Answer on Question #39202, Physics, Other

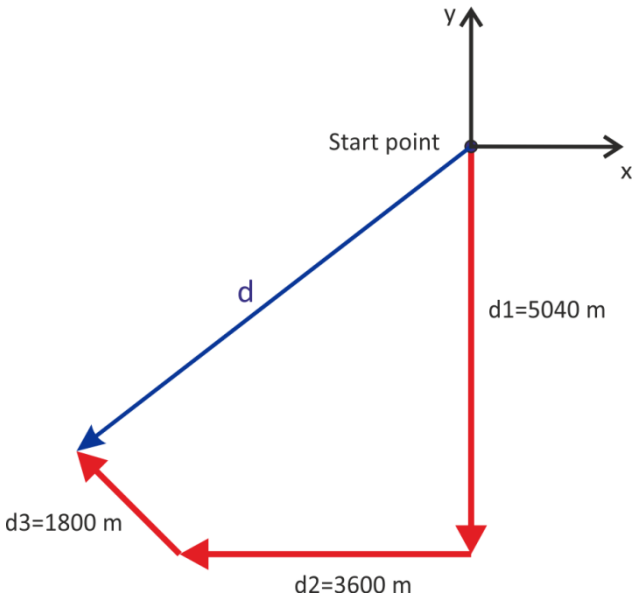
A motorist drives south at 28.0 m/s for 3.00 min, then turns west and travels at 25.0 m/s for 2.40 min, and finally travels northwest at 30.0 m/s for 1.00 min. For this 6.40 min trip, find the following values. Let the positive x axis point east.

(a) total vector displacement_____M magnitude. _____deg south of west

(b) average speed _____ m/s

(c) average velocity_____ m/s (magnitude) ____ ° south of west

Solution:



(a) Let construct three vectors and find their sum:

Distance=velocity x time

$$\overrightarrow{\mathrm{d1}} = -28 * 3 * 60\ \vec{\mathrm{j}} = -5040\,\vec{\mathrm{j}}$$

$$\overrightarrow{\mathrm{d2}} = -25 * 2.4 * 60\,\vec{\mathrm{i}} = -3600\,\vec{\mathrm{i}}$$

$$\overrightarrow{\mathrm{d3}} = -30\cos 45° * 60\,\vec{\mathrm{i}} + 30\sin 45° * 60\,\vec{\mathrm{j}} = -1273\,\vec{\mathrm{i}} + 1273\,\vec{\mathrm{j}}$$

Total vector displacement:

$$\vec{\mathrm{d}} = \overrightarrow{\mathrm{d1}} + \overrightarrow{\mathrm{d2}} + \overrightarrow{\mathrm{d3}} = -5040\,\vec{\mathrm{j}} - 3600\,\vec{\mathrm{i}} - 1273\,\vec{\mathrm{i}} + 1273\,\vec{\mathrm{j}} = -4873\vec{\mathrm{i}} - 3767\vec{\mathrm{j}}$$

The magnitude of the displacement is

$$\mathrm{d} = \sqrt{(x)^2 + (y)^2} = \sqrt{(4873)^2 + (3767)^2} = 6160\ \mathrm{m}$$

The direction of vector d:

$$\tan\theta = \frac{y}{x} = \frac{3767}{4873}$$

$$\theta = \arctan(0.773) = 37.7°$$

(b) The average speed of an object in an interval of time is the distance travelled by the object divided by the duration of the interval.

$$\bar{v} = \frac{d1 + d2 + d3}{t1 + t2 + t3} = \frac{5040 + 3600 + 1800}{(3 + 2.4 + 1) * 60} = 27.1875 \approx 27.19 \text{ m/s}$$

(c) The magnitude of an average velocity

$$v = \frac{d}{t1 + t2 + t3} = \frac{6385.8}{(3 + 2.4 + 1) * 60} \approx 16.63 \text{ m/s}$$

The direction of an average velocity $40.26°$ south of west.

Answer.

(a) total vector displacement$= -4873\vec{\imath} - 3767\vec{\jmath}$; magnitude 6160 m; $37.7°$ south of west

(b) average speed 27.19 m/s

(c) average velocity 16.63 m/s (magnitude) 40.26° south of west