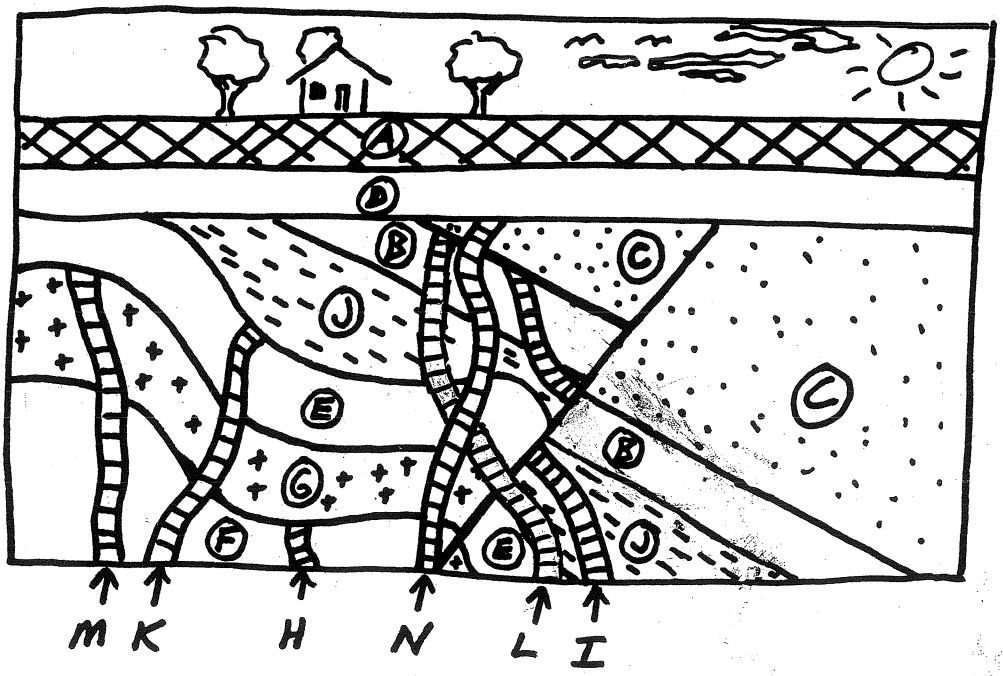
The Rock Record

Earth Science Notes **Name:** _____
Relative Dating

1. The diagram below shows a cross-section of a portion of the Earth's crust. Most of the rocks in the picture are sedimentary, which means that they were created by sediment settling onto the ground in layers. At various times in the past, this area has been covered by water. Some of the rock layers in the picture have been folded. Other layers have been cracked. In some places, tubes of magma have burned, melted, and pushed their way to the surface. By looking at the diagram, you can determine which rocks are older and which are younger. Try to rank the rocks from oldest to youngest.

Oldest														Youngest

↑
Tube of hardened Magma



* there is a mistake in this problem. Can you find it?

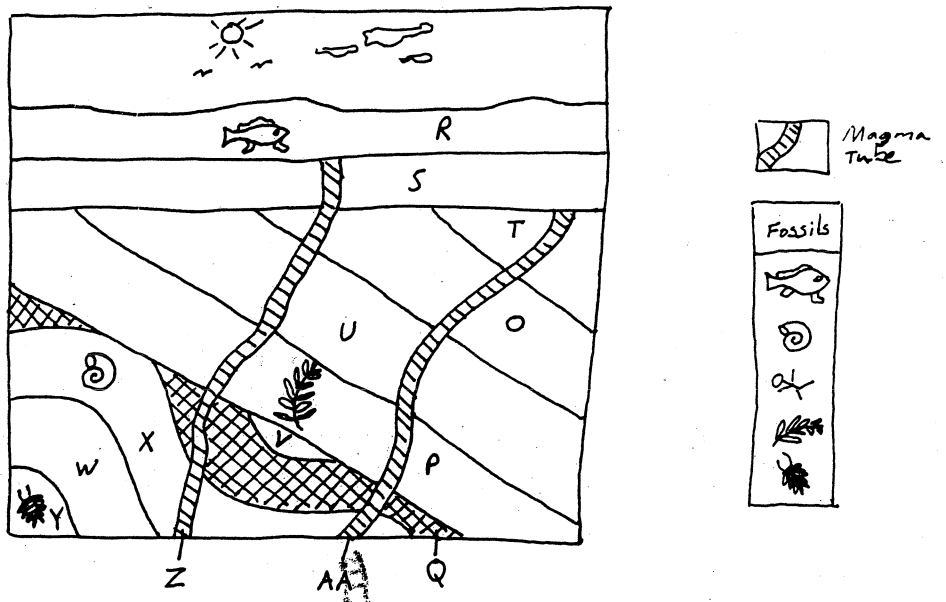
Definitions/Information:
Principle of Original Horizontality: Rock layers are horizontal when they are deposited.
Relative Dating: Comparing or ranking the ages of rocks without actually determining their actual ages. For example, with relative dating we might say that rock A is older than rock B, but we don't know the actual age of either rock.
Absolute Dating: Determining (or approximating) the exact age of a rock.
Principle of Superposition: The closer a rock layer is to the surface of the Earth, the younger it is.
Principle of Cross-Cutting Relationships: If a layer of rock is found cutting through another layer of rock, the layer which is cutting through must be younger.
Principle of Faunal Succession: In the history of the Earth, many species of living things have come and gone. Some animals and plants are not alive today, but their fossils are evidene that they lived in the past. Layers of rokcs with similar types of fossils are probably of similar ages.

HINTS: Questions to ask yourself when you are trying to determine which of two rock layers is older:
1. Which layer reaches highest?
2. Which layer cuts through the other layer?
3. Which layer was broken by the earthquake?

2. Rank the rocks in diagram A, below, from oldest to youngest.

Oldest												Youngest

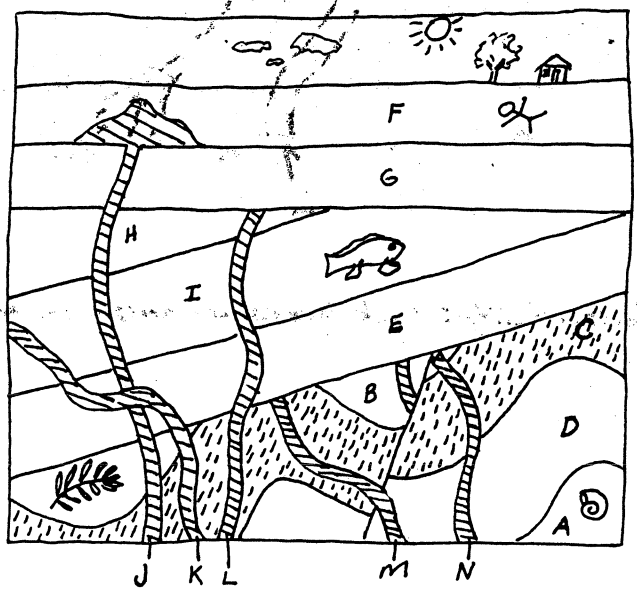
Diagram A



3. Rank the rocks in diagram B, below, from oldest to youngest.

Oldest												Youngest

Diagram B

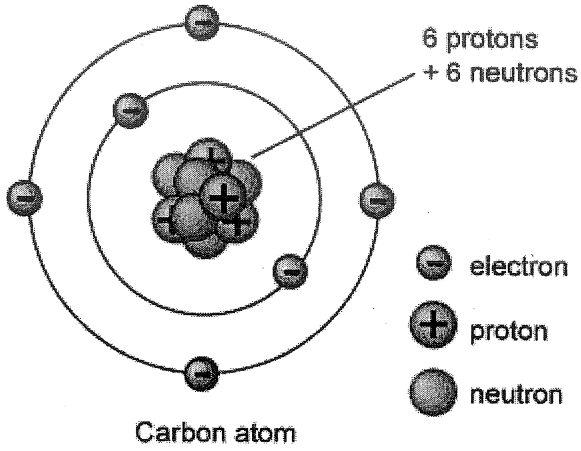


3.5. Which layers cannot be ranked with certainty?

4. a. Which rock layer is probably older, Layer S (diagram A) or Layer H (diagram B)?
   b. How did you decide?
5. Which of the two diagrams (A or B) probably contains the very oldest rock layer?
6. Which of the two diagrams (A or B) probably contains the very youngest rock layer?

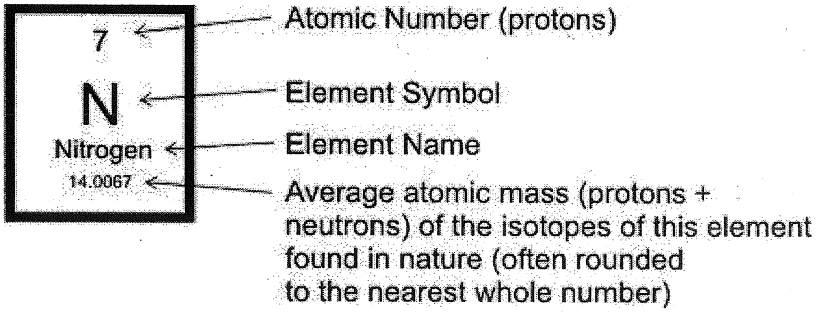
EPS 200 (Stapleton)
Atoms

- **Nucleus**: the center of an atom
- **Proton**: A positively charged particle in the nucleus of an atom.
- **Neutron**: A neutrally charged particle in the nucleus of an atom
- **Electron Shells (orbitals; energy levels):** Layers of space outside the nucleus of an atom. In these layers, "orbiting" electrons can be found. More energetic electrons inhabit bigger orbitals, more distant from the nucleus.
- **Electron**: A negatively charged particle which orbits the nucleus of an atom.



Carbon atom

- Relative Masses:
  - **Proton Mass = Neutron Mass** = 1.7×10^{-27}kg = 1839 Electron masses
  - **Electron Mass** = 9.1×10^{-31}kg
- **Atomic Mass** of an atom = number of protons plus number of neutrons
- **Atomic Number (proton number)** = number of protons; this determines the type of element. Carbon atoms, for example, always have 6 protons.



- **Isotopes:** two atoms are isotopes if they have the same number of protons (same element) but different numbers of neutrons.
- An atom is 99.9999...% empty space (because electrons, protons, and neutrons are so small relative to the electrons' orbitals. According to one source, all of the human race's electrons, protons, and neutrons would fit inside one sugar cube.
- **Charges**:
  - Protons = +1
  - Electrons = -1
  - Neutrons = 0
  - Net Charge of an atom = sum of the charges of all of the particles in an atom
  - Ion = an atom with a net charge

Practice Questions:
The following questions refer to an uncharged Pb atom (not an ion).

1. What type of element is Pb?
2. What is its atomic number?
3. What is its atomic mass?
4. How many protons does it have?
5. How many neutrons does it typically have?
6. How many electrons does it have?

The following questions refer to an uncharged Bromine atom (not an ion).

7. What is its symbol?
8. What is its atomic number?

9. What is its atomic mass?
10. How many protons does it have?
11. How many neutrons does it typically have?
12. How many electrons does it have?

13. How many electrons does an Mg^{2+} ion have?
14. How many electrons does a Br^{-} ion have?
15. How many electrons does a Na^{+} ion have?

A first atom has 19 protons and 21 neutrons. A second atom has 19 protons and 20 neutrons.

16. Both of these atoms represent the element _____.
17. These atoms are referred to as _____ of one another.

18. Explain how Pb-206 is different from normal lead.

19. Explain how C-14 is different from normal carbon.

mistakes!

PERIODIC TABLE OF ELEMENTS

1 H Hydrogen 1																	2 He Helium 4
2 Li Lithium 3	3 Be Beryllium 9											5 B Boron 11	6 C Carbon 12	7 N Nitrogen 14	8 O Oxygen 16	9 F Fluorine 19	10 Ne Neon 20
11 Na Sodium 23	12 Mg Magnesium 24											13 Al Aluminium 27	14 Si Silicon 28	15 P Phosphorus 31	16 S Sulfur 32	17 Cl Chlorine 35.5	18 Ar Argon 40
19 K Potassium 39	20 Ca Calcium 40	21 Sc Scandium 45	22 Ti Titanium 48	23 V Vanadium 51	24 Cr Chromium 52	25 Mn Manganese 55	26 Fe Iron 56	27 Co Cobalt 59	28 Ni Nickel 59	29 Cu Copper 64	30 Zn Zinc 65	31 Ga Gallium 70	32 Ge Germanium 73	33 As Arsenic 75	34 Se Selenium 79	35 Br Bromine 80	36 Kr Krypton 84
37 Rb Rubidium 86	38 Sr Strontium 88	39 Y Yttrium 89	40 Zr Zirconium 91	41 Nb Niobium 93	42 Nb Niobium 96	43 Tc Technetium 98	44 Ru Ruthenium 101	45 Rh Rhodium 103	46 Pd Palladium 106	47 Ag Silver 108	48 Cd Cadmium 112	49 In Indium 115	50 Sn Tin 119	51 Sb Antimony 122	52 Te Tellurium 128	53 I Iodine 127	54 Xe Xenon 131
55 Cs Cesium 133	56 Ba Barium 137	57 La Lanthanum 139	72 Hf Hafnium 179	73 Ta Tantalum 181	74 W Tungsten 184	75 Re Rhenium 186	76 Os Osmium 190	77 Ir Iridium 192	78 Pt Platinum 195	79 Au Gold 197	80 Hg Mercury 201	81 Tl Thallium 204	82 Pb Lead 207	83 Bi Bismuth 209	84 Po Polonium 210	85 At Astatine 210	86 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226	89 Ac Actinium 227	104 Unq Unnilquadium 257	105 Unp Unnilpentium 260	106 Unh Unnilhexium 263	107 Uns Unnilseptium 262	108 Uno Unniloctium 265	109 Une Unnilennium 266									

← Proton number
← Symbol
← Name of element
← Relative atomic mass

58 Ce Cerium 140	59 Pr Praseodymium 141	60 Nd Neodymium 144	61 Pm Promethium 147	62 Sm Samarium 150	63 Eu Europium 152	64 Gd Gadolinium 157	65 Tb Terbium 159	66 Dy Dysprosium 136	67 Ho Holmium 165	68 Er Erbium 167	69 Tm Thulium 169	70 Yb Ytterbium 173	71 Lu Lutetium 175
90 Th Thorium 232	91 Pa Protactium 231	92 U Uranium 238	93 Np Neptunium 237	94 Pu Plutonium 244	95 Am Americium 243	96 Cm Curium 247	97 Bk Berkelium 247	98 Cf Californium 249	99 Es Einsteinium 254	100 Fm Fermium 253	101 Md Mendelevium 256	102 No Nobelium 254	103 Lr Lawrencium 257

Kamal. A.
SMDBL
http://kemhawk.webs.com

Earth Science Notes Name: _____
RADIOMETRIC DATING

PURPOSE: to be able to determine the age of a rock by measuring the number of radioactive atoms in it.

Helpful Information:

Radioactive Element: An element whose atoms turn into other types of atoms over time. As these atoms turn into other atoms, they lose mass. That lost mass turns into a form of energy called radiation. [Example: Uranium-238 is a radioactive element which gives off energy when it turns into Lead-206, a smaller element.]

Radioactive Decay: The process of large radioactive atoms losing mass and becoming smaller atoms.

Half-life: The amount of time it takes for half of something to die or to turn into something else. [Example: If you have 50 U-238 atoms, one half-life is the amount of time it takes for 25 of those atoms to turn into Pb-206 (Pb is the symbol for lead.)]

Parent Atom: A larger atom which can turn into a smaller atom by radioactive decay.

Daughter Atom: What the parent atom turns into when it decays.

How to tell if a rock is old: If there are many daughter atoms and few parent atoms, the parent atoms have been decaying for a long time, so the rock is old. If there are many parent atoms and few daughter atoms, the parent atoms have not been decaying for very long, so the rock is new.

Resetting the Clock: When lava hardens and becomes rock, parent atoms and daughter atoms become separated. They form different types of minerals. When rock is melted, its atoms are re-set.

Sedimentary Rock Cannot Be Dated: Its atoms are not "re-set" by melting.

HALF-LIVES OF COMMONLY USED RADIOACTIVE ELEMENTS		
Parent Element	**Daughter Element**	**Approximate Half-life**
Uranium-238 (U-238)	Lead-206 (Pb-206)	4.5 Billion Years
Potassium-40 (K-40)	Argon-40 (Ar-40)	1.5 Billion Years
Carbon-14 (C-14)	Nitrogen-14 (N-14)	6,000 Years

AN EXAMPLE OF THE DECAY OF **U-238** ATOMS					
Number Of Half-lives Which Have Passed	0	1	2	3	4
Age Of The Rock In Years					
Number Of Parent Atoms In Rock	400				
Number Of Daughter Atoms In Rock					
Total Number Of Atoms In Rock					
What % Of The Atoms Are Parent Atoms?					

AN EXAMPLE OF THE DECAY OF **K-40** ATOMS					
Number Of Half-lives Which Have Passed	0	1	2	3	4
Age Of The Rock In Years					
Number Of Parent Atoms In Rock	64				
Number Of Daughter Atoms In Rock					
Total Number Of Atoms In Rock					
What % Of The Atoms Are Parent Atoms?					

AN EXAMPLE OF THE DECAY OF **C-14** ATOMS					
Number Of Half-lives Which Have Passed	0	1	2	3	4
Age Of The Rock In Years					
Number Of Parent Atoms In Rock	240				
Number Of Daughter Atoms In Rock					
Total Number Of Atoms In Rock					
What % Of The Atoms Are Parent Atoms?					

Use the data from the charts above to complete the graphs which are provided on a separate sheet.

Rock Dating Questions:

1. As a rock gets older, does the number of parent atoms in a rock increase, decrease, or stay the same?
2. As a rock gets older, does the total number of parent and daughter atoms in the rock change?
3. a) 10 years ago there were 80 atoms of mercurium in a rock. Now there are only 40. What is the half-life of mercurium?
   b) How many atoms of mercurium will remain 10 years from now?
4. a) A rock started out with 48 atoms of C-14. Now it contains 24 atoms of C-14 and 24 atoms of N-14. b) How many half-lives have passed?
   c) How old is the rock?
   d) How old will the same rock be when it contains 6 atoms of C-14?

5. a) A rock started out with 100 atoms of U-238. Now it has 50 atoms of U-238. How old is the rock?
   b) How many atoms of Pb-206 does it contain?
   c) How many U-238 atoms will the rock has when it contains 75 Pb-206 atoms?
   d) How old will the rock be when it contains 75 atoms of Pb-206?

6. a) A rock contains 64 Ar-40 atoms and 64 K-40 atoms. When the rock was new, how many K-40 atoms were there in the rock?
   b) How old is the rock now?

7. A rock contains 5 atoms of C-14 and 35 atoms of N-14. How old is the rock?

Use the formula below to answer these questions. A calculator would be helpful.

8. A rock contains 8 Ar-40 atoms and 17 K-40 atoms. What percentage of the atoms in the rock are parent atoms?
9. A rock contains 24 C-14 atoms and 47 N-14 atoms. What percentage of the atoms in the rock are parent atoms?
10. A rock contains 43 U-238 atoms and 35 Pb-206 atoms. What percentage of the atoms in the rock are parent atoms?

How to determine the percentage (%) of atoms in a rock which are parent atoms:
USE THIS FORMULA.
% Which Are Parent Atoms = Number Of Parent Atoms Remaining ÷ Total Number Of Atoms In Rock
*****You will need to move the decimal point in your answer 2 places to the right.*****

Example Question: A rock contains 14 U-238 atoms and 9 Pb-206 atoms. What percentage of the atoms in this rock are parent atoms?

# of Parent Atoms = 14
Total # of Atoms = 14 + 9 = 23
(% which are parent atoms) = 14 ÷ 23

14 ÷ 23 =

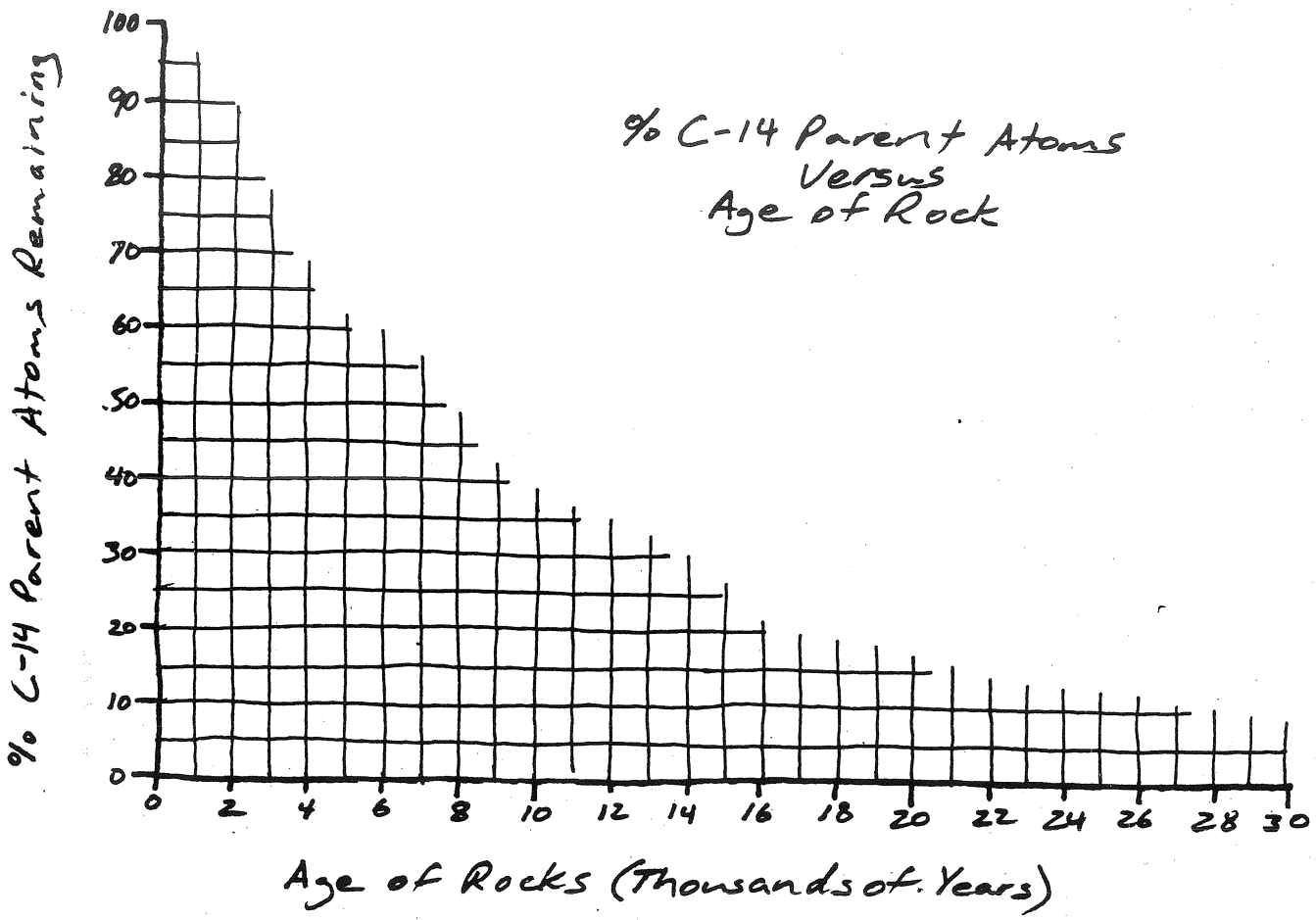
$$23\overline{)14.0} = .608$$

138
200
184
16

⇒ .608 Move decimal two spaces to get 60.8%

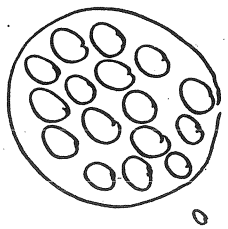
Use your graphs to answer the following questions.

11. If a rock containing U-238 and Pb-206 contains 80% parent atoms, how old is the rock?
12. If a rock containing C-14 and N-14 contains 25% parent atoms, how old is the rock?
13. If a rock containing K-40 and Ar-40 contains 65% parent atoms, how old is the rock?
14. How old was the rock in question number 8?
15. How old was the rock in question number 9?
16. How old was the rock in question number 10?
17. A rock contains 90 atoms of U-238 and 7 atoms of Pb-206. How old is it?
18. A rock contains 17 atoms of K-40 and 3 atoms of Ar-40. How old is it?

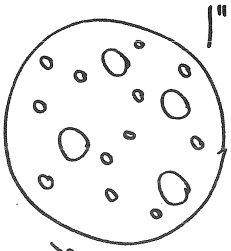


Assume here that 1 Half-Life =

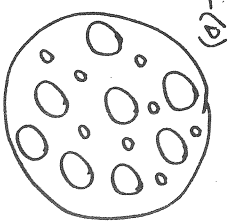
O = Parent Atom (P)
o = Daughter (D) Atom



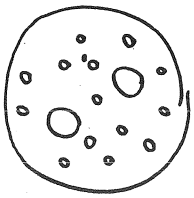
% P = ___ Half-lives = ___
% D = ___ Age = ___



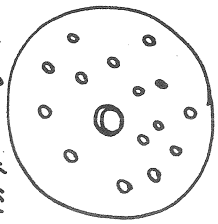
% Parent = ___ Half-Lives = ___
% Daughter = ___ Age = ___



% Par. = ___ Half-lives = ___
% D. = ___ Age = ___



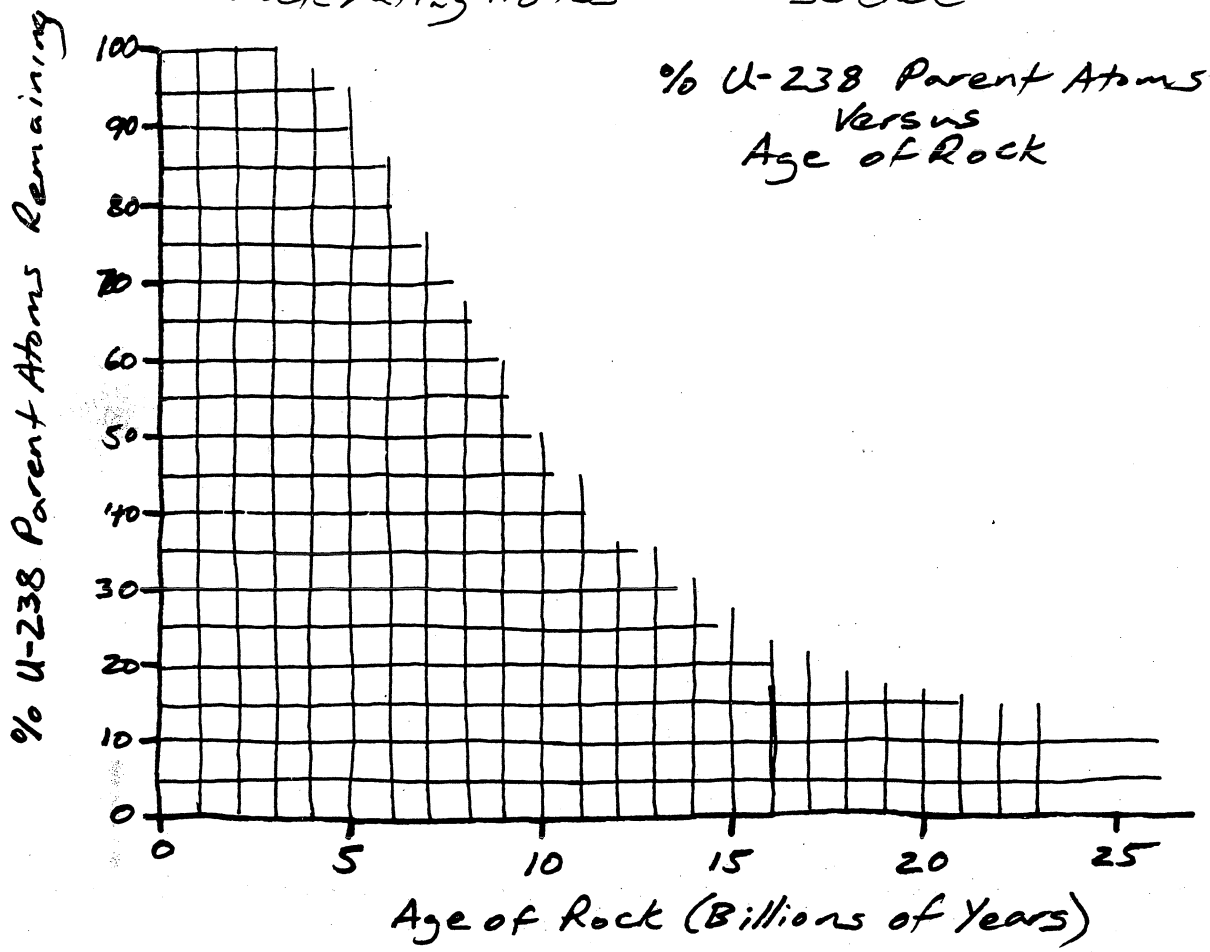
% P = ___ Half-lives = ___
% D = ___ Age = ___



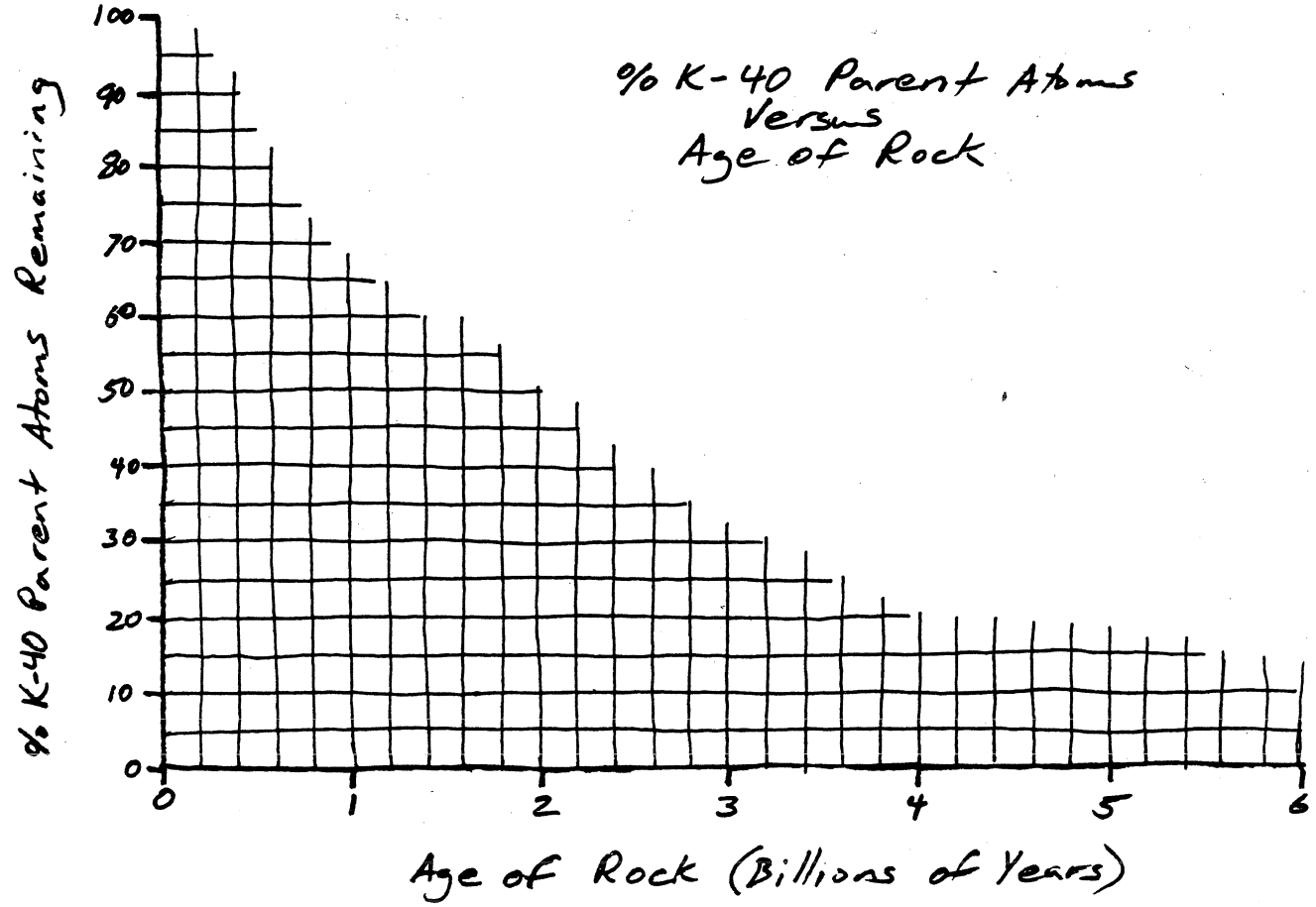
% P = ___ Half-lives = ___
% D = ___ Age = ___

Rock Dating Notes Science

% U-238 Parent Atoms Versus Age of Rock

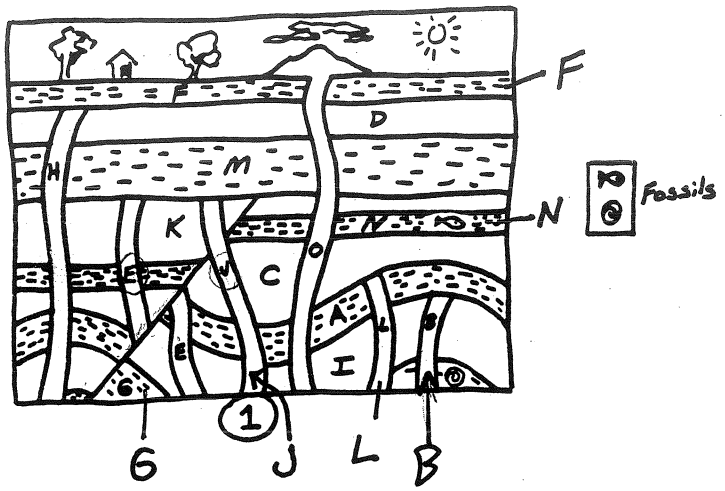


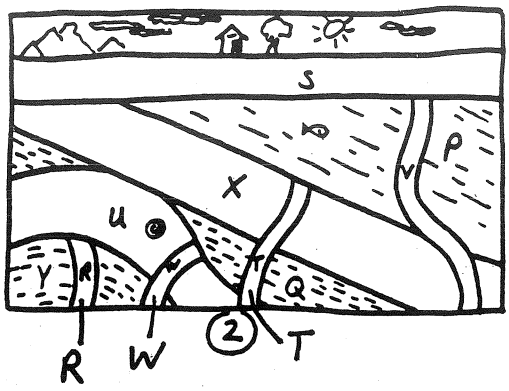
% K-40 Parent Atoms Versus Age of Rock



Earth Science
Rock Dating Review

Name: _____





Use Diagram 1 to answer questions 1-10.

1. Which rock layer is barely younger than I? _____.
2. Which layer is barely older than I? _____
3. Which rock layer is barely younger than A? _____.
4. Which layer is barely older than A? _____
5. Which rock layer is barely younger than N? _____.
6. Which layer is barely older than N? _____
7. Which rock layer is barely younger than F? _____.
8. Which layer is barely older than F? _____
9. Which rock layer is barely younger than J? _____.
10. Which layer is barely older than J? _____

The samples below contain atoms of a radioactive element which has a half-life of 4 million years. Use the graph on the back to determine the age of each sample. **DARKEN** the correct choice for each sample.

Example: (a) 5-6 (b) 6-7 (c) 7-8 ● 8-9 (e) 9-10

Sample	# of Parent Atoms	# of Daughter Atoms	% Which Are Parent Atoms	Age of Sample (Millions of years) **CHOOSE ONE OF THESE**
B	14	37		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
L	10	21		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
E	12	10		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
W	7	24		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
O	35	4		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
V	25	29		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
R	8	33		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
H	12	4		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
J	32	18		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
T	23	36		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10

Use your answers to the previous questions, and the diagram above, to determine the ages of the rock layers and the earthquake below. Circle the correct answers.

Rock Layer or Event	Age (Millions of Years) **CHOOSE ONE OF THESE**
F	(a) 0-3 (b) 3-5 (c) 5-7 (d) 7-10
G	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10
N	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10
A	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10
EARTHQUAKE	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10

Base Ten Grid Paper Version A