconino Sandstone. In the depths of the canyon, you can see the dark Precambrian rocks.

Pima Point takes its name from the Pima people of south central Arizona. Monument Creek lies east of Pima Point. Rocky debris carried down the creek eventually ended up in the Colorado River, creating major whitewater, Granite Rapids.

Barely visible remnants of Hermit Camp remain below and to the west of Pima Point. This tent-cabin lodging for mule riders operated from about 1911 to 1930. Around 1925, a 6300-foot cable tram connected the rim to the site to carry supplies.

Elevation: 6720 feet

Questions

_____

_____

_____

_____

_____

_____

_____

_____

Stop 2: Earth History Photo Exhibit

Look carefully at the images on pages 4–7 in the *Earth History Resources* book. Describe two or three features you observe in each image.

Space shuttle view of the Grand Canyon

View of the North Rim of the Grand Canyon

View of Vasey's Paradise at river level

View along Bright Angel Trail

Stop 3: Grand Canyon Rock Samples

Describe each rock sample.

Rock 1

Rock 7

Rock 8

Rock 10

Name _____

Period _____ Date _____

GRAND CANYON QUESTIONS

Part 1: My six questions about the Grand Canyon:

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Part 2: Our group's five best questions about the Grand Canyon:

1. _____

2. _____

3. _____

4. _____

5. _____

Name _____

Period _____ Date _____

NORTH CANYON SKETCH

Name _____

Period _____ Date _____

NORTH CANYON ROCK OBSERVATIONS

Name _____

Period _____ Date _____

NANKOWEAP CANYON SKETCH

Name _____

Period _____ Date _____

NANKOWEAP CANYON ROCK OBSERVATIONS

Name _____

Period _____ Date _____

GRAND CANYON ROCKS

Nankoweap Canyon
Mile 52

Rock ID	Rock-Layer name
Colorado River	

Elevation of river: 2800 feet

North Canyon
Mile 20

Rock-Layer Name	Rock ID
Colorado River	

Elevation of river: 2925 feet

GRAND CANYON ROCK LINEUP

Name _____

Period _____ Date _____

Name _____

Period _____ Date _____

GRAND CANYON ROCK CORRELATIONS

You correlated the rocks from two locations at the Grand Canyon. To *correlate* means to match rock layers from two or more locations.

You will need your *Grand Canyon Rock Lineup* sheet and your *Earth History Resources* book to answer these questions.

1. How far apart are North and Nankoweap Canyons?_____

2. What is the elevation of the river at North Canyon?_____

3. What is the elevation of the river at Nankoweap Canyon?_____

4. Which way is the Colorado River flowing, from North Canyon to Nankoweap or vice versa? How do you know? _____

5. Which rock layer is at river level in North Canyon?_____

6. Which rock layer is at river level in Nankoweap Canyon?_____

7. How can you explain the evidence that different rock layers are exposed at river level at these two sites? _____

8. Suppose you could drill a hole into the rock at Mile 20. What kind of rock would you expect to find? Why? _____

9. Suppose you stopped at Mile 30 along the Colorado River in the Grand Canyon. Which rock layer would you expect to see at river level? Why?

Name _____

Period _____ Date _____

CHUAR BUTTE OBSERVATIONS

Turn to the picture of Chuar Butte in the *Earth History Resources* book. Look at the shape of the outline of the butte and the area on both sides of the Colorado River.

1. How would you describe the shape of Chuar Butte's outline?

2. What kinds of rocks tend to form the cliffs?

3. What kinds of rocks tend to form the slopes?

4. What is it about sandstone, shale, and limestone that might cause the slopes and cliffs to form?

5. What do you think Chuar Butte would look like today if it were made only of shale?

Name _____

Period _____ Date _____

GRAND CANYON ROCK AGES

- Geologists have determined that Earth is probably about 4.5 billion years old.
- The Kaibab Limestone is about 250 million years old.
- The Muav Limestone is about 530 million years old.
- Under the Muav Limestone is a layer of shale and then a layer of sandstone.
- The oldest rock layer in the Grand Canyon, found far under the Muav Limestone, is at least 1.7 billion years old.

What events or processes do you think caused these rock layers to form? Keep track of the evidence you use to support your answers.

Name _____

Period _____ Date _____

SAND OBSERVATIONS

Location_____

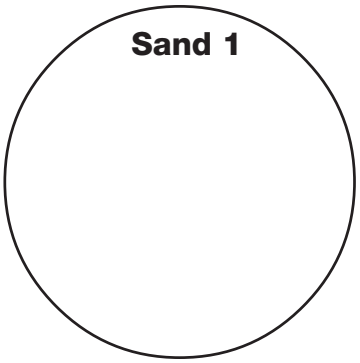
Shape _____

Sorting _____

Grain size(s)_____

Composition/colors_____

Other_____



Location_____

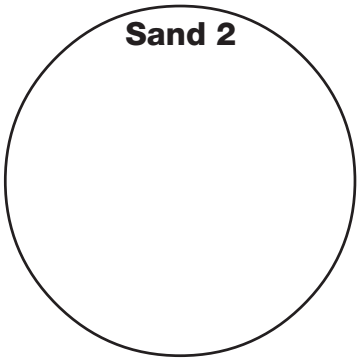
Shape _____

Sorting _____

Grain size(s)_____

Composition/colors_____

Other_____



Location_____

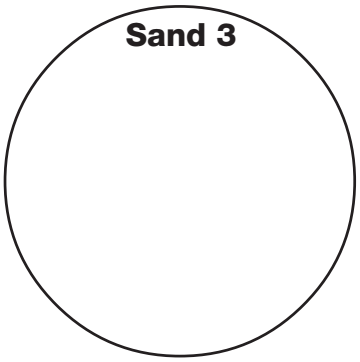
Shape _____

Sorting _____

Grain size(s)_____

Composition/colors_____

Other_____



Location_____

Shape _____

Sorting _____

Grain size(s)_____

Composition/colors_____

Other_____

Name _____

Period _____ Date _____

MULTIMEDIA SAND OBSERVATIONS

Location _____

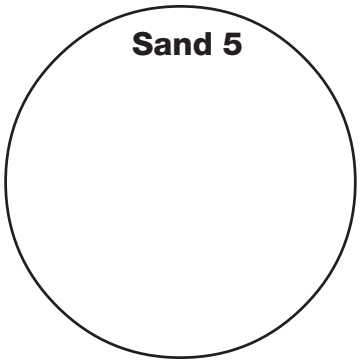
Shape _____

Sorting _____

Grain size(s) _____

Composition/colors _____

Other _____



Location _____

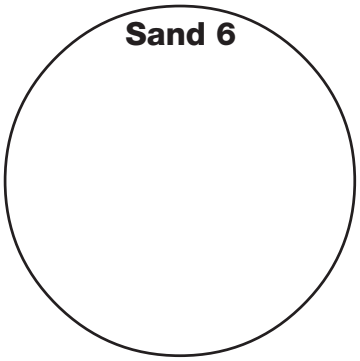
Shape _____

Sorting _____

Grain size(s) _____

Composition/colors _____

Other _____



Location _____

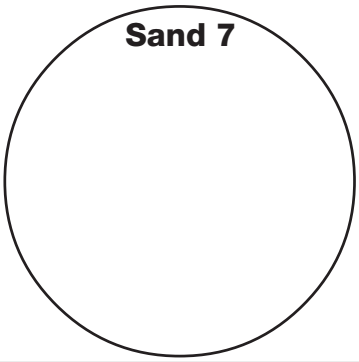
Shape _____

Sorting _____

Grain size(s) _____

Composition/colors _____

Other _____



Location _____

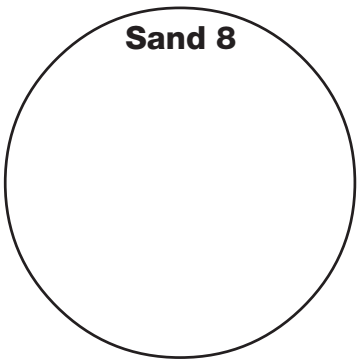
Shape _____

Sorting _____

Grain size(s) _____

Composition/colors _____

Other _____



Name _____

Period _____ Date _____

SAND QUESTIONS

1. You observe a sand sample from Rocky Mountain National Park in Colorado. It has the following properties.

   - Shape: angular
   - Sorting: poorly sorted
   - Grain sizes: a mixture of coarse sand to gravel
   - Composition/color: clear, pink, black, and white particles

   What can you infer about the sand?
   - Its source?
   - How far the sand was moved or transported?
   - Anything else?

2. Which sand sample do you think would have more rounded edges, one that has been transported a short distance or a long distance? Why?

3. A coarse sand is very well sorted, has rounded edges, and is composed mostly of quartz. Make an inference about how the sand was transported—wind, water, or ice. Support your inference with evidence.

4. A geologist discovered a sandstone that contained very fine particles of sand. The sand was well sorted, had rounded edges, and was composed mostly of quartz. When she looked at the sand grains more closely through a magnifier, she observed that the sand grains were covered with tiny nicks and scrapes that made the grain look frosted.

   - What inferences can you make about the origin of the sand?
   - What type of depositional environment can you infer?

5. Homework question: Three students who were studying sand got sand samples from around the world.

   Amanda's parents had saved some beach sand from a vacation they took to Oslo, Norway.

   Jamica's uncle sent her some sand he collected from the side of a stream high on Mt. Kilimanjaro.

   Ricky's family visited Death Valley in California, and he kept some of the sand from his shoes after he took a hike through the dunes.

Visualize the three sources of sand and the sand itself. Write a description of the sand each student had.

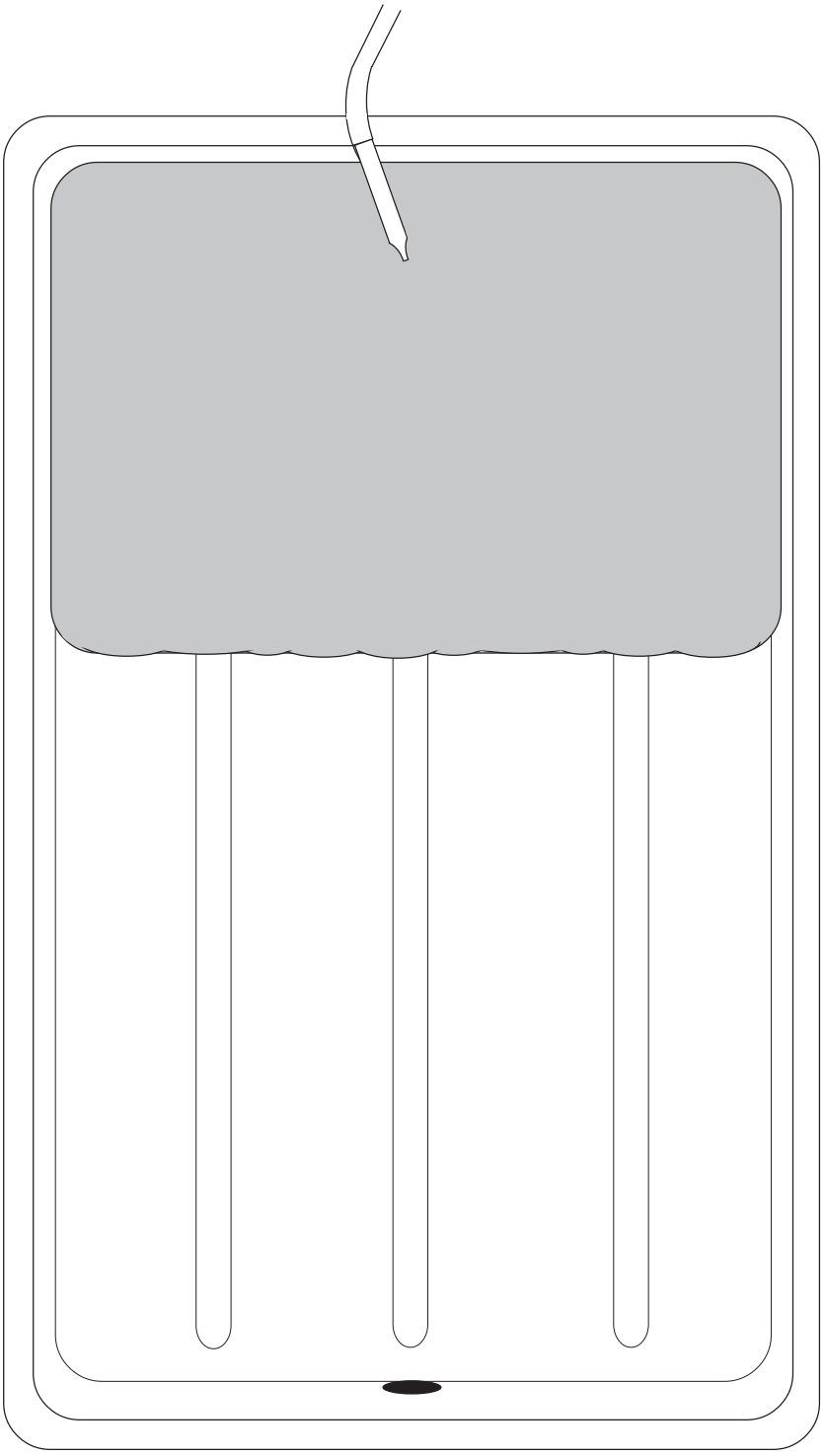
6. Take the Sand Quiz on the *FOSS Earth History* CD-ROM. You will see ten different sands. For each of the pictures, write the **code** in the space provided in the chart below, and record whether the sand is **mountain, dune,** or **beach** sand.

Sand number	Sand code	Sand type (mountain, dune or beach)	Correct answer
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Name _____

Period _____ Date _____

STREAM-TABLE MAP



Starting time

_____

Observation time

_____

Elapsed time

_____

Name _____

Period _____ Date _____

GRAND CANYON MODEL

Observe the classroom stream table in action.

- Where is the eroded material being deposited?
- Where are the largest particles being deposited? The smallest particles?
- Is a delta forming? Where? Why is it forming there?
- Where is water flowing fastest? Slowest?
- What color is the water flowing out of the stream table into the basin?

Answer the questions below.

1. Watch a grain of sand as it moves along. What words describe its motion?

2. Fill in the time information to indicate how long the stream table has been flowing. Observe where the different materials were deposited. Use the Stream-Table Map to draw and label the locations of the deposited materials.

3. Use the Stream-Table Map to identify and label the landforms that were created in the stream table.

4. Consider the Grand Canyon. Where do you think the material that was eroded by the Colorado River was deposited? Refer to the U.S. map in your classroom.

5. Which do you think came first, the Colorado Plateau, the Colorado River, or the Grand Canyon? Describe why you think so and support your idea with evidence.

Name _____

Period _____ Date _____

MULTIMEDIA STREAM TABLES

On the *FOSS Earth History* CD-ROM, go to the Geology Lab, stream table. Run View Stream Table and Compare Stream Table. Work with the variables of slope, time, and stream-flow rate, and streambed material (with or without resistant layer). List two simulations you observed and describe what you found out.

Name _____

Period _____ Date _____

QUESTIONS: WEATHERING AND EROSION VIDEO

1. What are the processes that cause Earth's surface to wear down?

2. How do plants wear down rocks? _____

3. What is the most frequent cause of rocks breaking apart? _____

4. What is an example of oxidation? _____

5. What are lichens, and how do they break down rocks?

6. Where does carbonic acid come from? _____

7. What does carbonic acid do to certain kinds of rocks? _____

8. What type of rock do you suppose is most easily broken down by carbonic acid? (Think about it. This was not answered in the video.)

9. What natural forces cause erosion? In your answer, circle the force that is the most powerful.

10. How and where does water cause erosion?

11. How does ice cause erosion?

12. What is mass movement?

13. How does wind cause erosion?

Think about the information in this video and what you learned from the stream table to answer items 14–16.

14. Wind blowing across bare soil moves earth material. Which size of particle do you think the wind would carry farther and which would it deposit first?

15. Explain the steps involved in breaking down mountain rocks and depositing the sand, silt, and clay in different places hundreds of miles away.

16. It has taken the Colorado River about 5 million years to erode the Grand Canyon from the flat Colorado Plateau. The Grand Canyon is about 4500 feet deep at the South Rim Grand Canyon Village. If you could visit the Grand Canyon about a million years from now, what changes in the canyon would you expect to see?

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

SANDSTONE RECIPE

Materials for each group of four students

6	Rounded spoonfuls of sand
15 ml	Sodium silicate solution (use syringe to measure)
1	1/2-liter plastic container
1	Plastic spoon
1	Group label for container (use small piece of paper and tape or sticky-note)
1	Paper towel
1	Permanent marker
•	Safety goggles

Instructions

1. Get one 1/2-liter plastic container for your group. This is your basin.

2. Write your group number and date on the label with a permanent marker.

3. Go to the sand station and add 6 spoonfuls of the sand to the container.

4. Go to the sodium silicate station. Use the syringe to carefully measure 15 ml of the solution and add it to the container. **SAFETY NOTE: Be careful not to get the sodium silicate solution on your skin or in your eyes. Safety goggles should be worn when handling chemicals.**

5. Gently tap the bowl on the desktop several times to mix the sand and sodium silicate solution. Observe what happens.

6. You can use a spoon to carefully mix the sand and the solution. Then use the spoon **(not your fingers!)** to smooth out the surface of the mixture. Use a paper towel to wipe the sand off the spoon. Throw the paper towel away.

7. When you have completed these tasks, bring your basin to the storage area.

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

SHALE RECIPE

Materials

3	Heaping spoonfuls of powdered clay
2	Heaping spoonfuls of plaster of paris
30 ml	Water
1	Plastic cup
1	Plastic spoon
1	1/2-liter container with sandstone layer (basin)
1	Paper towel

Instructions

1. Go to the clay station and put 3 spoonfuls of powdered clay in a plastic cup.

2. Go to the plaster-of-paris station and add 2 spoonfuls of plaster of paris. Mix the dry clay and plaster of paris thoroughly.

3. Go to the water station and add 30 ml of water to the cup. You can come back later for more if you need it.

4. Mix the dry materials and water with a plastic spoon. The mixture should be fairly thick, like cookie dough. You should be able to spoon it out. You can add more water if you need it, but **be careful not to add too much.** The mixture should not be runny.

5. Spoon the clay mixture onto the sandstone layer in your basin. Smooth it out with the spoon.

6. Use a paper towel to clean off the spoon. Throw the paper towel away.

7. When you have completed these tasks, bring your basin to the storage area.

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Name _____

Period _____ Date _____

SEAWATER INVESTIGATION

Materials

1	Plastic cup
1	Plastic lid for cup, with hole
60 ml	Limewater (calcium hydroxide solution)
4	Straws with hole punched in side
•	Safety goggles

Instructions

1. Work with your group. Measure 60 ml of limewater [$Ca(OH)_2$ solution] into a cup.
2. Place the lid on the cup.
3. What does the calcium hydroxide solution look like? Write your observations in the "Notes on Seawater" table below.
4. Take turns poking your straw through the hole in the lid and gently blowing air into the limewater. Continue taking turns for 2 or 3 minutes.

SAFETY NOTE: Don't suck up the limewater. Make sure you don't blow so hard that the water splatters into your eyes. If you get some limewater on your hands, rinse them with clear water.

5. What does the limewater solution look like now? Record your observations.
6. Let the cup stand for 5 minutes and then record your observations.

Notes on Seawater

Observations of $Ca(OH)_2$ cup *before* bubbling	Observations of $Ca(OH)_2$ cup *after* bubbling	Observations of $Ca(OH)_2$ cup *after* standing for 5 minutes

Observations the Following Day

What was the purpose of the cup that your teacher set aside (the control cup)?

_____

_____

_____

_____

What happened when you placed acid on the white material in the bottom of your experimental cup? Explain.

_____

_____

_____

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Name _____

Period _____ Date _____

LIMESTONE RECIPE

Materials for each group of four students

1 Heaping spoonful of plaster of paris
4 Heaping spoonfuls TOTAL of one or more of the following
- Oyster shells
- Sand
- Clay

30 ml Water
1 Mixing cup
1 Plastic spoon
1 Container with sandstone and shale layers (basin)
1 Paper towel

Instructions

1. Measure 1 spoonful of plaster of paris into the cup.

NOTE: The plaster acts as the matrix for our limestone. Calcium carbonate would usually act as the matrix itself, but we don't have a few million years to wait for this to happen.

2. Measure no more than 4 spoonfuls of the other materials into the cup. The total amount of material you will add is no more than 4 spoonfuls, whatever combination you use.

3. Record the amount of *each material* you used in the space below, called "Our Limestone Recipe."

4. Add 30 ml of water to the cup.

5. Stir the ingredients together. The mixture should be as thick as paste. If you need more water, add *a tiny bit* at a time. It should not be runny.

6. Spread your mixture on top of the shale layer in your basin. Smooth and compact it with your spoon.

7. Rinse and wipe off your spoon and wash out the mixing cup.

Our Limestone Recipe

_____

_____

_____

_____

_____

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Name _____

Period _____ Date _____

BASIN QUESTIONS

1. What are the three rock types in your basin? _____

2. Which rock layer is the oldest? _____

3. Where is it located in the sequence, top or bottom? _____

4. Which layer is youngest? _____

5. Where is it located? _____

6. If you wanted to make a model of the Grand Canyon in your basin, what would you do?

7. Which Grand Canyon rock layer is the oldest that we have observed so far?

8. How do you know it is the oldest? _____

9. Which layer in the Grand Canyon is the youngest that we have observed?

10. How do you know it is the youngest? _____

Name _____

Period _____ Date _____

GRAND CANYON ENVIRONMENTS A

Rock layer	Rock evidence	Fossil evidence	Environment interpretation
Kaibab Formation	Mostly limestone containing some grains of sand.	Sponges, corals, brachiopods, clams, and snails.	
Toroweap Formation	Mostly limestone with some sandstone and siltstone layers.	Sponges, corals, brachiopods, clams, snails, and crinoids.	
Coconino Sandstone	Sandstone with broken rock fragments, especially quartz and feldspar. Well-sorted sand grains are mostly the same size. Large crossbeds.	Reptile and insect tracks.	
Hermit Shale	Shaley siltstone in many areas. Erodes easily. Raindrop imprints and mud cracks.	Plant fossils, including arid-climate ferns and conifers; insects; worm trails; reptile or amphibian tracks.	
Supai Group	Red and tan sandstones, siltstones, and a few limestones.	Vertebrate tracks in the sandstone layers; some brachiopods in the limestone layers. Fossils few and far between.	

Name _____

Period _____ Date _____

GRAND CANYON ENVIRONMENTS B

Rock layer	Rock evidence	Fossil evidence	Environment interpretation
Redwall Limestone	Thick gray limestone stained red from iron oxide.	Brachiopods, corals, crinoids, and bryozoans common. Most fossils whole, but much limestone made of fragments of fossilized shells.	
Temple Butte Limestone	Mostly dolomite, a rock formed by addition of magnesium to limestone.	Protective plates from primitive armored fish; conodonts.	
Muav Limestone	Shaley, yellowish gray limestone.	Trilobites, brachiopods.	
Bright Angel Shale	Shaley, gray mud-stone with some layers of sandstone.	Trilobites, mollusks, and brachiopods. Tracks, trails, and burrows, probably left by worms, snails, and trilobites, common.	
Tapeats Sandstone	Crossbedded sandstone. Sand grains are rounded and smooth. Lots of quartz grains. Ripple marks.	Trilobite tracks and worm burrows.	

Name _____

Period _____ Date _____

PERSONAL HISTORY

1. Fill in dates for the events in the Personal History chart below.

2. Add other significant events in your personal history in the blank spaces in the first column. For example, if you have brothers or sisters, when were they born? When did you learn how to walk? When did you say your first word? When did you move to a new home?

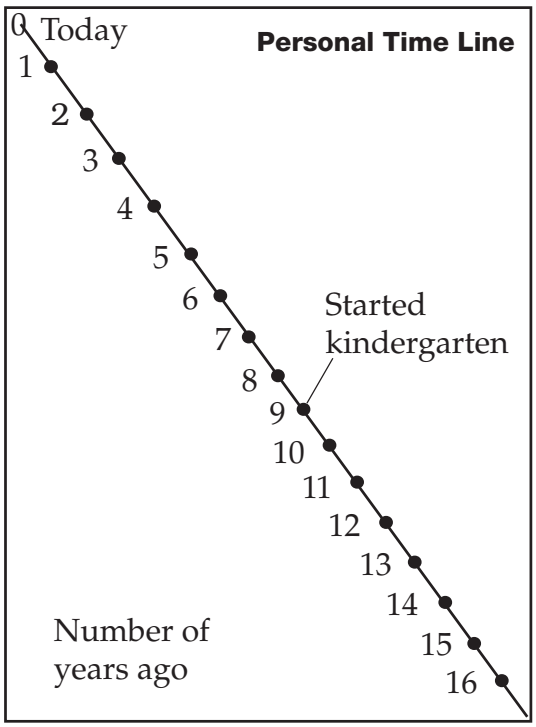
3. The events you listed are what you know about yourself. The dates are when those events happened. Fill in the source of your information (how you know what you know) in the third column. This might be your memory, your baby book, or some other source.

Personal History Chart

Event	Date	Source of information	Location on time line
Today			0 cm
I started middle school			
I started elementary school			
I was born			

4. Now you are ready to use this information to draw your personal time line to scale on the next page, called *Personal Time Line.* Follow the instructions below.

- Draw a line 32 cm long, starting at the top left-hand corner of the sheet of paper and ending close to the bottom right-hand corner.
- Label the left side of your line "Number of years ago."
- Label the top end of the line "0" for zero years ago.
- On your time line 2 cm will equal 1 year. Mark dots every 2 cm to represent years. Number the years along the left-hand side of the line.
- Fill in the last column of the chart with the distance you need to measure from the zero end of the time line. If you started kindergarten at age 5 and you are now 14, you started 9 years ago, which equals 18 cm on the time line.
- Add all of the events you listed in the table to the time line.



Stop here. Finish this sheet in class.

5. Once you have constructed your time line, think about significant events in your life. Using these events, divide your time line into three or four eras. Label these eras on your time line. An example might be preschool era.

6. Is it easier to describe an event that happened last week or one that happened 5 years ago? Why?

7. Where would you look for evidence for an event that happened 1 week ago? One that happened 5 years ago?

Name _____

Period _____ Date _____

PERSONAL TIME LINE

Name _____

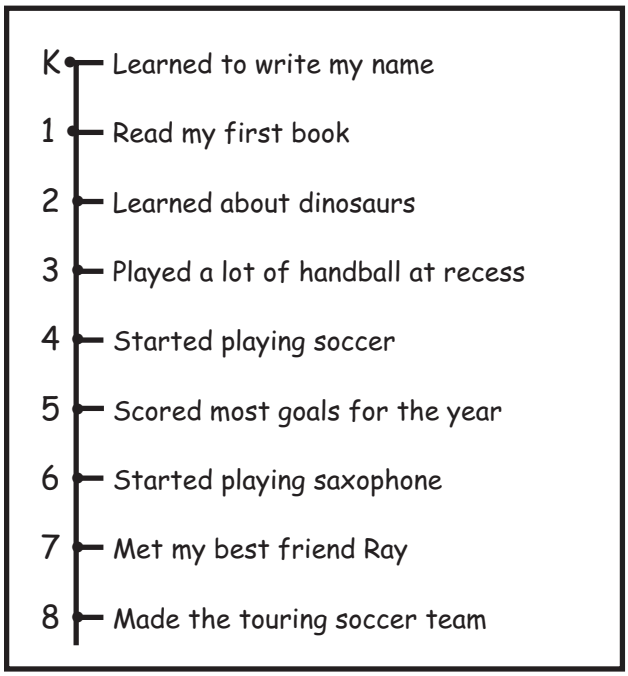
Period _____ Date _____

RESPONSE SHEET—IT'S ABOUT TIME

Brent and Josiah were asked to make a time line of special events that had happened to them since they had entered school. Their assignment was to model a geological time line.

Brent's time line

Josiah's time line



Which boy do you think modeled the better time line? Why do you think so?

Name _____

Period _____ Date _____

EARTH HISTORY TIME LINE

Era	Time period	Age (years)	Distance on time line (mm)	Distance on time line (cm)
Cenozoic	Today	0.00		
	Quaternary period	1,600,000		
	Tertiary period	66,000,000		
Mesozoic	Cretaceous period	144,000,000		
	Jurassic period	208,000,000		
	Triassic period	245,000,000		
Paleozoic	Permian period	286,000,000		
	Pennsylvanian period	320,000,000		
	Mississippian period	360,000,000		
	Devonian period	408,000,000		
	Silurian period	438,000,000		
	Ordovician period	505,000,000		
	Cambrian period	570,000,000		
Precambrian		4,500,000,000		

1 mm = 1 million years

1. Label one end of the adding-machine tape "0 = Now."

2. Draw a line across the tape to mark the start of the Quaternary period, which began 1,600,000 years ago. Remember, 1 mm on the adding-machine tape equals 1 million years of Earth history. The beginning of the Quaternary is 1.6 mm back from "now." Not very far!

3. Locate the beginning of the Tertiary period. Divide 66,000,000 years by 1,000,000 years per millimeter to get 66 mm. 66 mm = 6.6 cm. Measure back 6.6 cm from zero and mark the beginning of the Tertiary period. The distance between 6.6 cm (the beginning of the Tertiary period) and the start of the Quaternary period (also the end of the Tertiary period), represents the entire Tertiary period.

4. Continue in the same manner for the rest of the time line.

5. Draw an extra heavy line marking the beginning of each era.

Name _____

Period _____ Date _____

ROCKS OVER TIME

Rock layer	Time of deposition (approximately)	Distance on time line (cm)	Period
Kaibab Formation	Ended 255,000,000 years ago Began 260,000,000 years ago		
Toroweap Formation	Ended 260,000,000 years ago Began 265,000,000 years ago		
Coconino Sandstone	Ended 265,000,000 years ago Began 270,000,000 years ago		
Hermit Shale	Ended 270,000,000 years ago Began 275,000,000 years ago		
Supai Group	Ended 275,000,000 years ago Began 325,000,000 years ago		
Redwall Limestone	Ended 325,000,000 years ago Began 360,000,000 years ago		
Temple Butte Limestone	Ended 370,000,000 years ago Began 375,000,000 years ago		
Muav Limestone	Ended 525,000,000 years ago Began 530,000,000 years ago		
Bright Angel Shale	Ended 530,000,000 years ago Began 540,000,000 years ago		
Tapeats Sandstone	Ended 540,000,000 years ago Began 545,000,000 years ago		

1 mm = 1,000,000 years

Name _____

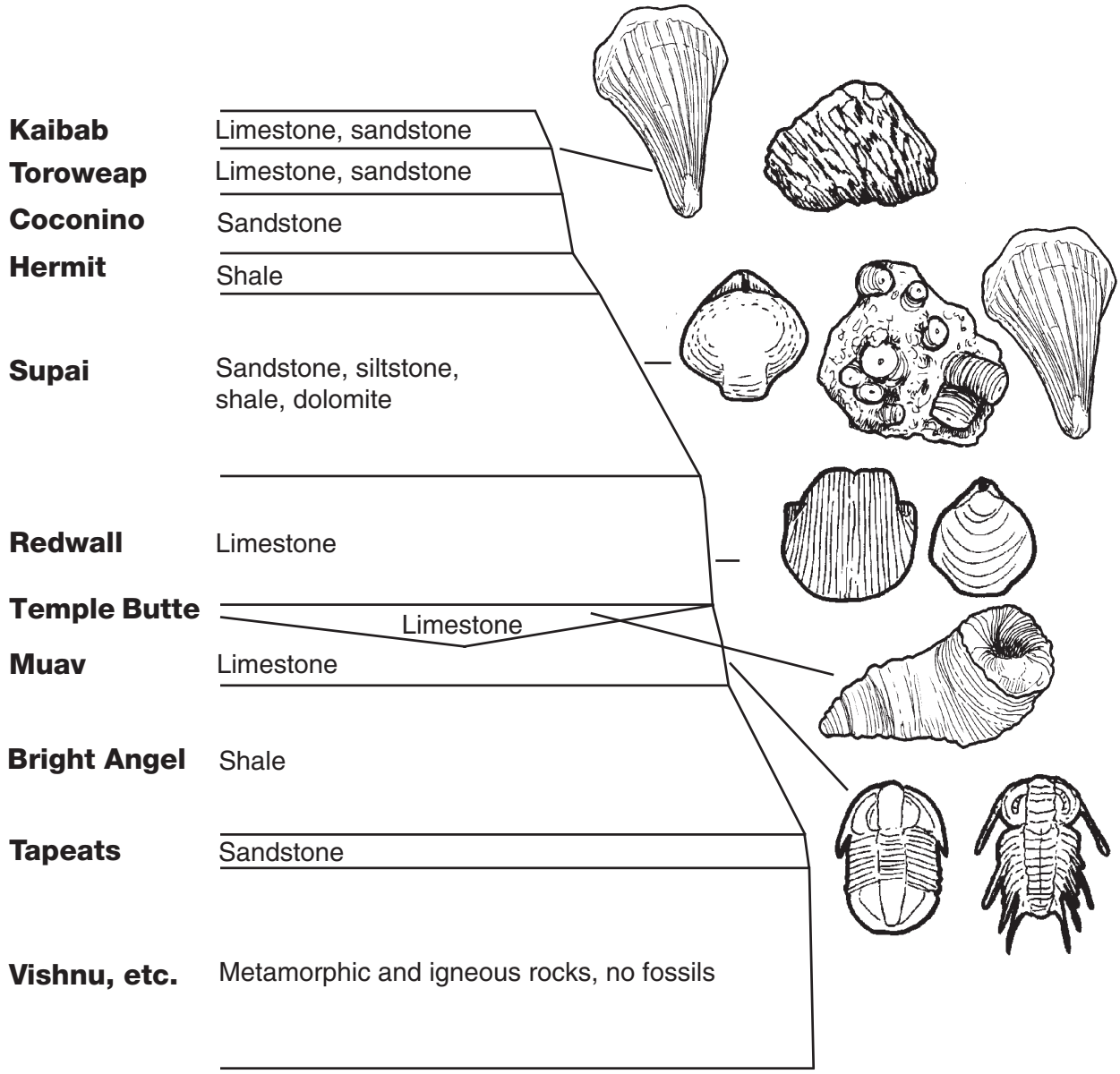
Period _____ Date _____

SHOW ME A MILLION!

Your group may choose one of the following ideas to help develop a mental picture of how big a million is or come up with an idea of your own.

- How many **soda cans** would you need to have a million milliliters? How much space would they take up?
- What would a million grains of **rice** look like? How many bags or boxes of rice would you need? How much space would they take up?
- How many **paperback books** would you need to have a million words? How much space would they take up?
- How thick would a million **sheets of paper** be?
- How long would a chain of a million **paper clips** be?
- How long would a line of a million **plastic centicubes** (centimeter cubes) be?
- How long would a line of a million **pennies** be? How far would they reach?
- How many sheets of **newspaper** would you need to have a million words? How big a stack would they make?
- How many sheets of **graph paper** would you need to have a million squares? How thick would this stack of graph paper be?

GRAND CANYON FOSSILS



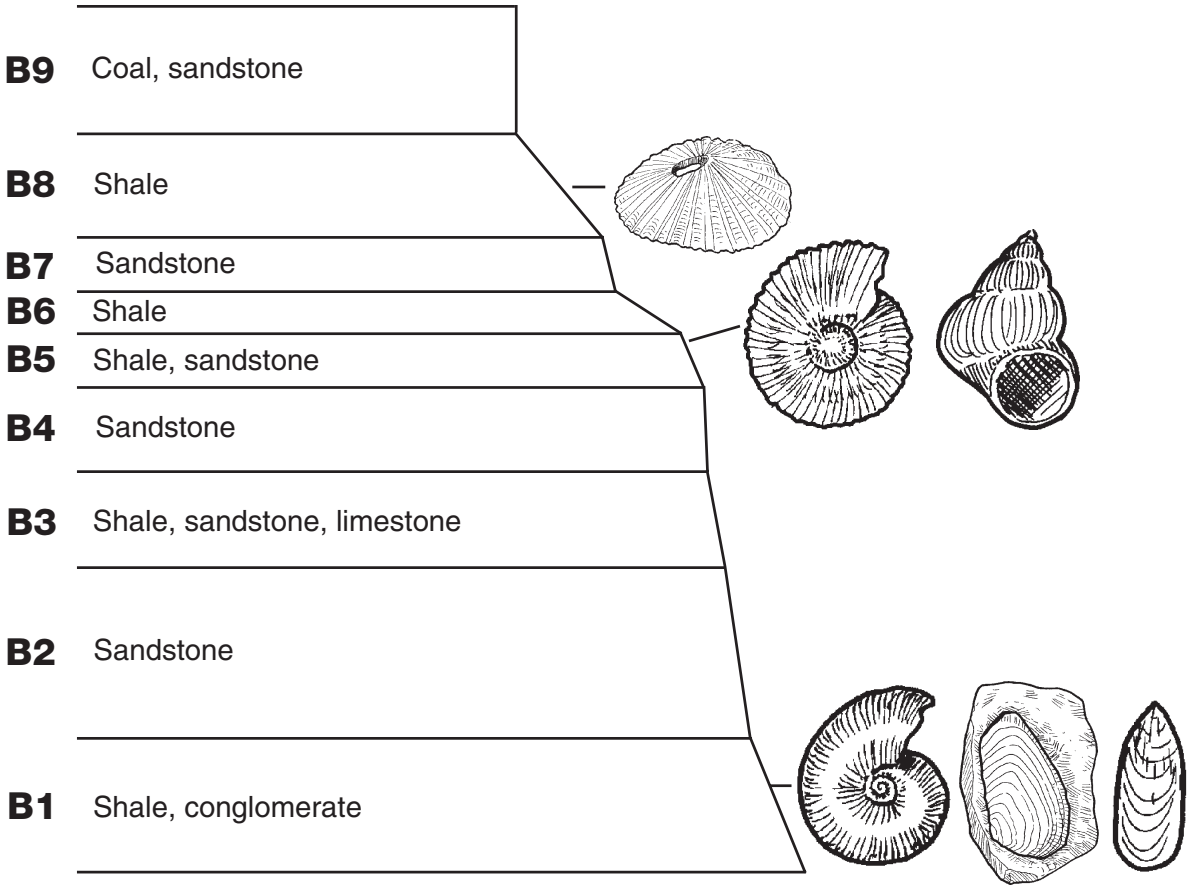
Name _____

Period _____ Date _____

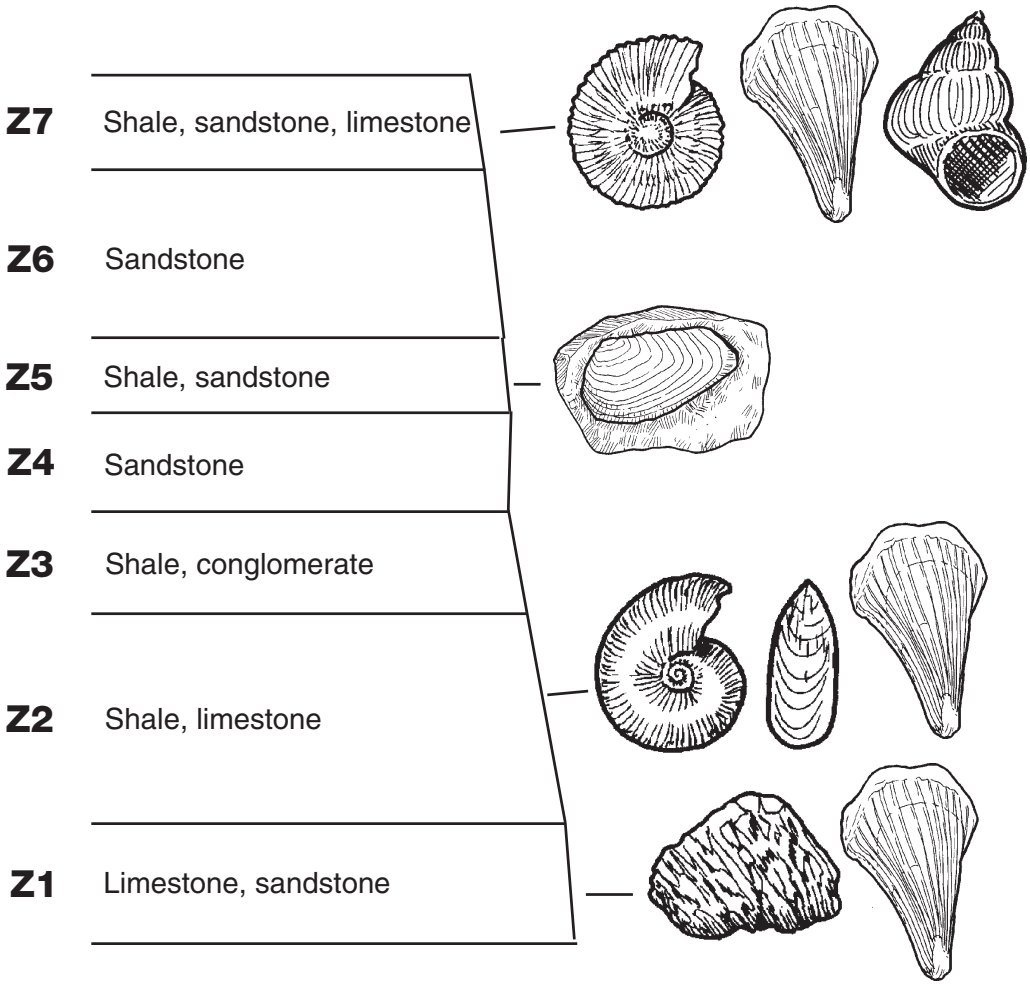
INDEX-FOSSIL IDENTIFICATION, GRAND CANYON

Rock layer	Index fossils identified	Ages
Kaibab Formation		
Toroweap Formation		
Coconino Sandstone		
Hermit Shale		
Supai Group		
Redwall Limestone		
Temple Butte Limestone		
Muav Limestone		
Bright Angel Shale		
Tapeats Sandstone		
Vishnu		

BRYCE CANYON FOSSILS



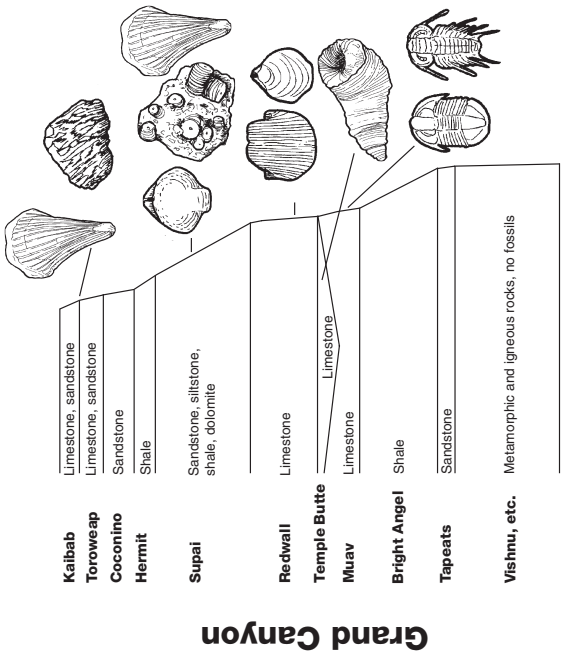
ZION NATIONAL PARK FOSSILS



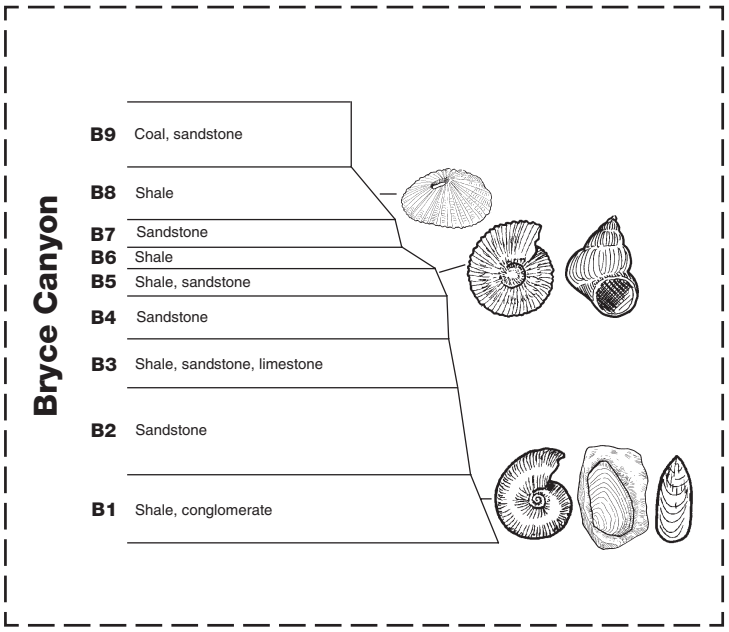
Name _____

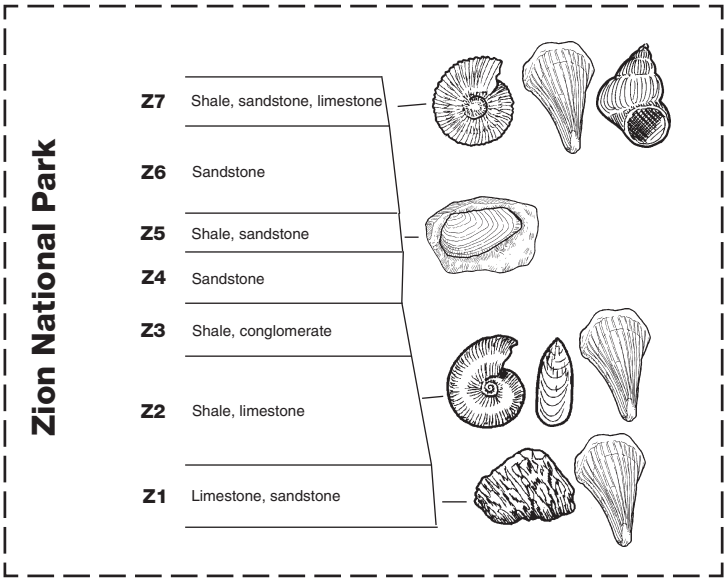
Period _____ Date _____

INDEX-FOSSIL CORRELATIONS



Cut these rock layers out on the dashed lines and tape them to the *Index-Fossil Correlations* sheet to observe the relationship of the rocks in the three national parks.





Name _____

Period _____ Date _____

INDEX-FOSSIL CORRELATION QUESTIONS

Answer these questions after you have identified and correlated the rock layers at the three parks.

1. Which rock layers contained the same index fossils at Zion and the Grand Canyon?

2. Which rock layers contained the same index fossils at Zion and Bryce?

3. Which rock layers contained the same index fossils at Grand Canyon and Bryce?

4. Is rock layer B3 at Bryce older or younger than Supai Group at the Grand Canyon? How do you know?

5. Is rock layer B2 at Bryce older or younger than rock layer Z1 at Zion? How do you know?

6. What do you think the environment was like at the time layer B9 was being deposited at Bryce?

Name _____

Period _____ Date _____

THINKING ABOUT INDEX FOSSILS

1. What big ideas did the following people contribute to the study of fossils? How did their ideas help people better understand fossils and what they mean?

   a. James Hutton _____

   b. Lamarck _____

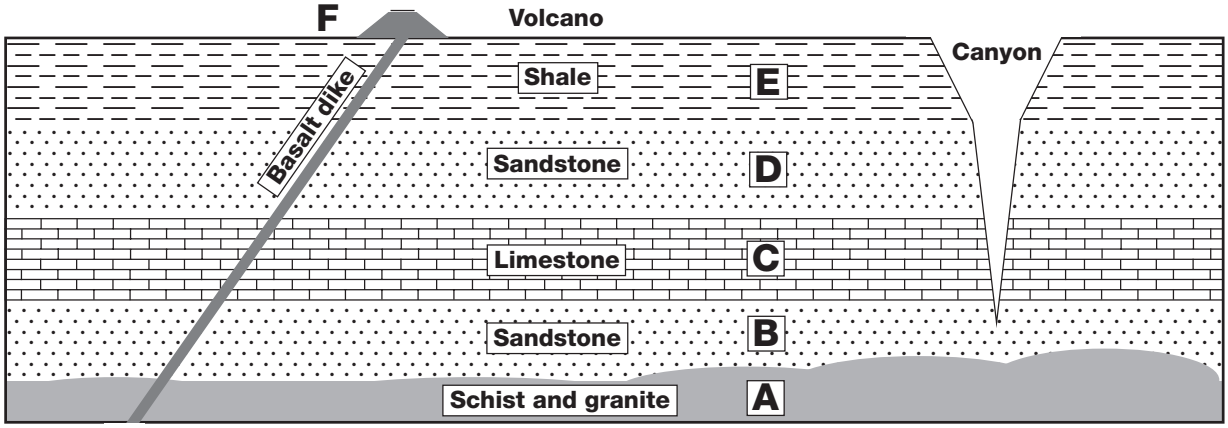
   c. William Smith _____

2. Fossils have been called the index to Earth history. What does that mean?

3. Smith noticed that wherever he found his index fossils, fossil a was always in the top layer, fossil b was in the layer under a, and fossil c was in the layer under b. One time he found a rock column with fossil a in the top layer and fossil c in the layer directly under layer a. There was no layer with fossil b. What might this mean? How would you find out for sure? Draw a picture to help you think about this.

4. Suppose you found a rock column with fossil c in the top layer, with fossil b in the next layer, and fossil a in the lowest layer. What might this mean? How would you find out for sure?

5. This illustration shows what might be a typical column of rocks exposed in a canyon on the Colorado Plateau. Using potassium-argon dating, geologists have calculated an age of 200 million years for rock A, a granite. Rock F, the volcano, has been given an age of 225,000 years.

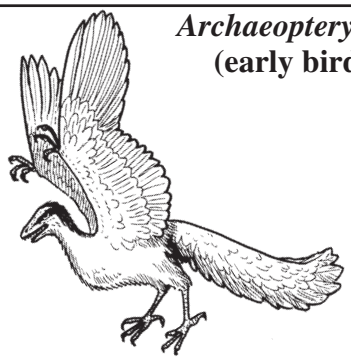


a. How can you use this information to estimate the age of rock layers B, C, D, and E?

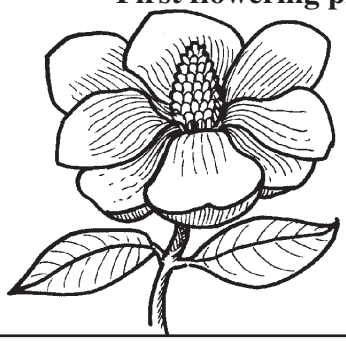
b. Which is younger, the volcano or the basalt dike leading up to it?

EVENT CARDS A

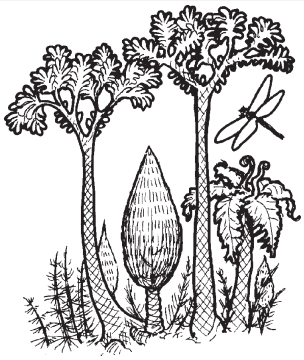
Archaeopteryx (early bird)



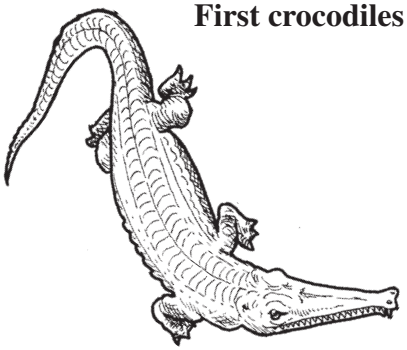
First flowering plants



Forests of coal plants



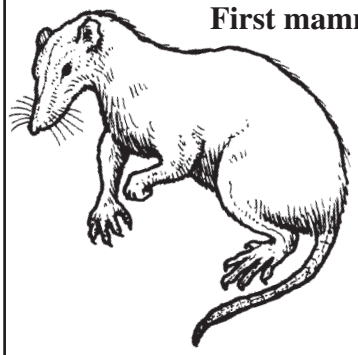
First crocodiles



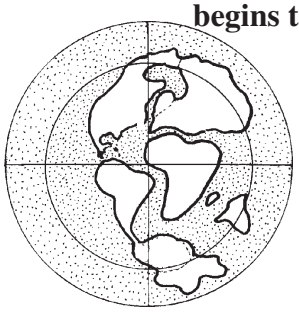
Recorded written history

Water appeared on Earth's surface

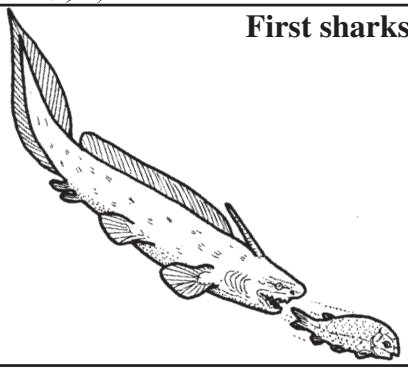
First mammals



Pangaea, the supercontinent, begins to divide

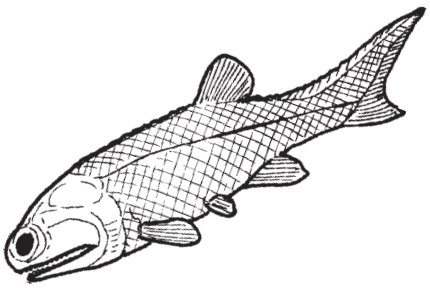


First sharks

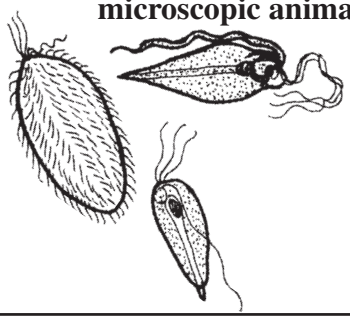


Neanderthal man (1400 cc brain)

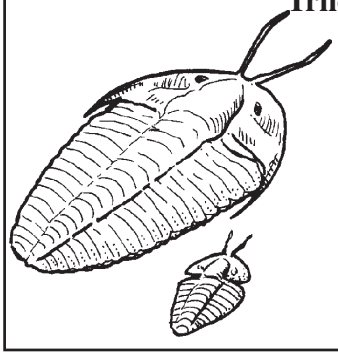
First bony fishes



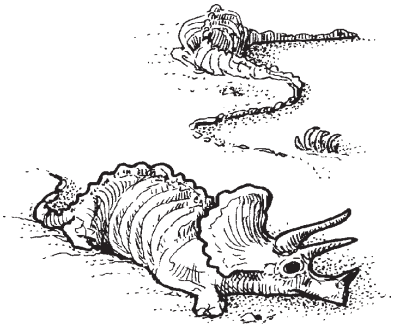
Protozoa (single-celled, microscopic animals)



Trilobites

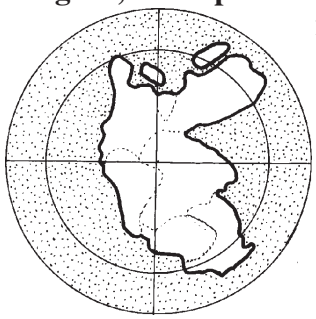
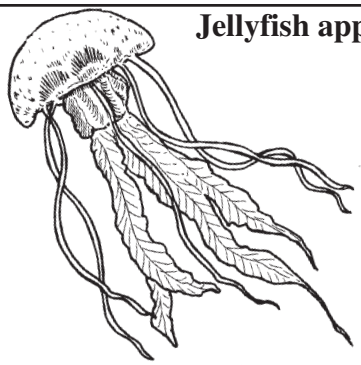
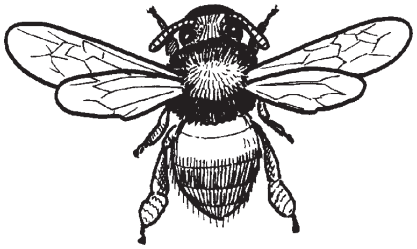
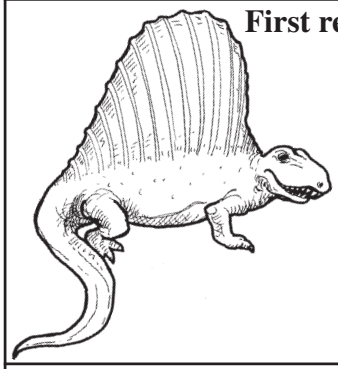
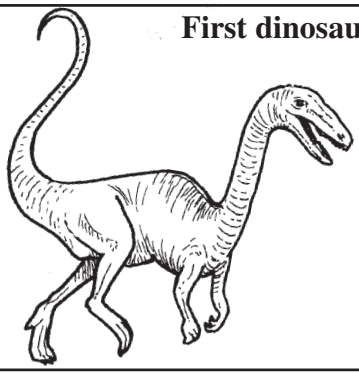
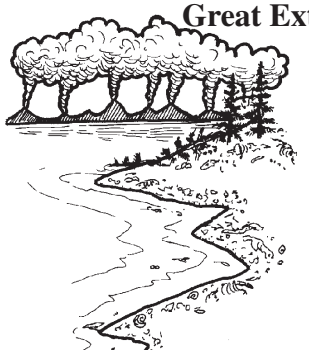
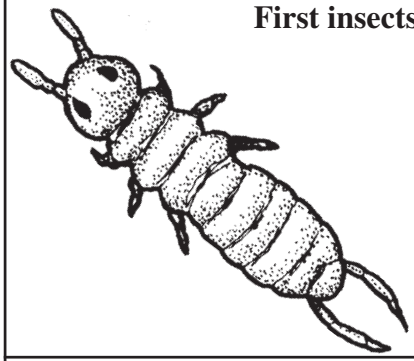
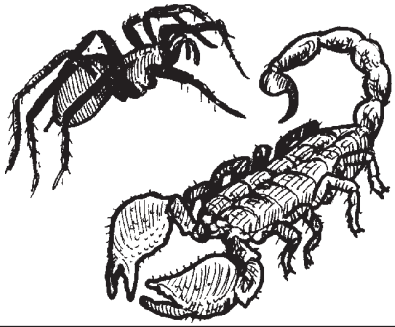
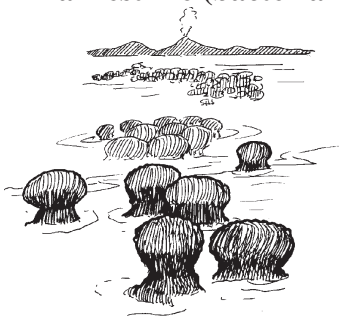
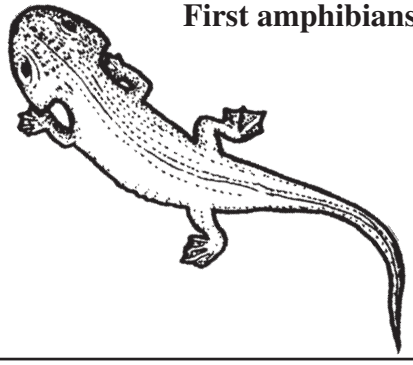
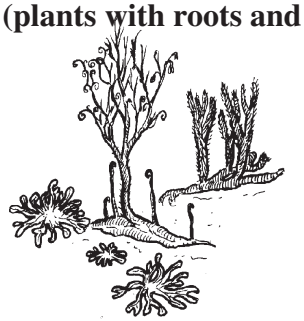
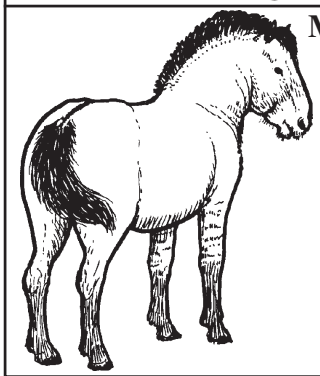
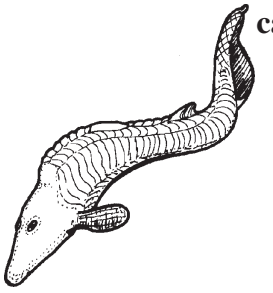


Dinosaur extinction



Grass

EVENT CARDS B

Pangaea, the supercontinent, forms 	**Jellyfish appear** 	**Bees** 
First reptiles 	**First dinosaurs** 	**Great Extinction** 
First insects 	**First land animals** 	**Earliest life (bacteria-like)** 
Tyrannosaurus rex 	**First amphibians** 	**First vascular land plants (plants with roots and stems)** 
Modern horse 	**Earth formed** 	**First vertebrates (jawless fish with skeletons made of cartilage)** 

Name _____

Period _____ Date _____

MAJOR EVENTS IN EARTH HISTORY

Consider the following pairs of events. Which do you think occurred first in each pair? Explain why you think so.

- Dinosaurs appear; dinosaurs become extinct.

- Jellyfish appear; protozoa (single-celled animals) appear.

- Bees appear; flowering plants appear.

- Trilobites appear; fish with backbones appear.

Take turns arranging the event cards in the order they might have occurred. Explain to your partner why you are putting them in that order. Reach an agreement about the order and record the sequence here.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____

After you have recorded your sequence, place the cards on your time lines where you think they should go.

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Name _____

Period _____ Date _____

ROCK IDENTIFICATION A

Rock number	Rock type and name	Description	Properties
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Name _____

Period_____ Date_____

ROCK IDENTIFICATION B

Rock number	Rock type and name	Description	Properties
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		
	Rock Type Rock Name		

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Name _____

Period _____ Date _____

CRYSTAL-SIZE INVESTIGATION

Research question: What variable affects the size of salol crystals?

1. Investigation plan

   What variable do you think will affect the size of the crystals that form?

   _____

   What effect will this variable have on crystal size?

   _____

2. What materials will you need for your investigation?

   _____ _____

   _____ _____

   _____ _____

3. Describe your procedure.

   _____

   _____

   _____

   _____

   _____

4. Describe your results.

   _____

   _____

   _____

   _____

5. What conclusions can you draw about igneous rocks?

   _____

   _____

   _____

   _____

Name _____

Period _____ Date _____

IGNEOUS-ROCK QUESTIONS

1. What type of igneous rock is granite? _____

2. What does that tell about where granite is formed, below Earth's surface from magma or above from lava? _____

3. Many mountain ranges are composed of granite, such as the Sierra Nevada in California and the Rocky Mountains. Considering what you know about granite, how can you explain this? _____

4. What kind of igneous rock is basalt? _____

5. What does that tell you about where basalt is formed? _____

6. You can find basalt at Mile 179 in the Grand Canyon. The basalt is on top of all the other layers. What does this tell you about the geological history of this area of the Grand Canyon? _____

7. If you walked around on the rim of the Grand Canyon near Mile 179, you might find chunks of obsidian.

   What kind of igneous rock is obsidian? _____

   What does obsidian look like? _____

   Explain this appearance of obsidian, using what you know about how temperature and cooling rate affects crystal size in igneous rock.

STUDENT SCORING GUIDE

4 **The answer or task is completed correctly and demonstrates understanding of concepts and connections beyond the mastery level.**

3 **Mastery Level. The question or task is complete and correct. All important information is included in the answer.**

2 **The answer or task has essentially correct elements; there are only minor mistakes, or minor pieces of information left out.**

1 **The answer or task contains related information, but has significant mistakes or misconceptions.**

0 **The student does not respond to the question or task, or gives an answer that has nothing to do with what was asked.**

NOTES

NOTES

NOTES