Environmental Science, Solutions Chapter 9

9.1

When working with Doppler laser spectroscopy to determine velocities one can measure the speed of clouds. At one instant a cloud is moving with a velocity of 110 m/s and is illuminated by an argon ion laser with wavlength 514.5308 nm. Calculate the relative Doppler shift given by:

$$\frac{f - f'}{f}$$

$$f' = f \left(1 - \frac{v}{c}\right) \Rightarrow \frac{f'}{f} = \left(1 - \frac{v}{c}\right) \Rightarrow \frac{f - f'}{f} = \frac{v}{c} = \frac{110}{299792458} = 3.67 \cdot 10^{-7}$$

Answer: $3.67 \cdot 10^{-7}$

9.2

When working with Doppler laser spectroscopy to determine velocities one can measure the speed of clouds. An argon ion laser with wavelength 514.5308 nm illuminates a cloud and we observe a wavelength shift of 0.0017 nm. Calculate the speed of the cloud.

The Doppler expression makes it possible to calculate the relative speed of the cloud. Using $c = f\lambda$ we rearrange the Doppler expression.

$$f' = f \left(1 - \frac{v}{c}\right) \Rightarrow \frac{\lambda}{\lambda'} = \left(1 - \frac{v}{c}\right) \Rightarrow v = c \left(1 - \frac{\lambda}{\lambda'}\right) =$$

$$= 299792458 \cdot \left(1 - \frac{514.5308}{514.5325}\right) \text{ m/s} \approx 990 \text{ m/s}$$

Answer: 990 m/s