February 12 2015 Name : Solution.

Test 1 : marked on 100

Points are given to needed schematics. Be clear in your answer

#1 /25 Knowing that $a = 4x + 2$, and that if x = 1, then v = 2, find (everything in SI units):

a) v if x = 3 m; Ans: $\pm 6,63 m/s$

b) X when v = 0. Ans: $-1,618 m$ $0,618 m$

(a) $a = \frac{v dv}{dx} \Rightarrow \int_2^v v dv = \int_1^x (4x+2) dx$

$\frac{v^2}{2} - 2 = 2x^2 - 2 + 2x - 2$

$v^2 = 4x^2 + 4x - 4$

If $x = 3 \Rightarrow v^2 = 44 \therefore \boxed{v = \pm 6,63 m/s}$

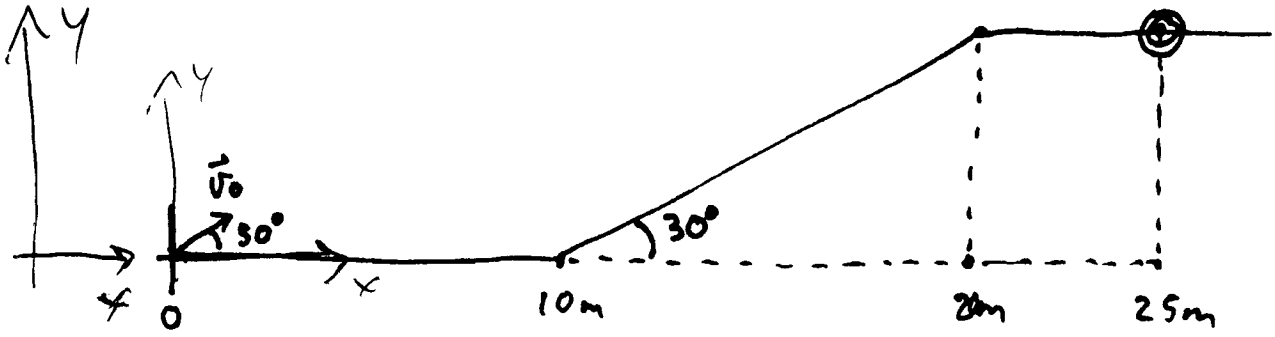
(b) $0 = 4x^2 + 4x - 4 \Rightarrow x = \frac{-4 \pm \sqrt{16 - 4 \cdot 4(-4)}}{8}$

$\boxed{x = \begin{cases} -1,618 m \\ 0,618 m \end{cases}}$

#2 /35 You need to build a device to throw a ball on a target on the top of a hill.

a) Find the initial velocity. Ans: $17,57 \text{ m/s} \angle 50°$

b) Find the normal acceleration 1 s before impact. Ans: $9,72 \text{ m/s}^2$



$x_0 = 0$

$y_0 = 0$

$x = 25 \text{ m}$

$y = 10 \tan 30° = 5,77 \text{ m}$

$v_{0x} = v_0 \cos 50°$

$v_{0y} = v_0 \sin 50°$

(a) in x: $x = x_0 + v_{0x} t$ (1)

in y: $y = y_0 + v_{0y} t - 4,905 t^2$ (2)

(1) $25 = v_0 \cos 50° \, t$

(2) $5,77 = v_0 \sin 50° \, t - 4,905 t^2$

$\Rightarrow t = \dfrac{25}{v_0 \cos 50°}$ (3)

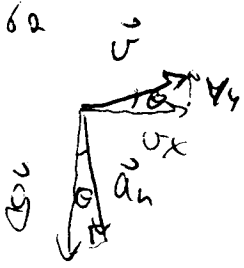
$5,77 = 25 \tan 50° - 4,905 \cdot \dfrac{25^2}{v_0^2 \cos^2 50°}$

$\underline{v_0 = 19,57 \text{ m/s}}$

(b) $t = 2,0136 \text{ s}$ (by (3)) or $t - 1 = 1,0136 \text{ s}$

$v_x = 11,2938$

$v_y = v_{0y} - 9,81 t = 1,55398$



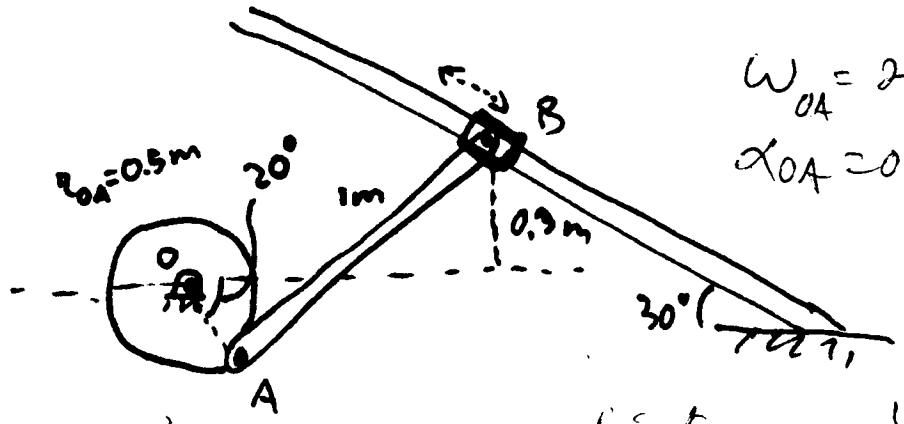
$\theta = 7,8345°$

$\underline{a_n = g \cos\theta = 9,72 \text{ m/s}^2}$

#3 /40 If the wheel OA has a constant angular velocity of 2 rad/s clockwise, find:

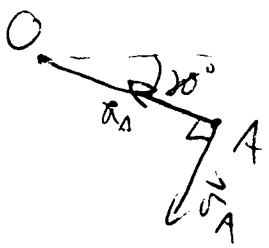
a) The angular velocity of member AB. ANS: 1,8636 rad/s ↻

b) The angular acceleration of member AB. ANS: 6,2368 rad/s² ↻



$\omega_{OA} = 2$ rad/s ↻

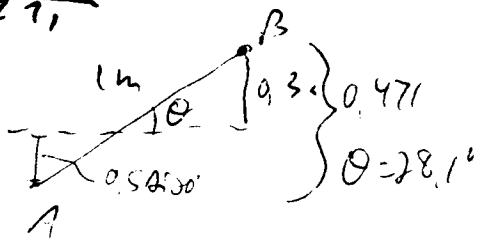
$\alpha_{OA} = 0$

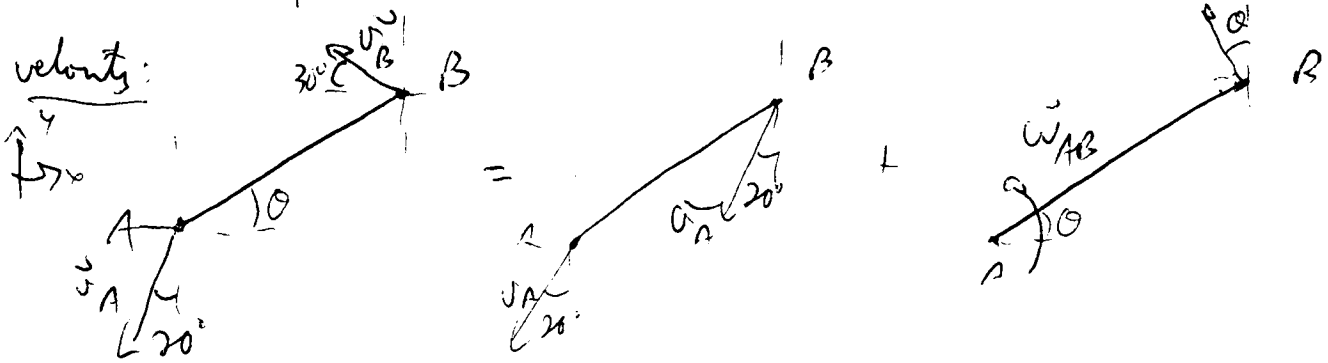


$\vec{v}_A = 1$ m/s ↙ 70°

$\vec{a}_A = 2$ m/s² ↘ 20°

velocity:





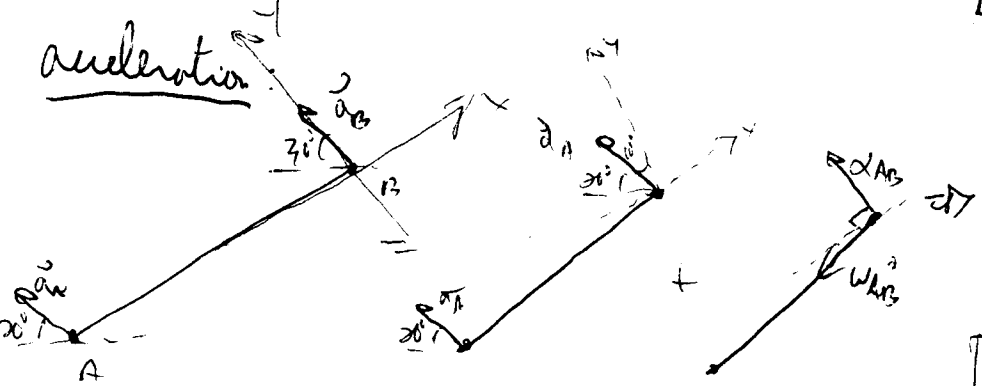
$\vec{i}$: $-v_B \cos 30° = -a \sin 20° - \omega_{AB} a \sin\theta$ (1)

$\vec{j}$: $v_B \sin 30° = -a \cos 20° + \omega_{AB} a \cos\theta$ (2)

(1) → $v_B = \omega_{AB} \frac{a \sin\theta}{\cos 30°} + \frac{a \sin 20°}{\cos 30°}$

(2) → $\omega_{AB} = 1,8636$ rad/s ↻

aceleration:



$\vec{i}$ ×

$0 = -a_A \sin 10° - \omega_{AB}^2 a \sin 58,1°$

$+ \alpha_{AB} a \cos 58,1°$

$\alpha_{AB} = 6,2368$ rad/s² ↻