Problem 39

Tectonic plates are large segments of Earth's crust that move slowly. Suppose one such plate has an average speed of 4.0 cm/yr. (a) What distance does it move in 1.0 s at this speed? (b) What is its speed in kilometers per million years?

Solution

Part (a)

Multiply the given speed by the appropriate conversion factors to get the desired units.

$$4.0\ \frac{\text{cm}}{\text{yr}} = 4.0\ \frac{\text{cm}}{\text{yr}} \times \frac{1\ \text{yr}}{365\ \text{days}} \times \frac{1\ \text{day}}{24\ \text{h}} \times \frac{1\ \text{h}}{60\ \text{min}} \times \frac{1\ \text{min}}{60\ \text{s}} \approx 1.3 \times 10^{-7}\ \frac{\text{cm}}{\text{s}}$$

In 1.0 s the distance the plate moves is roughly

$$1.3 \times 10^{-7}\ \text{cm} = 1.3 \times 10^{-7}\ \text{cm} \times \frac{1\ \text{m}}{100\ \text{cm}} \times \frac{10^9\ \text{nm}}{1\ \text{m}} = 1.3\ \text{nm}.$$

Part (b)

Multiply the given speed by the appropriate conversion factors to get the desired units.

$$4.0\ \frac{\text{cm}}{\text{yr}} = 4.0\ \frac{\text{cm}}{\text{yr}} \times \frac{1\ \text{m}}{100\ \text{cm}} \times \frac{1\ \text{km}}{1000\ \text{m}} = 4.0 \times 10^{-5}\ \frac{\text{km}}{\text{yr}}$$

The speed in kilometers per million years is then

$$4.0 \times 10^{-5}\ \frac{\text{km}}{\text{yr}} \times \frac{10^6}{10^6} = 4.0 \times 10^1\ \frac{\text{km}}{10^6\ \text{yrs}} = 40\ \frac{\text{km}}{10^6\ \text{yrs}}.$$