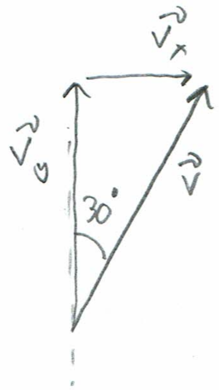
1.



From trigonometry, $\vec{V}_x = V \sin 30^\circ \hat{\imath} = \frac{30\,m/s}{2}\,\hat{\imath}$

$= 15\,\frac{m}{s}\,\hat{\imath}$

$\vec{V}_y = V \cos 30^\circ\,\hat{\jmath} = 30 \cdot \frac{\sqrt{3}}{2}\,\frac{m}{s}\,\hat{\jmath} = 26.0\,\frac{m}{s}\,\hat{\jmath}$

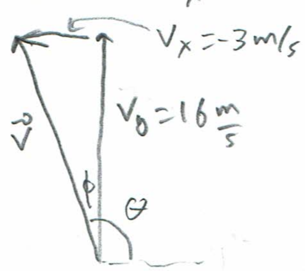
2. Take the derivative to find $\vec{v}$:

$\vec{v} = -A\hat{\imath} + 2Bt\,\hat{\jmath}$

a) $\vec{v}(0s) = -A\hat{\imath} = -3\frac{m}{s}\,\hat{\imath}$

b) $\vec{v}(4s) = -3\frac{m}{s}\,\hat{\imath} + 2\left(2\frac{m}{s^2}\right)(4s)\,\hat{\jmath} = -3\frac{m}{s}\,\hat{\imath} + 16\,\frac{m}{s}\,\hat{\jmath}$

c) $V = \sqrt{V_x^2 + V_y^2} = \sqrt{(-3)^2 + (16)^2}\,\frac{m}{s} = 16.28\,\frac{m}{s}$



From trig, $\tan\phi = \frac{3\,m/s}{16\,m/s} \Rightarrow \phi = \tan^{-1}\left(\frac{3}{16}\right)$

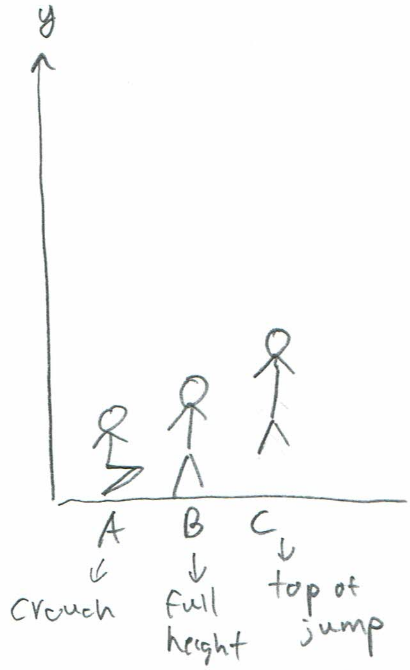
$= 10.62^\circ$

and $\theta = 90^\circ + \phi = 100.62^\circ$

so $\vec{v}$ is $16.28\frac{m}{s}$ 100.62° CCW of the x-axis

d) $\vec{a}_{ave} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}(4s) - \vec{v}(0s)}{4s - 0s} = \frac{\left(-3\frac{m}{s} - -3\frac{m}{s}\right)\hat{\imath} + \left(16\frac{m}{s} - 0\frac{m}{s}\right)\hat{\jmath}}{4s}$

$= 4\frac{m}{s^2}\,\hat{\jmath}$



We are told $y_B = 1.8\,m$, and $y_B - 0.5\,m = y_A$,
so $y_A = 1.3\,m$. We also know
$V_{Ay} = 0\,m/s$, $V_{cy} = 0\,m/s$,
$a_{AB,y} = 5\,m/s^2$ $a_{BC,y} = -g = -9.8\,m/s^2$

First analyze AB using const accel equations to find V_B. Then analyze BC, again w/ const accel, to find Δy_{BC}.

AB: $V_{By}^2 = \cancel{V_{Ay}^2}^{\,0} + 2a_{ABy}\Delta y_{AB}$

$\Rightarrow V_B = \sqrt{2a_{ABy}\Delta y_{AB}} = \sqrt{2 \cdot 5\,m/s^2 \cdot 0.5\,m} = \sqrt{5}\,\frac{m}{s} = 2.24\,\frac{m}{s}$

BC: $\cancel{V_{cy}^2}^{\,0} = V_{By}^2 + 2a_{Bcy}\Delta y_{BC}$

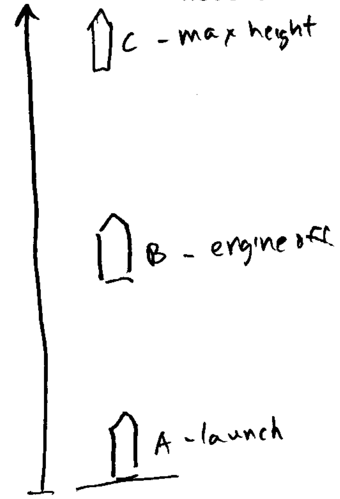
$\Rightarrow \Delta y_{BC} = \dfrac{-V_{By}^2}{2a_{Bcy}} = \dfrac{-\left(\sqrt{5}\,\frac{m}{s}\right)^2}{2(-9.8\,m/s^2)} = 0.256\,m$

Not exactly leaping tall buildings in a single bound.

The final answer is the y height of his head:
$y_c = y_B + \Delta y_{Bc} = 1.8m + 0.256m = 2.055\,m$

3. A rocket leaves the launch pad and travels straight up with constant acceleration of 1 m/s² to a height of 450 m. The engine then shuts off, and the rocket enters free fall (the effects of air resistance are negligible). What is the maximum height the rocket reaches? (10 points)

Show all of your work. Use proper problem solving steps, including drawing a diagram and listing your variables. Partial credit will be given for showing this work, and you will lose credit if it is not shown.



$y_A = 0\,m$, $y_B = 450\,m$

$v_A = 0\,m/s$

$v_C = 0\,m/s$

$a_{AB} = 1\,m/s^2$

$a_{BC} = -g$

Use AB to find the velocity at B, then use BC to find the height.

For AB: $v_B^2 = \cancel{v_A^2}^{\,0} + 2\,a_{AB}\,\Delta y_{AB}$

$\Rightarrow \quad v_B = \sqrt{2(1\,\frac{m}{s^2})(450\,m)} = 30\,m/s$

Now for BC:

$\cancel{v_C^2}^{\,0} = v_B^2 + 2\,a_{BC}\,\Delta y_{BC}$

$\Rightarrow \quad \Delta y_{BC} = \dfrac{-v_B^2}{2a_{BC}} = \dfrac{-(30\,m/s)^2}{2(-9.8\,m/s^2)} = 45.9\,m$

So $y_C = y_B + \Delta y_{BC} = 450\,m + 45.9\,m$
$= 495.9\,m$

This is kinda vimpy: less than $\frac{1}{2}$ km. Not in space!