jumps that correspond to the four spectral lines in the visible spectrum of hydrogen are shown in **Figure 15.** Bohr's calculations successfully account for the wavelengths of all the spectral lines of hydrogen.

As noted earlier, fewer absorption lines than emission lines are typically observed. The reason is that absorption spectra are usually observed when a gas is at room temperature. Thus, most electrons are in the ground state, so all transitions observed are from a single level (E_1) to higher levels. Emission spectra, on the other hand, are seen by raising a gas to a high temperature and viewing downward transitions between any two levels. In this case, all transitions are possible, so more spectral lines are observed.

Bohr's idea of the quantum jump between energy levels provides an explanation for the aurora borealis, or northern lights. Charged particles from the sun sometimes become trapped in Earth's magnetic field and are deposited around the northern and southern magnetic poles. (Light shows in southern latitudes are called *aurora australis,* or *southern lights.*) When deposited, these charged particles from the sun collide with the electrons of the atoms in our atmosphere and transfer energy to these electrons, causing them to jump to higher energy levels. When an electron returns to a lower orbit, some of the energy is released as a photon. The northern lights are the result of billions of these quantum jumps happening at the same time.

The colors of the northern lights are determined by the type of gases in the atmosphere. The charged particles from the sun are most commonly released from Earth's magnetic field into a part of the atmosphere that contains oxygen, which releases green light. Red lights are the result of collisions with nitrogen atoms. Because each type of gas releases a unique color, the northern lights contain only a few distinct colors rather than a continuous spectrum.

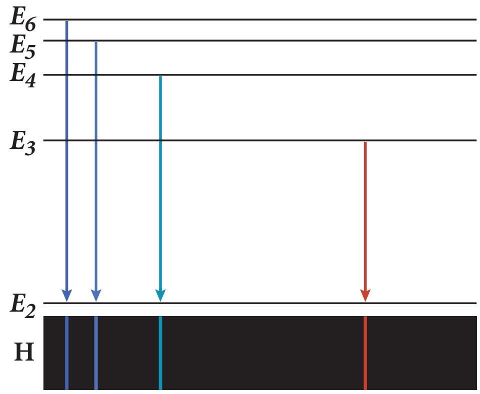

Figure 15
Every jump from one energy level to another corresponds to a specific spectral line. This example shows the transitions that result in the visible spectral lines of hydrogen. The lowest energy level, E_1, is not shown in this diagram.

Why it Matters

Conceptual Challenge

1. Neon Signs When a potential difference is placed across electrodes at the ends of a tube that contains neon, such as a neon sign, the neon glows. Is the light emitted by a neon sign composed of a continuous spectrum or only a few lines? Defend your answer.

2. Energy Levels If a certain atom has four possible energy levels and an electron can jump between any two energy levels of the atom, how many different spectral lines could be emitted?

3. Identifying Gases Neon is not the only type of gas used in neon signs. As you have seen, a variety of gases exhibit similar effects when there is a potential difference across them. While the colors observed are sometimes different, certain gases do glow with the same color. How could you distinguish two such gases?