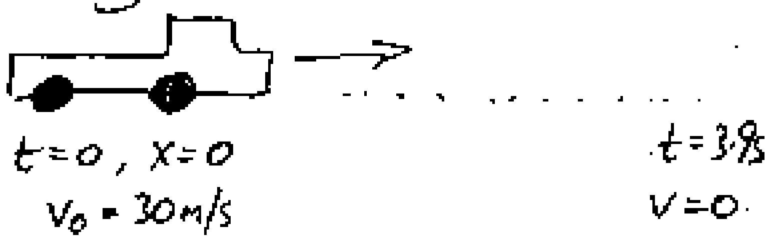
Physics 1A Quiz 2 Solutions

1.



a) i) Truck's accel. $a = \frac{V - V_0}{t} = \frac{0 - 30\,m/s}{3.9s} = -7.692\,m/s^2$

ii) So braking distance is $(x - x_0) = \frac{0 - V_0^2}{2a} = \frac{-V_0^2}{2a}$

For $V_0 = 30\,m/s$, $(x - x_0)_{30} = \frac{-30^2}{2 \times 7.692} = 58.5\,m$

iii) For $V_0 = 15\,m/s$, $(x - x_0)_{15} = \frac{15^2}{2 \times 7.692} = 14.625\,m$ ($= \frac{1}{4}$ of $(x - x_0)_{30}$).

b) For unloaded truck $M_u = 900\,kg$, if braking $a = -7.692\,m/s^2$

i) $\Rightarrow$ braking force $F_B = M_u a = 6922.8\,N$ (or 6923N)

ii) If loaded mass is now M_L, for same force

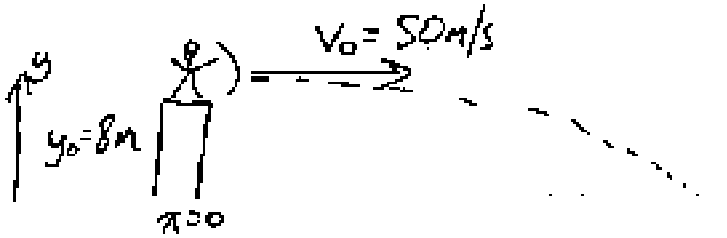
accel $a_L = \frac{F_B}{M_L} = \frac{6922.8\,N}{1500\,kg} = 4.6152\,m/s^2$

c) Using a_L, stopping distance = braking + thinking distance

i) braking dist. $(x - x_0) = \frac{V_0^2}{2a_L} = \frac{30^2}{2 \cdot 4.6152} = 97.5\,m$

thinking distance $x_0 = V_0 t_R = 30 \times 0.4s = 12.0\,m$

ii) $\Rightarrow$ total $109.5\,m$



$g = -10 m/s^2$

2. Time of flight t_f given by $y(t_f) = 0$ where

height $y(t) = y_0 - \underbrace{(V_{0y} \cdot t)}_{=0} - \frac{1}{2} g t^2 = y_0 - \frac{1}{2} g t^2$

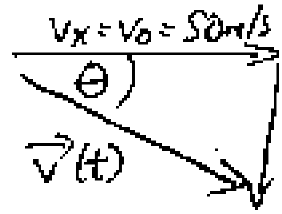
i.e. $0 = 8 - \frac{1}{2} g t_f^2 \Rightarrow t_f = \sqrt{\frac{2y_0}{g}} = \sqrt{\frac{2 \times 8}{10}}$

$= \underline{1.265 s}$

b) i) Range in x is $x(t_f) = \underbrace{x_0}_{=0} + \underbrace{V_x}_{=V_0 = 50 m/s} t_f = 50 \times 1.265$

$= \underline{63.245 m}$

ii) Impact velocity:



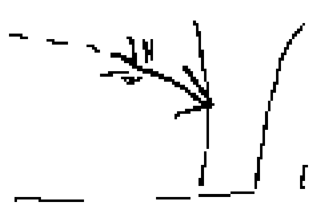
$V_y = 0 - gt$

At $t = t_f$, $V_y = -g t_f = -10 \times 1.265 = -12.65 m/$

$\Rightarrow V(t_f) = \sqrt{V_x^2 + V_y^2} = \sqrt{50^2 + 12.65^2} = \underline{51.57 m/s}$

iii) and angle $\theta = \tan^{-1}\left(\frac{V_y}{V_x}\right) = \tan^{-1}\left(\frac{-12.65}{50}\right) = \underline{14.2°}$

c) i)

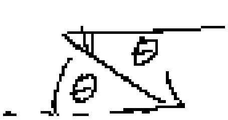


at $x = 45m$, time of flight $t = \frac{x}{V_x}$

i.e. $t = \frac{45}{50} = 0.9s$

$\Rightarrow$ height of arrow $y = 8 - \frac{1}{2} g (0.9)^2 = \boxed{3.95 m}$

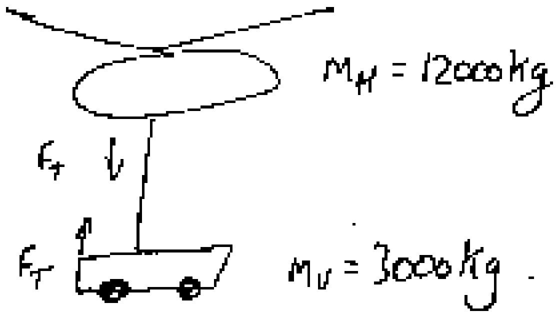
ii)



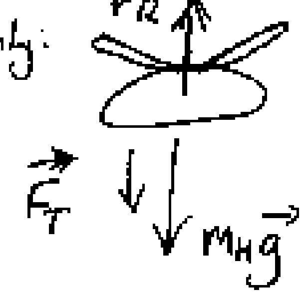
angle of arrow $= \tan^{-1}\left(\frac{V_y}{V_x}\right)$

$= \tan^{-1}\left(\frac{gt}{50}\right) = \tan^{-1}\left(\frac{0.9 \times 10}{50}\right) = 10.2°$

3.



Chopper only:



Vehicle only:

a) i) Net force (up) on vehicle

*(1) $F_V = F_T - M_V g \quad = 0$ if hovering

$\Rightarrow$ tensile force $F_T = M_V g = 10 \times M_V = \underline{30\,kN}$

ii) Net force on chopper $\equiv F_C = F_R - F_T - Mg \quad = 0$ if hovering

*(2) $\Rightarrow$ rotor force $F_R = F_T + M_H g = (M_V + M_H)g$ from (1)

i.e. F_R = total weight $= 10 \times (M_V + M_H) = \underline{150\,kN}$

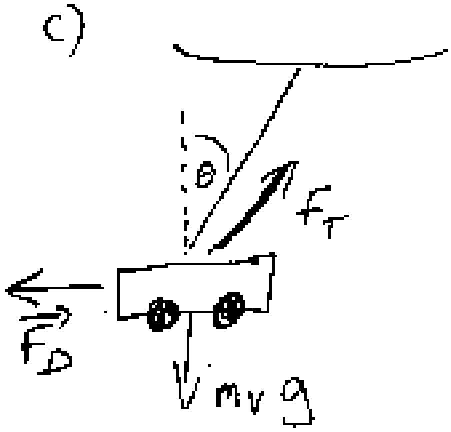
b) Use $F_V = M_V a$ for vehicle with $a = +0.6\,m/s^2$ (up)

i) *(1) $\Rightarrow F_V = M_V a = F_T - Mg$, so $F_T = M_V(g + a) = \underline{31.8\,kN}$

ii) For chopper, *(2) $\Rightarrow F_C = M_C a = F_R - F_T - Mg$,

so rotor force $F_R = (M_V + M_H)(g + a) = \underline{159\,kN}$

c)



(i) for no accel, equate components

horiz: drag force $F_D = F_T \sin 10°$ (A)*

vertical: weight $M_V g = F_T \cos 10°$ (B)*

$\Rightarrow F_T = 30.46\,kN$, $F_D = 5.29\,kN$