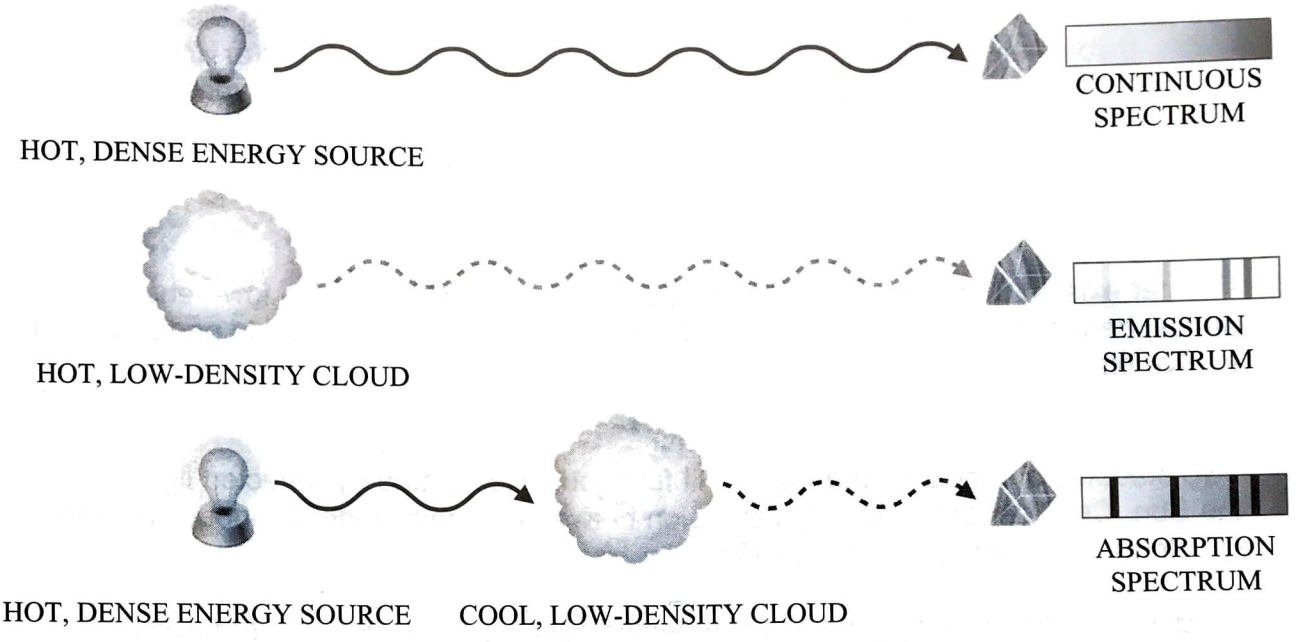
# Types of Spectra




1) What type of spectrum is produced when the light emitted directly from a hot, dense object passes through a prism?

2) What type of spectrum is produced when the light emitted directly from a hot, low-density cloud of gas passes through a prism?

3) Describe in detail the source of light and the path the light must take to produce an absorption spectrum.

4) There are dark lines in the absorption spectrum that represent missing light. What happened to this light that is missing in the absorption line spectrum?

5) Stars like our Sun have low-density, gaseous atmospheres surrounding their hot, dense cores. If you were looking at the spectra of light coming from the Sun (or any star), which of the three types of spectrum would be observed? Explain your reasoning.

6) If a star existed that was only a hot, dense core and did **NOT** have a low-density atmosphere surrounding it, what type of spectrum would you expect this particular star to give off?

7) Two students are looking at a brightly lit full Moon, illuminated by reflected light from the Sun. Consider the following discussion between the two students about what the spectrum of moonlight would look like.

**Student 1:** *I think moonlight is just reflected sunlight, so we will see the Sun's absorption line spectrum.*

**Student 2:** *I disagree. An absorption spectrum has to come from a hot, dense object. Since the Moon is not a hot, dense object, it can't give off an absorption line spectrum.*

Do you agree or disagree with either or both of the students? Explain your reasoning.

8) Imagine that you are looking at two different spectra of the Sun. Spectrum #1 is obtained using a telescope that is in a high orbit far above Earth's atmosphere. Spectrum #2 is obtained using a telescope located on the surface of Earth. Label each spectrum below as either Spectrum #1 or Spectrum #2.

Spectrum #_____

Spectrum #_____

Explain the reasoning behind your choices.

In this activity, we will use a representation of the atom in which a central nucleus containing the protons and neutrons is surrounded by circles that represent the energy levels electrons can occupy.

1) Draw an atom including a nucleus and five energy levels that electrons could occupy. Use a dot to represent an electron at the lowest energy level.

One way an atom emits light (photons) occurs when an electron drops down from a high energy level (also referred to as an excited state) to a lower energy level (the lowest energy level is referred to as the ground state.)

2) Will an atom emit light if all of the atom's electrons are in the ground state? Explain your reasoning.

3) In which case does an atom emit more energy (*circle one*)?

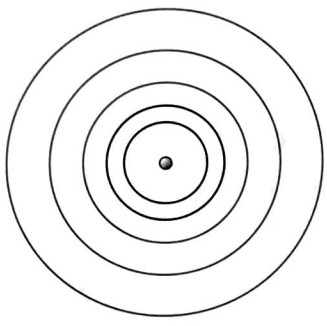
**Case A:** *An electron drops down from the first excited state to the ground state.*
**Case B:** *An electron drops down from the third excited state to the ground state.*

Explain your reasoning.

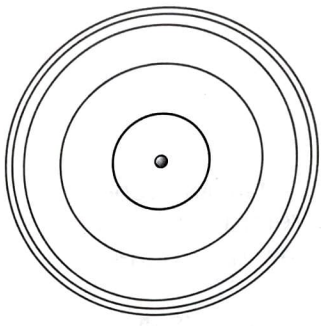
4) Two students are talking about how light is emitted from atoms. Consider the following discussion between the two students and the sketches each student drew to illustrate their thinking.

**Student 1:** *I drew my atom like this because my professor said that the gap between the energy levels gets bigger and bigger as you go up in energy from the ground state.*

**Student 2:** *I think you've got it backward. The gap between energy levels will get smaller as you go up in energy levels, like I've drawn.*



Student 1 Drawing



Student 2 Drawing

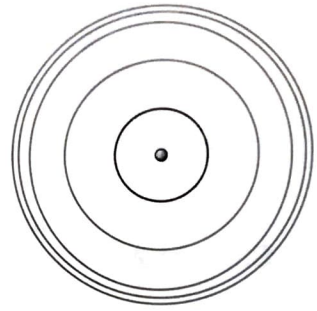
Do you agree or disagree with either or both of the students? Explain your reasoning.

5) A solid, glowing-hot object will emit light over the full range of wavelengths resulting in a continuous spectrum. If a diffuse and relatively cool cloud of gas is located between the glowing, hot object and an observer, what type of spectrum will the observer detect coming out of the cloud (*circle one*)?

continuous spectrum absorption spectrum emission spectrum

Explain the reasoning behind your choice.

6) At the right is a sketch showing one of the atoms in the diffuse, cool cloud of gas described in the previous question. Note that the atom has several energy levels that an electron could exist in. Using a dot to represent an electron, a straight arrow to represent the motion of the electron, and a squiggly arrow to represent the photon, sketch what you think would happen within this atom to cause the type of spectrum described in the previous question. Explain the reasoning behind why you drew the electron and arrows the way you did.

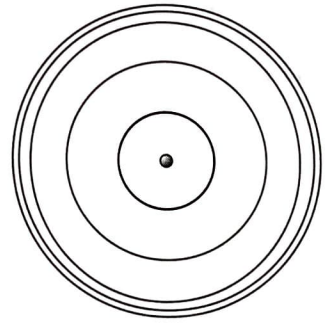


7) Imagine that you are looking at a neon sign in a store window that says "OPEN." This sign can be thought of as a tube filled with a gas of neon atoms that have electrons changing from one energy state to a different energy state and in the process are giving off mostly red light. Which type of spectrum would you observe coming from the "OPEN" sign (*circle one*)?

continuous spectrum absorption spectrum emission spectrum

Explain the reasoning behind your choice.

8) At the right is a sketch showing one of the atoms in the neon sign described in the previous question. Note that the atom has several energy levels that an electron could exist in. Using a dot to represent an electron, a straight arrow to represent the motion of the electron, and a squiggly arrow to represent the photon, sketch what you think would happen within this atom to cause the type of spectrum described in the previous question. Explain the reasoning behind why you drew the electron and arrows the way you did.



9) Consider the following discussion between the two students about the atoms and light coming from the red "OPEN" sign from the previous question and the light coming from a yellow "OPEN" sign they see across the street.

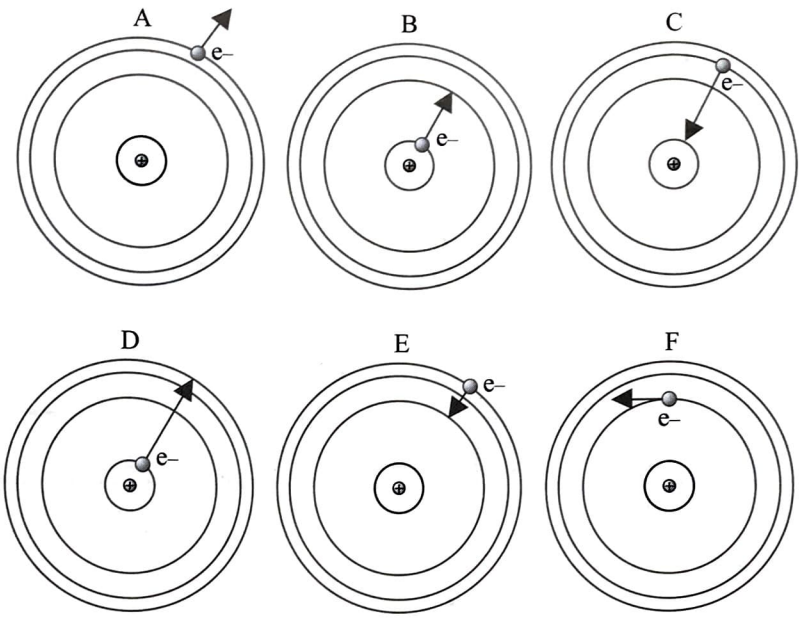
**Student 1:** *I think that all you need to do to get signs to give off light of different colors is to use tinted glass of different colors. If you electrify a gas, white light is emitted so the color of glass gives the sign its color.*

**Student 2:** *That can't be it because the electrons will always move between the same energy levels for atoms in a neon sign and so they will mostly give off red light. I think the yellow sign is filled with a different type of atoms with energy levels that are farther apart, so when the electrons drop down from a higher energy level to a lower energy level, the atoms will give off yellow light instead of red light.*

Do you agree or disagree with either or both of the students? Explain your reasoning.

10) Redraw the initial drawing you made in Question 1. Describe what additions or changes you made on this new drawing so that it better conveys what you understand about the relationship between light and atoms.

11) Use the hypothetical atom drawings (A–F) below to answer the next five questions. Note there is only one correct choice for each question and each choice is used only once.




a) Which shows the absorption of violet light? Explain your reasoning.

b) Which shows the emission of blue light? Explain your reasoning.

c) Which shows the absorption of green light? Explain your reasoning.

d) Which shows the emission of orange light? Explain your reasoning.

e) Which shows an electron being ejected from the atom?