Objective:

The Greenhouse Effect and recent human activity that has greatly increased the concentration of greenhouse gases in the atmosphere have recently become subjects of intense research, controversy, and significance. In this exercise, we will examine some of the causes of climate change, some of the evidence that suggests that the greenhouse effect is being caused by human activity, and what some possible solutions to the problem are. Follow the instructions below and answer the questions with brief (about one or two sentences each) responses.

Procedure:

1. Refer to your lecture notes on climate and pages 125-126; 250; 282-283; 296-304 (Lutgens and Tarbuck, 2005). Some of the factors which can be shown to cause climate change are effective only over a long period of time (thousands to millions of years), whereas other factors may cause rapid (almost instantaneous to hundreds of years) climate change.
   
   a. Two causes of long-term climate change are:

   b. Two causes of possible short-term or rapid climate change are:

2. Examine the graph on the attached page which shows the change of global average temperature from 1880 to 1990. On this graph, plot the data contained in the table below which shows the amount of SO2 emissions per year and the concentration of atmospheric CO2 since 1880. Use the scales on the right hand side of the graph and the year (Date) to plot the SO2 and CO2 data. Use plus signs (+) to plot the SO2 data and circles (O) to plot the CO2 data. On the graph, connect the plusses with a smooth line and the dots with a smooth line. Note the strong correlation of both the CO2 and SO2 data with the global temperature change data.
<table>
<thead>
<tr>
<th>Year</th>
<th>SO₂ (x10⁶ tons)</th>
<th>CO₂ (ppm) Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1880</td>
<td>16</td>
<td>292</td>
</tr>
<tr>
<td>1890</td>
<td>20</td>
<td>296</td>
</tr>
<tr>
<td>1900</td>
<td>28</td>
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<td>1910</td>
<td>44</td>
<td>301</td>
</tr>
<tr>
<td>1920</td>
<td>51</td>
<td>303</td>
</tr>
<tr>
<td>1930</td>
<td>56</td>
<td>305</td>
</tr>
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<td>1940</td>
<td>65</td>
<td>308</td>
</tr>
<tr>
<td>1950</td>
<td>78</td>
<td>311</td>
</tr>
<tr>
<td>1960</td>
<td>101</td>
<td>316</td>
</tr>
<tr>
<td>1970</td>
<td>140</td>
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<td>1980</td>
<td>158</td>
<td>337</td>
</tr>
<tr>
<td>1990</td>
<td>172</td>
<td>355</td>
</tr>
</tbody>
</table>

a) How would you interpret the information in the graph in terms of the possible causes of global warming?

b) Are there possible alternative explanations? If so, briefly describe.

3. Read pages 282-285 and note Figure 11.4 on page 284 (Lutgens and Tarbuck, 2005) which discuss another, related atmospheric air quality issue, ozone depletion. Also note Figure 11.20 on page 298.

a) Based on your reading and your own thoughts on the issues of CO₂ emissions and greenhouse warming, and of the problem of ozone depletion, what steps do you think should be taken to deal with these issues?