Name: Date:
Period:

Graphing Human Population Growth, the Greenhouse Effect & Global Warming

Introduction:

For most of human existence, the population grew slowly because life was harsh. Food was hard to find. Predators and diseases were common and life-threatening. As civilization advanced, life became easier, and the human population began to grow more rapidly. The Industrial Revolution in the 1800's introduced many positive changes. Inventions such as the light bulb greatly improved our quality of life. Agricultural productivity increased, and sanitation, nutrition, and medical care vastly improved. Yet with all of these advances, the Industrial Revolution introduced many new environmental problems. As the human population grew, many environmental problems such as pollution and habitat loss became more common. One tremendous concern today is how human-generated greenhouse gases in the atmosphere are speeding up global warming and climate change.

To represent the effects of human population growth on greenhouse gas emissions, global warming, and climate change, we will create a variety of graphs. A graph is a diagram that shows how sets of numbers relate to one another. Graphs arrange information into a picture form. The information that you want to graph is called data. Graphs make it easier to see patterns and trends in data. You can see the data in a graph and make comparisons between variables at almost a glance.

Objective: The objective of this investigation is to illustrate and interpret data related to human population growth, greenhouse gases, and global warming.

Vocabulary: Define the following terms.

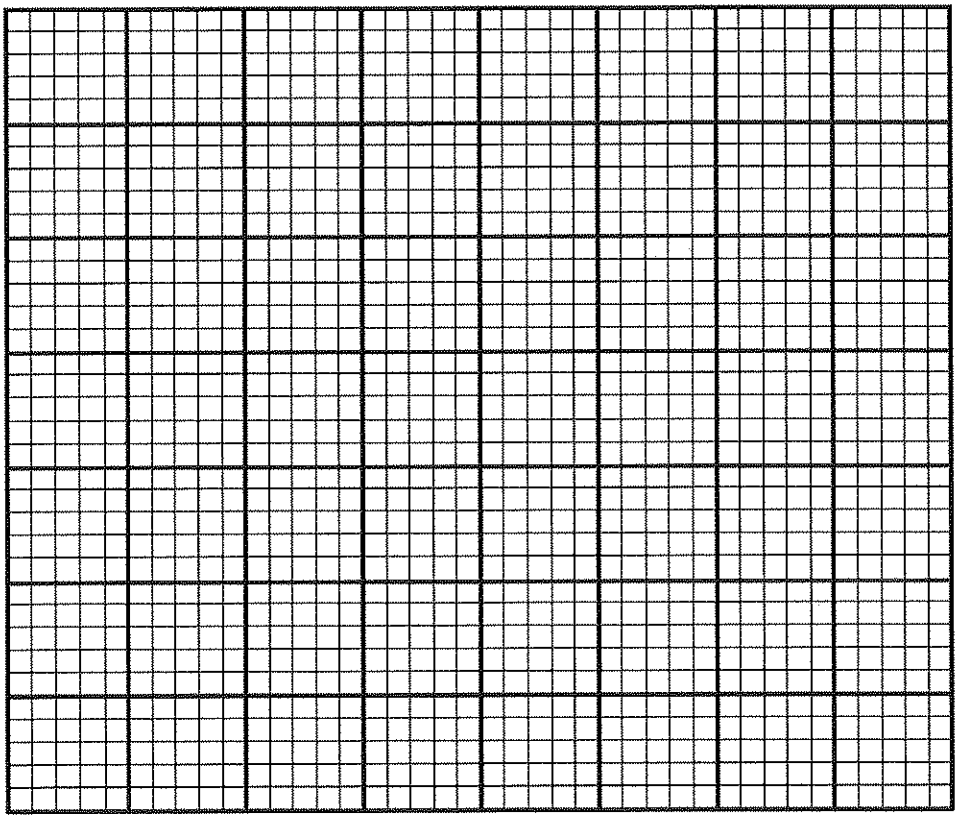
- **Human Population**: _____
  _____
- **Fossil fuel:** _____
  _____
- **Concentration:** _____
  _____
- **Greenhouse gas:** _____
  _____
- **Emission:** _____
  _____
- **Glacier:** _____
  _____

Part 1: Human Population Growth

1. The data table below shows the changes in the human population over time.[1] On the grid below, label and scale each axis. Then, plot the points from the data table below. Connect the points with a smooth line. Use your completed graph and the data table to answer the questions on the next page.

Year	Human Population (in billions of people)
1650	0.5
1700	0.6
1750	0.7
1800	0.8
1850	1.2
1900	1.6
1910	1.8
1920	1.9
1930	2.1
1940	2.3
1950	2.6
1960	3.1
1970	3.7
1980	4.5
1990	5.3
2000	6.1
2010	6.9

Human Population Growth, 1650 - 2010



[1] https://www.census.gov/population/international/data/worldpop/table_history.php and https://www.census.gov/population/international/data/worldpop/table_population.php

2. Which axis (x or y) shows population? _____

3. What was the world population in 1950? _____

4. What was the world population in 1960? _____

5. What was the approximate population in the year you were born? _____

6. In which year was the world population 1 billion? _____

7. In which year was the world population 2 billion? _____

8. How long did it take the world population to increase from 1 billion to 2 billion? _____

_____

9. In which year was the world population 4 billion? _____

10. How long did it take world population to increase from 2 billion to 4 billion? _____

11. What is different about the time it took the world population to double from 1 billion to 2 billion and the time it took to double from 2 billion to 4 billion? _____

_____

_____

12. According to the graph, will the doubling time from 4 billion to 8 billion be greater of less that the time for the previous doubling? _____

Part 2: Global CO_2 Emissions from Fossil Fuel Burning Over Time[2]

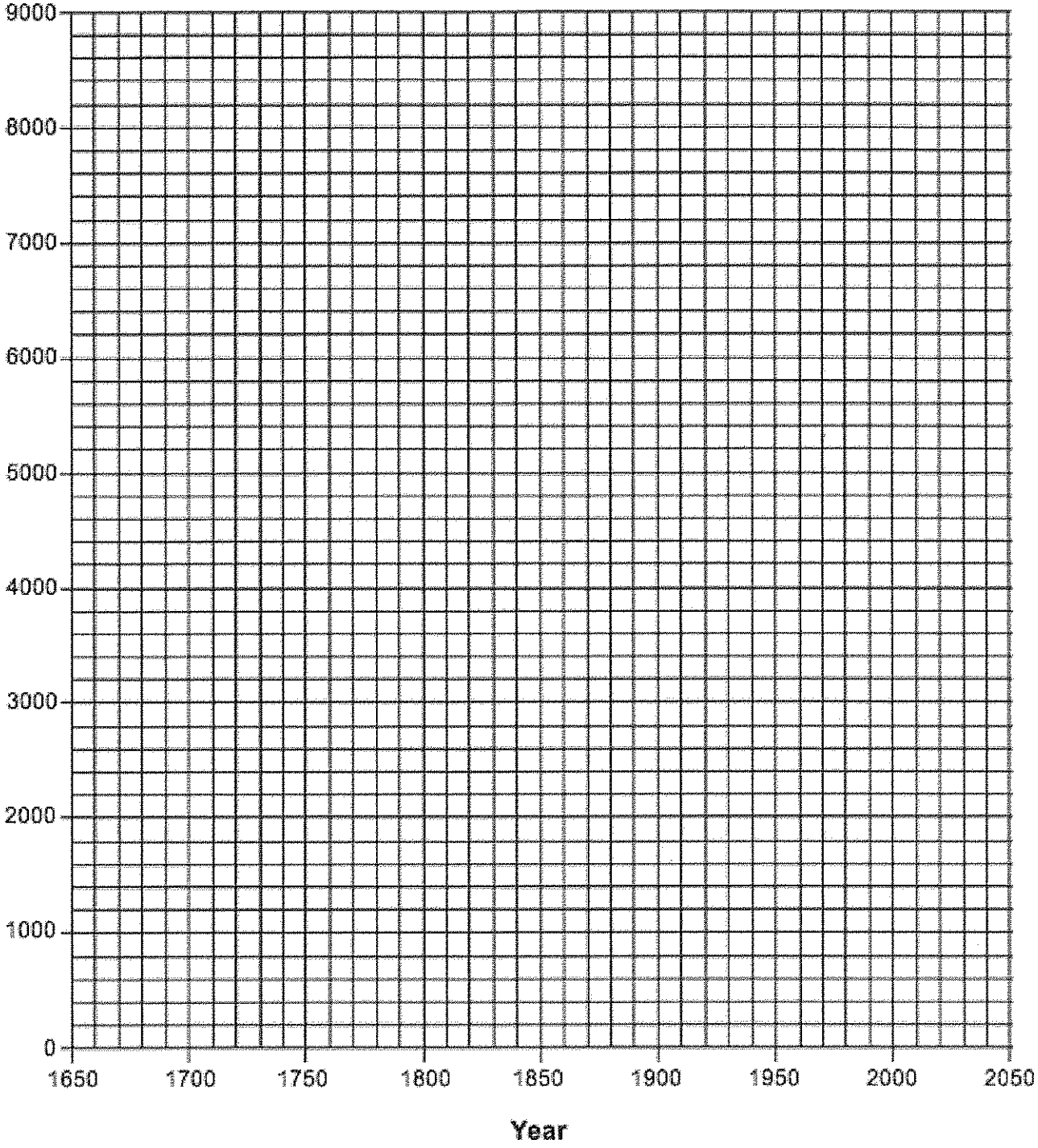
Fossil fuels are natural resources such as coal, oil (including gasoline and diesel fuel) and natural gas. They are formed from the remains of ancient plant and animal life. Burning fossil fuels powers our vehicles and industries, heats and cools our buildings, and runs appliances. It also produces electricity that we use for all sorts of purposes, such as lights and computers. The burning of fossil fuels by humans is the largest source of emissions of carbon dioxide, which is one of the greenhouse gases that traps heat near Earth's surface and contributes to global warming.

1. On the grid the next page, construct a line graph by plotting the average carbon dioxide concentrations in Earth's atmosphere for each year shown on the data table. Connect the plots with a line.

Year	CO_2 Emissions (Million Metric Tons of Carbon)
1650	1
1700	2
1750	3
1800	8
1850	54
1900	534
1910	819
1920	932
1930	1053
1940	1299
1950	1630
1960	2569
1970	4053
1980	5316
1990	6151
2000	6750
2010	9000

[2] http://cdiac.ornl.gov/trends/emis/tre_glob.html

Carbon Dioxide Concentrations in the Atmosphere over Time



2. Identify the relationship as depicted on the graph between time and the carbon dioxide emissions.

3. Calculate the rate of change from 1900 to 1910 of the carbon dioxide emissions, in million metric tons of carbon.
   a. Write out the equation.
   b. Substitute values into the equation.
   c. Calculate the rate of change and label with the correct units.

4. Calculate the rate of change from 2000 to 2010 of the carbon dioxide emissions, in million metric tons of carbon.
   a. Write out the equation.
   b. Substitute values into the equation.
   c. Calculate the rate of change and label with the correct units.

5. How does the rate of carbon dioxide emissions from 1900-1910 compare to the rate of carbon dioxide emissions from 2000-2010?

6. Increased carbon dioxide emissions is largely responsible for increased global temperatures. This is known as global warming. Name two effects global warming could have on our planet.

Part 3: Global Land-Ocean Temperatures, 1950 – 2010[3]

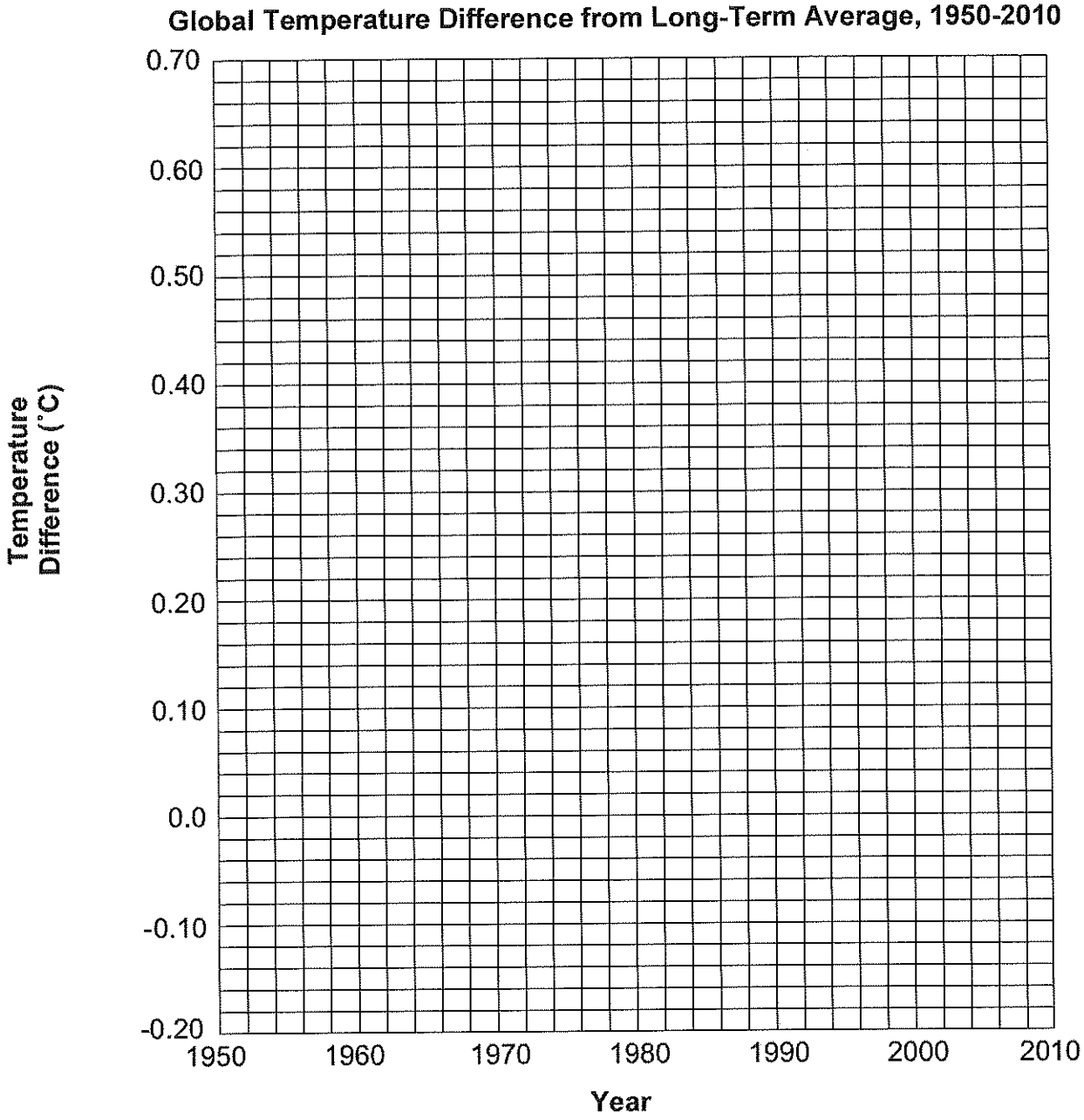
The warming of Earth's surface and lower atmosphere tends to intensify with an increase in atmospheric carbon dioxide. The atmosphere allows a large percentage of the visible light rays from the Sun to reach Earth's surface. Some of this energy is reradiated by Earth's surface in the form of long-wave infrared radiation. Much of this infrared radiation warms the atmosphere when it is absorbed by molecules of carbon dioxide and water vapor. A similar warming effect is produced by the glass of a greenhouse, which allows sunlight in the visible range to enter, but prevents infrared radiation from leaving the greenhouse.

Many scientists believe that modern industrialization and the burning of fossil fuels (coal, oil, and natural gas) have increased the amount of atmospheric carbon dioxide. This increase may result in an intensified greenhouse effect on Earth causing significant alterations in climate patterns in the future. Scientists estimate that average global temperatures could increase by as much as 5°C by the middle of the 21st century.

1. The data table below shows the temperature difference from the long-term average in degrees Celsius between 1950 and 2010. On the grid below, construct a line graph by plotting the data in the data table. Connect the points with a smooth line. Use your graph to answer the questions on the next page.

Year	Temperature Difference (°C)
1950	-0.19
1960	-0.04
1970	0.04
1980	0.23
1990	0.39
2000	0.41
2010	0.67

[3] http://data.giss.nasa.gov/gistemp/graphs_v3/



2. Describe the changes in temperature difference compared to average from 1950 to 2010.

3. During which ten-year period was there the greatest change in temperature difference compared to average?

4. What was the likely cause of the increase in temperature difference compared to average during this time?

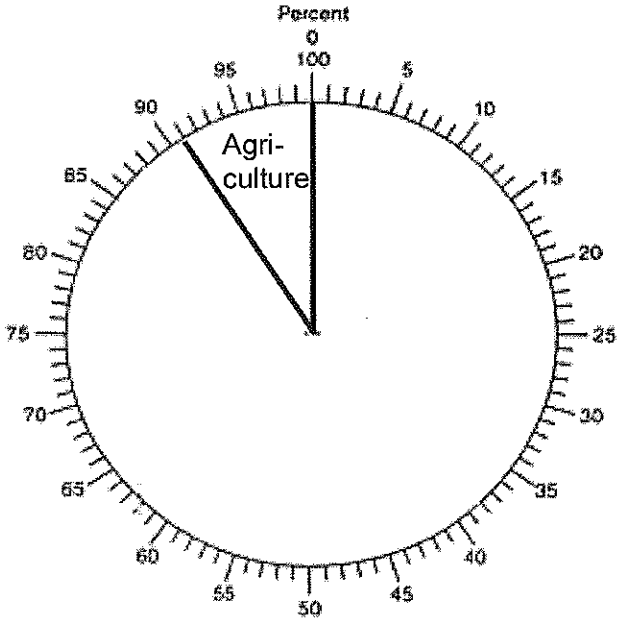
Part 4: Greenhouse Gas Emissions[4]

Greenhouse gases trap heat and make the planet warmer. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. In this part, you will draw two pie graphs. A pie graph is used to show how a certain quantity has been divided into several parts, as well as to show the comparisons among these parts.

1. The data table below shows the total U.S. greenhouse gas emissions by economic sector in 2013, in million metric tons of CO_2.

   On the pie graph provided, complete the graph to show the percent of greenhouse gas emissions for each economic sector. Label each section of the pie graph with its economic sector. The percent for "Agriculture" has been drawn and labeled for you.

Economic Sector	Percent of Greenhouse Gas Emissions
Electricity	31
Transportation	27
Industry	21
Commercial & Residential	12
Agriculture	9



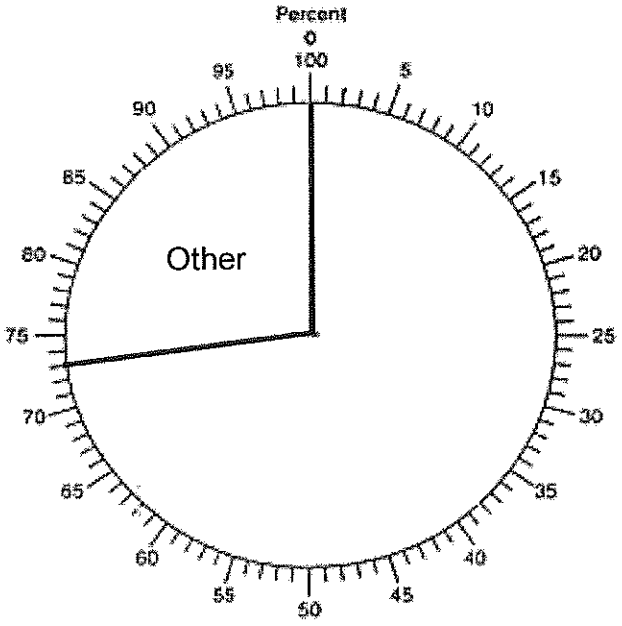
2. State two ways you could decrease the amount of *your* greenhouse gas emissions.

[4] http://www.epa.gov/climatechange/ghgemissions/sources.html

3. The data table below shows the 2008 global CO_2 emissions from fossil fuels combustion and some industrial processes.[5]

   On the pie graph provided, complete the graph to show the percent of CO_2 emissions for each country. Label each section of the pie graph with its country name. The percent for "All Other Countries" has been drawn and labeled for you.

Country	Percent of CO_2 Emissions
China	23
USA	19
European Union	13
India	6
Russian Federation	6
Japan	4
Canada	2
Other	27



4. Which country produces the greatest amount of CO_2 emissions from fossil fuel combustion?

5. How does the United States CO_2 fossil fuel emissions compare to the other countries in the world?

6. Why is it essential for all countries around the world to decrease their CO_2 emissions?

[5] http://www.epa.gov/climatechange/ghgemissions/global.html

Part 5: Change in Glacial Mass, 1975 - 2010[6]

Earth's climate is in a delicate state of balance. Many factors affect climate. Any small change in the factors may lead to long-term cooling or warming of Earth's atmosphere. For example, during the last 100 years, measurements have shown a gradual increase in atmospheric carbon dioxide. This change has been linked to an increase in Earth's average atmospheric temperature.

In this part, you will construct a bar graph to show changes in glacier mass on Earth. A bar graph is useful in comparing similar measurements at different times or in different places.

1. The data table below shows the average change in glacier mass, in meters of water, between 1975 and 2010.

   On the grid on the next page, construct a bar graph of the change in glacier mass for each year shown on the data table.

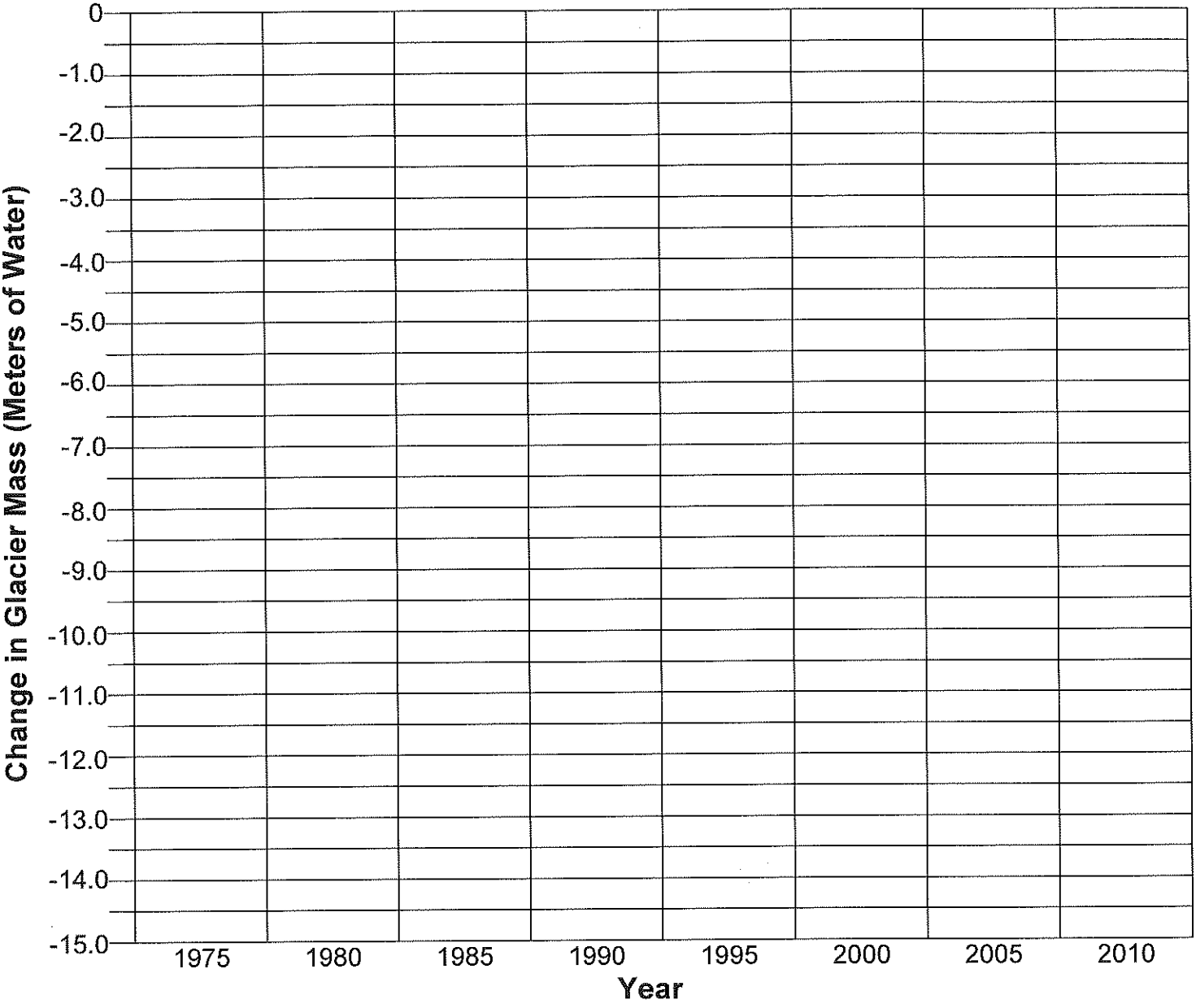
Year	Change in Glacier Mass (Meters of Water)
1975	0.0
1980	-0.8
1985	-1.7
1990	-3.2
1995	-5.0
2000	-7.2
2005	-10.8
2010	-14.6

2. State one way that the recent increase in average global temperature can cause changes in ocean water level.

3. State two problems that could be caused by decrease in glacier mass on Earth.

[6] http://www.climate.gov/news-features/understanding-climate/climate-change-glacier-mass-balance

Change in Glacier Mass, 1975 - 2010



Conclusions:

1. State how human population growth is related to the increase in the amount of greenhouse gas emissions on Earth.

2. How will the increase in the amount of greenhouse gas emissions on Earth affect Earth's temperature, amount of glacial ice, and the current sea level?

3. State one action the United Nations, a worldwide governing body, could take to decrease greenhouse gas emissions.