

Problem 82

(a) A car speedometer has a 5% uncertainty. What is the range of possible speeds when it reads 90 km/h? (b) Convert this range to miles per hour. Note 1 km = 0.6214 mi.

Solution

Part (a)

Use the percent uncertainty formula.

$$\text{Percent Uncertainty} = \frac{\delta A}{A} \times 100\%$$

Plug in the given numbers.

$$5\% = \frac{\delta A}{90 \frac{\text{km}}{\text{h}}} \times 100\%$$

Solve for δA , the uncertainty.

$$\delta A = \frac{5\%}{100\%} \left(90 \frac{\text{km}}{\text{h}} \right) = 4.5 \frac{\text{km}}{\text{h}}$$

Consequently, the range of possible speeds when the speedometer reads 90 km/h is

$$(90 \pm 4.5) \frac{\text{km}}{\text{h}}.$$

The minimum and maximum speeds are

$$\text{Minimum Speed: } 90 - 4.5 = 85.5 \frac{\text{km}}{\text{h}} \approx 86 \frac{\text{km}}{\text{h}}$$

$$\text{Maximum Speed: } 90 + 4.5 = 94.5 \frac{\text{km}}{\text{h}} \approx 95 \frac{\text{km}}{\text{h}}.$$

Part (b)

Use the given conversion factor to change these speeds to units of miles per hour.

$$\text{Minimum Speed: } 86 \frac{\text{km}}{\text{h}} \times \frac{0.6214 \text{ mi}}{1 \text{ km}} \approx 53 \frac{\text{mi}}{\text{h}}$$

$$\text{Maximum Speed: } 95 \frac{\text{km}}{\text{h}} \times \frac{0.6214 \text{ mi}}{1 \text{ km}} \approx 59 \frac{\text{mi}}{\text{h}}$$

The range of possible speeds in miles per hour is therefore roughly

$$\left(\frac{59 + 53}{2} \pm \frac{59 - 53}{2} \right) \frac{\text{mi}}{\text{h}}$$

$$(56 \pm 3) \frac{\text{mi}}{\text{h}}.$$