A cyclist travels 5.0 km [S] in 45 minutes, then travels 9.0 km [E] in 90 minutes. What is the cyclist's displacement and velocity?

Solution

The average velocity of a cyclist is

$$v = \frac{s_1 + s_2}{t_1 + t_2} = \frac{5\ km + 9\ km}{45 min + 90 min} = \frac{14\ km}{135 min} = \frac{14000\ m}{135 * 60\ s} = 1.7284\frac{m}{s}$$

The cyclist's displacement is the vector sum of vectors $\vec{s_1}$ and $\vec{s_2}$. Let's find it using Pythagorean theorem (because directions [S] and [E] are perpendicular).

$$S = \sqrt{s_1{}^2 + s_2{}^2} = \sqrt{5^2 + 9^2} = 10.2956\ km$$

We can find the direction of cyclist's displacement

$$\tan a = \frac{s_2}{s_1} = \frac{9}{5};\ a = \tan^{-1}\frac{9}{5} = 61°.$$

So the direction is 61° from south of east or (90-61)=29° from east of south.

Answer: 10.3 km in the direction 29° from east of south; $1.73\frac{m}{s}$