

Velocity. Acceleration and Position sample Problems

General Formulas:

$$\text{eq (1). } s (\text{speed}) = \frac{\text{distance}(x)}{\text{time}(t)}$$

$$\text{eq (2). } \text{AVERAGE SPEED} = \frac{\text{Total Distance}}{\text{Total Time}}$$

$$\text{eq (3). } t(\text{time}) = \frac{\text{Total Distance}}{\text{Average Speed}}$$

$$\text{eq (4). } \text{velocity } (v) = \frac{\text{displacement}}{\text{time of travel}}$$

1. A person walks 750m due north, then 250m due east. If the entire walk takes 12 minutes, find the person's average velocity.

Solution:

Average velocity (eq. 2) is displacement divided by the elapsed time. Displacement is also a vector that obeys the addition vector rules. Thus, in this velocity problem, add each displacement to get the total displacement.

In the first part, displacement is $\Delta x_1 = 750 \text{ N}$ and in the second part $\Delta x_2 = 250 \text{ E}$. The total displacement vector,

$$\Delta x = \Delta x_1 + \Delta x_2 = 750 \text{ N} + 250 \text{ E}$$

is with magnitude of,

$$|\Delta x| = \sqrt{(750 \text{ N})^2 + (250 \text{ E})^2}$$

$$|\Delta x| = 790.5 \text{ m}$$

In addition, the total elapsed time is,

$$t = 12 \times 60 (\text{seconds})$$

Therefore, the magnitude of the average velocity is

$$\text{average velocity} = \frac{790.5}{(12)(60)} = 1.09 \text{ m/s}$$

2. How long will it take if you travel 400km with an average speed of 100m/s?

Solution:

Average speed is the ratio of the total distance to the total time. Thus, the elapsed time is,

$$\text{eq (3).} \quad t(\text{time}) = \frac{\text{Total Distance}}{\text{Average Speed}}$$
$$t(\text{time}) = \frac{40 \times 10^3 \text{ m/s}}{100 \text{ m/s}}$$

To convert it to hours, it must be divided by 3600s which gives $t = 1.11 \text{ h}$.

3. To reach a park located south of his jogging path, Henry runs along a 15-kilometer route. If he completes the journey in 1.5 hours, determine his speed and velocity.

Solution:

Henry travels his route to the park without changing direction along a straight line. Therefore, the total distance traveled in one direction equals the displacement,

i.e., distance traveled $= \Delta x = 15 \text{ km}$

Velocity is displacement divided by the time of

$$\text{eq (4).} \quad v(\text{velocity}) = \frac{\text{displacement}}{\text{time of travel}}$$
$$v(\text{velocity}) = \frac{15 \text{ km}}{1.5 \text{ h}} = 10 \text{ km/h}$$

and by definition, its average speed

$$\text{eq (2).} \quad \text{average speed} = \frac{\text{distance covered}}{\text{time traveled}}$$

Henry's velocity is 10km/h to the south, and its speed is 10km/h. As you can see, speed is simply a positive number, with units but velocity specifies the direction in which the object is moving.

