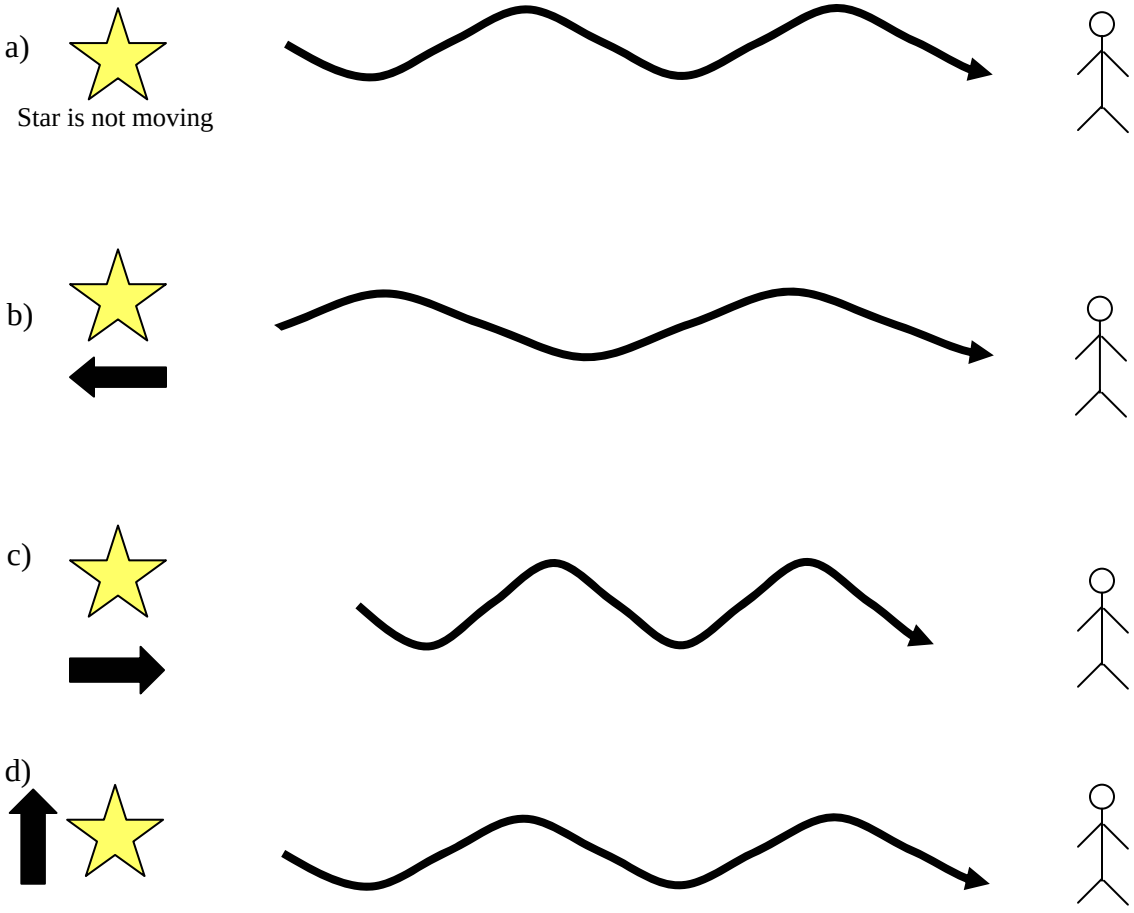
Doppler Shift

Part I. Motion of Source

Because of the Doppler effect, light emitted by an object can appear to change wavelength due to its motion toward or away from an observer. When the observer and the source of light are moving toward each other the light is shifted to shorter wavelengths (blueshifted). When the observer and the source of light are moving away from each other the light is shifted to longer wavelengths (redshifted).



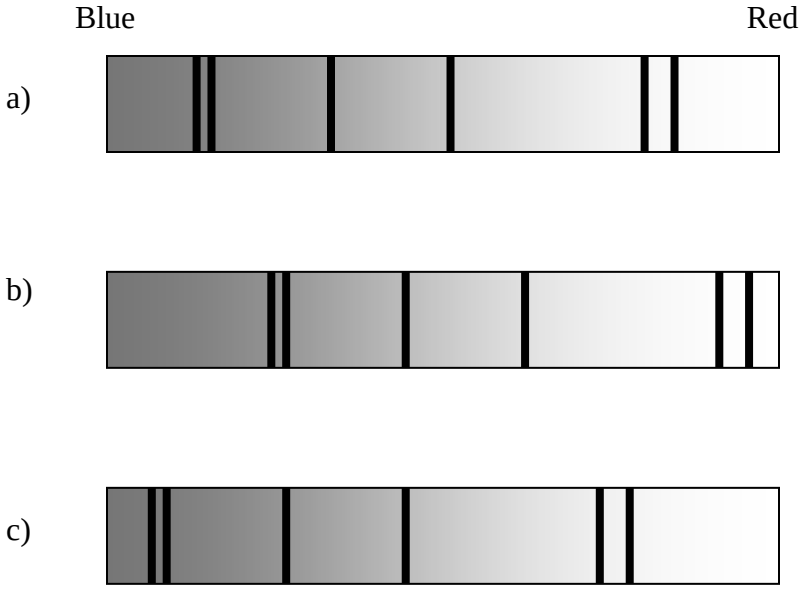
1. In which of the situations shown (a – d) will the observer receive light that is shifted to shorter wavelengths? Explain your reasoning.

2. In which of the situations shown (a – d) will the observer receive light that is shifted to longer wavelengths? Explain your reasoning.

3. In which of the situations shown (a – d) will the observer receive light that is not shifted at all? Explain your reasoning.

Part II. Shift in Absorption Spectra

When we study an astronomical object like a star or galaxy, we usually examine the spectrum of light it gives off. Recall that the spectrum of an object contains lines that work like fingerprints to help identify different elements. Since the lines of a spectrum occur at specific wavelengths we can determine that an object is moving when we see that the lines have been shifted to either longer or shorter wavelengths. For the absorption line spectra shown below, blue light is shown on the left-hand side and red light is shown on the right-hand side.



For the three absorption line spectra shown above (a, b and c), one of the spectra corresponds to a star that is not moving relative to you, one spectra is from a star that is moving towards you and one spectra is from a star that is moving away from you.

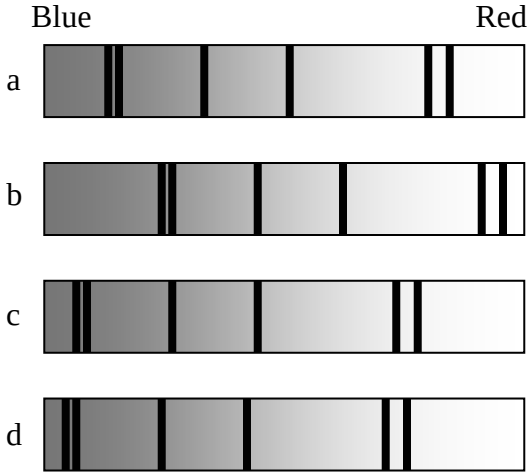
4. Which of the three spectra, corresponds with the star moving toward you? Explain your reasoning.

5. Which of the three spectra, corresponds with the star moving away from you? Explain your reasoning.

Part III. Size of Shift and Speed

If two sources of light are moving relative to an observer, the star that is moving faster will appear to undergo a greater Doppler Shift.

Consider the four spectra below. The spectrum labeled (c) is an absorption line spectrum from a star that is at rest. Again, note that blue light is shown on the left-hand side of each spectrum and red light is shown on the right-hand side of each spectrum.



6. Which of the four spectra would be from the star that is moving the fastest? Would this star be moving toward or away form the observer?

7. Which of the four spectra would be from the star that is moving the slowest? Describe the motion of this star.

8. You overhear two students discussing the topic of Doppler shifts.

Student 1: *Since Betelgeuse is a red star, it must be going away from us, and since Rigel is a blue star it must be coming towards us.*

Student 2: *I disagree, the color of the star does not tell you if it is moving. You have to look at the shift in wavelength of a star's spectral lines to determine whether it's moving towards or away from you.*

Do you agree with Student 1, Student 2, neither or both? Why or why not?