Example 1:

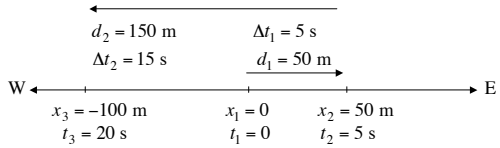
Larry travels east 50 m in 5.0 seconds. He then turns around and travels 150 m west in 15.0 seconds.

a.) Draw a diagram that illustrates Larry's motion.

b.) For the entire trip find.
- i.) the displacement
- ii.) the distance traveled
- iii.) the average speed
- iv.) the average velocity

Example 1 $d_1 = 50$ m east, $\Delta t_1 = 5$ s, $d_2 = 150$ m west, and $\Delta t_2 = 15$ s

a.) Diagram of motion



b.)

i.) Δx = ? (for the entire trip)

$\Delta x = x_3 - x_1$

$\Delta x = -100 \text{ m} - 0$

$\boxed{\Delta x = -100 \text{ m}}$

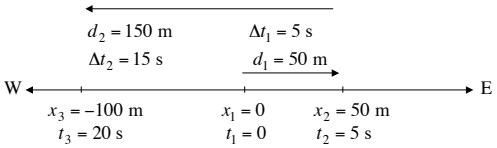
ii.) d = ? (for the entire trip)

$d = d_1 + d_2$

$d = 50 \text{ m} + 150 \text{ m}$

$\boxed{d = 200 \text{ m}}$

Example 1 $d_1 = 50$ m east, $\Delta t_1 = 5$ s, $d_2 = 150$ m west, and $\Delta t_2 = 15$ s



b.)

iii.) s = ? (for the entire trip)

$s = \dfrac{d}{\Delta t}$

$s = \dfrac{d}{\Delta t_1 + \Delta t_2}$

$s = \dfrac{200 \text{ m}}{5 \text{ s} + 15 \text{ s}}$

$\boxed{s = 10 \dfrac{\text{m}}{\text{s}}}$

iv.) v_{av} = ? (for the entire trip)

$v_{av} = \dfrac{\Delta x}{\Delta t} = \dfrac{x_3 - x_1}{t_3 - t_1}$

$v_{av} = \dfrac{-100 \text{ m} - 0}{20 \text{ s} - 0}$

$\boxed{v_{av} = -5 \dfrac{\text{m}}{\text{s}}}$

Example 2:

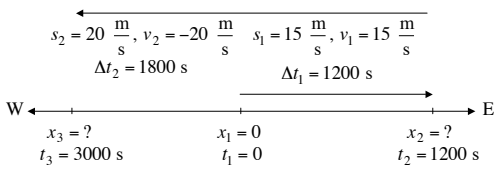
A car travels east for 20.0 min at a speed of 15 m/s and then west for 30.0 min at a speed of 20 m/s.

a.) Draw a diagram that illustrates the motion of the car.

b.) For the entire trip find:
- i.) the average velocity
- ii.) the average speed

Example 2 $\Delta t_1 = 20$ min, $s_1 = 15 \dfrac{\text{m}}{\text{s}}$ east, $\Delta t_2 = 30$ min, and $s_2 = 20 \dfrac{\text{m}}{\text{s}}$ west

a.) Diagram of motion



b.) i.) v_{av} = ? (for the entire trip) $v_{av} = \dfrac{\Delta x}{\Delta t} = \dfrac{x_3 - x_1}{t_3 - t_1}$

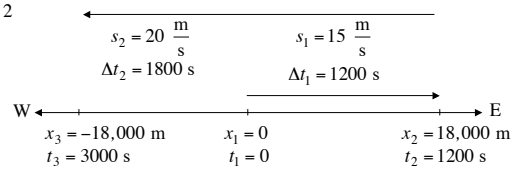
$x_2 = v_1(t_2 - t_1) + x_1$ $\qquad$ $x_3 = v_2(t_3 - t_2) + x_2$

$x_2 = \left(15 \dfrac{\text{m}}{\text{s}}\right)(1200 \text{ s} - 0) + 0$ $\qquad$ $x_3 = \left(-20 \dfrac{\text{m}}{\text{s}}\right)(3000 \text{ s} - 1200 \text{ s}) + 18{,}000 \text{ m}$

$x_2 = 18{,}000$ m $\qquad$ $x_3 = -18{,}000$ m

$v_{av} = \dfrac{x_3 - x_1}{t_3 - t_1} = \dfrac{-18{,}000 \text{ m} - 0}{3000 \text{ s} - 0}$ $\qquad$ $\boxed{v_{av} = -6 \dfrac{\text{m}}{\text{s}}}$

Example 2



b.)

ii.) s = ? (for the entire trip) $s = \dfrac{d}{\Delta t} = \dfrac{d_1 + d_2}{\Delta t_1 + \Delta t_2}$

$s_1 = \dfrac{d_1}{\Delta t_1}$ $\qquad$ $s_2 = \dfrac{d_2}{\Delta t_2}$ $\qquad$ $s = \dfrac{d_1 + d_2}{\Delta t_1 + \Delta t_2}$

$d_1 = s_1 \Delta t_1$ $\qquad$ $d_2 = s_2 \Delta t_2$

$d_1 = \left(15 \dfrac{\text{m}}{\text{s}}\right)(1200 \text{ s})$ $\qquad$ $d_2 = \left(20 \dfrac{\text{m}}{\text{s}}\right)(1800 \text{ s})$ $\qquad$ $s = \dfrac{18{,}000 \text{ m} + 36{,}000 \text{ m}}{1200 \text{ s} + 1800 \text{ s}}$

$d_1 = 18{,}000$ m $\qquad$ $d_2 = 36{,}000$ m $\qquad$ $\boxed{s = 18 \dfrac{\text{m}}{\text{s}}}$

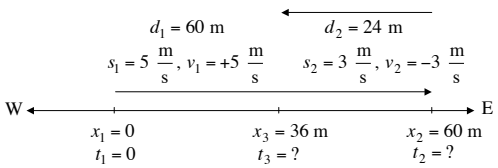
Example 3:

Rat moves 60.0 m towards the east at a speed of 5.0 m/s then turns around and moves 24.0 m towards the west at a speed of 3.0 m/s. For the entire motion find:

a.) the average velocity

b.) the average speed

Example 3 $d_1 = 60$ m east, $s_1 = 5\ \frac{\text{m}}{\text{s}}$, $d_2 = 24$ m west, and $s_2 = 3\ \frac{\text{m}}{\text{s}}$



a.) $v_{av} = ?$ (for the entire trip) $v_{av} = \dfrac{\Delta x}{\Delta t} = \dfrac{x_3 - x_1}{t_3 - t_1}$

$x_2 = v_1(t_2 - t_1) + x_1$

$t_2 = \dfrac{x_2 - x_1}{v_1} + t_1$

$t_2 = \dfrac{60\text{ m} - 0}{5\ \frac{\text{m}}{\text{s}}} + 0$

$t_2 = 12$ s

$x_3 = v_2(t_3 - t_2) + x_2$

$t_3 = \dfrac{x_3 - x_2}{v_2} + t_2$

$t_3 = \dfrac{36\text{ m} - 60\text{ m}}{-3\ \frac{\text{m}}{\text{s}}} + 12\text{ s}$

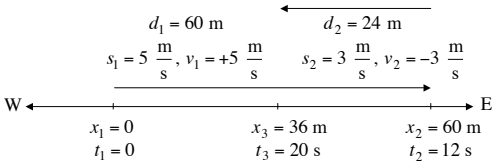
$t_3 = 20$ s

$v_{av} = \dfrac{x_3 - x_1}{t_3 - t_1}$

$v_{av} = \dfrac{36\text{ m} - 0}{20\text{ s} - 0}$

$\boxed{v_{av} = 1.8\ \frac{\text{m}}{\text{s}}}$

Example 3 $d_1 = 60$ m east, $s_1 = 5\ \frac{\text{m}}{\text{s}}$, $d_2 = 24$ m west, and $s_2 = 3\ \frac{\text{m}}{\text{s}}$



b.) $s = ?$ (for the entire trip) $s = \dfrac{d}{\Delta t} = \dfrac{d_1 + d_2}{\Delta t_1 + \Delta t_2}$

$\Delta t_1 = t_2 - t_1$

$\Delta t_1 = 12\text{ s} - 0$

$\Delta t_1 = 12$ s

$\Delta t_2 = t_3 - t_2$

$\Delta t_2 = 20\text{ s} - 12\text{ s}$

$\Delta t_2 = 8$ s

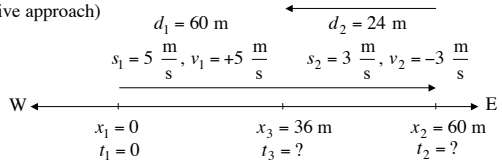
$s = \dfrac{d_1 + d_2}{\Delta t_1 + \Delta t_2}$

$s = \dfrac{60\text{ m} + 24\text{ m}}{12\text{ s} + 8\text{ s}}$

$\boxed{s = 4.2\ \frac{\text{m}}{\text{s}}}$

Example 3: $d_1 = 60$ m east, $s_1 = 5\ \frac{\text{m}}{\text{s}}$, $d_2 = 24$ m west, and $s_2 = 3\ \frac{\text{m}}{\text{s}}$

(Alternative approach)



a.) $v_{av} = ?$ (for the entire trip) $v_{av} = \dfrac{\Delta x}{\Delta t} = \dfrac{x_3 - x_1}{t_3 - t_1}$

$s_1 = \dfrac{d_1}{\Delta t_1}$ $\quad s_2 = \dfrac{d_2}{\Delta t_2}$

$\Delta t_1 = \dfrac{d_1}{s_1}$ $\quad \Delta t_2 = \dfrac{d_2}{s_2}$

$\Delta t_1 = \dfrac{60\text{ m}}{5\ \frac{\text{m}}{\text{s}}}$ $\quad \Delta t_2 = \dfrac{24\text{ m}}{3\ \frac{\text{m}}{\text{s}}}$

$\Delta t_1 = 12$ s $\quad \Delta t_2 = 8$ s

$\Delta t_1 = t_2 - t_1$ $\quad \Delta t_2 = t_3 - t_2$

$t_2 = \Delta t_1 + t_1$ $\quad t_3 = \Delta t_2 + t_2$

$t_2 = 12\text{ s} + 0$ $\quad t_3 = 8\text{ s} + 12\text{ s}$

$t_2 = 12$ s $\quad t_3 = 20$ s

$v_{av} = \dfrac{x_3 - x_1}{t_3 - t_1}$

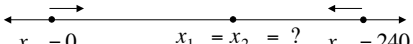
$v_{av} = \dfrac{36\text{ m} - 0}{20\text{ s} - 0}$

$\boxed{v_{av} = 1.8\ \frac{\text{m}}{\text{s}}}$

Example 4:

Two cars are 240 km apart and are traveling towards each other at speeds of 50. km/h and 30. km/h. At what time and position do the cars pass one another?

Example 4



$x_{1f} = v_1 t + x_{1i}$ $\quad x_{2f} = v_2 t + x_{2i}$

$x_{1f} = x_{2f}$

$v_1 t + x_{1i} = v_2 t + x_{2i}$

$v_1 t - v_2 t = x_{2i} - x_{1i}$

$(v_1 - v_2)t = x_{2i} - x_{1i}$

$t = \dfrac{x_{2i} - x_{1i}}{v_1 - v_2} = \dfrac{240\text{ km} - 0}{50\ \frac{\text{km}}{\text{h}} - \left(-30\ \frac{\text{km}}{\text{h}}\right)} = \boxed{3\text{ h}}$

$x_{1f} = v_1 t + x_{1i} = \left(50\ \frac{\text{km}}{\text{h}}\right)(3\text{ h}) + 0 = \boxed{150\text{ km}}$