Section 3.2: Velocity Vectors in One Dimension

Speed – scalar quantity Velocity – vector quantity

Velocity can also be represented by vectors and are added together the same way as displacement vectors.

$$_o\vec{v}_e = {}_0\vec{v}_m + {}_m\vec{v}_e$$

where $_0\vec{v}_e$ – *velocity of the object with respect to the earth*

$_o\vec{v}_m$ – *velocity of the object with respect to the medium*

$_m\vec{v}_e$ – *velocity of the medium with respect to the earth*

1 A train moves at 20 km/h [E]. A passenger on the train moves toward the front of the train at a velocity of 3 km/h. What is the passenger's velocity relative to a person standing on the ground?

$_tV_e = 20\ km/h\ [E]$

$_pV_t = 3\ km/h\ [E]$

$_pV_e = ?$

$_pV_t + {}_tV_e = {}_pV_e$

$3\ km/h + 20\ km/h = {}_pV_e$

$23\ km/h = {}_pV_e$

$23\ km/h\ [E] = {}_pV_e$

2 A train moves at 15 km/h. A person on the train moves toward the back at 3 km/h. What is the person's velocity relative to the ground?

$_tV_e = 15\ km/h$

$_pV_t = -3\ km/h$

$_pV_e = ?$

$_pV_t + {}_tV_e = {}_pV_e$

$15\ km/h - 3\ km/h = {}_pV_e$

$12\ km/h = {}_pV_e$

3 A goose is flying 30 km/h [S]. A hunter is driving due north at 60 km/h. Determine the:

A) velocity of the goose with respect to the hunter.

√

B) velocity to he hunter with respect to the goose.

4 A wildlife crew are on a moose counting expedition when they spot a herd 4.0 km [W] and running directly away from the helicopter at 10.0 m/s [W]. The helicopter follows the herd at 42 m/s [W].

A) What is the velocity of the helicopter relative to the moose?

$_{m}V_{e} = -10$ m/s
$_{h}V_{e} = -42$ m/s
$_{h}V_{m} = ?$

$_{h}V_{m} + {}_{m}V_{e} = {}_{h}V_{e}$
$_{h}V_{m} - 10\text{m/s} = -42\text{m/s}$
$_{h}V_{m} = -32$ m/s
$_{h}V_{m} = 32$ m/s [W]

B) What is the velocity of the moose with respect to the helicopter?

$_{m}V_{e} = -10$ m/s
$_{h}V_{e} = -42$ m/s
$_{m}V_{h} = ?$

$_{m}V_{h} + {}_{h}V_{e} = {}_{m}V_{e}$
$_{m}V_{h} - 42\text{m/s} = -10\text{m/s}$
$_{m}V_{h} = 32$ m/s [E]

C) How long does it take the helicopter to ~~reach the spot where the herd was first seen~~?

$V = 42$ m/s [W]
$d = 4000$ m [W]
$t =$

$t = \frac{d}{V} = \frac{4000\text{m}}{42\text{m/s}} = 95\text{s}$

D) How long from the time of the first sighting will it take the helicopter to catch the herd?

$_{h}V_{m} = 32$ m/s [W]
$d = 4000$ m [W]
$t =$

$t = \frac{d}{V} = \frac{4000\text{m}}{32\text{m/s}} = 125\text{s}$

5 A person can swim at a speed of 5 m/s in still water. The current is 3m/s. What is the swimmer's velocity if she goes (a) downstream and (b) upstream?

(a)

still water ${}_sV_w = 5\,m/s$

current ${}_wV_e = 3\,m/s$

${}_sV_e = ?$

${}_sV_w + {}_wV_e = {}_sV_e$

$5\,m/s + 3\,m/s = {}_sV_e$

$8\,m/s = {}_sV_e$

no current

downstream - with the current

upstream - against the current

(b)

${}_sV_w = -5\,m/s$

${}_wV_e = 3\,m/s$

${}_sV_e = ?$

${}_sV_w + {}_wV_e = {}_sV_e$

$-5\,m/s + 3\,m/s = {}_sV_e$

$-2\,m/s = {}_sV_e$

$2\,m/s$ upstream $= {}_sV_e$

6 A canoe is paddled downstream with a velocity of 1.0 m/s. The river current has an average velocity of 1.5 m/s. A fly is walking on the canoe at a speed of 0.5 m/s. Determine the fly's velocity relative to the shore if it walks:

A) toward the front of the canoe (with the current)

${}_cV_w = 1.0\,m/s$

${}_wV_e = 1.5\,m/s$

${}_fV_c = 0.5\,m/s$

${}_fV_e = ?$

${}_fV_e = {}_fV_c + {}_cV_w + {}_wV_e$

${}_fV_e = 0.5\,m/s + 1.0\,m/s + 1.5\,m/s$

${}_fV_e = 3.0\,m/s$

B) toward the back of the canoe (against the current).

${}_cV_w = 1.0\,m/s$

${}_wV_e = 1.5\,m/s$

${}_fV_c = -0.5\,m/s$

${}_fV_e$

${}_fV_e = {}_fV_c + {}_cV_w + {}_wV_e$

${}_fV_e = -0.5\,m/s + 1.0\,m/s + 1.5\,m/s$

${}_fV_e = 2.0\,m/s$