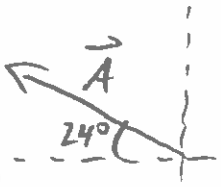
Physics 10154 - Exam #1D

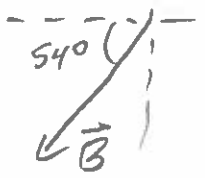
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) Three people are attempting to push a heavy piece of furniture across a rough surface. Person A pushes with a force of 325 Newtons in a direction 24.0° North of West. Person B pushes with a force of 284 Newtons in a direction 54.0° South of West. What must be the magnitude and direction of the third force (from person C) so that the net force is 562 Newtons directly West?



$A_x = -325 \cos 24^\circ = -296.90$

$A_y = +325 \sin 24^\circ = +132.19$



$B_x = -284 \cos 54^\circ = -166.93$

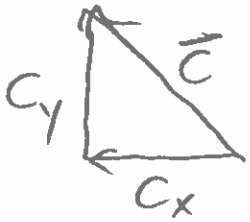
$B_y = -284 \sin 54^\circ = -229.76$

Want $A_x + B_x + C_x = -562$

$A_y + B_y + C_y = 0$

$\Rightarrow C_x = -562 + 296.90 + 166.93 = -98.17$

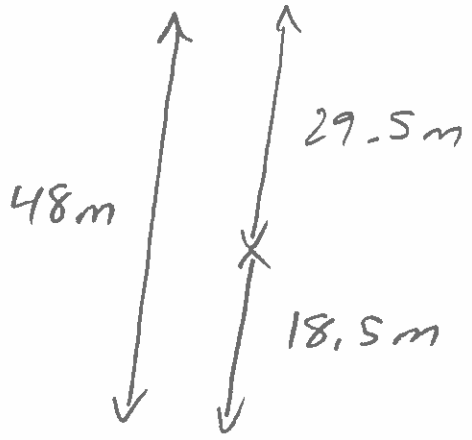
$C_y = 0 - 132.19 + 229.76 = +97.57$



$|C| = \sqrt{C_x^2 + C_y^2} = \boxed{138\ N}$

$\theta = \tan^{-1}\left(\frac{|C_y|}{|C_x|}\right) = \boxed{44.8^\circ\ N\ of\ W}$

2. (35 pts) A stone drops from rest from a height of 48.0 meters above the ground. An ant at ground level looks up and notices the stone when it is 18.5 meters above the ground. How much time (in seconds) does the ant have to get out of the way?



1st part

$\Delta y = 29.5\ m$

$v_{oy} = 0$

$v_y = ?$

$a_y = 9.8\ m/s^2$

$t = ?$

$v_y^2 = v_{oy}^2 + 2a_y \Delta y$

$= 0 + 2(9.8)(29.5) \Rightarrow v_y = \pm 24.0$

use $v_y = 24.0\ m/s$

as v_0 for part 2

2nd part

$\Delta y = 18.5$

$v_0 = 24.046\ m/s$

$v = ?$

$a = 9.8\ m/s^2$

$t = ?$

$v^2 = (24.046)^2 + 2(9.8)(18.5)$

$\Rightarrow v = \pm 30.67$

use $v = 30.67$

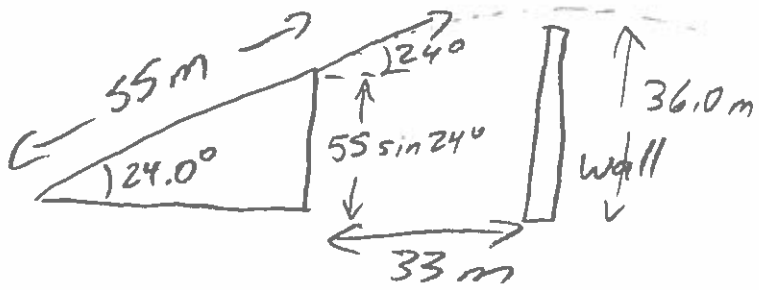
$v = v_0 + at$

$30.67 = 24.05 + 9.8t$

$\boxed{t = 0.676\ s}$

3. (35 pts) Starting from rest, a car accelerates up a 55.0 meter long ramp at a rate of 21.8 m/s². The ramp is angled 24.0° above the horizontal. 33.0 meters horizontally from the end of the ramp is a wall that rises 36.0 meters from the ground. Does the car make it over the wall? Justify your answer mathematically.

Part 1



$\Delta s = 55\,m$

$v_0 = 0$

$v = ?$

$a = 21.8$

$t = ?$

$v^2 = 0^2 + 2(21.8)(55)$

$v = \pm 48.97$, use $+48.97$

use as v_0 for free-fall

Find Δy when $\Delta x = 33\,m$

x	y
$\Delta x = 33\,m$	$\Delta y = ?$
$v_{0x} = 48.97\cos 24^\circ = 44.74\ m/s$	$v_{0y} = 48.97\sin 24^\circ = 19.92\ m/s$
$v_x = 44.74\ m/s$	$v_y = ?$
$a_x = 0$	$a_y = 9.8\ m/s^2$
$t = ?$	$t = ?$

$\Delta x = v_{0x}t + \frac{1}{2}a_x t^2$

$33 = 44.74\,t$

$t = 0.7376\,s$

$\Delta y = v_{0y}t + \frac{1}{2}a_y t^2$

$= (19.92)(.7376) + \frac{1}{2}(-9.8)(.7376)^2$

$= 14.69 - 2.666$

$= 12.0\,m$

$\Delta y_{tot} = 55\sin 24^\circ + 12.02\,m = 34.4\,m < 36.0\,m \Rightarrow$ NO