

This homework covers materials presented in lectures 1,2 and 3, as well as the accompanying reading assignments for those lectures (see syllabus). These are primarily short answer questions. In most cases, a few sentences should suffice. Please try to answer all questions in the space provided, use the back of the page if you have to. Be careful to answer each part of multi-part questions. **Note:** Homeworks will be graded on the basis of a *random subset* of these questions – so your best strategy will be to answer all the questions to the best of your ability.

1) Earth formed approximately 4.6 billion years ago. The first life forms are thought to have arisen about 3 billion years ago. Mankind (ie. *Homo sapiens sapiens*) arrived on the scene about 50,000 years ago. What if you were to compress this entire timeline into 60 minutes? Assuming the formation of the Earth occurred at time zero, at what time would the first life forms appear? When would mankind appear?

2) In this course we sometimes use “CH₂O” as a formula to symbolize “organic carbon” or “biomass” in chemical reactions. Does this chemical formula actually include all of the major elements which make up living tissue? Explain.

3) Given the following pairs of elemental compounds, circle the *more oxidized* form of each element:

for oxygen: O₂ or H₂O

for carbon: “CH₂O” or CO₂

for nitrogen: NH₄⁺ or NO₃⁻

for iron: Fe₂O₃ or FeS₂

4) Element X is found in two reservoirs on planet Earth: there are 10²⁰ atoms of X in the lithosphere, and X is lost from this reservoir via volcanic eruption at a rate of 10⁶ atoms per year.

Once erupted from volcanoes, X resides in the atmosphere, in which there is a stable inventory of 10⁹ atoms of X. In which reservoir (the lithosphere or the atmosphere) does X have the longest mean residence time? (You should determine this not by guessing, but by calculating the residence time of X in each reservoir. Show your work.)

5) Name three “greenhouse gases” that are currently increasing in concentration in the Earth’s atmosphere. What is the primary source of these gases? Which of these geological archives is used to determine pre-industrial levels of these gases in the atmosphere? a) tree rings b) ocean sediment cores c) ice cores d) zircon crystals

6) Is there currently scientific consensus regarding the overall effect that anthropogenic activities (ie. humans) have had on Earth’s climate, in terms of global warming? Explain.

7) What do glacial/interglacial records (going back about 400,000 years) indicate about the relationship between atmospheric CO₂ concentration and Earth surface temperature?

8) Name the four fundamental components of the Earth system. According to the Gaia Hypothesis, which of these components is most important in terms of regulating Earth’s climate? Explain.

9) How is the Earth’s moon thought to have formed? What is one piece of available evidence to support this hypothesis?

10) As we discussed in class, the Earth's early atmosphere and oceans were produced during the bombardment period that lasted until about 3.8 billion years ago. What were the major constituents of the early atmosphere, and where did these volatiles come from?

11) Name and briefly explain two important factors conducive to the development of life on Earth.

12) Although Venus and Earth are a similar distance from the sun and were similar in terms of their initial size and chemical composition when first formed by planetary accretion, the surface temperature of Venus is now about 400°C hotter than the surface temperature of Earth. Why is Venus so hot? Is the development of the Venusian atmosphere an example of a positive or negative feedback loop?