Name _____ Lab section _____

EXAM 1
Version A

EAS1601 How to Build a Habitable Planet

Feb 9, 2012

- **Answer all questions**
- **Place your name and lab section on each page**
- **Only pencil or pen and exam paper are allowed (no calculator). This is a closed-book exam; all are expected to comply with Georgia Tech Honor Code**
- **Explanations must be clear, concise and as complete as possible (no more than three sentences – only the first three sentences will be graded)**

I am aware and in compliance with the Georgia Tech Honor Code

Signature: _____

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1) (16 points) Over a period of a year, a group of astronomers in an alternate universe witness three Type IA supernovae. They measure the distance and recessional velocity for each supernova:

Supernova	Distance (m)	Recessional velocity (m/year)
#1	6×10^{25}	3×10^{16}
#2	2×10^{25}	1×10^{16}
#3	10×10^{25}	5×10^{16}

a) (4 pts) Make a plot of the data above. Indicate the data with closed circles. Did this universe started with a big bang?

b) (4 pts) If astronomers were to make these measurements 2 billion years later what would they find? Indicate the distance and recessional velocities with open circles on the graph.

c) (4 pts) Briefly explain how distance is estimated from the Type I supernovae?

d) (4 pts) Briefly describe how the recessional velocities of the supernovae are calculated

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2) (12 points) For each question, choose the best answer:

_____ ^{24}Mg has 12 protons. How many neutrons does ^{26}Mg have?

a) 2
b) 12
c) 13
d) 14

_____ The cosmic background radiation tells us

a) That the temperature of the early universe, when light was first able to travel freely through space, was 2.76°C.
b) That the temperature of the early universe, when light was first able to travel freely through space, was 4500°C.
c) That microwaves were very abundant at early stages in the development of the universe
d) That there is a dark energy which is causing the expansion of the universe to accelerate

_____ What is an alpha particle nuclide?

a) a nuclide with an atomic mass that is a multiple of 4
b) any isotope of helium
c) a nuclide that is unstable and must decay by alpha decay
d) any isotope of hydrogen

_____ How are alpha particle nuclides mainly formed:

a) shortly after the big bang
b) in the center of stars by fusion
c) by the r-process
d) by the s-process

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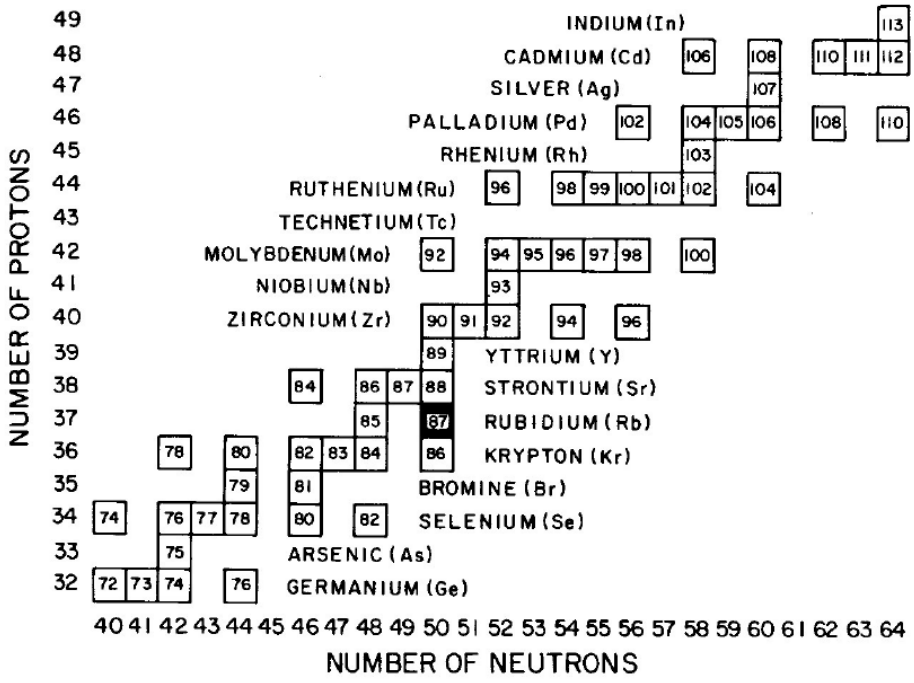
3) (16 pts) Below is a small section of the chart of the nuclides.



a) (8 pts) Indicate whether the following nuclides could have been formed by the r and/or s process:

	r-process	s-process
^{96}Ru	_____	_____
^{100}Mo	_____	_____
^{94}Mo	_____	_____
^{95}Mo	_____	_____

b) (4 pts) Explain where and how the r-process occurs.

c) (4 pts) Explain where and how the s-process occurs.

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4) (12 points) For each question, choose the best answer:

_____ An element with one electron in its outermost shell will be in
a) The first row of the periodic table of the elements
b) The first column of the periodic table of the elements
c) The last row of the periodic table of the elements
d) The last column of the periodic table of the elements

_____ An element with 2 electrons missing in its outermost shell will form a molecule by bonding with
a) one hydrogen atom
b) two hydrogen atoms
c) three hydrogen atoms
d) four hydrogen atoms

_____ Which of the following ices was *not* a dominant component of the solar nebula (cloud of gas, ice and dust) from which the solar system formed?
a) CH_4
b) NH_4
c) H_20
d) CO_2

_____ Which of the following types of dust was *not* a dominant component of the solar nebula?
a) $MgFeSiO_4$
b) $MgSiO_3$
c) SiO_2
d) Fe metal

5) (16 points)
a) (4pts) Why are the planets in the outer solar system primarily made of ices whereas the planets in the inner solar system are primarily made of metals and silicates?

b) (4 pts) Ordinary chondrites are representative of the solids in which part of the early solar system, inner or outer?

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c) (4 pts) If P is a moderately volatile element, is the ratio of P/Si higher in a carbonaceous chondrite or an ordinary chondrite?

d) (4 pts) Is the P/Si ratio higher on Earth or on Uranus?

6) (16 points) ^{40}K decays to ^{40}Ar (10%) and ^{40}Ca (90%) with a half-life of 1.28 billion years.

A geologist finds an igneous rock and measures the following:

^{40}K (% by weight)	^{40}Ar (% by weight)	^{40}Ca (% by weight)
10×10^{-7}	1×10^{-7}	20

a) (4pts) What was the original % by weight of ^{40}Ar in the rock when it solidified?

b) (4pts) What is the total amount of daughter product (% by weight) in the rock from the decay of ^{40}K since the rock solidified?

c) (4 pts) What was the original % by weight of ^{40}K when the rock solidified?

d) (4 pts) How long ago did the rock solidify?

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7) (12 points) For each question, choose the best answer:

_____ The center of the Earth is composed primarily of the elements
a) Fe and Si
b) Fe and Ni
c) Fe and Mg
d) Mg and Si

_____ The mantle is composed primarily of the elements
a) Fe, Mg, Ni, Si
b) Si, Na, Mg, O
c) Si, Mg, Fe, K
d) Si, Mg, Fe, O

_____ One source of energy for the melting that was required to separate the core and mantle was provided by
a) the heat given off by the sun
b) tidal motions which were much stronger when the earth was young
c) fusion in the early core
d) the kinetic energy associated with planetary accretion

_____ We know the outer core is liquid because
a) p-waves travel faster than s-waves
b) s-waves travel faster than p-waves
c) p-waves don't arrive from an earthquake on the opposite side of the earth
d) s-waves don't arrive from an earthquake on the opposite side of the earth