

1. Quiz (Sept. 13, 2005)

(multiple correct answers are possible!)

(name)

Fall 2005 *Global Biogeochemical Cycles Class*

1. Which elements that still comprise 99% of the universe were formed within minutes after the “Big Bang”?

- carbon and oxygen
- hydrogen and helium
- helium and lithium
- hydrogen, carbon and nitrogen

1 pt

2. Our sun “burns” mostly hydrogen in nuclear fusion reactions. Once that element is nearly spent, the sun will begin burning He to form ...?

- ^8Be
- ^{15}N
- ^{12}C
- ^{16}O

1 pt.; I gave 0.5 if you checked ^8Be , but remember that ^8Be is not stable, which made nucleosynthesis a conundrum for a long time (“triple alpha”-process makes ^{12}C !)

3. Stellar nucleosynthesis produces lighter elements up to ^{56}Fe . Why does it stop there?

- ^{56}Fe has the highest ‘mass defect’
- no more energy can be gained from nuclear fusion to higher elements
- ^{56}Fe quenches nuclear fusion
- all heavier elements are radioactive and will decay rapidly after formation

2 pts; Note: There are plenty of elements higher the ^{56}Fe that are NOT radioactive!

4. True or false: Early earth was much hotter than today because of more intensive radioactive heating.

- TRUE
- FALSE

1 pt; most radioactive elements have decayed in Earth’s 4.5 Ga history

5. Which of the following gases was likely not a significant constituent of Earth’s early atmosphere:

- methane, CH_4
- carbon monoxide, CO
- hydrogen sulfide, H_2S
- nitrogen, N_2
- oxygen, O_2
- ammonia, NH_3

1 pt (0.5 pts if you checked CO); my apologies for not defining “significant”; I did consider traces of NH_3 , H_2S , and CH_4 significant

6. Dating rocks shows that the Earth is likely ...

- ... 6.5 Ga old ... 5.56 Ga old
 ... 4.56 Ga old ... 2.3 Ga old

1 pt

7. Energy for the abiotic formation of simple organic molecules on early Earth could have been provided by

- ... infrared radiation from the sun ... lightning
 ... ultraviolet radiation from the sun ... radioactive decay

3 pts; these processes release energy sufficient in density and quality to split inorganic molecules (such as H₂S, NH₃, CH₄) so that simple organic molecules could form

8. True or false: 'Banded Iron Formations' are clear evidence that oxygen from photosynthesis in an active biological process on Earth since >3.5 Ga ago.

- TRUE FALSE

1 pt; recall that BIFs were deposited in the oceans long before oxygen appeared in the atmosphere, then stopped after oxygen entered the atmosphere

9. Oxygen in the atmosphere is a result of an imbalance of its geological sources and sinks. Oxygen sources are ...

- burial of organic matter in sediments
 escape of hydrogen to space
 burial of Fe₂O₃ in sediments
 burial of FeS₂ in sediments

3 pts; it helps to actually read the reading assignments ...

10. Order the following events describing the rise of oxygen in the atmosphere and its timing first to last:

1. photosynthesis produces oxygen and organic matter in the oceans
2. (3.) oxygen oxidizes iron in the oceans creating large "BIFs"
3. (2.) organic matter slowly sinks to the ocean floor
4. methanogenesis in anoxic ocean sediments releases methane
5. methane escapes to the atmosphere and keeps Earth "warm"
6. hydrogen from abundant methane photolysis escapes to space
7. a slowly oxidized earth crust releases fewer and fewer reducing gases and Fe²⁺
8. oxygen builds up and enters the atmosphere, oxidizing methane
9. atmospheric oxygen oxidizes sulfur on land to sulfate, which runs off to the oceans

8 pts (1 pt each for a single correct order; I also gave an extra point each for an exact match); I guess it would have helped if I had given the starting process ...