Quizbit 4 Solution

Monday, October 31, 2022 10:42 AM

Problem Statement | Helicopters can be used to fight forest fires. One task they perform is to drop fire suppressant fluids on targeted hot spots. Consider a firefighting helicopter traveling horizontal with a constant speed $\mathbf{V_i}$. It flies at an altitude **h** above the ground. You've been tasked by the crew to calculate the horizontal distance **d** away from the fire, from which you must release the fluids to hit the fire. Assume air resistance is negligible.

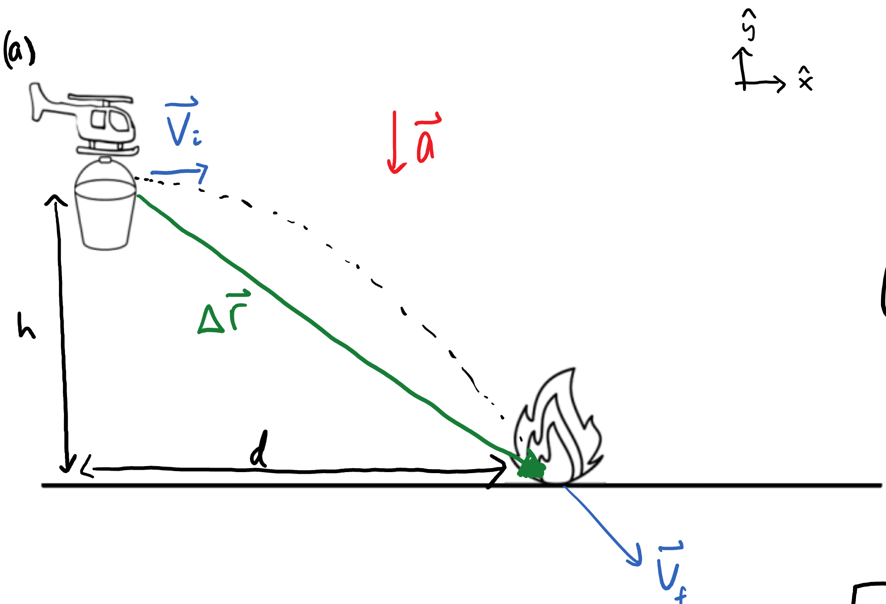
(a) Draw a physical representation for this situation. Be sure to include representations of your coordinate system, the initial and final velocity, displacement, and acceleration of the dropped fluid.

(b) Find an equation for the distance **d** in terms $\mathbf{V_i}$, **h**, and **g**, the acceleration of gravity. This equation should have no numbers except for a 2 from one of the equations used to construct it.

(c) Use Dimensional Analysis sensemaking to determine if your expression in part (b) is plausible.

(d) If V_i = 44 m/s and h = 100 m, what must d be equal to hit the target?

(a)



eq's

(i) $\Delta x = V_i \Delta t + \frac{1}{2} a \Delta t^2$

(ii) $V_f = V_i + a \Delta t$

(iii) $V_f^2 = V_i^2 + 2a\Delta x$

(b)

[y] $\Delta y = \cancel{V_{iy}}^{0} \Delta t + \frac{1}{2} a_y \Delta t^2 \Rightarrow \Delta t = \sqrt{\frac{2h}{g}}$

[x] $\Delta x = V_{ix} \Delta t + \frac{1}{2} \cancel{a_x}^{0} \Delta t^2 \Rightarrow \boxed{d = V_i \sqrt{\frac{2h}{g}}}$

(c) $[L] = \frac{[L]}{[T]} \left(\frac{\cancel{[L]}}{\cancel{[L]}/[T]^2} \right)^{1/2}$ dimensional analysis shows consistency

(d) $d = (44\,\text{m/s}) \sqrt{\frac{2(100\,\text{m})}{9.8\,\text{m/s}^2}} = \boxed{199\,\text{m}}$

Problem Statement | A small 2000-kg cargo ship, deep in outer space, is traveling at a constant 1.20 km/s in the positive x-direction.

(a) What is net force acting on the cargo ship while it travels at a constant speed? Explain your reasoning.

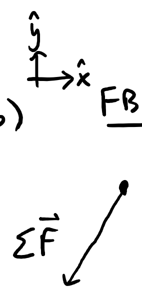
(b) All of the sudden, the thrusters unexpectedly engage, providing the ship a net force equal to <-40.0 kN, -60.0 kN>. If there are humans in the ship, would the acceleration felt by the occupants be survivable? Humans can sustain accelerations a few times larger than g, the free-fall acceleration. Explain your reasoning.

(c) Draw a detailed physical representation of the ship's motion from the time the thrusters engage to when they turn off, 3 minutes later. Along with representations of the kinematic variables, show the trajectory the ship would take. You may have to solve for some physical quantities to get this figure correct.

(a) w/ $\vec{v}$ = constant, + $\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$, $a = 0$.

if $\Sigma \vec{F} = m\vec{a}$, then $\Sigma \vec{F} = 0$

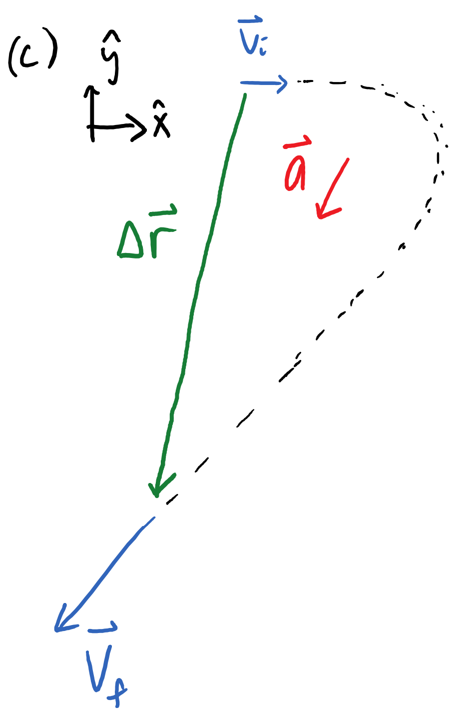
(b) FBD



$\vec{a} = \frac{\Sigma \vec{F}}{m} = \langle -20, -30 \rangle \, m/s^2$

or about 3.5 g's, which is on the edge of what humans can sustain. It would be hard to maintain this for long.

(c)



K	UK
$V_{ix} = 1200\ m/s$	V_{fx}
$a_x = -20\ m/s^2$	Δx
$\Delta t = 180\ s$	

x:

$\Delta x = V_{ix}\Delta t + \frac{1}{2}a_x \Delta t^2 = -108{,}000\ m$

$V_{fx} = V_{ix} + a_x \Delta t = -2400\ m/s$

K	UK
$V_{iy} = 0\ m/s$	V_{fy}
$a_y = -30\ m/s^2$	Δy
$\Delta t = 180\ s$	

y:

$\Delta y = V_{iy}\Delta t + \frac{1}{2}a_y \Delta t^2 = -486{,}000\ m$ (with $V_{iy} = 0$)

$V_{fy} = V_{iy} + a_y \Delta t = -5400\ m/s$ (with $V_{iy} = 0$)