Into The Troposphere

THANK GOODNESS FOR the atmosphere. It keeps us warm. Without it, Earth would be a lifeless ball of ice with an average temperature of minus 60 degrees Fahrenheit. In addition, the atmosphere absorbs or deflects incoming swarms of cosmic rays, charged particles, ultraviolet rays, and the like. Altogether, the gaseous padding of the atmosphere is equivalent to a fifteen-foot thickness of protective concrete, and without it these invisible visitors from space would slice through us like tiny daggers. Even raindrops would pound us senseless if it weren't for the atmosphere's slowing drag.

The most striking thing about our atmosphere is that there isn't very much of it. It extends upward for about 120 miles, which might seem reasonably bounteous when viewed from ground level, but if you shrank the Earth to the size of a standard desktop globe it would only be about the thickness of a couple of coats of varnish.

For scientific convenience, the atmosphere is divided into four unequal layers: troposphere, stratosphere, mesosphere, and ionosphere (now often called the thermosphere). The troposphere is the part that's dear to us. It alone contains enough warmth and oxygen to allow us to function, though even it swiftly becomes uncongenial to life as you climb up through it. From ground level to its highest point, the troposphere (or "turning sphere") is about ten miles thick at the equator and no more than six or seven miles high in the temperate latitudes where most of us live. Eighty percent of the atmosphere's mass, virtually all the water, and thus virtually all the weather are contained within this thin and wispy layer. There really isn't much between you and oblivion.

Beyond the troposphere is the stratosphere. When you see the top of a storm cloud flattening out into the classic anvil shape, you are looking at the boundary between the troposphere and stratosphere. This invisible ceiling is known as the tropopause and was discovered in 1902 by a Frenchman in a balloon, Léon-Philippe Teisserenc de Bort. Pause in this sense doesn't mean to stop momentarily but to cease altogether; it's from the same Greek root as menopause. Even at its greatest extent, the tropopause is not very distant. A fast elevator of the sort used in modern skyscrapers could get you there in about twenty minutes, though you would be well advised not to make the trip. Such a rapid ascent without pressurization would, at the very least, result in severe cerebral and pulmonary edemas, a dangerous excess of fluids in the body's tissues. When the doors opened at the viewing platform, anyone inside would almost certainly be dead or dying. Even a more measured ascent would be accompanied by a great deal of discomfort. The temperature six miles up can be -70 degrees Fahrenheit, and you would need, or at least very much appreciate, supplementary oxygen.

After you have left the troposphere the temperature soon warms up again, to about 40 degrees Fahrenheit, thanks to the absorptive effects of ozone (something else de Bort discovered on his daring 1902 ascent). It then plunges to as low as -130 degrees Fahrenheit in the mesosphere before skyrocketing to 2,700 degrees Fahrenheit or more in the aptly named but very erratic thermosphere, where temperatures can vary by a thousand degrees from day to night—though it must be said that "temperature" at such a height becomes a somewhat notional concept. Temperature is really just a measure of the activity of molecules. At sea level, air molecules are so thick that one molecule can move only the tiniest distance—about three-millionths of an inch, to be precise—before banging into another. Because trillions of molecules are constantly colliding, a lot of heat gets exchanged. But at the height of the thermosphere, at fifty miles or more, the air is so thin that any two molecules will be miles apart and hardly ever come in contact. So although each molecule is very warm, there are few interactions between them and thus little heat transference. This is good news for satellites and spaceships because if the exchange of heat were more efficient any man-made object orbiting at that level would burst into flame.

Even so, spaceships have to take care in the outer atmosphere, particularly on return trips to Earth, as the space shuttle Columbia demonstrated all too tragically in February 2003. Although the atmosphere is very thin, if a craft comes in at too steep an angle—more than about 6 degrees—or too swiftly it can strike enough molecules to generate drag of an exceedingly combustible nature. Conversely, if an incoming vehicle hit the thermosphere at too shallow an angle, it could well bounce back into space, like a pebble skipped across water.

excerpt from *A Short History of Nearly Everything*

by Bill Bryson

Name: ____ Period: _______ Date: _______________

Layers of the Atmosphere

Directions: *Your job is to create an "internal dialogue" with the text. Write comments in the margins, make connections, raise questions, underline words or phrases you find intriguing or are new to you. You should make a minimum of 6 comments. As you read, answer the questions below. After you read, you will write a six-word summary sentence of the section in the space below.*

1) Which of the following does the atmosphere do for us?
   - A. Keeps us warm
   - B. Protects us from harmful radiation
   - C. Provides us with oxygen and water
   - D. All of the above

2) How thick would the atmosphere be if the Earth was the size of a desk globe?
   - A. Coat of paint
   - B. Coat of wax
   - C. Coat of varnish
   - D. Coat of stain

3) How many layers is the atmosphere divided into?
   - A. 2
   - B. 3
   - C. 4
   - D. 5

4) Since the troposphere contains most of all of the water found in the atmosphere, this means the troposphere also contains all of the:
   - A. weather
   - B. warmth
   - C. oxygen atoms
   - D. none of the above

5) What could be deadly to you if you were near the top of the troposphere?
   - A. Ultra violet radiation
   - B. Lack of oxygen
   - C. Extremely hot temperatures
   - D. Too much air pressure

6) Why does the stratosphere warm up to about 400°F?
   - A. Closer to the sun
   - B. Ozone absorbs ultra violet radiation
   - C. Greenhouse effect
   - D. Abundance of air molecules

7) The thermosphere (50 miles in altitude) can reach 2700°F. Why doesn't this high temperature burn-up satellites and spaceships traveling at this altitude?
   - A. not enough molecules of air
   - B. no oxygen molecules to create fire
   - C. too many molecules of air
   - D. none of the above

Six-Word Summary:

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