Motion Problem Set

1. What must be your car's average speed in order to travel 235 km in 3.25 h?
2. A bird can fly $25\,\text{km/h}$. How long does it take to fly 15 km?
3. If you are driving $110\,\text{km/h}$ along a straight road and you look to the side for 2.0 s, how far do you travel during this inattentive period?
4. Convert $35\,\text{mi/h}$ to (*a*) km/h, (*b*) m/s, and (*c*) ft/s.
5. A rolling ball moves from $x_1 = 3.4\,\text{cm}$ to $x_2 = -4.2\,\text{cm}$ during the time from $t_1 = 3.0\,\text{s}$ to $t_2 = 6.1\,\text{s}$. What is its average velocity?
6. According to a rule-of-thumb, every five seconds between a lightning flash and the following thunder gives the distance to the flash in miles. Assuming that the flash of light arrives in essentially no time at all, estimate the speed of sound in m/s from this rule.
7. A horse canters away from its trainer in a straight line, moving 116 m away in 14.0 s. It then turns abruptly and gallops halfway back in 4.8 s. Calculate (*a*) its average speed and (*b*) its average velocity for the entire trip, using "away from the trainer" as the positive direction.

Solutions:

1. The average speed is given by:

$$\overline{v} = d/\Delta t = 235\ \text{km}/3.25\ \text{h} = \boxed{72.3\,\text{km/h}}.$$

2. The time of travel can be found by rearranging the average speed equation.

$$\overline{v} = d/\Delta t \rightarrow \Delta t = d/\overline{v} = (15\ \text{km})/(25\,\text{km/h}) = \boxed{0.60\ \text{h}} = 36\ \text{min}$$

3. The distance of travel (displacement) can be found by rearranging the average speed equation. Also note that the units of the velocity and the time are not the same, so the speed units will be converted.

$$\overline{v} = \frac{d}{\Delta t} \rightarrow d = \overline{v}\Delta t = (110\,\text{km/h})\left(\frac{1\,\text{h}}{3600\ \text{s}}\right)(2.0\,\text{s}) = 0.061\ \text{km} = \boxed{61\ \text{m}}$$

4. (*a*) $35\,\text{mi/h} = (35\,\text{mi/h})(1.61\,\text{km/mi}) = \boxed{56\,\text{km/h}}$

(*b*) $35\,\text{mi/h} = (35\,\text{mi/h})(1610\,\text{m/mi})(1\ \text{h}/3600\ \text{s}) = \boxed{16\,\text{m/s}}$

(*c*) $35\,\text{mi/h} = (35\,\text{mi/h})(5280\,\text{ft/mi})(1\ \text{h}/3600\ \text{s}) = \boxed{51\,\text{ft/s}}$

5. The average velocity is given by $\overline{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{-4.2\,\text{cm} - 3.4\,\text{cm}}{6.1\,\text{s} - 3.0\,\text{s}} = \dfrac{-7.6\,\text{cm}}{3.1\,\text{s}} = \boxed{-2.5\,\text{cm/s}}$.

6. The speed of sound is intimated in the problem as 1 mile per 5 seconds. The speed is calculated by:

$$\text{speed} = \frac{\text{distance}}{\text{time}} = \left(\frac{1\,\text{mi}}{5\,\text{s}}\right)\left(\frac{1610\ \text{m}}{1\ \text{mi}}\right) = \boxed{300\,\text{m/s}}.$$

Note that only 1 significant figure is given, (5 sec), and so only 1 significant figure is justified in the result.

7. The distance traveled is $116\ \text{km} + \frac{1}{2}(116\ \text{km}) = 174\ \text{km}$, and the displacement is $116\ \text{km} - \frac{1}{2}(116\ \text{km}) = 58\ \text{km}$. The total time is 14.0 s + 4.8 s = 18.8 s.

(*a*) Average speed = $\dfrac{d}{\Delta t} = \dfrac{174\ \text{m}}{18.8\ \text{s}} = \boxed{9.26\,\text{m/s}}$

(*b*) Average velocity = $\overline{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{58\ \text{m}}{18.8\ \text{s}} = \boxed{3.1\,\text{m/s}}$