

Answer on Question # 60267 - Chemistry - Physical Chemistry

What is the Doppler-shifted wavelength of a red (680 nm) traffic light approached at 60 km/h?

Solution

The wavelength change ($\Delta\lambda$) is related to velocity (v) by the following formula:

$$\frac{\Delta\lambda}{\lambda_0} = \frac{v}{c},$$

where c is the speed of light, $c = 3 \times 10^8 \text{ m/s}$;

Converting speed to SI units: $60 \text{ km/h} = 16.67 \text{ m/s}$;

Converting wavelength to SI units: $680 \text{ nm} = 6.8 \times 10^{-7} \text{ m}$;

$$\frac{\lambda - \lambda_0}{\lambda_0} = \frac{v}{c},$$

$$\lambda - \lambda_0 = \lambda_0 \frac{v}{c},$$

$$\lambda = \lambda_0 \frac{v}{c} + \lambda_0,$$

$$\lambda = 6.8 \times 10^{-7} \frac{16.67}{3 \times 10^8} + 6.8 \times 10^{-7} = 680.000038 \text{ nm}.$$