

First Hour Exam
NEEP-602/EMA-601/Geol-376
October 3, 1997

1.) 20 points

During the second meeting of the Resources from Space class, most of you decided that water (H₂O) is the most important import for a lunar settlement. Based on what you now understand about all potential sources of water, indigenous or imported, please create a three (3) column table as follows:

As the columns, list any three (3) possible primary sources of the water or the hydrogen and oxygen that could make water, for a lunar settlement.

Under each primary source, list the following:

1. The physical state of the hydrogen and oxygen in the primary source.
2. The body in the solar system the nature of which would have largely determined the isotopic ratios in the hydrogen and oxygen in the primary source.
3. A brief summary of how the water, or the hydrogen and/or oxygen, came to be concentrated in their present location.
4. A brief summary of a process that could make the water, or the hydrogen and oxygen combined as water, available for use or export.

2.) 15 points

The good news is that you have been appointed the Energy Czar of the World! The bad news is that your advisors tell you that, for reasons of global security and to avoid irreversible damage to the environment, the total energy use in the year 2050 cannot exceed twice the value in 1995 (see table below). Given the expected population increases over the 55 year period between 1995 and 2050 (see table) and the increased energy use per capita in the rest of the world, what will you have to tell the citizens of the U. S. about the maximum energy that they will be able to use/capita in the year 2050?

Do you think that is feasible? Why or why not?

| Region | 1995 | | 2050 | |
|-------------------------------------|---------|---------------------|---------|---------------------|
| | boe/cap | Population-billions | boe/cap | Population-billions |
| U. S. | 59 | 0.26 | ??? | 0.4 |
| Non-US OECD | 26 | 0.74 | 26 | 1.1 |
| Eastern Europe/Former Soviet. Union | 22 | 0.40 | 22 | 0.5 |
| Middle East | 16 | 0.10 | 20 | 0.2 |
| Central/South America | 8 | 0.40 | 16 | 0.7 |
| Non-OECD Asia | 4 | 3.00 | 9 | 5.8 |
| Africa | 3 | 0.70 | 8 | 1.3 |
| Total | | 5.60 | | 10.0 |

3.) 15 points

It is impossible for man to have perfect knowledge of the inventory of mineral "resources" or "reserves" available on the Earth, moon or other planets. The aggregate empirical observations over the past 50 years, however, have provided us with some summary information for the Earth which allow predictions about less well known commodities to be made from better known ones.

(a) Sketch a plot relating the abundance in the Earth's crust of various elements to the identified reserves of that element. You need not put numbers on the axes but state or your plot whether they are linear or logarithmic. However, you should identify any useful trends that may be gleaned from such a plot. Based on what you know (or can guess) about the composition of the Earth's crust, roughly plot at least 3 specific elements on your diagram.

(b) Based on the definition of "reserve", can an analogous plot be created for the lunar crust? Discuss briefly.

4.) 20 points total

a) What is meant by the statement that certain particles "freeze out" (annihilate) as the universe evolves? Among electrons, neutrons and protons what was the order in which they froze out and why? (10 points)

b) Give 3 conditions that favor star formation and explain how these might be achieved in the interstellar medium. (10 points)

5.) 15 Points

Earth's average distance from the Sun is 1 AU (1.5×10^8 km), and the asteroids average about 3 AU from the Sun. Use Kepler's third law (T^2 proportional to a^3 , where a is the semimajor axis of the elliptical orbit) to calculate the time it would take a chemical rocket to travel from Earth's solar orbit to orbit at an average asteroid's solar distance using a minimum-energy (Hohmann ellipse) trajectory. Assume that the orbits are circular and all are in the same plane. Assume also that no gravity assists and only two impulses (thrust bursts) are used.

6.) 15 Points

"The government is thinking of going to Mars as an extension of the Human Exploration and Development of Space (HEDS) mission. It recognizes, however, that there isn't enough taxpayer money available to carry through the entire mission and NASA has turned to you, a space entrepreneur, for additional funds to complete the job. What investment conditions would you insist upon before making what promises to be a sizable investment? Remember, NASA needs YOU now, so think big in terms of what you would ask in return for taking this risk. The sky's the limit!"