Arnau Llorens

MIDTERM 1

2. ESTIMATIONS AND UNIT ANALYSIS

1. $\Delta x = 0,5\,Km = 500\,m$

$\Delta t = 1,5\,s$

a) $\Delta v = \frac{\Delta x}{\Delta t} \qquad v = \frac{500\,m}{1,5\,s} = \boxed{333,\overline{33}\ m/s}$

b) ~~333,33 m 3600~~

$333,\overline{33}\ \frac{m}{s} \cdot \frac{3600\,s}{1\,h} \cdot \frac{1\,Km}{1000\,m} = \boxed{1200\ \frac{Km}{h}}$

2 a) $0,25\,m^3 \cdot \frac{1000000\,cm^3}{1\,m^3} = \boxed{250000\,cm^3}$

b) $100\ \frac{Km}{h} \cdot \frac{1\,h}{3600\,s} \cdot \frac{1000\,m}{1\,Km} = \boxed{27,\overline{77}\ m/s}$

c) $2\ \frac{Kg\,m}{s^2} \cdot \frac{1\,s^2}{100000\,m\,s^2} \cdot \frac{1000\,g}{1\,Kg} \cdot \frac{100\,cm}{1\,m} = \boxed{0,2\ \frac{g\,cm}{ms^2}}$

$2\ \frac{Kg\,m}{s^2} = \boxed{0,2\ \frac{g\,cm}{ms^2}}$

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9) 3 VECTORS

1 a) $\vec{X}_1 = 10\,m \quad \gamma_1 = 15^\circ \quad \vec{X}_1 = (10 \cdot \cos 15\,\hat{i} + (10 \cdot \sin 15)\hat{j}\ m$

$$\boxed{\vec{X}_1 = (9{,}66\,\hat{i} + 2{,}59\,\hat{j})\ m}$$

b) $\vec{X}_2 = 20\,m \quad \gamma_2 = 135^\circ \quad \vec{X}_2 = (20 \cdot \cos 135)\hat{i} + (20 \cdot \sin 135)\hat{j}\ m$

$$\boxed{\vec{X}_2 = (-14{,}14\,\hat{i} + 14{,}14\,\hat{j})\ m}$$

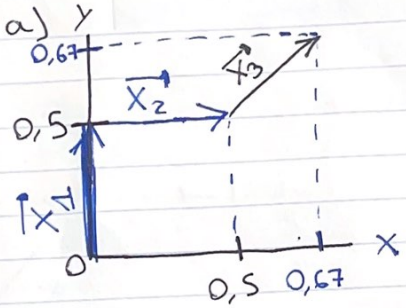
2 $\vec{X}_1 = 0{,}5\,\hat{j}\ Km$

$\vec{X}_2 = 0{,}5\,\hat{i}\ Km$

$\vec{X}_3 = 0{,}25\,Km \quad \gamma_3 = 45$

$\vec{X}_3 = 0{,}25 \cdot \cos 45\,\hat{i} + 0{,}25 \cdot \sin 45\,\hat{j} = \boxed{0{,}177\,\hat{i} + 0{,}177\,\hat{j}}\ Km$

a)



b) $\vec{X}_T = \vec{X}_1 + \vec{X}_2 + \vec{X}_3$

$\vec{X}_T = (0{,}5 + 0{,}177)\,\hat{i} + (0{,}5 + 0{,}177)\,\hat{j}\ Km$

$$\boxed{\vec{X}_T = (0{,}677\,\hat{i} + 0{,}677\,\hat{j})\ Km}$$

c) $X_T = \sqrt{(0{,}677^2 + 0{,}677^2)} = \sqrt{0{,}91665} = \boxed{0{,}957\ Km}$

4 MOTION ALONG A STRAIGHT LINE

1 $X(t) = -1 - 4t$

$\Delta x = x_f - x_0$ $\Delta x = x(2) - x(-2)$

$x(2) = -1 - (4 \cdot 2) = -9\ m$ $x(-2) = -1 - (4 \cdot -2) = 7\ m$

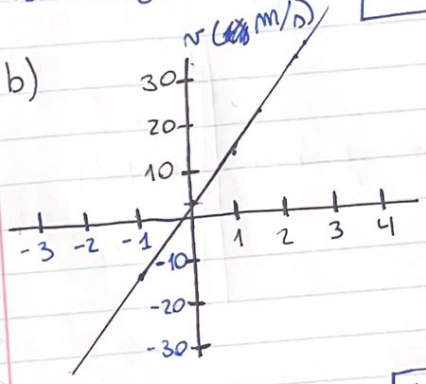
$\Delta x = 9_{\text{b}} - 7 = \boxed{2\ m}$ b) $v(t) = x'(t) = \boxed{-4\ m/s}$

2 a) $X(t) = -2t + 7t^2$ $v(t) = x'(t) = 14t - 2$

average velocity $= \frac{\Delta x}{\Delta t} = \frac{x(2) - x(0)}{2 - 0} = \frac{-(2 \cdot 2) + 7(2^2) - 0}{2}$

∴ average velocity $= \boxed{12\ m/s}$

b)



Velocity vs time graph

$x = 14x - 2$

c) $v(1) = 14(1) - 2 = \boxed{12\ m/s}$

d) $a(t) = v'(t) = \boxed{14\ m/s^2}$

3 $a(t) = 5\ m/s^2$ $v(t) = 5t\ m/s$ $x(t) = 2{,}5t^2\ m$

$5t = 10$ $\frac{10}{5} = t = 2$ a) $\boxed{t = 2\,s}$

b) $x(t) = 2{,}5t^2\ m$ $x(2) = 2{,}5(2)^2 = \boxed{10\,m}$

c) 10 m, 2 s

First 10 m $\Rightarrow 2\,s = t_1$

Remaining 90 m $\Rightarrow$? 10 m/s

$x(t) = v_0 t + \frac{1}{2} a t^2$ $90 = 10t + 0$

$t_2 = 9\,s$

$\boxed{9\,s + 2\,s = 11\,s} = t_t$

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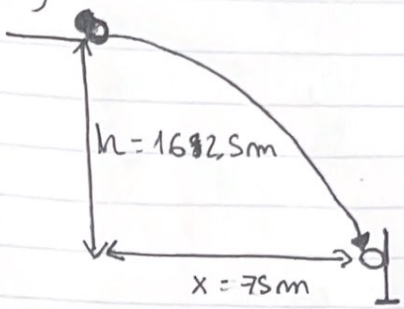
5 MOTION IN 2 AND 3 DIMENSIONS

1 a)



b) $v_x = ?$

$\Delta x = V_x \Delta t$

$\Delta x = -\frac{1}{2} g t^2$

b) $\Delta y = -162,5 \quad g = 9,8 \, m/s^2$

$-162,5 = -\frac{1}{2} 9,8 \, t^2 \qquad t = \sqrt{\frac{2(-162,5)}{-9,8}} = 5,76 \, s$

$\Delta x = V_x \cdot 5,76 \qquad \frac{75}{5,76} = \boxed{V_x = 13,02 \, m/s}$

2 $t = ? \quad v_0 = 40 \, m/s \quad 45^\circ = \gamma$

$V_x = 40 \cdot \cos 45 = 28,28 \, m/s \qquad V_y = 40 \cdot \sin 45 = 28,28 \, m/s$

$R = \frac{V_0^2 \cdot \sin(2 \cdot \gamma)}{g} \qquad T = \frac{2 v_0 \sin(\gamma)}{g}$

a) $R = \frac{40^2 \cdot \sin(90)}{9,8} = \frac{1600}{9,8} = \boxed{163,27 \, m}$

b) $T = \frac{2 \cdot 40 \cdot \sin 45}{9,8} = \frac{80 \sin 45}{9,8} = \boxed{5,77 \, s}$

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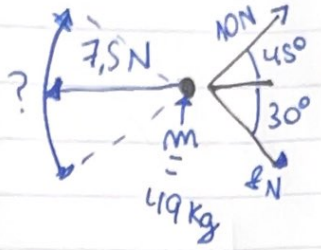
6. FORCES

$\vec{F} = m \cdot a$

1.



$F_1 = 10\,N \quad \gamma_1 = 45°$

$F_2 = 8\,N \quad \gamma_2 = -30°$

$F_3 = 7{,}5\,N \quad \gamma = ?$

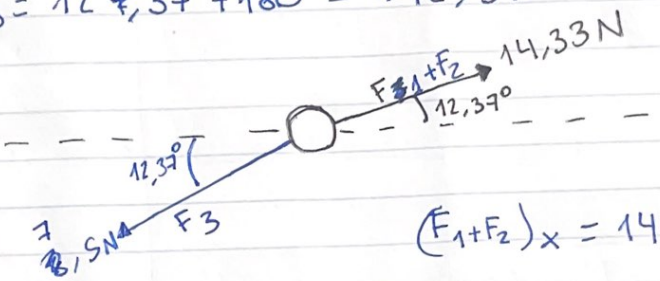
$F_1 + F_2 = (10 \cdot \cos 45 + 8 \cdot \cos 330)\,\hat{i} + (10 \cdot \sin 45 + 8 \cdot \sin 330)\,\hat{j}$

$(F_1 + F_2) = 14\,\hat{i} + 3{,}07\,\hat{j}$

$\vec{F_1 + F_2} = \sqrt{(14)^2 + (3{,}07)^2} = 14{,}33\,N$

$\gamma_{F_1,F_2} = \arctan\left(\frac{3{,}07}{14}\right) = 12{,}37°$

$\gamma_3 = 12{,}37 + 180° = 192{,}37°$



$(F_1 + F_2)_x = 14{,}33 \times \cos(12{,}37) = 14\,N$

$F_{3x} = -7{,}326\,N = 7{,}5 \cdot \cos(192{,}37)$

$\vec{F_T} = 14 - 7{,}326 = 6{,}674$

$F = m \cdot a \qquad a = \frac{F}{m} = \frac{6{,}674\,N}{4{,}9\,Kg} = \boxed{0{,}136\,m/s^2}$