

Chapter 1 - The Atmosphere

Questions & Answers

1. What are the major non-varying constituents of the atmosphere?

They are O₂, N₂ and the noble gases, e.g., Ar, Ne, He, etc.

2. What is the significance of atmospheric O₂?

Oxygen makes life as we know it possible because most organisms depend on oxidative metabolism.

3. Why are concentrations of H₂O vapor and CO₂ so variable?

Water vapor concentrations vary because of continual phase changes caused by changes of temperature. Carbon dioxide variability is related to its uptake and release by plants.

4. What gases absorb incoming solar radiation?

Ozone, O₂, CO₂, and H₂O absorb portions of the solar spectrum.

5. What gases absorb outgoing thermal radiation?

Carbon dioxide, H₂O, O₃, N₂O, CH₄, and chlorofluorocarbons absorb portions of the thermal emission spectrum.

6. Why don't atmospheric gases simply flow away from the earth's surface and be lost to space?

They are held close to the earth's surface by the force of gravity.

7. With one exception, the relative concentrations of atmospheric gases do not change with height. Indicate this exception, its concentration patterns and reasons why this is the case.

The exception is O₃. Concentrations increase with height, reaching peak levels in the middle stratosphere, and then decrease up to ~ 50 km. High O₃ concentrations are produced in the stratosphere by photodecomposition of O₂ and recombination to form O₃.

8. There is a considerable difference between solar energy received at the extremity of the earth's atmosphere and that received at the surface. Describe these differences and factors responsible.

About 30% of solar energy is reflected back to space (primarily by clouds). A significant amount of solar energy is also absorbed by atmospheric gases such as O₃, O₂, CO₂, and H₂O.

9. Significant temperature changes occur with height out to a distance of 500 km. Describe these differences and factors that contribute to them.

In the troposphere, temperature decreases with height up to ~12-15 km, followed by isothermal conditions, increases with height up to the top of the stratosphere, becomes isothermal, decreases with height up to ~ 80 km, becomes isothermal, and then increases with height. These changes result from processes that cause warming and cooling, respectively, in different regions of the atmosphere, i.e., in the troposphere, solar heating while in the stratosphere, absorption of UV light, etc.

10. Thermal emissions from the earth and its atmosphere are characterized by electromagnetic energy in which spectral range?

The 4-30 μm spectral region.

11. What is the atmospheric window? What is its significance?

The atmospheric window is the spectral region of ~7-14 μm . The atmosphere in this spectral region is, for the most part, transparent to the emission of infrared energy.

12. What is atmospheric pressure? What causes it?

Atmospheric pressure is the force exerted on an object by the weight of the atmosphere above it. The cause is the transfer of momentum by the random motion of air molecules.

13. Why is H₂O vapor such an important atmospheric constituent?

Water vapor is the major greenhouse gas. It rapidly changes phase to produce clouds that reflect sunlight; these clouds may also result in precipitation.

14. The atmosphere is in constant motion. Why?

Unequal heating of the earth's surface causes air to move because of temperature and pressure differences.

15. Why does air flow counterclockwise in a low-pressure system in the northern hemisphere?

As air flows inward to the center of the low pressure cell, the combined effect of friction, pressure gradient force, and the earth's rotation causes air to flow counterclockwise.

16. Air flowing from the equator in the middle latitudes in the northern hemisphere appears to flow from the southwest to the northeast. Why?

Because of the earth's rotation, air flowing northward appears to be deflected to the northeast.

17. The three-zone model is used to describe what type of air motion?

The three-zone model describes planetary scale air motions and latitudinal differences in air flow.

18. Why does air flow aloft in different patterns than it does near the surface?

Above the planetary boundary level, airflow is no longer affected by friction associated with the earth's surface and air immediately above it.

19. What causes the earth to have an albedo? What is the significance of the earth's albedo?

The earth's ability to reflect light, i.e., its albedo, is due to clouds and "bright" earth surfaces.

20. How, where, and why are jet streams formed?

Jet streams are formed at high tropospheric altitudes along fronts, typically in the discontinuities of Hadley-type airflows. They are produced as a result of the high temperature/pressure differences that exist in these regions.

21. How did O₂ originate in the atmosphere?

Atmospheric O₂ was produced by plant photosynthesis.

22. How have atmospheric CO₂ levels changed over time?

Very high concentrations of CO₂ existed in the early atmosphere. Much of this was removed as oceans formed, with further reductions associated with plant uptake in the great "Coal Age". Recent increases are occurring as a result of our use of fossil fuels.

23. What is the origin of H₂ and He in the atmosphere?

Both H₂ and He are produced by chemical processes in the earth's crust.

24. The composition of the earth's atmosphere has changed in the past 200 years. What were/are these changes?

There have been significant increases in concentrations of CO₂, CH₄, N₂O, and tropospheric O₃. There have also been decreases in stratospheric O₃.