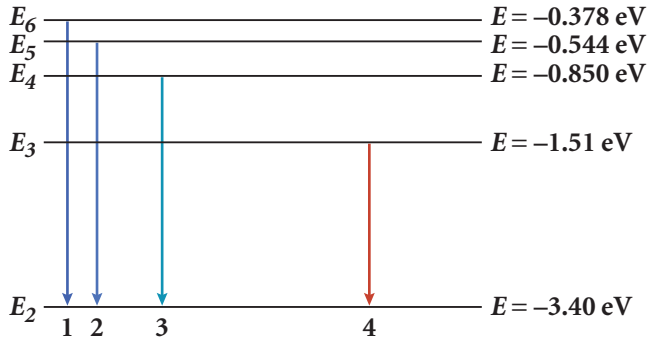
SAMPLE PROBLEM C

STRATEGY Interpreting Energy-Level Diagrams

PROBLEM

An electron in a hydrogen atom drops from energy level E_4 to energy level E_2. What is the frequency of the emitted photon, and which line in the emission spectrum corresponds to this event?



SOLUTION

1. Find the energy of the photon.

The energy of the photon is equal to the change in the energy of the electron. The electron's initial energy level was E_4, and the electron's final energy level was E_2. Using the values from the energy-level diagram gives the following:

$$E = E_{initial} - E_{final}$$

$$E = (-0.850 \text{ eV}) - (-3.40 \text{ eV}) = 2.55 \text{ eV}$$

TIP

Note that the energies for each energy level are negative. The reason is that the energy of an electron in an atom is defined with respect to the amount of work required to remove the electron from the atom. In some energy-level diagrams, the energy of E_1 is defined as zero, and the higher energy levels are positive. In either case, the difference between a higher energy level and a lower one is always positive, indicating that the electron loses energy when it drops to a lower level.

2. Use Planck's equation to find the frequency.

$$E = hf$$

$$f = \frac{E}{h}$$

$$f = \frac{(2.55 \text{ eV})(1.60 \times 10^{-19} \text{ J/eV})}{6.63 \times 10^{-34} \text{ J} \cdot \text{s}}$$

$$\boxed{f = 6.15 \times 10^{14} \text{ Hz}}$$

TIP

Note that electron volts were converted to joules so that the units cancel properly.