NEEP 602/EMA 601/Geol/376
FINAL EXAM
Dec. 15, 1997

Note: Please do questions 1 & 2 in the designated blue book.
Do questions 3,4,5,6,7,8,9, & 10 in a separate blue book
Please add your names to each blue book before you start

#1. (18 pts.) [20 minutes]

Part A: Using the list given below, place the six (6) major stages in the evolution of Mars as a planet in chronological order. Contrast this sequence with the corresponding major stages of lunar evolution and suggest reasons why they are similar or different.

- LARGE BASINS
- MAGMA OCEAN/PLANETARY DIFFERENTIATION
- MATURE CRUST/ATMOSPHERE
- BEGINNING
- PLANETARY VOLCANISM
- CRATERED UPLANDS/CLAY SOUP

Part B: Note the factor or factors, if any, in each Martian planetary evolutionary stage that may have influenced the development of life forms on that planet.

#2: (18 pts.) [20 minutes]

Part A: (1) Draw a diagram illustrating the three "pure" components of possible management approaches to a ^{3}He mining, technology, and power enterprise, (2) indicate the relative placement on the diagram of five examples of existing or historical enterprises, and (3) briefly describe a hypothetical example, Hypothetical ^{3}He, Inc., which is a combination of all three management components.

Part B: Now, for a totally private ^{3}He mining, technology, and power enterprise , provide the best relative chronological sequence for the initiation of major categories of business activities randomly listed below. Add any major category or categories of business activity not included in the list below but which would be important to the success of the enterprise.

RANDOM LISTING OF MAJOR BUSINESS ACTIVITIES

Operations Management
Business Planning
Systems Design
Corporate Management
Design Data Acquisition
Marketing and Sales
Systems Manufacturing and Construction

3.) 8 points (10 minutes)

Efficient long-range propulsion within the Solar System requires a system with both high exhaust velocity (m/s) and high specific power (kw/kg).

a) A fission, solar, or D-T fusion electric energy source could produce a high exhaust velocity by powering a plasma thruster. List the three categories of plasma thrusters described in class and describe the key characteristics of one of them.

b) Give three reasons why magnetic fusion using D-^{3}He fusion is expected to outperform D-T fusion in terms of achieving high specific power levels.

4.) 8 points (10 minutes)

Assume that you had the choice of being the CEO of a company that would;

a.) market the resources of the Moon, or,
b.) market the resources of Mars

Which would you choose? Why?

(hint, fill out the following matrix for the source of the resources, the location of their use, and whether they provide energy or generally satisfy the life support or physical needs of the designated location. The choice should be easy from there.)

	From the Moon		***From Mars***	
Location of Use	***Energy***	***Volatiles, Metals, Minerals***	***Energy***	***Volatiles, Metals, Minerals***
On Earth				
In Space				
On the Moon				
On Mars				

5.) 8 points (10 minutes)

You are asked to write an Environmental Impact Statement (EIS) for using ^{3}He fuel or solar energy to generate electricity on Earth. What are the major advantages and disadvantages of each approach (Compare solar to fusion and fusion to solar, <u>not</u> to coal, fission, etc. in the following table format)?

	Advantages	Disadvantages
Solar (SPS)		
Solar (lunar based)		
^{3}He Fusion		

6.) 8 points (10 minutes)

Assume that sometime in the future the $^3He^3He$ fuel cycle can be used to make electricity in a fusion device. Contrast the features (advantages and disadvantages) of an electricity economy based on $^3He^3He$ versus one based on a.) coal and b.) fission. Use the following table format.

	$^3He^3He$ Advantages	*$^3He^3He$ Disadvantages*
Coal		
Fission		

7.) 8 points (10 minutes)

"During the lecture on heavy-lift launch vehicles, four top-level transportation architecture requirements were presented. Engineers often find themselves in situations where not all 'requirements' can be met, or met equally well. It then becomes necessary to prioritize among the requirements, addressing the most important ones first or most fully, and omitting or degrading others.

Consider the stated transportation requirements from the viewpoint of early manned lunar return missions, intended to establish a permanent base for the purpose of extracting lunar ^3He. How would you rank-order the top-level requirements, and why?

Now consider your answer in the context of planning for more-or-less routinely scheduled cargo (unmanned) transportation to and from an existing lunar base extracting ^3He. How would you rank-order the requirements now, and why?

8.) 8 points (10 minutes)

What are the important financial questions that would need to be answered by a private company interested in providing ^3He for generating electric power? Explain the issues associated with each question and the factors that are relevant to getting an answer to it.

9.) 8 points (10 minutes)

[a] On the basis of the geology of Mars and the Moon, identify two important geological processes that the Earth and Mars and the Earth and the Moon have (or had in the past) in common (2 processes for each pair of bodies). One process should deal with surficial form (the surface of the planet) the other example should touch on interior processes.

[b] Identify the most important difference between the Earth and each of these worlds at the present time.

You should do more than provide the name of the process- in 1 or 2 sentences justify your choice.

10.) 8 Points (10 minutes)

a.) (4 points)
In our discussion of the origin of the elements, we argued that the elements were synthesized either in the cores of stars or in the Big Bang or both. Among the

following elements indicate whether the element was produced only in the Big Bang or only in stars or in both.

H
D
He
Fe

b) (4 points)
Explain why the abundance of ^{3}He is much greater on the surface of the Moon than on the surface of the Earth.