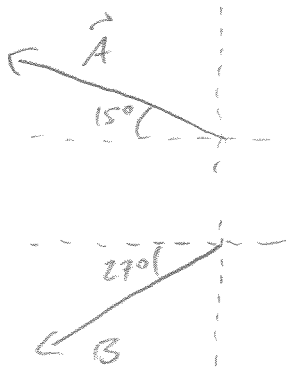
Physics 10154 - Exam #1 D

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) A boat crossing a wide body of water is attempting to get to a small island that is 357 miles due West from its initial location. The boat travels 192 miles in a direction 15.0° North of West, then 218 miles in a direction 27° South of West. What must the final straight line displacement of the boat be in order to find the island?



$A_x = -|\vec{A}| \cos 15° = -185.46$

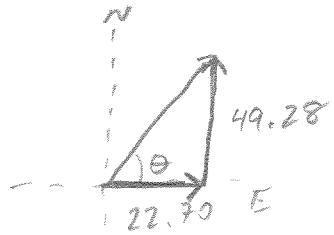
$A_y = +|\vec{A}| \sin 15° = 49.69$

$B_x = -|\vec{B}| \cos 27° = -194.24$

$B_y = -|\vec{B}| \sin 27° = -98.97$

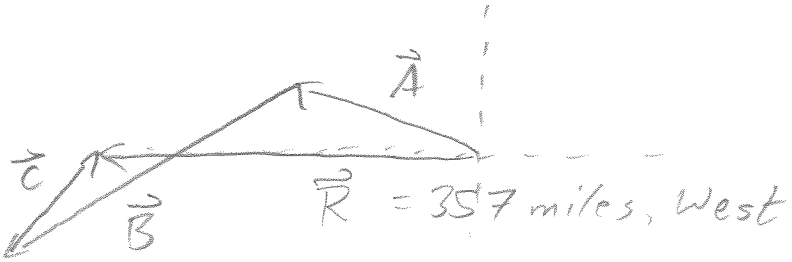
$A_x + B_x + C_x = -357 \Rightarrow C_x = +22.70$

$A_y + B_y + C_y = 0 \Rightarrow C_y = +49.28$



$|\vec{C}| = \sqrt{C_x^2 + C_y^2} = \boxed{54 \text{ miles}}$

$\theta = \tan^{-1}\left(\frac{C_y}{C_x}\right) = \boxed{65° \text{ N of E}}$



2. (35 pts) A person standing on a cliff fires a pellet gun straight down toward the ground from an altitude of 27.0 meters. The pellet's speed the instant before it hits the ground is 42.5 m/s.

a) How far above the cliff edge would the pellet have gone had the gun been fired straight upward?
b) What would have been the final velocity of the pellet (magnitude and direction) fired upwards just before the pellet hit the ground?

a) $\Delta y = 27.0\ m$ (down is positive)
$v_0 = ?$
$v = 42.5\ m/s$
$a = 9.8\ m/s$
$t = ?$

$v^2 = v_0^2 + 2a\Delta y$

$(42.5)^2 = v_0^2 + 2(9.8)(27)$

$v_0 = \pm 35.74\ m/s$, use $+35.74$ since it is down

a) Going up to max height

$\Delta y = ?$
$v_{0y} = -35.74$
$v_y = 0$
$a_y = +9.8$
$t = ?$

$0^2 = (-35.74)^2 + 2(9.8)\Delta y$

$\Delta y = 65.2\ m$

or (65.2 m, upwards)

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b) $\Delta y = 27.0\ m$
$v_0 = -35.74$
$v = ?$
$a = +9.8$

$v^2 = v_0^2 + 2a\Delta y$

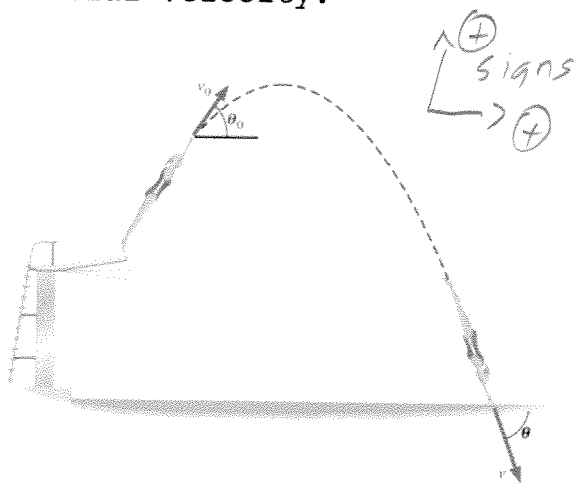
$= (-35.74)^2 + 2(9.8)(27)$

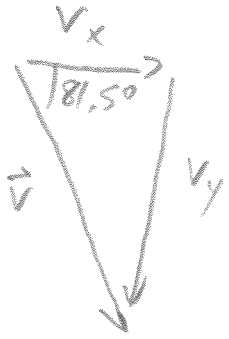
$v = \pm 42.5$, use $+42.5$ since it is down

(v = 42.5 m/s, down)

or just use symmetry argument.

3. (35 pts) A diver springs upward from a board that is 3.35 meters above the water. At the instant she contacts the water, her velocity is 12.1 m/s in a direction 81.5° below the horizontal. Determine the magnitude and direction of her initial velocity.





$V_x = 12.1 \cos 81.5°$

$= 1.788$ m/s

$V_y = -12.1 \sin 81.5°$

$= -11.967$ m/s

Since $a_x = 0$, $V_{0x} = V_x$

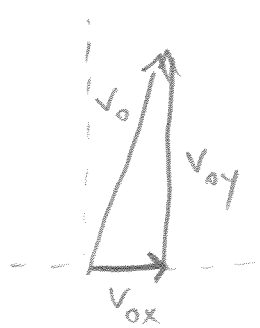
x	y
$\Delta x = ?$	$\Delta y = -3.35$
$V_{0x} = 1.788$	$V_{0y} = ?$
$V_x = 1.788$	$V_y = -11.967$
$a_x = 0$	$a_y = -9.8$
$t = ?$	$t = ?$

$$V_y^2 = V_{0y}^2 + 2a_y \Delta y$$

$$(-11.967)^2 = V_{0y}^2 + 2(-9.8)(-3.35)$$

$$V_{0y}^2 = 77.55$$

$V_{0y} = \pm 8.81$ m/s, use $+8.81$ m/s since V_0 up



$$|\vec{V}_0| = \sqrt{V_{0x}^2 + V_{0y}^2} = \boxed{8.99 \text{ m/s}}$$

$$\theta = \tan^{-1}\left(\frac{8.81}{1.788}\right) = \boxed{78.5° \text{ above } +x}$$