Physics 122: Application of Vectors Examples

2. What is the acceleration of a glider that goes from 10 m/s [N] to 10 m/s [E] in 2.5 seconds?

$a = \frac{v_f - v_0}{t}$ $v_{fE} = 10 m/s$ $v_{oE} = 0 m/s$

$v_{fN} = 0 m/s$ $v_{oN} = 10$

$a_E = \frac{v_{fE} - v_{oE}}{t} = \frac{10 - 0}{2.5} = 4 m/s^2$

$a_N = \frac{v_{fN} - v_{oN}}{t} = \frac{0 - 10}{2.5} = -4 m/s^2$

$|a| = \sqrt{a_E^2 + a_N^2}$

$= \sqrt{32}$

$= 5.7 m/s^2$

$\theta = \tan^{-1}\left|\frac{a_N}{a_E}\right| = \tan^{-1} 1$

$\theta = 45^\circ$

$\vec{a} = 5.7 m/s^2 \ [E\ 45^\circ S]$

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3. What is the average force on the glider if it has a mass of 92kg?

$$\vec{F} = m\vec{a}$$

$$\vec{F} = (92)(5.7\ m/s^2)$$

$$\vec{F} = 524\ N\ [E\ 45^\circ\ S]$$

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5. An object initially has a velocity of 25 m/s [E62°N] and accelerates at 5.5 m/s^2 [E12°N] for 15 seconds. What is the displacement in that time?

$$\vec{d}_f = \cancel{\vec{d}_0}^{\,0} + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

$v_{0E} = 25\cos 62^\circ = 11.7\ m/s$ $\quad v_{0N} = 25\sin 62 = 22.1\ m/s$

$a_E = 5.5\cos 12 = 5.4\ m/s^2$ $\quad a_N = 5.5\sin 12 = 1.1\ m/s^2$

$$d_{fE} = v_{0E}t + \tfrac{1}{2}a_E t^2$$
$$= (11.7)(15) + \tfrac{1}{2}(5.4)(15)^2$$
$$d_{fE} = 783\ m$$

$$d_{fN} = v_{0N}t + \tfrac{1}{2}a_N t^2$$
$$= (22.1)(15) + \tfrac{1}{2}(1.1)(15)^2$$
$$d_{fN} = 455\ m$$

$$|d_f| = \sqrt{d_{fN}^2 + d_{fE}^2}$$
$$= 906\ m$$

$$\theta = \tan^{-1}\left(\frac{d_{fN}}{d_{fE}}\right) = \tan^{-1}\left(\frac{455}{783}\right) = 30^\circ$$

$$\vec{d}_f = 906\ m\ [E\ 30^\circ\ N]$$