Physics 10154 - Exam #1b

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 rocket accelerates straight upward from rest at a rate of 22 m/s² for 4.0 seconds, then it is in free fall after the engines cut out.

a) To what maximum height does the rocket rise?

b) How long is the rocket in the air, starting from launch?

Part 1

$\Delta y = ?$
$V_{oy} = 0$
$V_y = ?$
$a = 22$
$t = 4$

$\Delta y = 0 + \frac{1}{2}(22)(16) = 176\ m$

$V_y = 0 + (22)(4) = 88\ m/s$

Part 2 (to max ht)

$a_y = ?$
$V_{oy} = 88$
$V_y = 0$
$a_y = -9.8$
$t = ?$

$0^2 = 88^2 + 2(-9.8)\Delta y$

$\Delta y = 395$

$\Delta y_{tot} = 176 + 395 = \boxed{570\ m}$

$V_y = V_{oy} + at$

$0 = 88 - 9.8t \Rightarrow t = 8.98\ s$

Part 3 (on way down)

$\Delta y = -570$
$V_{oy} = 0$
$V_y = ?$
$a_y = -9.8$
$t = ?$

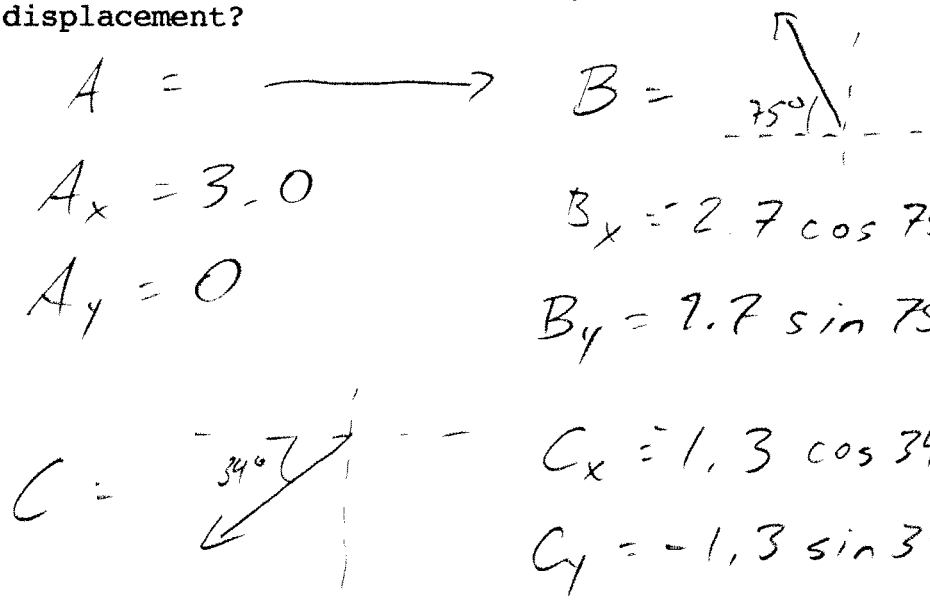
$-570 = 0 - 4.9t^2$

$t = 10.79\ s$

$t_{tot} = 4 + 8.98 + 10.79$

$= \boxed{24.5}$

2. (30 pts) A hiker travels 3.0 miles due East, then 2.7 miles in a direction 15° West of North, then 1.3 miles in a direction 34° South of West. What is the magnitude and direction of the total displacement?



$A_x = 3.0$

$A_y = 0$

$B_x = 2.7 \cos 75° = -0.699$

$B_y = 2.7 \sin 75° = 2.608$

$C_x = 1.3 \cos 34° = -1.08$

$C_y = -1.3 \sin 34° = -0.727$

$R_x = 3.0 - .699 - 1.08 = 1.22$

$R_y = 0 + 2.608 - .727 = 1.88$

$|\vec{R}| = \sqrt{1.22^2 + 1.88^2} = \boxed{2.2 \text{ mi}}$

$\theta = \tan^{-1}\left(\frac{1.88}{1.22}\right) = \boxed{57° \text{ above } +x}$

or N of E

3. (40 pts) A stone is thrown at an angle of 22° below the horizontal with a speed of 12 m/sec from a cliff with an altitude of 120 meters.

a) How far (horizontal distance) from the base of the cliff does the stone land?

b) What is the magnitude and direction of the stone's velocity the instant before the stone hits the ground?

x	y
	down is positive ✓
$\Delta x = ?$	$\Delta y = 120$
$V_{0x} = 12\cos 22^\circ = 11.13\ m/s$	$V_{0y} = 12\sin 22 = 4.5\ m/s$
$V_x = 11.13\ m/s$	$V_y = ?$
$a_x = 0$	$a_y = 9.8$
$t = ?$	$t = ?$

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

$$= 4.5^2 + 2(9.8)(120) = 48.7\ m/s$$

$$V_y = V_{0y} + a_y t$$

$$48.7 = 4.5 + 9.8t \Rightarrow t = 4.5\ s$$

$$\Delta x = V_{0x} t = (11.13)(4.5) = \boxed{50\ m}$$

$$|V| = \sqrt{11.13^2 + 48.7^2} = 50\ m/s$$

$$\theta = \tan^{-1}\left(\frac{48.7}{11.13}\right) = \boxed{77^\circ \text{ below } +x}$$