Our Air- Why We Should Care!

Solution Key

We live *on* earth, but we live *in* its atmosphere- a mixture of gases we call air. Just as water surrounds aquatic life, air surrounds us. People seldom think about the sea of colorless, odorless, and tasteless gases that make up the air surrounding them except, of course, when that air becomes polluted. We use atmospheric gases when we breathe, burn fuel, and carry out various industrial processes. Because human activities can lower air quality, the understanding, monitoring, measuring, and ultimately, the controlling of air quality is an important effort.

How much do you know about the atmosphere? What are the atoms or molecules present in air? What are the properties of the gases which make up our atmosphere? We will explore these questions in the following units of instruction....Our Air- Why We Should Care!

Composition of Air

The region of the atmosphere that contains most of it's mass, all of its weather and the air we breathe is called the troposphere. The air we breathe is a mixture of gases. The mixture is pretty evenly mixed around the world, and based on chemical analysis of air trapped in glacial ice, the chemical makeup has changed very little over time- until now. The concentration of carbon dioxide is rising quickly (the concentration of CO_2 in our atmosphere is currently 40% higher than it was at the start of the Industrial Revolution) due to the burning of fossil fuels and is cause of global warming and its associated challenges.

Gaseous composition of dry air

Constituent	Chemical symbol	Percent
Nitrogen	N_2	78.084
Oxygen	O_2	20.947
Argon	Ar	0.934
Carbon dioxide	CO_2	0.0350
Neon	Ne	0.001818
Helium	He	0.000524
Methane	CH_4	0.00017
Krypton	Kr	0.000114
Hydrogen	H_2	0.000053
Nitrous oxide	N_2O	0.000031
Xenon	Xe	0.0000087
Ozone*	O_3	trace to 0.0008
Carbon monoxide	CO	trace to 0.000025
Sulfur dioxide	SO_2	trace to 0.00001
Nitrogen dioxide	NO_2	trace to 0.000002
Ammonia	NH_3	trace to 0.0000003

Mackenzie, F.T. and J.A. Mackenzie (1995) **Our changing planet**. Prentice-Hall, Upper Saddle River, NJ, p 288-307.(After Warneck, 1988; Anderson, 1989; Wayne, 1991.)

The Major Constituents of Air

A. Nitrogen - 78% - Dilutes oxygen and prevents rapid burning at the earth's surface. Living things need it to make proteins. Nitrogen cannot be used directly from the air. The Nitrogen Cycle is nature's way of supplying the needed nitrogen for living things.

B. Oxygen - 21% - Used by all living things. Essential for respiration. It is necessary for combustion or burning

C. Argon - 0.9% - Used in light bulbs.

D. Carbon Dioxide - 0.03% - Plants use it to make oxygen. Acts as a blanket and prevents the escape of heat into outer space. Scientists know that the burning of fossil fuels such as coal and oil is adding more carbon dioxide to the atmosphere.

E. Trace gases - gases found only in very small amounts. They include neon, helium, krypton, and xenon.

I. Using the information above , and a Periodic Table, answer the questions below about the composition of air.

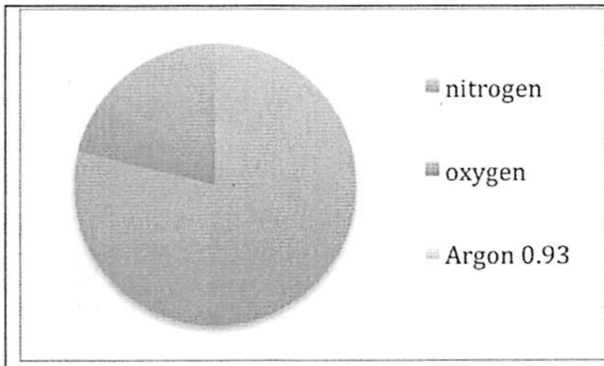
1. List the top 4 components of air.

2. Based on the percentages listed above, what percent of air is composed of "trace elements"?

3. Complete the following table

Gas	Percent in Dry Air	Atomic Number	Atomic or Molecular Mass (g/mol) Rounded to 1 decimal place
Oxygen	20.9	8	16.0
Nitrogen	78.1	7	14.0
Carbon dioxide	0.035	X	44.0
Hydrogen (gas)	5.3×10^{-5}	1	2.0
Argon	0.93	18	40.0
Neon	0.0018	10	20.0
Helium	0.00052	2	4.0
Krypton	0.00011	36	83.8
Xenon	8.7×10^{-6}	54	131.3

4. Using Excel, construct a pie chart of the data. You only need to include the top 4 components of air- the others are too low in concentration to include. After you construct the chart, insert it into the box below.



II. How the Atmosphere Changes- Using Atmospheric Data

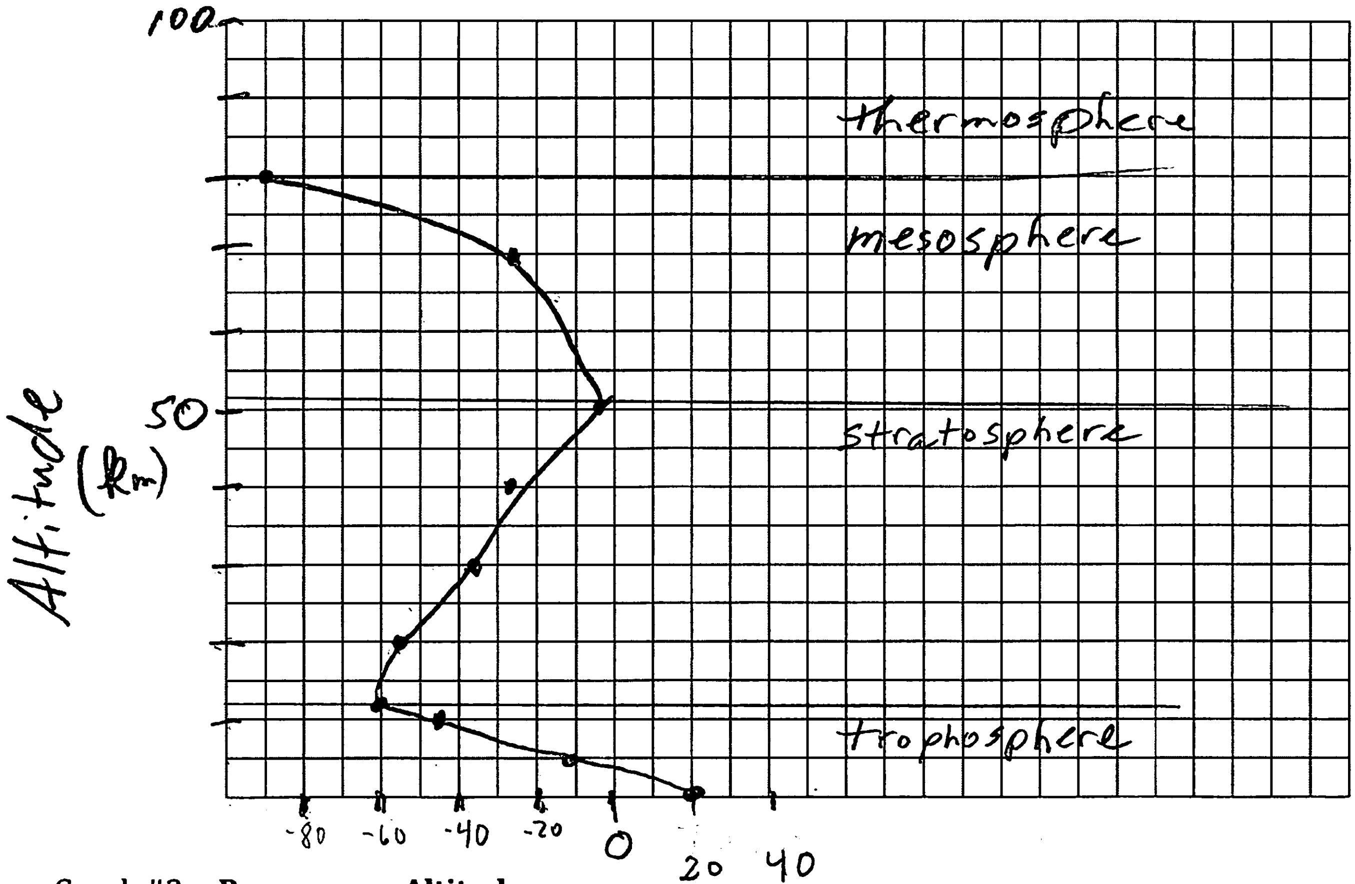
The air we breathe, most of the atmosphere's mass, and all of its weather take place within 10-12 km (6-7mi) of the Earth's surface. Well, just like if you dove into the ocean and sank to the bottom you would notice changing conditions, imagine yourself in a craft designed to fly upward to the highest parts of the atmosphere. If your imaginary craft recorded the altitude, temperature, pressure, and collected samples of along the way, you might get data similar to that presented below.

Atmospheric Data				
Altitude (km)	**Temp (^oC)**	**Pressure (mmHg)**	**Mass (g) of 1-L sample**	**Total Molecules in 1-L sample**
0	20	760	1.2	250×10^{20}
5	-12	407	0.73	150×10^{20}
10	-45	218	0.41	90×10^{20}
12	-60	170	0.37	77×10^{20}
20	-53	62	0.13	27×10^{20}
30	-38	18	0.035	7×10^{20}
40	-18	5.1	0.009	2×10^{20}
50	2	1.5	0.003	0.5×10^{20}
60	-26	0.42	0.0007	0.2×10^{20}
80	-87	0.03	0.00007	0.02×10^{20}

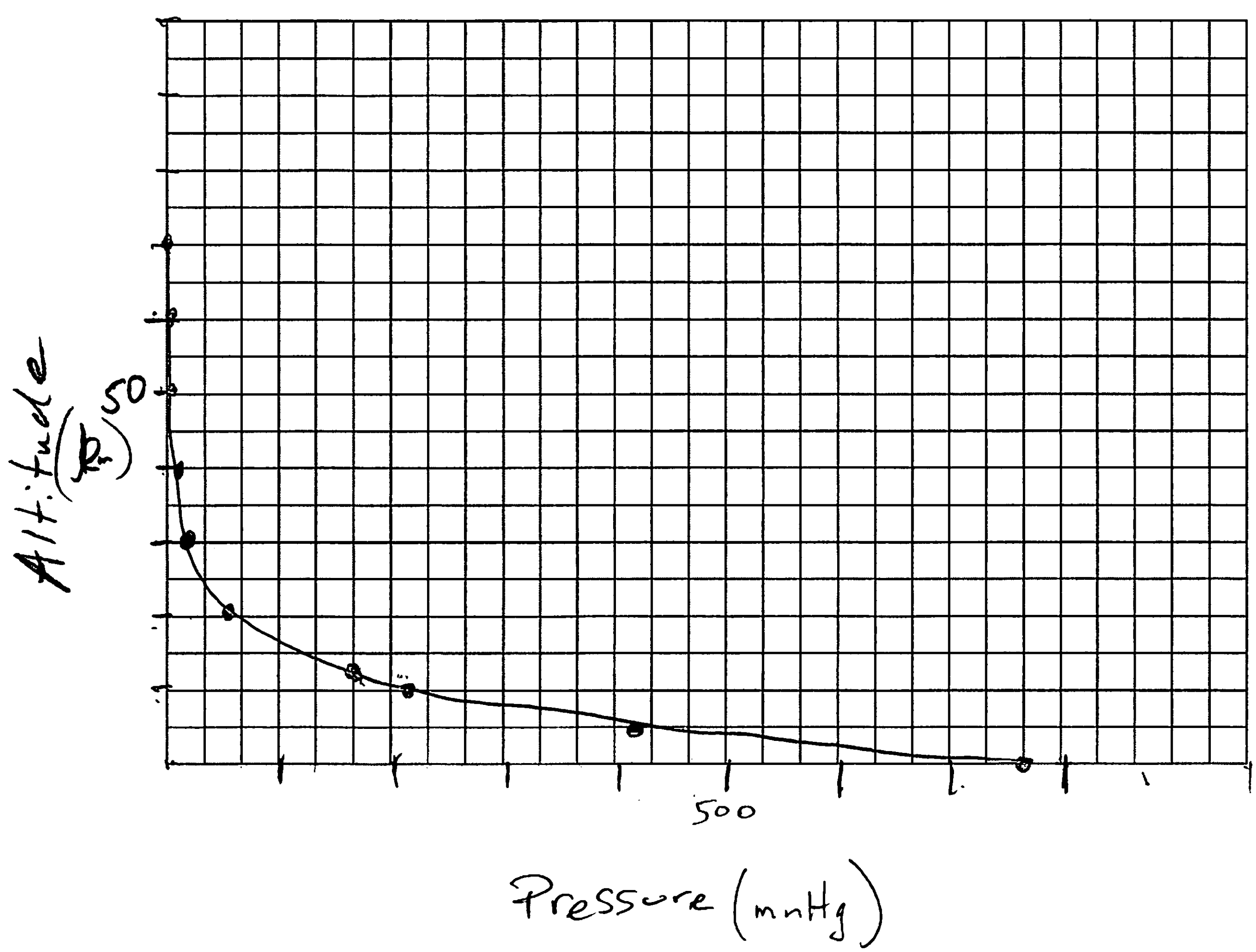
1. Prepare 2 line graphs.
   a. **Graph #1 Temperature vs. Altitude**- put altitude on the y-axis with a range from 0 to 100 km. The x-axis scale (temperature) should range from -100^{o}to +40^{o}C. Draw a best-fit-line through the points.

   b. **Graph #2 Pressure vs. Altitude**- put altitude on the y-axis with a range from 0 to 100 km. (same as above). The x-axis scale (pressure) extends from 0 to 780 mmHg. Draw a best-fit line through the points.

Graph #1 **Temperature vs. Altitude**



Graph #2 **Pressure vs. Altitude**



2. Compare how air temperature and air pressure change with increasing altitude.

Temperature decreases linearly from sea level to 12 km; then, increases linearly to 50 km; then, decreases again linearly to 80 km.

Pressure decreases nearly exponentially with altitude.

3. Based on the data, would you expect air pressure to rise or fall if you traveled from sea level (0 km) to:

a. Lake Tahoe (4000 m above sea level)? Fall

b. Death Valley (86 m below sea level)? Rise

4. Imagine you gathered 1-L samples of air at several altitudes.

a. How would the mass of the air samples change?

The mass decreases.

b. How would the total number of molecules in the sample change?

The number of molecules decreases with increasing altitude.

5. The model of the atmosphere we currently use divides the atmosphere into four general layers. In order, they are the trophosphere (nearest Earth's surface), the stratosphere, the mesosphere, and the thermosphere (the outermost layer).

a. Mark both graphs with lines at the approximate altitude where you think the general transition between each region might be. It is difficult to estimate the transition from the mesosphere to the thermosphere so, do your best!

The temperature-change graph shows three thermal layers.
Layer boundaries appear at 12 km, 50 km, 80 km, and 90 km altitude levels.