You drive 109 km/h east for 31 min , then 82 km/h north for 42 min . Let the +x-axis point east and the +y-axis north. Find your average velocity for the entire trip.

Enter the x and y components of the velocity separated by a comma.

Solution:

Given:

$v_1 = 190$ km/h,

$v_2 = 82$ km/h,

$t_1 = 31$ min $= \dfrac{31}{60}$ hour,

$t_2 = 42$ min $= \dfrac{42}{60}$ hour,

Velocity is a vector quantity, and average velocity can be defined as the displacement divided by the time.

$$v = \frac{d}{t_1 + t_2}$$

The displacement is

$$d = \sqrt{d_1^2 + d_2^2} = \sqrt{(v_1 t_1)^2 + (v_2 t_2)^2} = \sqrt{\left(109 \cdot \frac{31}{60}\right)^2 + \left(82 \cdot \frac{42}{60}\right)^2} = 80.41 \text{ km}$$

Thus,

$$v = \frac{80.41}{\dfrac{31}{60} + \dfrac{42}{60}} = 66.09 \text{ km/h} \approx 66.1 \text{ km/h}$$

The x and y components of the velocity is

$$v_x = v \cos \theta = v \frac{d_1}{d} = 66.09 \cdot \frac{109 \cdot \dfrac{31}{60}}{80.41} = 46.29 \text{ km/h} \approx 46.3 \text{ km/h}$$

$$v_y = v \sin \theta = \frac{d_2}{d} = 66.09 \cdot \frac{82 \cdot \dfrac{42}{60}}{80.41} = 47.18 \text{ km/h} \approx 47.2 \text{ km/h}$$

Answer: $v = 66.1$ km/h; $v_x = 46.3$ km/h, $v_y = 47.2$ km/h.