Name KEY Period 1, 5, & 6

Earth Science
Semester 1 Final Exam Study Guide

- ✓ The final exam will be all multiple-choice/matching.
- ✓ The exam is worth 15% of your final semester grade.
- ✓ Do not bring electronic devices to the exam. This includes cell phones, tablets, iPads, etc. If seen, they will be taken!
- ✓ If you finish your review packet (meet ***ALL*** due dates) AND are focused during the review days, then you may use a 3x5" HANDWRITTEN note card (both sides) on the final. The card will be turned in with your final.
- ✓ There will be no rest room passes until you are done with the test.
- ✓ BRING a PENCIL.
- ✓ BRING a book or something to do (NOT ELECTRONIC) to use when you are done with your final.

"Success is a state of mind. If you want success, start thinking of yourself as a success."

- ✓ Keys to success:
  - Complete this study guide.
  - Don't wait until 1 or 2 days before finals to get help.
  - Start studying early. Remember, you have all summer to relax! ☺
  - Use your note outlines in addition to this study guide for help and extra practice. Be sure to focus on what this study guide covers, but your chapter note outlines help a lot.
  - Make flash cards for definitions and key concepts.
  - Other resources include: Quizlet, textbook, textbook website for practice quizzes, my webpage with videos, etc.

Final exam main **topics**:

- ✓ Planet Composition and Formation
- ✓ Chapter 4: Minerals
- ✓ Chapters 5 & 6: Rocks
- ✓ Chapter 21: Fossils & the Rock Record
- ✓ Chapter 17: Plate Tectonics
- ✓ Chapter 19: Earthquakes

Final Exam Schedule: Find your class period and time. Be on time.

- Do NOT be late. School policy is that tardy students will not be admitted to the classroom to take the final. Instead, tardy students must return Tuesday after 12:30 to take the exam.
- Only need to be here for periods that have a final. (Buses run on their regular schedule.)
- If here during resource/lunch, go to the cafeteria (open study hall), library (quiet), or gym.

1st Semester Finals Schedule					
Wednesday, January 10th		**Thursday, January 11th**		**Friday, January 12th**	
Resource	8:10-9:40	Resource	8:10-9:40	Resource	8:10-8:45
5th period	9:50-11:20	1st period	9:50-11:20	3rd period	8:50-10:20
6th period	12:20-1:50	2nd period	12:20-1:50	4th Period	10:30- 12:00
7th period	2:00-3:30	Resource	2:00-3:30	Busses Leave	12:30
				8th period make-up	12:30-3:30

Intro to Planet Formation & Composition

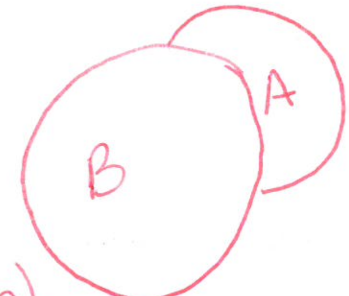
1. Define the following terms:
   a. Impact Crater – A crater produced by a space object/piece of debris colliding with a solid surface.

   b. Radioactive Decay – The process by which unstable parent elements decay into daughter elements.

   c. Half-Life – The amount of time it takes for ½ the molecules in a substance to decay.

   d. Erosion – Moving of land/rock/sediments by wind, water, etc.

2. Draw a picture of 2 moon craters that overlap.



   a. Which one would be younger? B
   b. How do you know?

   A is underneath so it had to form first (law of superposition).

3. Describe the composition of an interstellar cloud. What is it made of?

   Gas and Dust (particularly lightweight gas H & He) (H ↑ Hydrogen, He ↑ Helium.)

4. Compare and contrast planetesimals vs. inner planets

   - structures that are needed to form inner planets
   - not planets

   - planets
   - formed from planetesimals colliding and sticking together.

   same
   - terrestrial < rocky, solid
   - found in the inner part of the solar system

5. Using the graph to the right, answer the following questions?
   a. How many minutes have gone by after N-13 experiences one half-life?

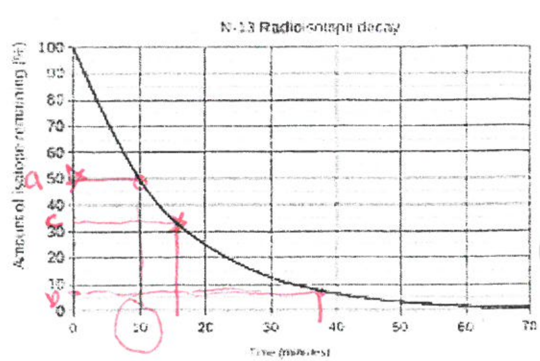
      10 min

   b. How much of N-13 is left after 4 half-lives?

      6.25%

   c. If you had 33% of N-13 left in a sample, how much time had gone by?

      15 min



6. Explain the process that formed the inner planets. Your explanation should contain the word "planetesimals." inner planets formed by planetesimals colliding and sticking together until a planet-sized terrestrial object was formed.

a. What are the inner planets mostly made of?

- rock
- metal

b. Why do they have few moons?

- The sun's gravitational pull stole all the close leftover debris from planetesimal collisions.

c. Why do they not have rings?

- The sun's gravitational pull stole all the gas and dust in the inner solar system and the sun used these materials to form itself.

7. Explain the process that formed the outer planets. Your explanation should contain the word "condense." The outer planets formed from gas and dust accumulations that began to condense and attract more gas and dust by gravity until a planet sized object was created.

a. What are the outer planets mostly made of?

- gas/dust
- rocky cores

b. Why do they have many moons?

- They are far enough away from the Sun so the Sun's gravitational pull can't steal debris from the outer solar system.

c. Why do they have rings?

- They are far enough away from the Sun so when the Sun was forming it could not use gas and dust from the outer region of the solar system to form itself.

8. Why aren't the outer planets made of the same materials as the inner planets?

The Sun creates a temperature difference so only objects like rock and metal that can be solid at high temperatures are found close whereas gas and dust are found farther away due to colder temperature.

9. What factors cause erosion to occur on planets?

1) solid/terrestrial surface
2) Presence of an atmosphere (creates wind and water sources)
3) Presence of tectonic activity

10. If a planet has a lot of impact craters that remain unchanged over millions of years, what erosion forces are present on the planet?

None, there must be no atmosphere (or wind/water would have slowly filled up craters with the sediment) and no tectonic activity or the craters would become slowly leveled out/disappear.

11. A plant has few impact craters, an atmosphere, and tectonic activity. Describe the process(es) that caused this planet to form?

This planet was formed by planetesimals colliding and sticking together because it is terrestrial. Only terrestrial planets have impact craters due to their solid surface.

12. Where would the planet in 11 be located in our Solar System?

A. Close to the Sun or far from the Sun. Close to the Sun

B. How do you know? It's terrestrial and planets made of rock and metal are only found close to the Sun due to high temperature

Chapter 4 Minerals

13. List the 5 characteristics that all minerals have. (NOTE – these are NOT tests like color, streak, etc.)

a. Inorganic

b. Naturally occurring

c. Specific Chemical Composition

d. Definite Crystal Structure

e. Solid

14. Define each of the following tests.

a. Color The appearance of a mineral caused by the presence of trace elements.

b. Luster The ability of a mineral to reflect light. Minerals can either be metallic (posses crystals) or non-metallic (contain no crystals)

c. Streak The color a mineral leaves behind when rubbed across a porcelin plate.

d. Hardness The ability of a mineral to be scratched by another mineral or to leave a scratch on another mineral.

e. Cleavage when a mineral breaks and leaves smooth flat planes exposed.

f. Fracture when a mineral breakes and leaves jagged rugh edges exposed.

15. Which of the above is the LEAST reliable test? Why?

Color, minerals can have a different color due to small differences in elements (trace elements)

16. What are the 2 main classifications of luster?

1) Metallic - contains crystals that are visible

2) Non metallic - contains no/none visible crystals

17. Explain how you determine hardness.

Perform a scratch test to identify what materials the mineral can scratch or what materials can scratch the minerals.

18. What is the name for molten material:

a. Beneath earth's surface? Magma

b. On earth's surface? lava

19. What size of mineral crystals form if magma cools slowly? large Cools quickly? small

20. Which 2 elements are associated with the formation of dark silicates?

Fe (Iron) and Mg (Magnesium)

Table 4-3 Mohs Hardness Scale			
Talc	1	(softest)	
Gypsum	2		fingernail (2.5)
Calcite	3		piece of copper (3.5)
Fluorite	4		iron nail (4.5)
Apatite	5		glass (5.5)
Feldspar	6		steel file (6.5)
Quartz	7		streak plate (7)
Topaz	8		scratches quartz
Corundum	9		scratches topaz
Diamond	10	(hardest)	scratches all common materials

Use the Table above to answer the next few questions:

21. What does it tell you if a mineral scratches glass?

It has a hardness above 5.5 — according to the chart above.

22. If Gypsum is rubbed against Talc:

a. Is a scratch made, or no scratch? yes, gypsum is harder than talc.

23. If a mineral with hardness of 3.4 is rubbed against feldspar:

a. Is a scratch made, or no scratch?

no, feldspar has a hardness of 6 so a mineral with a hardness of 3.4 would not be able to scratch it.

24. **Use attached Mineral Identification Flow Chart on the following page to identify the minerals with the following characteristics:**

A) Hardness greater than 6, non-metallic luster, fracture, scratches glass, dark red color

Name of mineral is Jasper or Garnet

B) Brass yellow, metallic, makes a black streak

What 2 possible minerals could this be? Pyrite or Chalcopyrite

****<u>NOW</u>, BASED ON the info in the FLOW CHART, <u>describe a test you could do</u>** to determine which of the 2 minerals it is? Include an explanation of how the results of the test would vary etween the 2 minterals. Be specific & detailed.

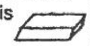
Hardness, if the mineral scratches glass it is pyrite and if it doesnt it is chalcopyrite.

C) Scratches glass, breaks along flat surfaces/planes, pink color, non-metallic, hardness

Name of mineral is Quartz

D) White, hardness 2, cleavage, does not scratch glass, non-metallic

Name of mineral is Gypsum

Metallic luster	Black, green-black, or dark green streak		Black; strongly magnetic; hardness, 6	Magnetite
			Lead-pencil black; smudges fingers; hardness, 1	Graphite
			Brass yellow; cubic crystals; hardness, 6 to 6.5	Pyrite
			Brass yellow, may be tarnished purple; hardness, 3.5 to 4	Chalcopyrite
			Shiny gray; very heavy; cubic cleavage; hardness, 2.5	Galena
	Yellow-brown or white streak		Yellow-brown to dark brown, may be almost black; hardness, 6	Limonite
			Yellow-brown; streak white to pale yellow; resinous luster; hardness, 3.5 to 4	Sphalerite
Nonmetallic, light-colored	Scratches glass	Cleavage	Pink to bluish gray to green; 2 cleavage planes at right angles; hardness, 6	Feldspar
		No cleavage	Glassy luster; crystals are 6-sided when present; hardness, 7; shell-like fracture	Quartz
			Glassy luster; shades of green and yellow; hardness, 6.5 to 7	Olivine
	Does not scratch glass	Cleavage	Colorless to white; salty taste; cubic cleavage	Halite
			White or yellow to colorless; hardness, 3; double image seen when crystal is placed on printed page 	Calcite
			White to transparent; hardness, 2	Gypsum
			Green to white; feels soapy; hardness, 1	Talc
			Colorless to light yellow; hardness, 2 to 2.5	Muscovite
			White, yellow, purple, or green; 8-sided cleavage; hardness, 4	Fluorite
		No cleavage	Green to white; feels soapy; hardness, 1	Talc
Nonmetallic, dark-colored	Scratches glass	Cleavage	Black; cleavage with 2 planes at 90° angles; hardness, 5 to 6	Augite
			Black; cleavage with 2 planes at 60° angles; hardness, 5 to 6	Hornblende
		No cleavage	Gray, brown, or blue-gray; 6-sided crystals; hardness, 9	Corundum
			Reddish brown; fracture resembles poor cleavage; brittle	Garnet
			Red, brown, or gray; dull luster; shell-like fracture; hardness, 7	Jasper
	Does not scratch glass	Cleavage	Brown to black	Biotite
			Shades of green; hardness, 2 to 2.5	Chlorite
		No cleavage	Red to brown streak; earthy appearance	Hematite
			Green, brown, blue, or purple; poor cleavage; hardness, 5	Apatite

Chapter 5 & 6 Rocks

Igneous Rocks

25. Fill in the Table below Regarding Extrusive and intrusive Rocks:

	Where do these rocks form?	What do the rocks look like? (Describe Crystal Size)	Fine Grained or Coarse Grained
Extrusive	Quickly on Earth's surface	small → no crystals	fine grained
Intrusive	slowly inside Earth	large crystals/ surfaces covered in crystals	coarse grained

26. Fill in the table below regarding igneous rocks and the magma they form from.

Types of Magma	Elements found in the magma	Viscosity of the magma	Rock Color	Type of Volcanic Hazard Produced
Light-colored	Si + O	thick (very viscous)	light	explosive eruptions
Dark-colored	Fe + Mg	thin (not viscous)	dark	quick lava flows

27. What would happen if you added water to light-colored magma?

the viscosity would decrease (it would become thinner).

28. What affects the color of an igneous rock?

The amount of Si + O (light) vs Fe + Mg (dark)

29. What would you have to do to a sedimentary rock covered in fossils to produce an igneous rock?

Melt it and cool/crystalize

Table 5-2 Classification of Igneous Rocks

	Light-Colored	In Medium Color	Dark-Colored	U Really Dark		Texture
Extrusive	Obsidian		Basaltic glass			Glassy (non-crystalline)
Extrusive	Rhyolite	Andesite	Basalt			Fine-grained
Intrusive	Granite	Diorite	Gabbro	Peri-dotite	Dun-ite	Coarse-grained
Intrusive	Pegmatite					Very coarse-grained

30. Using the diagram above, describe the following about Rhyolite:

a. Color: Light

b. Texture: Fine-grained (Extrusive)

c. Location where it formed: on Earth's surface quickly

31. List and Define two processes that must be present to form an igneous rock?

1. Melting

2. Cooling/Crystalizing

SEDIMENTARY ROCKS:

32. What is a "sediment"? A broken down piece of Earth's crust.

33. What are the 3 subtypes of sedimentary rocks?
**For each type, tell how the subtype forms.

a. Clastic/common - sediments are deposited, burried, and lithified to make rock.

b. organic - remains of once living organisms are deposited, burried, and lithified to make rock

c. chemical - water evaporates and leaves behind cemented mineral crystals.

34. How is weathering different from erosion?

weathering = breaking rock into sediments } erosion = moving sediments around.

35. Describe the 2 types of weathering that can occur in nature and provide an example of each.
**Make sure you are able to explain what your example is and how it works.

a. Physical/Mechanical - Rock is broken into smaller pieces of the same rock (sediments).

b. Chemical - Rock is dissolved or changed into something new (not the same rock).

36. Define deposition:

Setting sediments down.

37. Lithification:

a. Define lithification: The compaction and cementation of sediments to make rock

b. How do you know when lithification has occurred?

you finally have a rock

c. List and describe the two steps that occur as a part of lithification.

1) Compaction - sediments are pressed tightly together

2) Cementation - sediments are glued together to make rock.

38. What would need to happen to obsidian to turn it into sediments?

it would need to be weathered (physically or chemically)

39. After the obsidian turns to sediments, what must happen to them to produce a sedimentary rock?

They must be deposited, burried, and lithified

METAMORPHIC ROCKS:

40. What two factors are needed to form metamorphic rock?

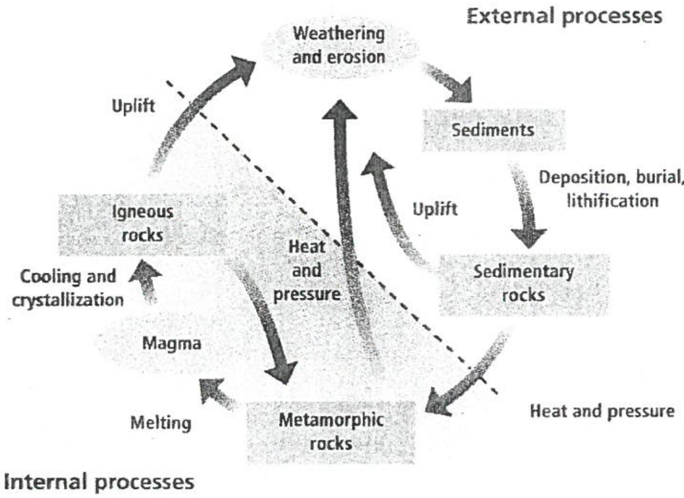
(1) HEAT

(2) Pressure

41. Fill in the table below regarding Metamorphic Rocks.

Types of Metamorphic Rocks	How was the rock formed?	Describe and/or draw the appearance of the rock.
1. Foliated	Intense Pressure	← layers
2. Non-folrated	Intense Heat	← cystals

Rock Cycle:



42. Marble is a metamorphic rock. Using the diagram on the previous page, list ALL the processes marble must go through to become: (On the final exam, be able to define each process)

d. An igneous rock

It must be melted, cooled, and crystallized.

e. A new metamorphic rock

you must apply heat and pressure.

f. A sedimentary rock

the rock must be uplifted, weathered, eroded, deposited, buried, and lithified

43. What types of rocks can turn into sedimentary rocks?

All types

Chapter 21 Fossils & the Rock Record

44. Fossils:

a. What is a fossil? A remain/evidence of once living creatures

b. What conditions make it more likely that a fossil will form? (1) QUICK BURIAL (2) Hard body parts.

45. Index fossils

a. What is an index fossil? An organism that lived during a short period of time and can be used to help age rocks.

b. What are the four criteria that make something an index fossil?

(1) Lived during a short period of time (2) abundant (3) widespread (4) Easily Recognized.

46. What does the Law of Superposition tell us about the relative age of rocks?

Rocks that are older are on the bottom/younger on top.

47. What is an exception to the law of superposition?

**Explain how/why this is the case.

intrusions, they are younger than rock they pass through

48. What is correlation?

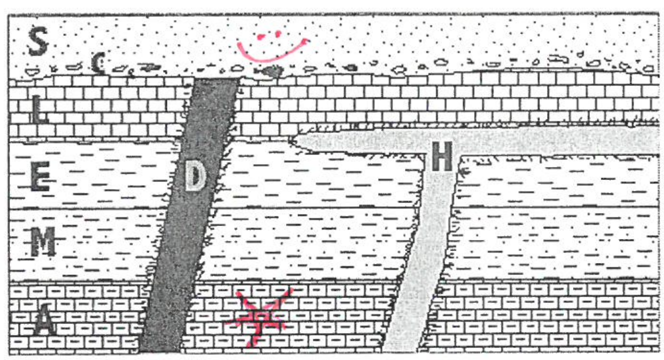
A rock you can use fossils contained within them to determine the rocks age.

49. What role can index fossils play in correlating rock layers?

index fossils can help match rock layers (same fossils = same age)

50. Star the letter of the oldest rock on the diagram to the right. Explain how you know it is the oldest

☆ on the bottom



51. Circle the letter of the youngest rock on the diagram to the right. Explain how you know it is the youngest.

☺ on the top

52. Is rock section "H" older or younger than rock section "M"? Explain.

younger, it passes through it (intrusion).

53. Using the diagram to the right, what is the youngest period ~~ep~~ in the Mesozoic Era? How do you know?

cretaceous - on the top

Geologic Time Scale

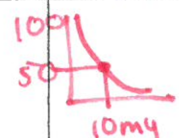
Eon	Era	Period	Epoch	Boundary Dates (Ma)
Phanerozoic	Cenozoic	Quaternary	Holocene	0.012
			Pleistocene	2.6
		Tertiary (Neogene)	Pliocene	5.3
			Miocene	23.0
		Tertiary (Paleogene)	Oligocene	33.9
			Eocene	55.8
			Paleocene	66
	Mesozoic	Cretaceous		146
		Jurassic		200
		Triassic		251
	Paleozoic	Permian		299
		Carboniferous: Pennsylvanian		318
		Carboniferous: Mississippian		359
		Devonian		416
		Silurian		444
		Ordovician		488
		Cambrian		542

54. What are the 2 criteria that are used to divide up geologic time (to decide when one era ends and another begins)?

(1) Extinction Events
(2) Landforms

Two Types of Dating

55. Fill in the table below regarding types of dating:

Type of Dating	Explanation	Example
1. Absolute	Assigning a actual numerical age to rocks	 ½ life
2. Relative	Ordering rocks (fossils) in terms of older/younger.	Law of Superposition

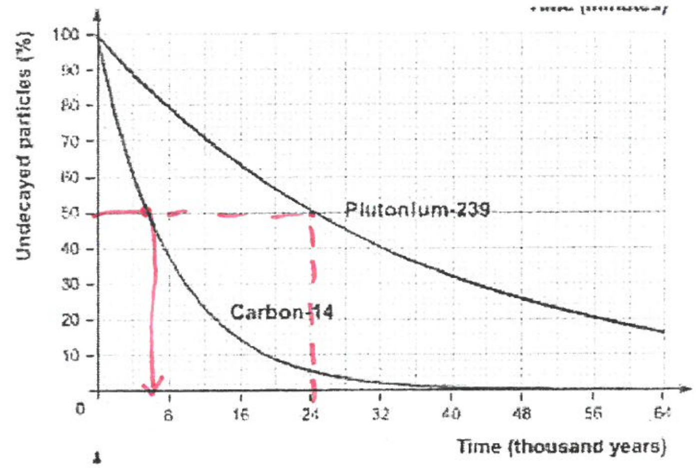
56. According to the graph to the right:

a. What is the half-life of Carbon-14?

6,000 yrs.

b. What is the half-life of Plutonium – 239?

24,000 yrs.



57. Which radioactive substance on the graph below has the longest half-life?

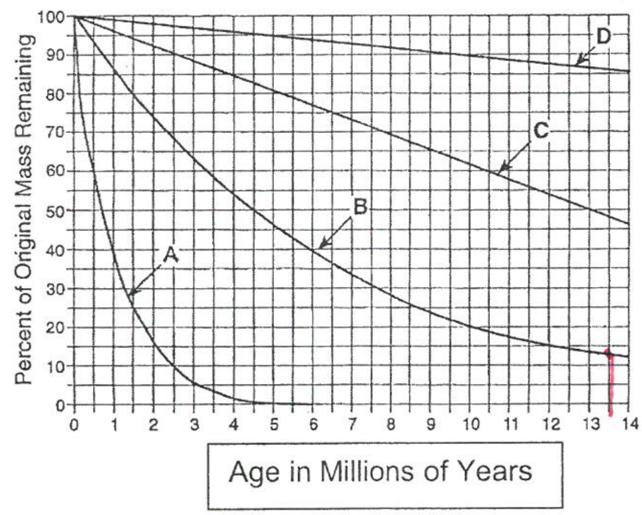
A. A
B. B
C. C
D. D

58. What percent of element B would be left after 3 half-lives?

A. 50%
B. 25%
C. 12.5%
D. 6.25%

59. What is the age of a rock containing element B after 3 half-lives?

A. 4.5 million
B. 18 million
C. 13.5 million
D. 9 million



ABSOLUTE **Dating**

60. What technique is used to absolute date rocks and/or remains of once living things?

Radioactive Decay/ Half Life

61. What is radioactive decay?

The process by which an unstable parent element decays into stable daughter elements

62. What happens to an element experiencing radioactive decay?

It turns into a new element that is more stable at a consistent rate

63. What is half-life?

The process by which radioactive elements decays by ½ at a constant rate.

ABSOLUTE Dating Continued

64. Fill in the table below comparing the two elements we examined in detail.

	C-14	U238
Half Life	5,600 yrs	3.5 Billion
What can it date?	FOSSILS / ONCE LIVING THINGS	ROCKS
What are 2 limitations?	1. TOO OLD specimens 2. INORGANIC (not living)	1. Too young specimens 2. organic (living)

Chapter 17 Plate Tectonics

65. What indicates that the continents have moved? Describe the 3 different types of evidence that Wegener used to support the idea of plate tectonics.

1. Climate Data - Glacier deposits are found on continents that are way too warm to ever have a glacier unless at one time they were closer to the poles.
2. Fossil Data - Large land creatures, plants, and freshwater fish that could never survive an ocean swim were found on different continents. The only way these organisms could be on different continents oceans away is if at one time the continents were closer together
3. Rock age - similar rock formations were found on different continents. Youngest rock is found on the ocean floor between continents showing they used to be closer together.

66. Continental Drift wasn't accepted:

a. Why wasn't Wegener's theory accepted when it was originally published?

Wegner couldn't explain HOW the continents moved without breaking

b. What is the name of the **process** that is now used to explain what causes the ~~plates~~ to move and supports the Theory of Continental Drift. (The process in this question is not just convection.)

Sea-floor Spreading

c. How does it work?

Crust is being created at Mid-Ocean ridges & (this pushes continents apart) and destroyed at deep-sea trenches.

d. What evidence do we have that supports how we think it works?

Isochron Maps - iron points different directions on the ocean floor showing crust is being created constantly.

67. Fill out the table below regarding plate boundary interactions.

	Definition	Example Location	Drawing/Illustration
Convergent	when plates collide/move together.	Aleutian Trench	→ ← destroys crust
Divergent	when plates move away from one another	Mid Ocean Ridge	← → creates crust.

68. Choose which is happening at each of the following **convergent** boundary subtypes?

	new crust is produced	Recycling old crust through subduction	Neither	Land Features Present (list multiple)
Oceanic – Oceanic		✓		• earthquakes, volcanoes, trench, subduction
Oceanic – Continental		✓		• earthquakes, volcanoes, small Mountains trench, subduction.
Continental – Continental			✓	• tall/folded mountains • earthquakes

69. Subduction:

a. Describe what happens during subduction. when plates collide the more dense plate is forced to sink and be melted down.

b. Why does this happen? Density differences

c. What land feature is produced because of subduction? Trench

d. What types of boundaries have subduction occurring? Convergent O-O & O-C

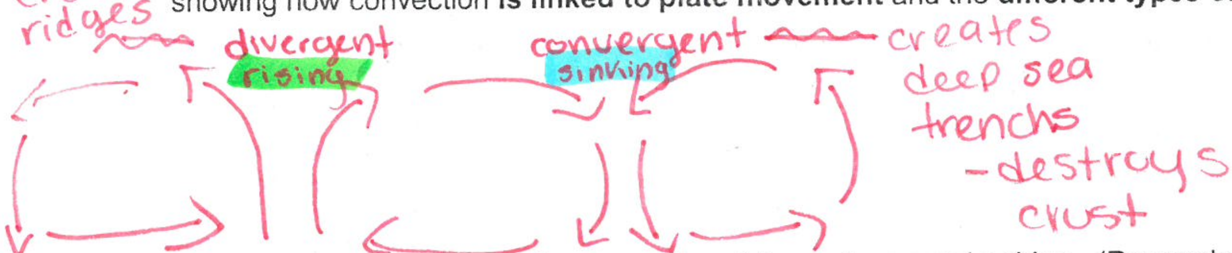
70. What feature forms when **two pieces of ocean crust** move away from each other; diverge?

Ocean Ridge

71. What feature forms when **two pieces of continental crust** move away from each other; diverge? (Hint: drawing a picture may be helpful when you are attempting to answer this question).

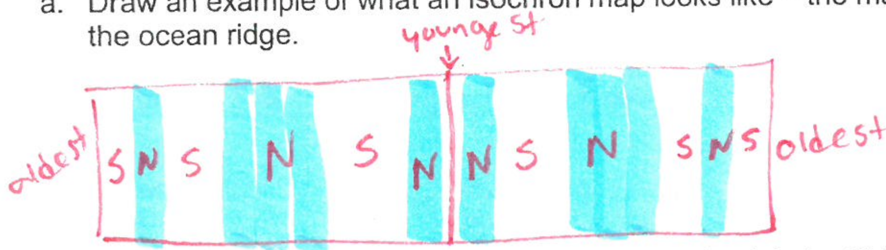
Rift Valley

72. Describe how **convection** plays a role in the Theory of Plate Tectonics. Be specific. Drawing a picture showing how convection **is linked to plate movement** and the **different types of boundaries** may hel



73. An Isochron map shows us the properties of the rocks around a ridge. (Remember the Seafloor Spreading Lab?)

a. Draw an example of what an isochron map looks like – the map should include both sides of the ocean ridge.



b. Now label the diagram you drew with the following labels: Oldest rock, Youngest rock, Normal Polarity, Reversed Polarity

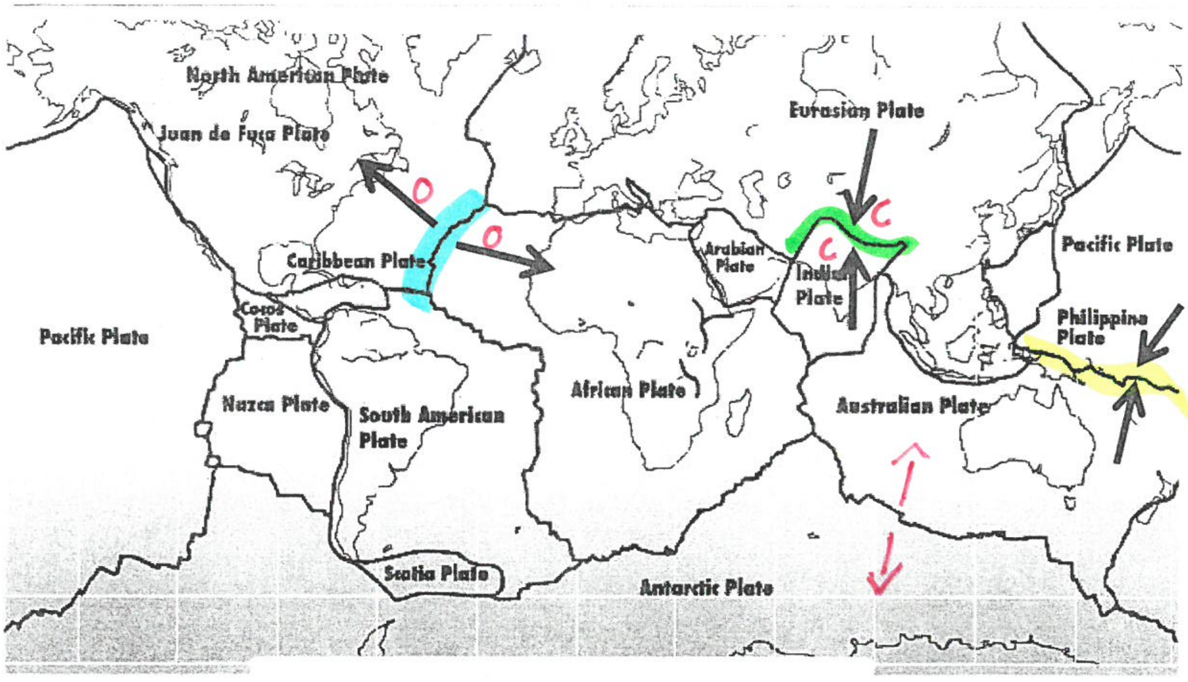
N S

c. Now explain what causes the oldest rock and youngest rock to be located where they are.

youngest rock has just been made at the ocean ridge so the farther you move from the ridge the older the rock gets

d. Now explain why the bands of polarity (direction the iron points) is a mirror image on both sides of the ridge.

Isochron maps of polarity should be mirror images because crust is being formed along the ridge evenly (both sides should match).



74. Look at the map of the major tectonic plates of the world, and note the directions of the moving plates.
   e. Explain where you might find a mountain range, a mid-ocean ridge, and a deep sea trench.

convergent C-C   divergent O-O   convergent O-O

   f. Why would you expect to see those features there?

They are tied with plate boundaries.

75. Doing some research, you find that that the boundary between the Australian Plate and the Antarctic Plate is a divergent boundary.
   g. Draw arrows on the map indicating which direction those two plates would be moving.
   h. What land feature should be found on that ridge?

Mid-Ocean Ridges, Volcanoes, Earthquakes, Islands

   i. What process is causing that land feature?

Rising Convection currents creating new crust

   j. How could you figure out whether or not that process was actually occurring if you could go down there in a submarine with a magnetometer?

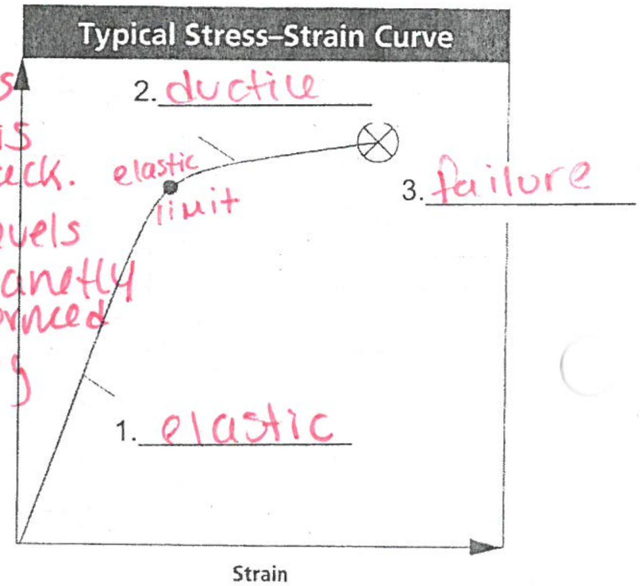
you should see a magnetic field reversal (all iron close to the Mid Ocean Ridges should be pointing the same direction because it just formed).

Chapter 19 Earthquakes

76. Label the 3 wave types on the graph to the right. Explain how you know where to put the labels. Give two distinguishing characteristics of each wave type. (Characteristics might include speed, what happens to them as they hit a different type of material/layer of earth, amount of damage…)

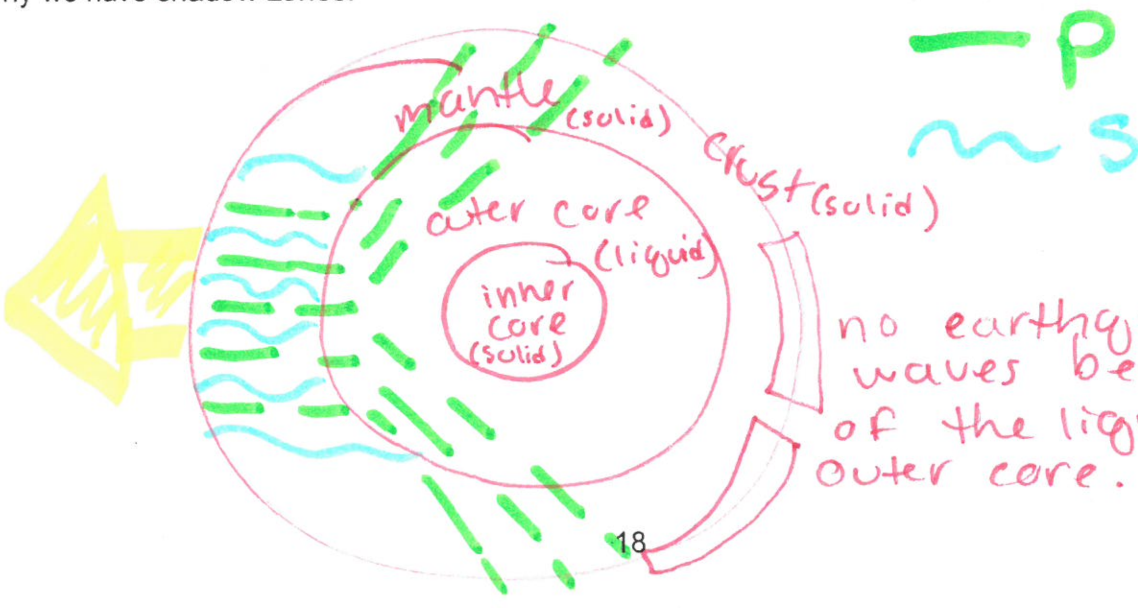
P	• push/pull ↔ • start at focus • arrive 1st (fastest) • travel solids + liquids
S	• travel through solids • start at focus • arrive 2nd • side to side ∿∿
surface	• start at epicenter • cause damage • arrive last.

77. Strain:
    a. Define the 3 types of strain and label them on the graph to the right.
       1. elastic: low stress levels are applied and if the stress is removed the object bounces back.
       2. ductile: higher stress levels that cause an object to be permanetly deformed
       3. failure: highest stress value resulting in an object breaking



    b. Label the elastic limit.
    c. What happens after rocks reach their elastic limit? they are permanetly deformed

78. Describe the layout of the Earth's interior and draw a picture. Use your picture to help you to explain why we have shadow zones.



no earthquake waves because of the liquid outer core.

79. Compare and contrast the Richter Scale and the Mercalli Scale. Why do we use two different scales? Explain the numbering system of each scale. (NOTE – for similarities you cannot use that they are both scales or that they both deal with earthquakes.)

Richter	SAME	Mercalli
• P + S waves • 1 ranking • highest wave.	• earthquakes waves.	• surface waves • multiple rankings • damage done.

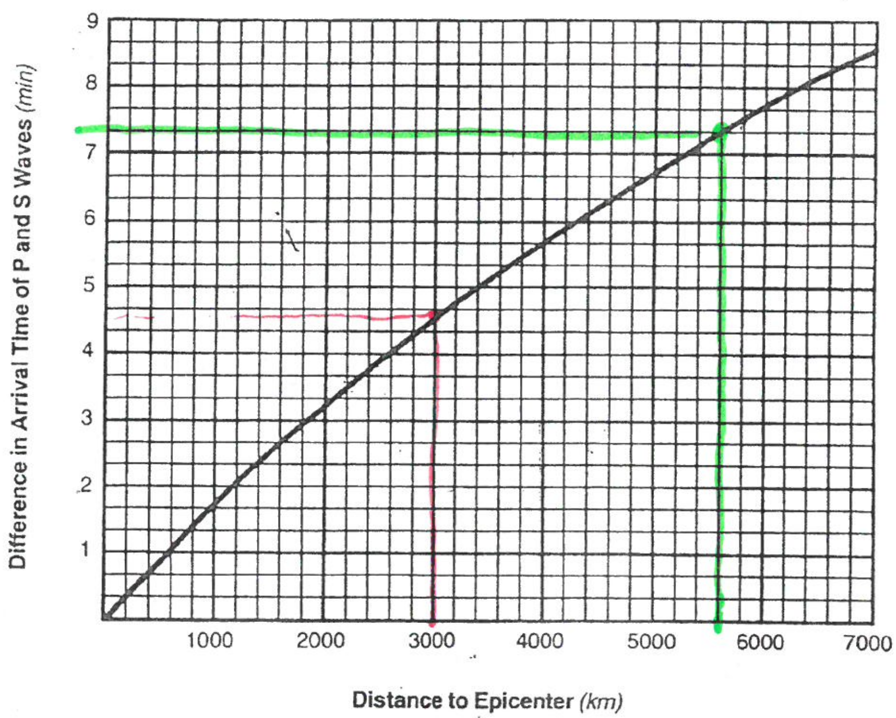


Figure 1

80. Figure 1 above shows the difference in arrival time of P and S waves in seconds. Use the graph to answer the following:
    a. If the S-wave arrives 4minutes 30 seconds after the P-wave, how far is the seismic station from the epicenter?

    3,000 km

    b. If the seismic station is 5600 km from the epicenter, what is the difference in arrival time between the P and S waves?

    7min 20 seconds

81. Locate the epicenter of the earthquake measured by the stations in the diagram to the right. Explain why data from three stations are necessary to locate an epicenter.

You have to have 3 stations to narrow it down to 1 point. (2 stations = 2 possible locations and 1 station = anywhere on circle).

82. Compare & contrast epicenter and focus. (It might be helpful to draw a picture.)

Epicenter	SAME	Focus
• Surface waves • on Earth's surface	• origin of earthquake waves	• S + P waves • under Earth