LAB 11.1 INVESTIGATION

Temperature Inversion

In some cities, the weather report often warns of high air-pollution levels. People are asked not to drive unless it is absolutely necessary, and open fires and barbecues are forbidden. A frequent reason for high levels of air pollution near the ground is a temperature inversion in the atmosphere. Although temperature and pressure in the overall troposphere decrease with height, the temperature inversion is an exception to this rule.

PREPARATION

PROBLEM

How can you detect a temperature inversion, and how does it trap pollution?

OBJECTIVES

- **Graph** temperature data for the atmosphere.
- **Describe** how a temperature inversion affects ground-level pollution.

MATERIALS

ruler
calculator

PROCEDURE

1. Use Box 1 to graph data sets A and B. The horizontal axis will be height and the vertical axis will be temperature. Label these axes.
2. Look at the data sets and choose suitable ranges and intervals for the axes. Mark the axes accordingly.
3. Plot data set A on your graph. Connect the points with a solid line. Plot data set B on the same graph but connect the points with a dashed line.
4. Indicate on your graph which line represents which data set. Give the graph a title.
5. When air is heated, it expands. As air expands, the number of molecules in a particular volume, for example, 1 m^3, decreases. So the mass of air molecules per cubic meter—or its density—decreases. Because of this relationship, if the pressure of the air remains unchanged, then its density is inversely proportional to its temperature, provided the temperature is expressed in kelvins (K). The Kelvin scale starts at absolute zero, which corresponds to −273.15°C. To convert a temperature in degrees Celsius to kelvins, you simply add 273.15. Convert the temperatures in the table into kelvins.
6. You can work out the density of air at a particular height from the temperature data if you know the density of air at ground level.

LAB 11.1 INVESTIGATION

PROCEDURE, *continued*

Density is inversely proportional to absolute temperature; therefore, the density at height x is equal to the density at ground level times the absolute temperature (kelvins) at ground level divided by the absolute temperature at height x. Use this information to calculate the density at each height for both data sets. Assume that the air density at ground level in both data sets is 1 kg/m^3.

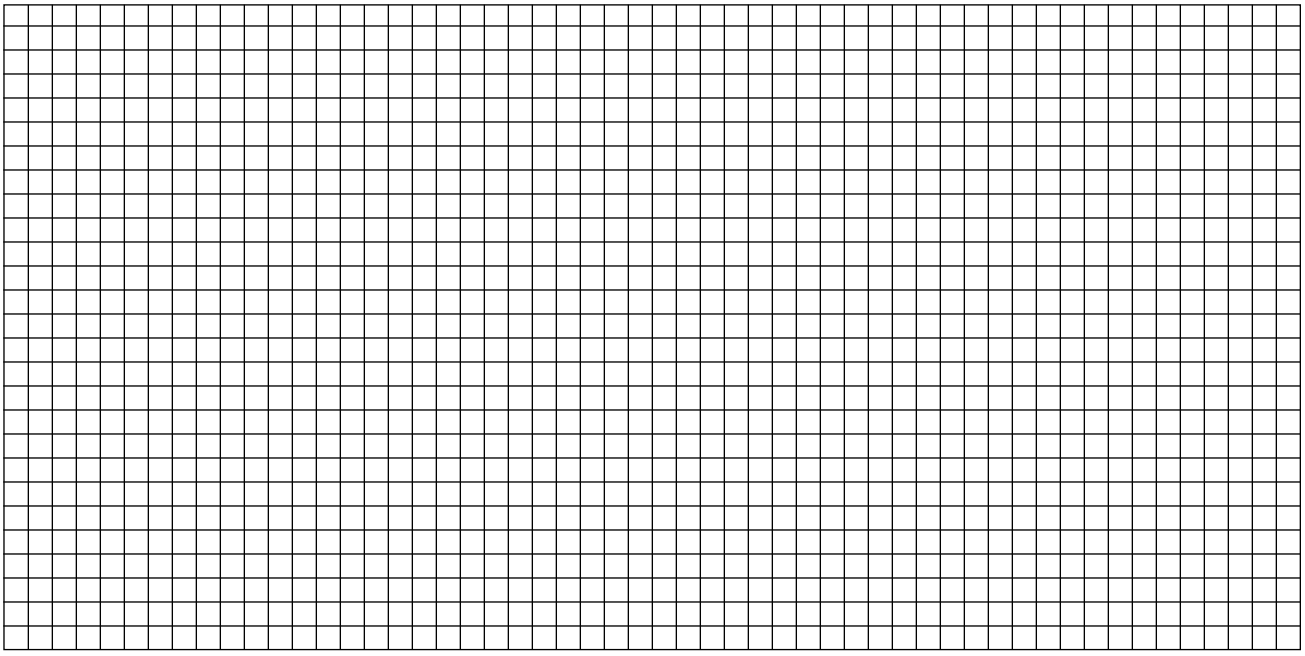
7. Use Box 2 to make a graph of density versus height similar to the first graph you made.

DATA AND OBSERVATIONS

Table

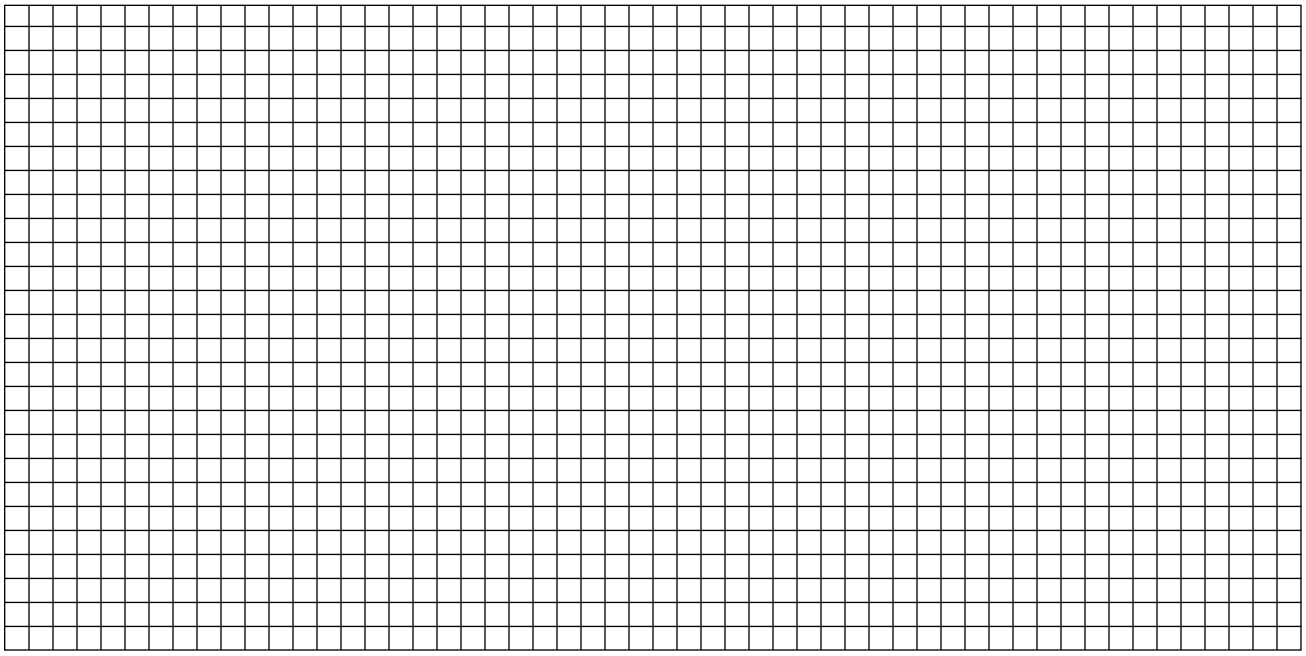
	Data Set A			Data Set B		
Height (m)	Temperature (°C)	Absolute Temperature (K)	Density (kg/m^3)	Temperature (°C)	Absolute Temperature (K)	Density (kg/m^3)
0	20.0			20.0		
100	19.5			19.3		
200	18.7			18.8		
300	18.0			18.0		
400	17.5			19.0		
500	16.9			19.5		
600	16.0			19.4		
700	15.5			18.8		

Box 1



LAB 11.1 INVESTIGATION

Box 2



ANALYZE

1. For data set A, does the temperature increase or decrease as height increases? At what altitude does the temperature first change by 1°C?

2. At what point do the two plotted lines from data sets A and B intersect?

3. Describe the plotted data of set B above 300 m.

4. Which data set shows normal conditions and which shows a temperature inversion?

5. In the data set with the temperature inversion, use your graph in Box 2 to compare the density in two regions: 300–500 m and 500–700 m.

LAB 11.1 INVESTIGATION

CONCLUDE AND APPLY

1. Air pollutants tend to move from more dense regions toward less dense regions. What does this imply for the movement of air pollutants in the data set with the temperature inversion?

2. At what height would you expect to find the greatest concentration of air pollutants in the data set with the temperature inversion?

3. In your own words, summarize how temperature inversions increase air pollution at ground level.