Name ____________________

Date __________ Per. ____

The Gaia theory was proposed by the British scientist, James Lovelock, in the 1960s. Gaia is the belief that the Earth is a self-regulating network of interdependent physical and biological systems.

The Gaia theory includes three main ideas. The first two are widely accepted. Firstly, the Earth contains a great variety of living and non–living things that depend upon one another. Changing any part of the Earth can have profound effects on a variety of different Earth systems. Secondly, our planet exists in a delicate state of equilibrium. Small stresses, such as environmental pollution, particularly if they are of limited geographic extent, are likely to result in only a temporary local imbalance of that equilibrium. The environment can recover from these small changes. However, much larger changes applied over wide areas for long periods of time may result in a new equilibrium. These new conditions may be hostile to established life forms. This could cause the extinction of life forms that evolved within the conditions of an earlier equilibrium.We can think of the Earth like a rubber band. Stretch it a little, and it bounces back. But, stretch it too much, and a permanent change (in the case of a rubber band, breakage) will occur.

The third idea is more controversial. Lovelock has suggested that our planet itself is really a gigantic living organism. This life form is composed of organs, such as the oceans, forests, and atmosphere, with each part having a kind of biological function; such as photosynthesis, natural selection and tectonic plate motions. But, many scientists are skeptical about taking the Gaia idea that far.

One of the most valuable aspects of the Gaia hypothesis has been a new understanding of the evolution of Earth's atmosphere. From studying other planets and from studies of very old geological formations, we know that the atmosphere of the early Earth was very different from the air of today. Use the following data to show the inferred composition of the atmosphere for the 4½ billion years of Earth's history.

Charging Percent Composition of Earth's Atmosphere

	Millions of years before the present									
Gas	4500	4000	3500	3000	2500	2000	1500	1000	500	Present
Carbon Dioxide	80%	20%	10%	8%	5%	3%	1%	0.07%	0.04%	0.025%
Nitrogen	10	35	55	65	72	75	76	77	78	78
Hydrogen	5	3	1	0.5	0	0	0	0	0	0
Oxygen	0	0	0	0	0	1	5	10	15	21
Other Gases	5	42	34	26	23	21	18	13	7	1

On page 3 you will find a form for making a special running time graph. Use the data above to construct a graph of the changing percentage composition of Earth's atmosphere since the formation of the Earth. Please note that these figures are cumulative; each gas must be shown on top of the previous gas, and they must add up to 100%, like the mineral composition chart of igneous rocks in the Reference Tables. Label each gas as a different chemical symbol, within or next to its own area on the graph. (CO_2, N_2, H_2, O_2, & Other Gases)

When you have constructed and labeled your graph, plot the times of the events listed on page 2 in the evolution of the atmosphere. Write each with an arrow showing the appropriate place below the graph. *(Please note that the first one has been done for you on page 3.)*

IMPORTANT EVENTS IN THE EVOLUTION OF THE EARTH

1.	Formation of the Earth.	4600 million years ago
2.	Oldest known Bedrock	3900
3.	Oldest Rocks of Organic Origin	3700
4.	Precambrian Iron Deposits	3700–1800
5.	Photosynthesis in Plants Begins	3000
6.	Oxygen in Air Dominates Weathering	2100
7.	Limestone Deposition Becomes Common	1800
8.	Fossils Become Abundant	540
9.	Earliest Plants and Animals on Land	420

Discussion:

1. What is the approximate age of planet Earth? ____________________

2. How long do we think that living things have existed on Earth? ____________________

   How many millions are there in a billion? ____________________

4. From your knowledge of biological evolution, what characteristic of organisms older than 540 million years ago makes fossils of these life forms relatively rare? ____________________

5. Why wasn't oxidation type chemical weathering common more than 2 billion years ago? *(Hint: See the graph.)* ____________________

6. From your knowledge of life science, what gas is given off by green plants during photosynthesis? ____________________

7. What gas was depleted (used up) by the time that oxygen became abundant? ____________________

8. Why couldn't this gas exist with oxygen in the atmosphere? ____________________

9. Therefore, what seems to have been the major cause of the dramatic change in the composition of Earth's atmosphere over the past 4½ billion years?

   ____

10. What major atmospheric changes seem likely in the future? *(Please be specific.)*

    ____

11. How do these changes in the atmosphere illustrate the Gaia theory?

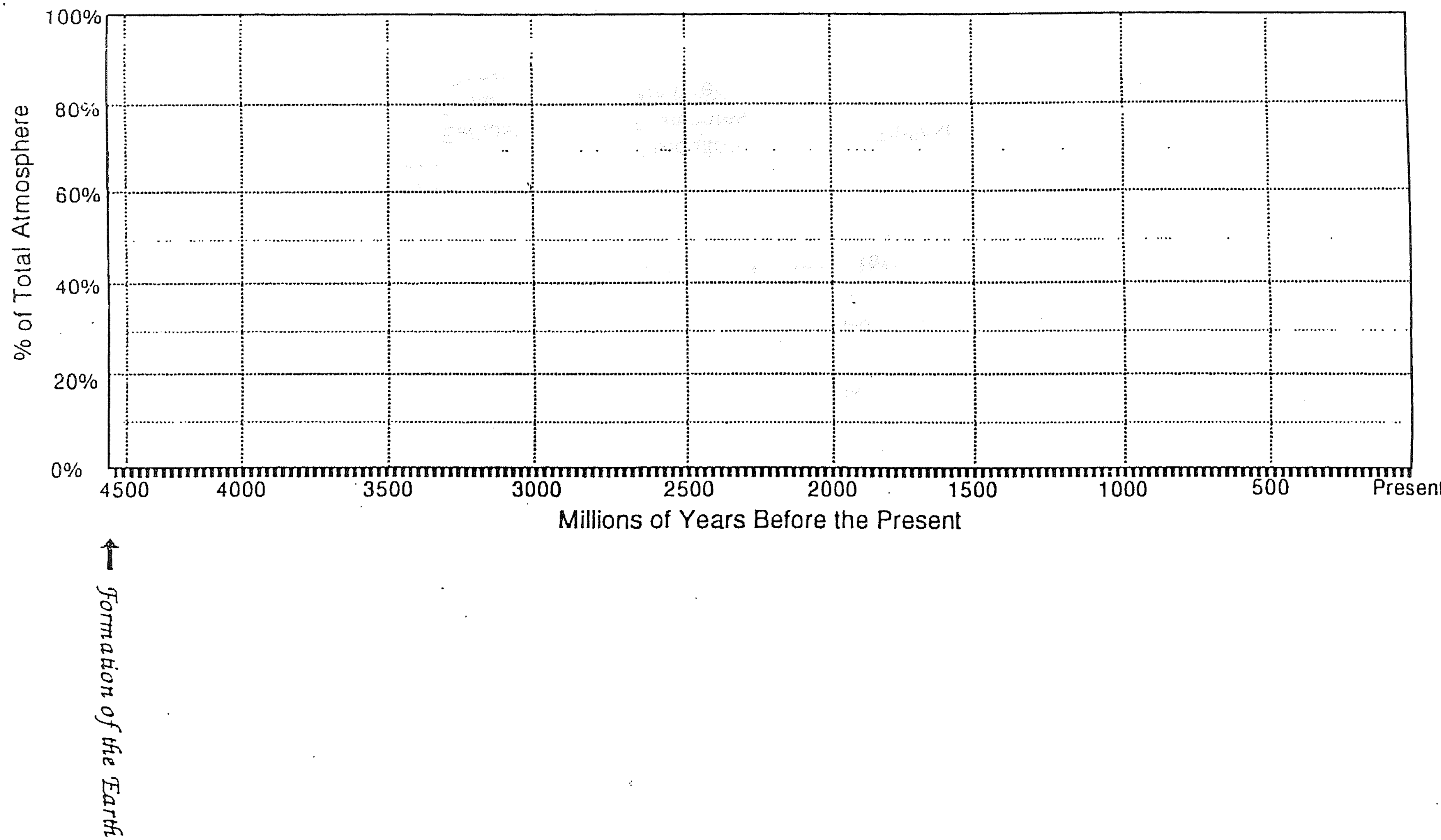
    ____

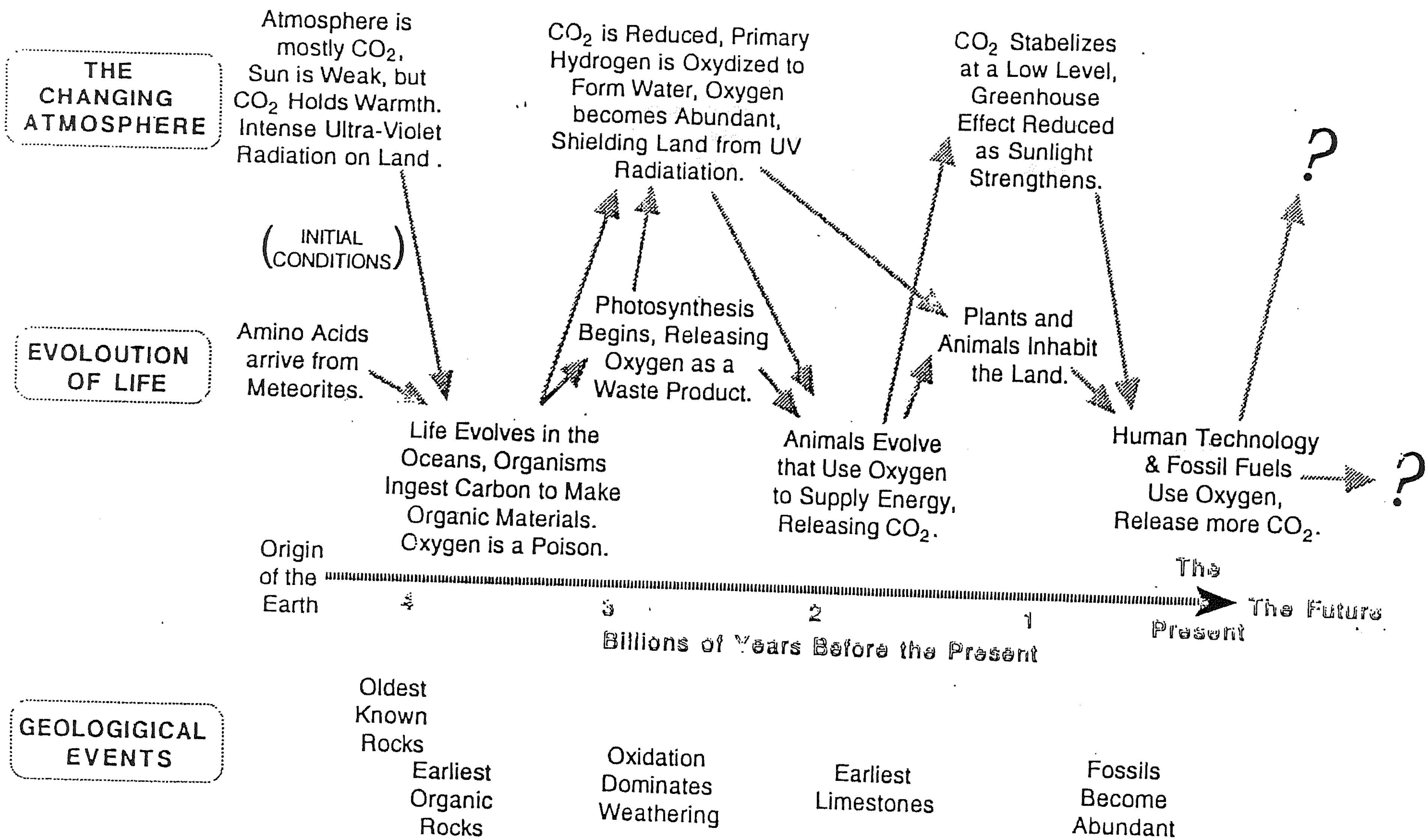
    ____

12. Both Mars and Venus have atmospheres that are dominated by carbon dioxide. Why is the Earth different? ____________________

13. Aside from providing oxygen for respiration. how else did the production of elemental oxygen within the atmosphere allow the development of land dwelling life forms? (Hint: This feature now being threatened by our technology; specifically refrigerants.) ____________________

The Changing Composition of Earth's Atmosphere




THE CHANGING ATMOSPHERE
Atmosphere is mostly CO_2, Sun is Weak, but CO_2 Holds Warmth. Intense Ultra-Violet Radiation on Land .
(INITIAL CONDITIONS)
CO_2 is Reduced, Primary Hydrogen is Oxydized to Form Water, Oxygen becomes Abundant, Shielding Land from UV Radiatiation.
CO_2 Stabelizes at a Low Level, Greenhouse Effect Reduced as Sunlight Strengthens.
?
EVOLOUTION OF LIFE
Amino Acids arrive from Meteorites.
Life Evolves in the Oceans, Organisms Ingest Carbon to Make Organic Materials. Oxygen is a Poison.
Photosynthesis Begins, Releasing Oxygen as a Waste Product.
Animals Evolve that Use Oxygen to Supply Energy, Releasing CO_2.
Plants and Animals Inhabit the Land.
Human Technology & Fossil Fuels Use Oxygen, Release more CO_2.
?
Origin of the Earth
4
3
2
1
The Present
The Future
Billions of Years Before the Present
GEOLOGIGICAL EVENTS
Oldest Known Rocks
Earliest Organic Rocks
Oxidation Dominates Weathering
Earliest Limestones
Fossils Become Abundant