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This is a 3-D problem involving average velocity and average speed.

In 4.2 h, a weather balloon drifts 10.2 Km west, 18.7 Km south, and 3.1 Km upward.

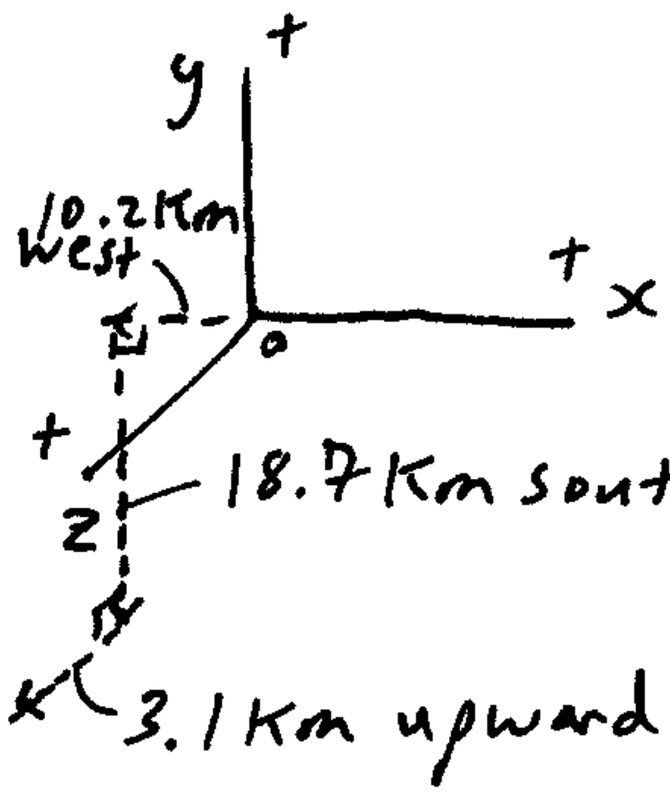
(a) Determine the magnitude of the balloon's average velocity, and the angle that this vector makes with the horizontal.

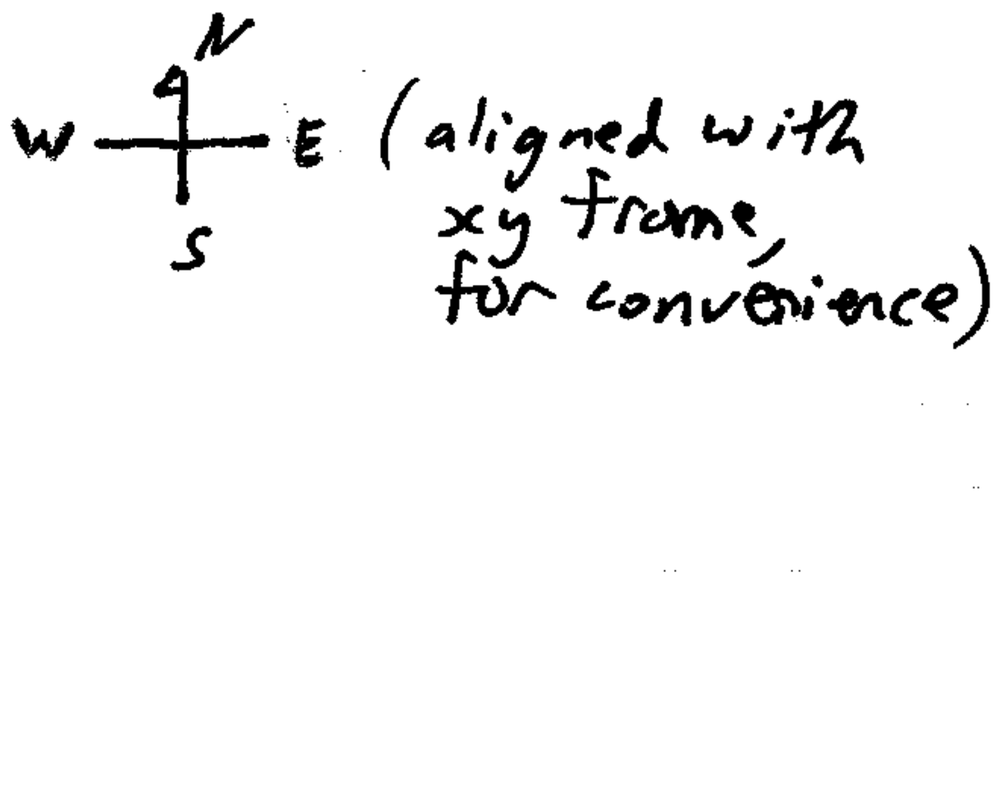
(b) Determine the average speed of the balloon.

Solution:

(a)

(Not to scale)





(aligned with xy frame, for convenience)

$$\bar{v} = \frac{\Delta \vec{r}}{\Delta t} \qquad \Delta \vec{r} = -10.2\,\hat{i} - 18.7\,\hat{j} + 3.1\,\hat{k}$$

(units in Km)

$$\bar{v} = \frac{-10.2\,\hat{i} - 18.7\,\hat{j} + 3.1\,\hat{k}}{4.2} \qquad \Delta t = 4.2\ h$$

$$\bar{v} = -2.43\,\hat{i} - 4.45\,\hat{j} + 0.74\,\hat{k}$$

$$|\bar{v}| = \sqrt{(-2.43)^2 + (-4.45)^2 + (0.74)^2} = 5.1\ Km/h$$

(answer)

Determine θ:

The xy-plane is the horizontal

$$\frac{\sqrt{10.2^2 + 18.7^2}\ \text{km}}{4.2\,\text{h}} = \frac{21.3\ \text{km}}{4.2\,\text{h}}$$

Using trigonometry, $\theta = \tan^{-1}\left(\frac{3.1}{21.3}\right)$

$\theta = 8.3°$ (answer)

(b) $\bar{s} = \dfrac{\text{total distance}}{\Delta t}$

$$\bar{s} = \frac{10.2 + 18.7 + 3.1}{4.2} = 7.6\ \text{km/h}\ \text{(answer)}$$