C.5

Redshift

IB PHYSICS | ASTROPHYSICS

The Doppler Effect

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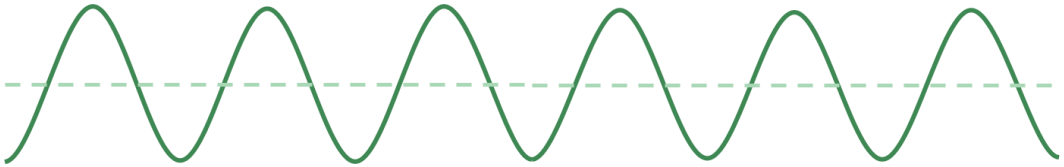
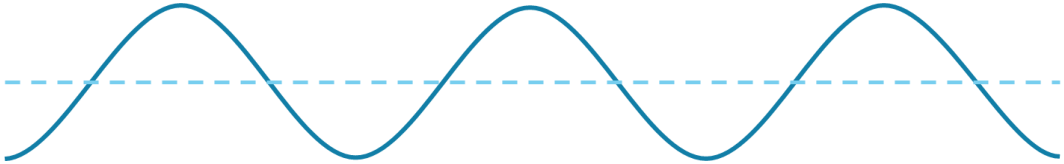
The shape of a sound wave affects how it sounds

Short Wavelength
High Frequency



Long Wavelength
Low Frequency



Stationary Sound Source

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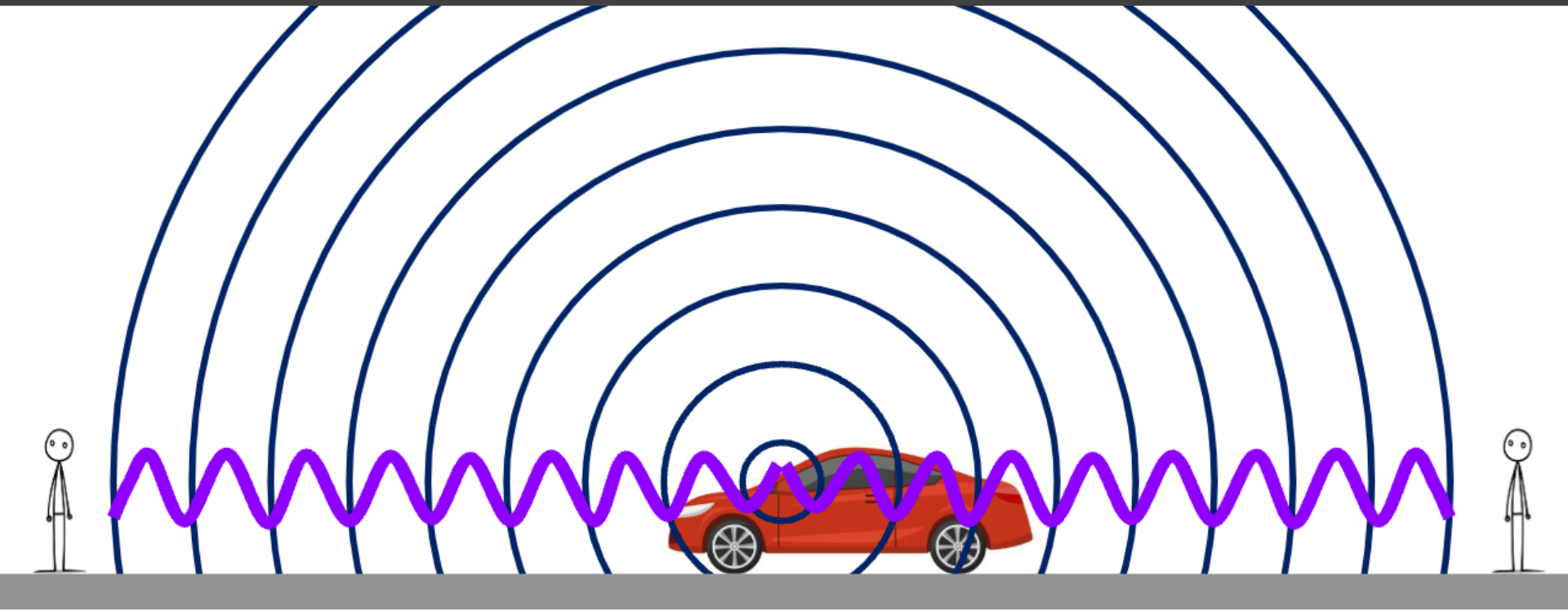

How does their sound experience compare?

They hear the same pitch

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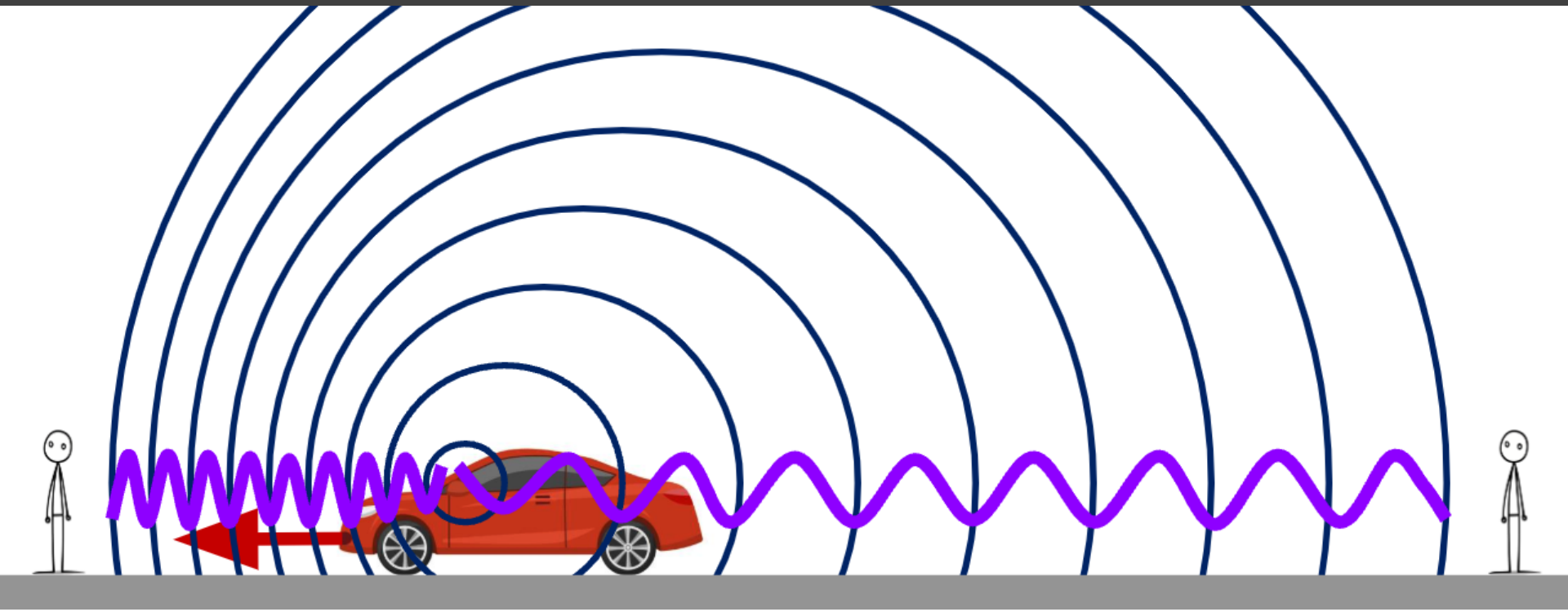
Moving Sound Source

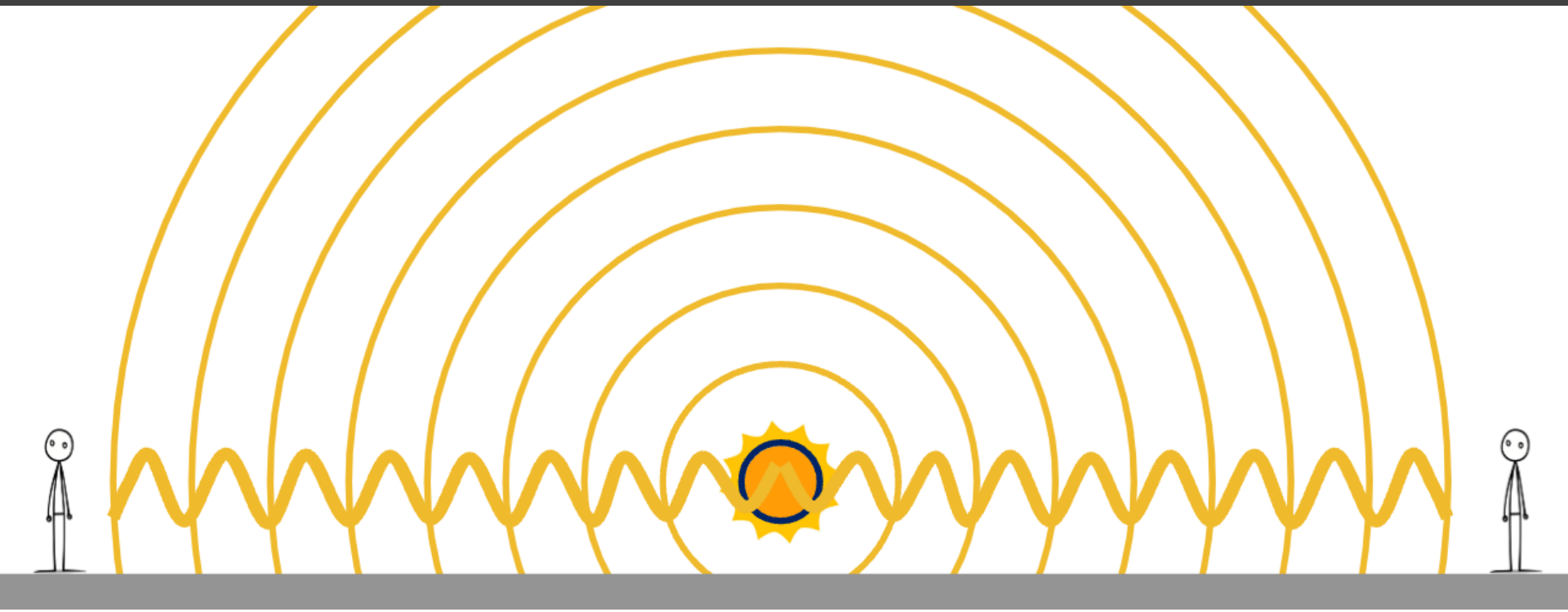


How does their sound experience compare?

High Pitch

Low Pitch

Stationary Light Source

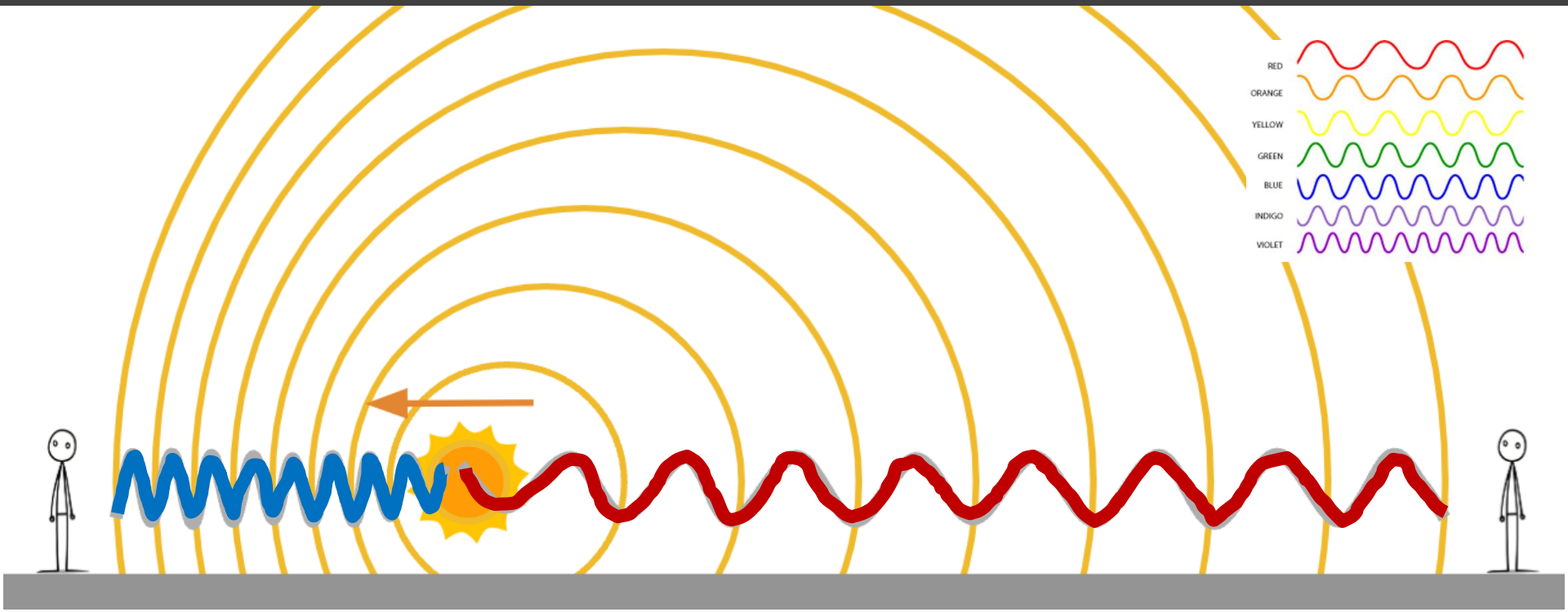


How does their **light** experience compare?

They see the same color light

C.5

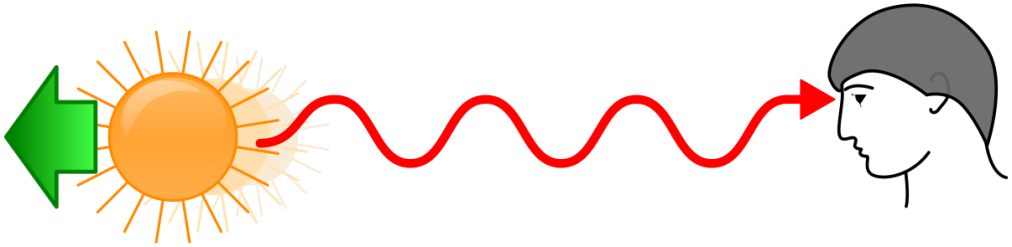
Moving Light Source



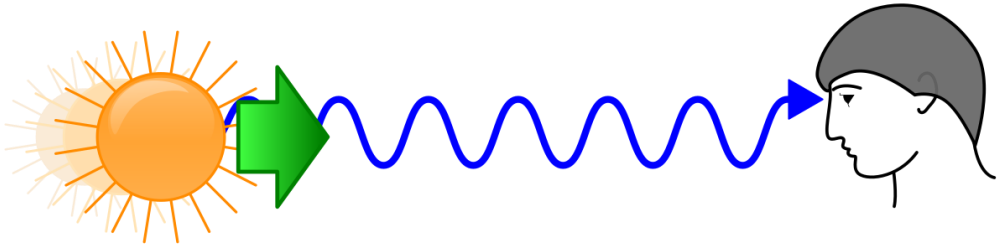
How does their **light** experience compare?

They see different colors

Moving Light Source



Redshift

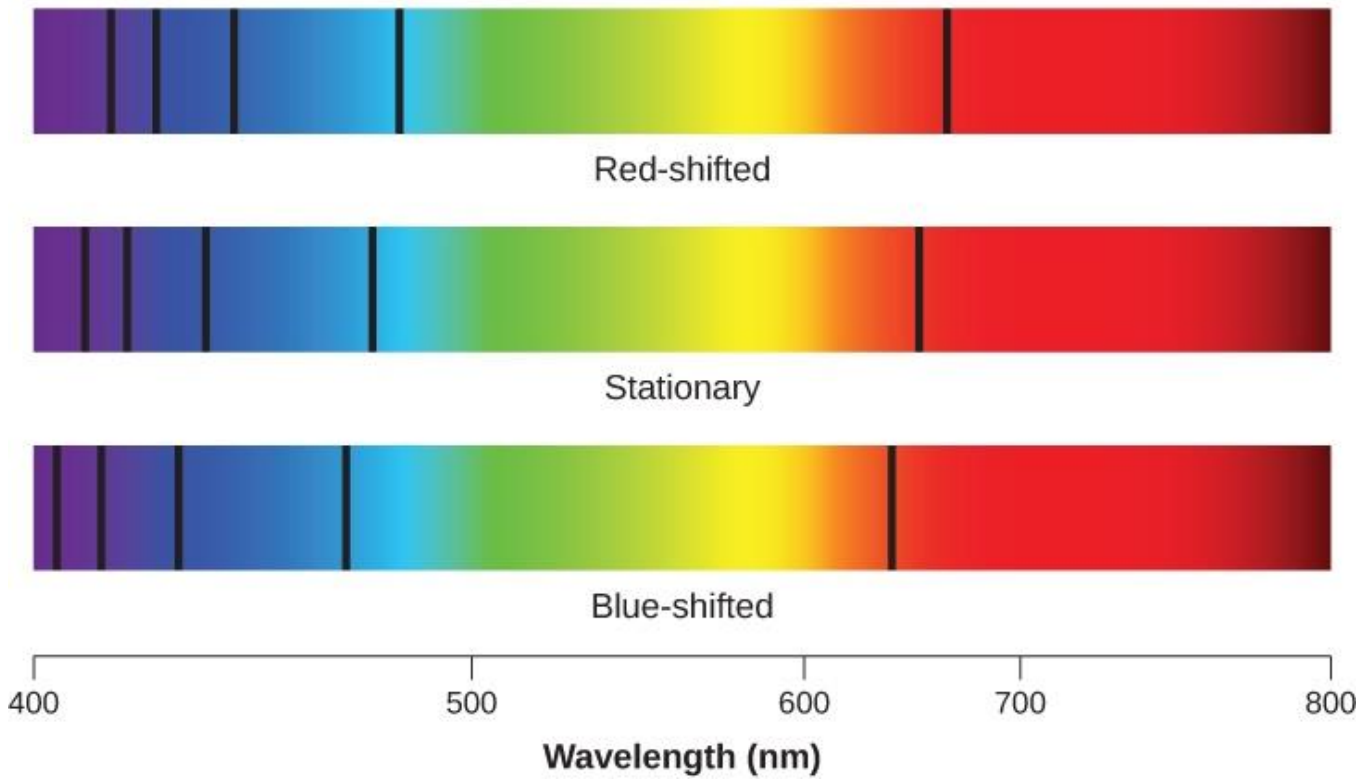


Blueshift

C.5

Red Shift, Blue Shift

C.5 Doppler effect	$\frac{\Delta f}{f} = \frac{\Delta \lambda}{\lambda} \approx \frac{v}{c}$



Calculating Redshift | #1

A characteristic absorption line often seen in stars is due to ionized helium. It occurs at 468.6 nm. If the spectrum of a star has this line at a measured wavelength of 499.3 nm what is the recession speed of the star?

$$\frac{\Delta\lambda}{\lambda} \approx \frac{v}{c} \qquad \frac{499.3 - 468.6}{468.6} \approx \frac{v}{3.00 \times 10^8}$$

$$v = 1.97 \times 10^7 \text{ m s}^{-1}$$

Calculating Redshift | #2

C.5

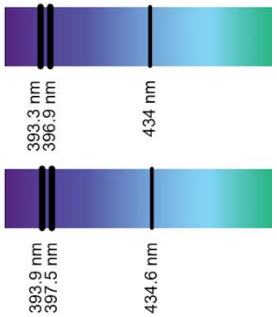
Reference Spectrum

$\Delta\lambda$ = 434.6 - 434

$\Delta\lambda$ = 659.7 - 656.4

Work Space

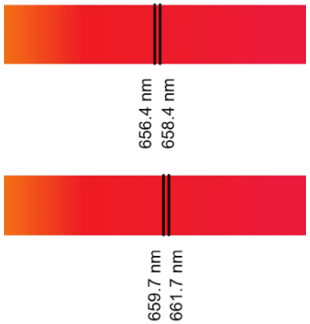
C.5 Doppler effect	$\frac{\Delta f}{f} = \frac{\Delta \lambda}{\lambda} \approx \frac{v}{c}$



$$\frac{434.6 - 434}{434} \approx \frac{v}{3.00 \times 10^8}$$

$v = 415{,}000 \text{ m s}^{-1}$

$v = 4.15 \times 10^5 \text{ m s}^{-1}$



$$\frac{659.7 - 656.4}{656.4} \approx \frac{v}{3.00 \times 10^8}$$

$v = 1{,}510{,}000 \text{ m s}^{-1}$

$v = 1.51 \times 10^6 \text{ m s}^{-1}$

Lesson Takeaways

C.5

- ❑ I can describe how light changes when the source is moving
- ❑ I can use a shift in wavelength or frequency to calculate the speed of the wave source