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 rock is thrown directly downward with an initial speed of 7.3 m/s, and it hits the ground 2.5 seconds after it is thrown.

a) From what height above the ground was the rock thrown?
b) What is the magnitude and direction of the rock's average velocity during the 2.5 second time interval while it is in the air in free fall?

a) Signs

$\downarrow = \oplus$

$\Delta y = ?$

$v_0 = 7.3\ m/s$

$v = ?$

$a = 9.8\ m/s^2$

$t = 2.5\ s$

$$\Delta y = v_0 t + \frac{1}{2} a t^2$$

$$= (7.3)(2.5) + \frac{1}{2}(9.8)(2.5)^2$$

$$= 18.25 + 30.63 = \boxed{49\ m}$$

b) $v = v_0 + at$

$$= 7.3 + (9.8)(2.5) = 31.8$$

$$\bar{v}_{Avg} = \frac{v + v_0}{2} = \frac{7.3 + 31.8}{2} = \boxed{20\ m/s,\ down}$$

or $\frac{\Delta y}{t} = \frac{48.88}{2.5} = 20\ m/s,\ down$

2. (35 pts) A car accelerates from rest at a rate of 12 m/s^2 for 6.5 seconds before running into a highway barrier designed to reduce the impact force of collisions. Can the barrier bring the car to a stop over a 15 meter length while keeping the average (negative) acceleration of the car below the likely fatal level of -240 m/s^2?

Part 1

$\Delta x = ?$

$v_0 = 0$

$v = ?$

$a = 12\ m/s^2$

$t = 6.5\ s$

$v = v_0 + at$

$= 0 + (12)(6.5) = 78\ m/s$

use as v_0 part 2

Part 2

$\Delta x = 15\ m$

$v_0 = 78\ m/s$

$v = 0$

$a = ?$ ← Find a, compare to $-240\ m/s^2$

$t = ?$

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

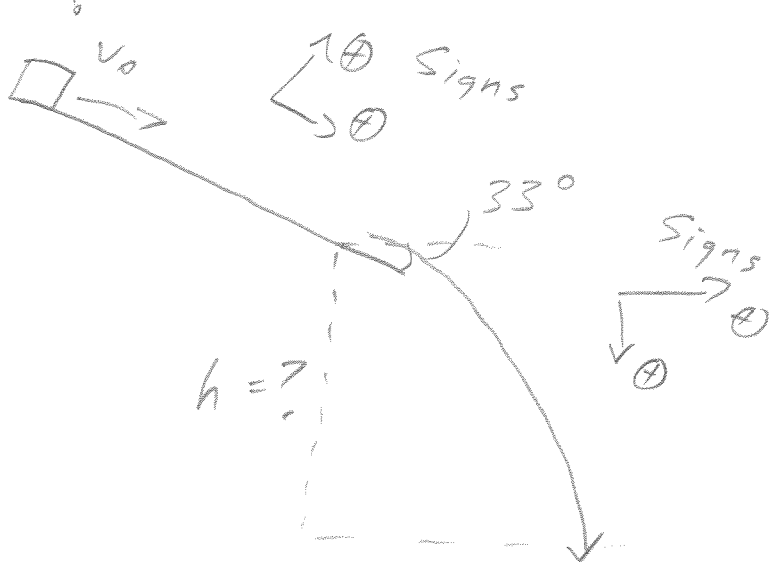
$0^2 = (78)^2 + 2a(15)$

$a = -\frac{78^2}{30} = -203\ m/s^2$

$|a| = 203 < 240$, so yes, a stays below fatal level

4 meter

3. (35 pts) A block slides from rest with an acceleration of 3.8 m/s² down a frictionless ramp angled 33° below the horizontal. Upon leaving the ramp, the block is in free fall until it hits the ground. The measured travel time from the end of the ramp to the ground is 1.7 seconds. How high is the bottom of the ramp above the ground?



Part 1

$\Delta s = 4.0\ m$

$v_0 = 0$

$v = ?$

$a = 3.8\ m/s^2$

$t = ?$

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

$= 0^2 + 2(3.8)(4.0) = \pm 5.514\ m/s$

use $v_0 = +5.514\ m/s$ for part 2

Part 2

$\Delta y = ?$

$v_{oy} = 5.514 \sin 33^\circ = 3.00$ ← y-component of v_0

down is (+) ↓ $v_y = ?$

↓ $a_y = 9.8$

$t = 1.7\ s$

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

$= (3.00)(1.7) + \frac{1}{2}(9.8)(1.7)^2$

$= 5.1 + 14.2$

$= 19\ m$