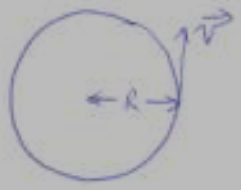
①



$|\vec{v}| = 20\,m/s$

$R = 100\,m$

(a) $v = \omega r$

$\omega = \frac{20}{100} = 0{,}2\,rad/s$

(b) Em $\Delta t = 30\,s$

$\Delta\theta = \omega_0 t$

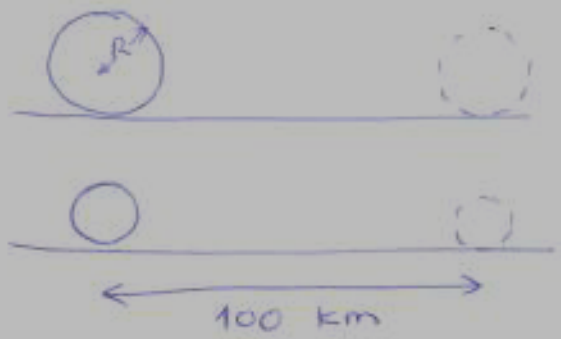
$= 0{,}2 \cdot 30 = 6\,rad$

1 volta — 2π rad

x — 6 rad

$x = \frac{\pi}{3}$ voltas

①



$R = 33\,cm$

$r = 32{,}9\,cm$

$s = \theta R$ $\quad \theta = \frac{100 \cdot 10^3}{33 \cdot 10^{-2}}$

$\theta = 3{,}03 \cdot 10^5$ ra

$\theta = 3{,}04 \cdot 10^5\,rad$

$\Downarrow$

48.224 volta

48.375 voltas

151 voltas

③ $D = 30\,cm = 30 \cdot 10^{-2}\,m \Rightarrow R = 0{,}15\,m$

(a) $\omega = 33{,}3\,rpm = \frac{33{,}3 \cdot 2\pi}{60} \approx 3{,}5\,rad/s$

(b) $v = \omega R$

$= 3{,}5 \cdot 0{,}15$

$= 0{,}525\,m/s$

(c) $a_t = 0$ $\quad (\alpha = 0)$

(d) $a_R = \frac{v^2}{R} = \frac{0{,}5^2}{0{,}15} = 1{,}8\,m/s^2$

④ $\omega_0 = 33{,}3\,rpm = 3{,}5\,rad/s$

$\omega = 0$

$\Delta t = 2\,min = 120\,s$

(a) $\omega = \omega_0 + \alpha t$

$\alpha = \frac{0 - 3{,}5}{120} = -0{,}03\,rad/s^2$

(b) $\vec{a}$ cte $\Rightarrow$ $\bar{\omega}$ = média das velocidades $\Rightarrow$ $\bar{\omega} = \frac{3{,}5 - 0}{2} = 1{,}75\,rad/s$

(c) $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\Delta\theta = \frac{0 - 3{,}5^2}{2 \cdot (-0{,}03)} = 204{,}17\,rad \Rightarrow 32{,}5$ voltas

⑤ $\Delta\theta = 40\,revol = 80\pi\,rad$

$\omega_0 = 1{,}5\,rad/s$

$\omega = 0$

(b) $\omega = \omega_0 + \alpha t$

$t = \frac{0 - 1{,}5}{-4{,}5 \cdot 10^{-3}} = 333{,}3\,s$

(a) $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\alpha = \frac{0 - 1{,}5^2}{2 \cdot 80\pi} = -4{,}5 \cdot 10^{-3}\,rad/s^2$

(c) Menos que a metade de 333,3 s:

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$40\pi = 1{,}5t - 0{,}0025\,t^2$ $\quad : t^2$

$t \rightarrow$ ~~559,2 s~~

$\rightarrow$ 112 s

⑥ $\omega_0 = 0$
$\vec{\alpha}$ cte
$\Delta t = 5s$
$\Delta\theta = 25$ rad

(a) $|\vec{\alpha}| = ?$

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$\alpha = \frac{2\Delta\theta}{t^2} = \frac{50}{25} = 2$ rad/s²

(b) $\bar{\omega} = \frac{25}{5} = 5$ rad/s

(c) $\omega = \omega_0 + \alpha t$
$= 2.5 = 10$ rad/s

(d) $\omega_0' = 10$ rad/s $\quad \Delta\theta = 10.5 + \frac{1}{2} 2.25 = 50 + 25 = 75$ rad

⑦ $\omega_0 = 0$ $\quad \alpha = 2$ rad/s² $\quad \Delta t = 3s$ $\quad \Delta\theta = 90$ rad

(a)

$90 = \omega_0' \cdot 3 + \frac{1}{2} 2 \cdot 9$

$\omega_0' = \frac{90 - 9}{3} = \frac{81}{3} = 27$ rad/s

$\omega = \omega_0 + \alpha t$
$27 = 2t$
$t = 13,5$ s

(b) 27 rad/s

⑧ $\Delta\theta = 90$ rev $= 180\pi$ rad
$\Delta t = 15s$
$\omega = 10$ rev/s $= 20\pi$ rad/s $\approx 62,8$ rad/s
$\vec{\alpha}$ cte

$\omega_0 = ?$

(a) $\omega = \omega_0 + \alpha t \rightarrow \alpha = \frac{\omega - \omega_0}{t}$

$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\omega^2 = \omega_0^2 + 2\frac{\omega - \omega_0}{t}\Delta\theta$

$\omega^2 = \omega_0^2 + 2\omega\frac{\Delta\theta}{t} - 2\frac{\omega_0\Delta\theta}{t}$

$\omega_0^2 - \frac{2\Delta\theta}{t}\omega_0 + \omega\left(\frac{2\Delta\theta}{t} - \omega\right) = 0$

$\omega_0^2 - 75,4\,\omega_0 + 789,6 = 0$

$\omega_0 \rightarrow$ ~~628~~
$\rightarrow$ 12,6 $\sim 4\pi$ rad/s

⑨ $\omega_0 = 0$
$\alpha = 2$ rad/s²
$\Delta t = 5s$

(a) $\omega = \omega_0 + \alpha t$
$= 10$ rad/s

(b) $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\Delta\theta = \frac{10^2 - 0}{2.2} = 25$ rad

(c) 2π rad $-$ 1 v
25 rad $-$ x = 4 v

(d) $r = 5$ cm $= 0,05$ m

$v = \omega r = 10\ 0,05 = 0,5$ m/s

$a_T = \alpha r = 2.0,05 = 0,1$ m/s²

(e) $a_c = \omega^2 r = 10^2 . 0,05 = 5$ m/s²

$a = \sqrt{a_T^2 + a_R^2} = 5$ m/s²

(a)

(10) $\theta_0 = 0$ $\quad \vec{\alpha}$ cte $\quad \omega = 33{,}3\ rpm = 33{,}3\,\frac{2\pi}{60} = 3{,}49\ rad/s$

$t = 0{,}25\ s$ $\quad \omega_0 = 0$

$\theta = 10^\circ = 0{,}17\ rad$

$(180^\circ - \pi\ rad$
$10^\circ - x = \frac{\pi}{18}\ rad)$

$\omega = 0 + \alpha t$

$t = \frac{\omega}{\alpha} = \frac{3{,}5}{5{,}4} = 0{,}6$

$\Delta\theta = 0 + \frac{1}{2}\alpha t^2$

$\alpha = \frac{2\Delta\theta}{t^2} = \frac{2 \cdot 0{,}17}{0{,}25^2} = 5{,}44\ rad/s^2$

(b) Sim $(a_T = \alpha r)$ (c) Não $(a_R = \omega^2 r)$

(11) $D = 60\ cm \Rightarrow R = 0{,}3\ m$

$\omega = 2{,}5\ rev/s = 5\pi\ rad/s$

$\ell = 20\ cm$

A flecha deve passar em

1 volta $(2\pi) \Longrightarrow \frac{1}{8}$ volta $(\text{é } \frac{\pi}{4}\ rad)$

$\Delta\theta = \omega_0 t \quad t = \frac{\pi}{4}\frac{1}{5\pi} = \frac{1}{20}\ s = 0{,}05\ s$

$t = \frac{\Delta\theta}{\omega_0}$

Nesse tempo a flecha de 20 cm tem que ter passado

$\Downarrow$

$\Delta x = v_0 t \quad v_0 = \frac{\Delta x}{t} = \frac{0{,}2}{0{,}05} = 4\ m/s$

(b) NÃO!

(12) $R = 10\ cm$

$\omega_0 = 0$

$\alpha = 10\ rad/s^2$

$t = 5\ s$ (a) $\omega = ?$ $\quad \omega = \omega_0 + \alpha t = 10 \cdot 5 = 50\ rad/s$

(b) $a_T = ?$ $\quad a_T = \alpha r = 10 \cdot 0{,}1 = 1\ m/s^2$

(c) $a_R = ?$ $\quad a_R = \omega^2 r = 50^2 \cdot 0{,}1 = 250\ m/s^2$

(d) $a = \sqrt{a_T^2 + a_R^2}$
$= 250\ m/s^2$

(13) $a_T = a_R$

$\alpha r = \omega^2 r$

$\alpha = \omega^2 \quad \omega = \sqrt{\alpha} = 3{,}2\ rad/s$

(b) $a_T = 1\ m/s^2$

(c) $a_R = 1\ m/s^2$

(d) $a = 1{,}4\ m/s^2$

(14) –

(15) $R = 10\ m$

$\theta = 0{,}3\,t^2$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2 \Rightarrow \frac{\alpha}{2} = 0{,}3 \quad \alpha = 0{,}6\ rad/s^2$

$t = 5s$

(a) $\omega = \omega_0 + \alpha t = 0{,}6 \cdot 5 = 3\ rad/s$

(b) $v = \omega r = 3 \cdot 10 = 30\ m/s$

(c) $a_T = \alpha r = 0{,}6 \cdot 10 = 6\ m/s^2$

(d) $a_R = \omega^2 r = 9 \cdot 10 = 90\ m/s^2$

(e) $a = \sqrt{a_T^2 + a_c^2} = 90{,}2\ m/s^2$

(16) $r_A = 15cm \quad r_B = 10cm \quad r_{B'} = 5cm \quad r_C = 25cm$

$\omega_A = 10\ rad/s$

(a) $v_A = ?$ $\quad v_A = \omega_A r_A = 10 \cdot 0{,}15 = 1{,}5\ m/s$

(b) $\omega_B = ?$ $\quad \omega_B = \frac{v_B}{r_B} = \frac{v_A}{r_B} = \frac{1{,}5}{0{,}1} = 15\ rad/s$

(c) $\omega_{B'} = ?$ $\quad \omega_{B'} = \omega_B = 15\ rad/s$

(d) $v_b = ?$ $\quad v_b = v_{B'} = \omega_{B'} r_{B'} = 15\ 0{,}05 = 0{,}75\ m/s$

(e) $\omega_C = ?$ $\quad \omega_C = \frac{v_C}{r_C} = \frac{v_{B'}}{r_C} = \frac{0{,}75}{0{,}25} = 3\ rad/s$

(17) $r_A = 10cm \quad \omega_{A0} = 0$

$r_B = 25cm \quad \alpha_A = 1{,}6\ rad/s^2$

(a) $\omega_B = 100\ \frac{rev}{min} = \frac{100 \times 2\pi\ rad}{60\ s} = 10{,}5\ rad/s$

(b) $a = ?$

$v_A = v_B$

$\omega_A r_A = \omega_B r_B$

$\omega_A = 10{,}5 \cdot \frac{0{,}25}{0{,}10} = 26{,}2\ rad/s$

(a) $\omega_A = \omega_{A0} + \alpha_A t$

$t = \frac{26{,}2}{1{,}6} = 16{,}4\ s$

(b) $a_T = \alpha_A r_A$

$= 16{,}4 \cdot 0{,}1$

$= 1{,}64\ m/s^2$

$a_R = \omega_A^2 r_A$

$= 68{,}64\ m/s^2$

$a_A = \sqrt{1{,}64^2 + 68{,}64^2}$

$= 68{,}7\ m/s^2$

$a_{T_B} = \alpha_B r_B = a_{TA} = 1{,}64\ m/s^2$

$a_{RB} = \omega_B^2 r_B = 27{,}56\ m/s^2$

$a_B = \sqrt{1{,}64^2 + 27{,}56^2}$

$= 27{,}6\ m/s^2$

Na correia: só $a_T = 1{,}64\ m/s^2$

(18) Ponteiro das horas: $\frac{1 \text{ volta}}{12 \text{ horas}} \Rightarrow \omega_h = \frac{2\pi}{12 \cdot 60} = \frac{\pi}{360}$ rad/min

Ponteiro dos min.: $\frac{1 \text{ volta}}{1 \text{ h}} \Rightarrow \omega_m = \frac{2\pi}{60} = \frac{\pi}{30}$ rad/min

Quando se encontrarem, o ponteiro dos minutos terá dado uma volta mais o quanto o ponteiro das horas andou:

$$\theta_m = 2\pi + \theta_h$$

Como ($\alpha_h = \alpha_m = 0$): $\omega_m t = 2\pi + \omega_h t$

$$\left(\frac{\pi}{30} - \frac{\pi}{360}\right) t = 2\pi \qquad t = \frac{2\pi}{\left(\frac{1}{30} - \frac{1}{360}\right)} = \frac{2}{\frac{12-1}{360}}$$

$$t = \frac{720}{11} \text{ min} = 65{,}45 \text{ min} = 1{,}09 \text{ h}$$

⇓

Supondo que saíram as 12:00, o encontro será depois das 13:05, mais precisamente às 13:5,45!

(19) Envolve velocidades relativas. (soma ou subtrai as velocidades)

(20) $\omega = 33\frac{1}{3}$ rev/min $= \frac{33{,}3}{3{,}5}$ rev/min $= \frac{3{,}5}{}$ rad/s

$r = 6 \text{ cm} = 0{,}06 \text{ m}$

(a) $a_R = \omega^2 r = 0{,}7 \text{ m/s}^2$ (b) e (c) envolvem dinâmica...