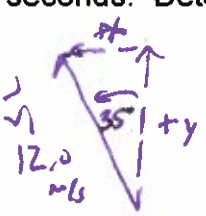
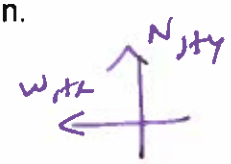
Solutions

SPH4U0 **Sample Kinematics Test Review Question**

1. A speed boat traveling at 12.0 m/s [N35.0°W] accelerates to reach a final velocity of 14.0 m/s [North] in a time of 5.00 seconds. Determine the boat's average acceleration.





$\vec{V}_1 = 12.0\ m/s\ [N35.0°W]$

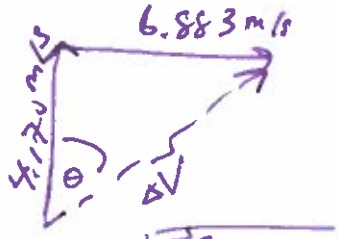
$\vec{V}_2 = 14.0\ m/s\ [N]$

$\Delta t = 5.00\ s$

$\vec{\Delta V} = ?$

$\vec{a} = ?$

X	Y
$\Delta V_x = V_{2x} - V_{1x}$	$\Delta V_y = V_{2y} - V_{1y}$
$= 0 - 12.0 \sin 35.0°$	$= 14.0\ m/s - 12.0 \cos 35.0°$
$= -6.883\ m/s$	$= 4.170\ m/s$



Analysis: $\vec{\Delta V} = \vec{V}_2 - \vec{V}_1$

$\Delta V = \sqrt{6.883^2 + 4.170^2} = 8.05\ m/s$

$\theta = \tan^{-1}\left(\frac{6.883}{4.170}\right) = 58.8°$

$\vec{\Delta V} = 8.05\ m/s\ [N58.8°E]$

$\vec{a} = \frac{\vec{\Delta V}}{\Delta t} = \frac{8.05\ m/s}{5.00\ s} = 1.61\ m/s^2\ [N58.8°E]$

2. A civil engineer calculates that the magnitude of the maximum centripetal acceleration of a car on a horizontal curve is 4.40 m/s^2. What is the maximum radius for a car travelling at 25.0 m/s?

$a_c = 4.40\ m/s^2$

$v = 25.0\ m/s$

$r = ?$

$a_c = \frac{v^2}{r}$

$r = \frac{v^2}{a_c} = \frac{(25.0\ m/s)^2}{(4.40\ m/s^2)} = 142\ m$

3. A vegetarian dinner is warming up on the rotating turntable of a microwave oven. A samosa located 16.0 cm from the centre of rotation experiences a centripetal acceleration of 0.220 m/s^2. Determine the period of rotation of the plate.

$r = 0.160\ m$

$a = 0.220\ m/s^2$

$T = ?\ \ v = ?$

$a_c = \frac{v^2}{r}$

$v = \sqrt{r a_c} = \sqrt{(0.160\ m)(0.220\ m/s^2)} = 0.1876\ m/s$

$v = \frac{2\pi r}{T} \rightarrow T = \frac{2\pi r}{v} = \frac{2\pi(0.160\ m)}{0.1876\ m/s} = 5.36\ s$

OR $a_c = \frac{4\pi^2 r}{T^2} \rightarrow T = \sqrt{\frac{4\pi^2 r}{a_c}} = \sqrt{\frac{4(\pi^2)(0.160\ m)}{0.220\ m/s^2}} = 5.36\ s$

4 A LASS soccer player kicks a wild ball during a playoff game giving the ball an initial velocity of 24.0 m/s [38.0° above the horizontal]/ The ball rises up and on the way down passes over a fence at the edge of the field. The ball just clears the 3.00 m high fence. Find:

a) The time for the ball to reach the fence. (2.797s)

b) The horizontal distance from the point where the ball was kicked to the fence. (52.9m)

c) The ball's velocity when it crosses the fence. (22.7 m/s [33.7° below horizontal])

$V_{y_1} = 18.91 m/s$

X	Y
$V_x = 24.0 \cos 38.0° m/s$	$V_{y_1} = 24.0 \sin 38.0° m/s$
$\Delta dx = ?$	$\Delta dy = 3.00 m$
$\Delta t = ?$	$a_y = -9.80 m/s^2$
	$\Delta t = ?$
	$V_{y2} = ?$

a) Solve for time:

$\Delta dy = V_{iy}\Delta t + \frac{1}{2}a_y\Delta t^2$

$3.00m = 24.0 \sin 38.0 \Delta t - 4.90\Delta t^2$

$4.90\Delta t^2 - 14.78\Delta t + 3.00 = 0$

$a = 4.90,\ b = -14.78,\ c = 3.00$

$\Delta t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{14.78 \pm \sqrt{14.78^2 - 4(4.90)(3.00)}}{2(4.90)}$

$= \frac{14.78 \pm 12.63}{9.80} = 0.219s$ OR $2.797s$

b) $\Delta dx = V_x \cdot \Delta t$

$= (24.0 \cos 38.0)(2.797)$ m/s

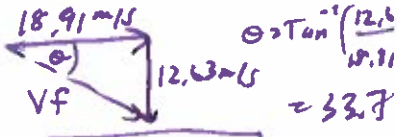
$= 52.9m$

c) $V_{y2} = ?$ $V_f = ?$

$V_{y2} = V_{y_1} + a_y \Delta t$

$= 24.0 \sin 38.0 - (9.80)(2.797)$

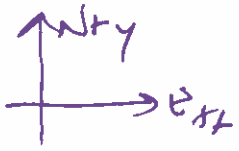
$= -12.63 m/s$

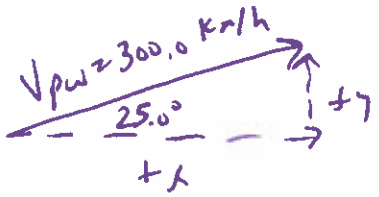


$V_f = 22.7 m/s$ [33.7° below the horizontal]

5 A plane is flying with an air velocity of 300.0 km/h [E25.0°N]. There is a wind of 80.0 km/h blowing from the North. What is the plane's resultant velocity relative to the ground?

P - plane
g - ground
w - wind





$\vec{V}_{pw} = 300.0 km/h [E 25.0°N]$

$\vec{V}_{wG} = 80.0 km/h [S]$

$\vec{V}_{pG} = ?$

Analysis:

$\vec{V}_{pG} = \vec{V}_{pw} + \vec{V}_{wG}$

X

$V_{pG_x} = V_{pw_x} + V_{wG_x}$

$= 300.0 \cos 25.0° + 0$

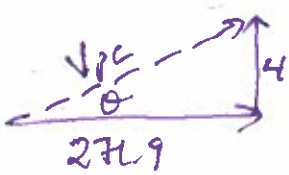
$= 271.9 km/h$

Y

$V_{pG_y} = V_{pw_y} + V_{wG_y}$

$= 300.0 \sin 25.0° - 80.0$

$= 46.79 km/h$



$V_{pG} = \sqrt{271.9^2 + 46.79^2} = 275.8$ km/h

$\theta = \tan^{-1}\left(\frac{46.79}{271.9}\right) = 9.76°$

$\vec{V}_{pG} = 276 km/h [E 9.76°N]$