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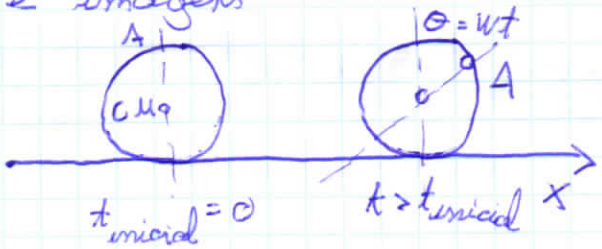
insuf.

Trabalho 2B

Estudo do rolamento dum aluído numa superfície horizontal

(1) Objetivos:

- Verificar o princípio de sobreposição no estudo do movimento dum aluído numa superfície horizontal
- Verificar a condição de rolamento sem escorregamento, isto é, que $V_{CM} = \omega r \qquad V_{CM} = 2\pi/T$
- Mostrar que o ponto de contato do aluído com o plano tem velocidade nula
- Mostrar que quando o ponto que se encontra no topo tem a velocidade máxima de valor $2V_{CM}$
- Familiarização com as técnicas de processamento de vídeo e imagem



$$x_A = x_{CM} + r \operatorname{sen} \omega t$$

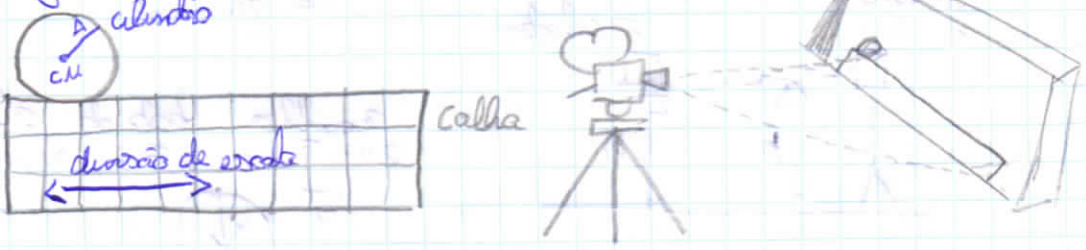
$$v_x = v_{CM} + \omega r \cos \omega t$$

$$x_A(t) = x_{CM} + \frac{v_{CM}}{\omega} \operatorname{sen} \omega t$$

$$v_x(t) = v_{CM}(1 + \cos \omega t)$$

- Se v_{CM} for constante $\rightarrow$ $x_A(t) = v_{CM}\left(t + \frac{1}{\omega} \operatorname{sen} \omega t\right)$

(2) Montagem experimental



- Medir o d do alvoto
- Nivelar a calha, V_{CM} = nos dois sentidos
- Boa iluminação
- Camera com tripé de forma a visualizar com a mascara de resolução
- Lançamento manual do alvoto.

(14-19)

Completar esq.

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(3) Análise de dados

Critérios	1	2	3	4	5	6	7
Visibilidade do Centro de Massa Ponto A e escala	Bom	Bom	Bom	Bom	Bom	Bom	Bom
Trajetória e escala comparadores	Muito Bom	Mau	Bom	Muito Bom	Bom	Muito Bom	Bocante
Velocidade adequada a leitura frames / rotação	moderada	moderada	moderada	lenta	muito Rapida	Bom	Bom

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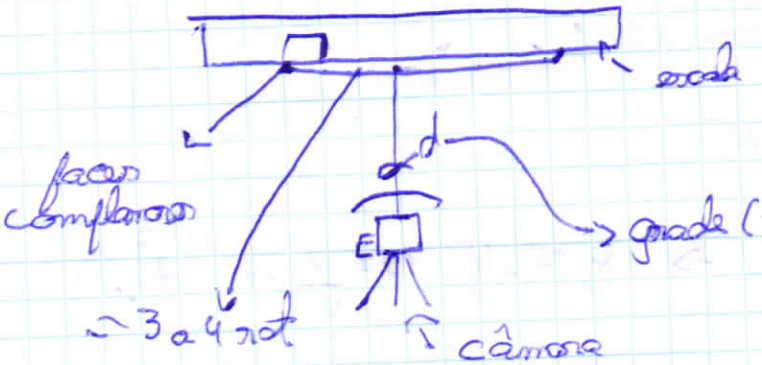
Inicio

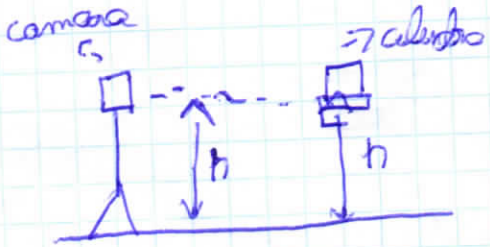
Fim

Esquema detalhado



$d_{alvoto} = 66{,}50\ mm \pm 0{,}01\ mm$

garantir q é possivel realizar 3 a 4 rotações na garagem

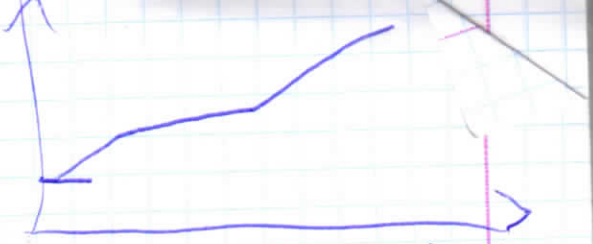


escolher lado do alvoto em que q o centro é mais legivel

$m = 4,3 \times 10^{14}$ $\quad b = 5 \times 10^{13}$

$s_m = 5 \times 10^{13}$ $\quad s_i = 7 \times 10^{13}$

$r^2 = 0,96$ $\quad s_y = 8 \times 10^{13}$



em branco apresentado

Na classe dos dados podemos verificar que no ajuste linear, apresenta resíduos pouco dispersos, conduzindo no mau ajuste.

Pensamos que isto se passa devido ao facto do defeito do tracker

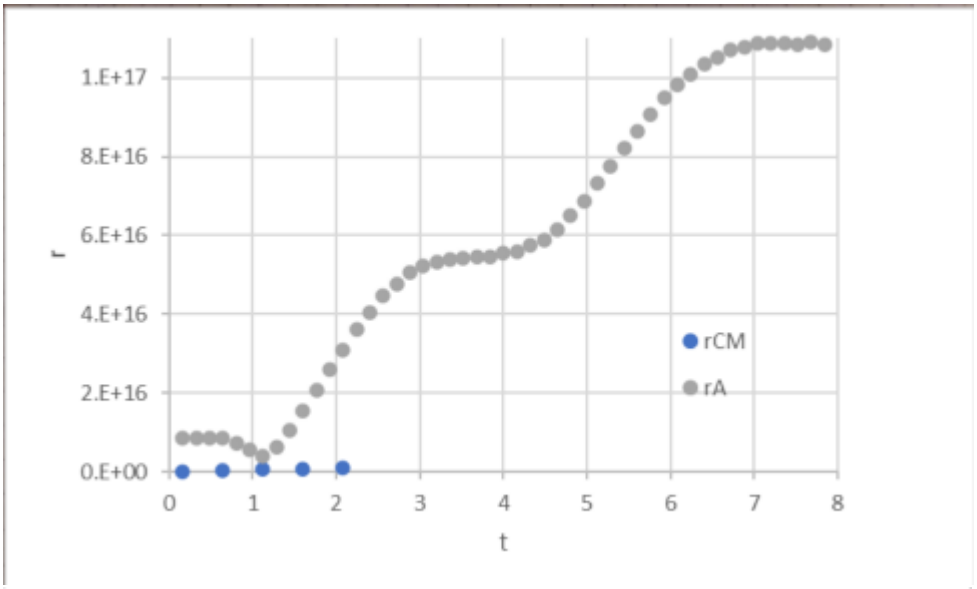
Não foi possível obter os dados pretendidos mas foi possível obter mais experiência no laboratório e saber como proceder da próxima vez.

Ou não souberam retirar os dados do vídeo com o tracker ou não retiraram todos os dados. Não fizeram o registo em vídeo de 3 a 4 notações como falámos no início?

(dados não analisáveis)

massa_A					
t	x	y	v	r	vel angula
1.12E+00	2.39E+15	-3.33E+15	2.35E+16	4.09E+15	3.53E+14
9.60E-01	5.29E+15	-1.47E+15	1.76E+16	5.49E+15	2.64E+14
1.28E+00	-5.17E+14	-6.24E+15	2.75E+16	6.26E+15	4.14E+14
8.00E-01	7.27E+15	-5.44E+14	1.14E+16	7.29E+15	1.72E+14
1.60E-01	8.46E+15	1.19E+14	NaN	8.46E+15	#VALUE!
3.20E-01	8.46E+15	1.19E+14	0.00E+00	8.46E+15	0.00E+00
4.80E-01	8.46E+15	1.19E+14	4.13E+14	8.46E+15	6.21E+12
6.40E-01	8.59E+15	1.19E+14	4.25E+15	8.59E+15	6.39E+13
1.44E+00	-3.28E+15	-1.01E+16	3.00E+16	1.06E+16	4.51E+14
1.60E+00	-5.52E+15	-1.44E+16	3.17E+16	1.55E+16	4.77E+14
1.76E+00	-6.84E+15	-1.96E+16	3.31E+16	2.07E+16	4.98E+14
1.92E+00	-7.36E+15	-2.49E+16	3.26E+16	2.59E+16	4.91E+14
2.08E+00	-7.22E+15	-3.00E+16	3.36E+16	3.09E+16	5.06E+14
2.24E+00	-6.15E+15	-3.56E+16	3.27E+16	3.61E+16	4.92E+14
2.40E+00	-4.69E+15	-4.02E+16	3.10E+16	4.05E+16	4.67E+14
2.56E+00	-1.91E+15	-4.45E+16	2.85E+16	4.46E+16	4.29E+14
2.72E+00	4.73E+14	-4.77E+16	2.43E+16	4.77E+16	3.65E+14
2.88E+00	3.25E+15	-5.04E+16	2.06E+16	5.05E+16	3.09E+14
3.04E+00	5.63E+15	-5.18E+16	1.57E+16	5.21E+16	2.36E+14
3.20E+00	7.61E+15	-5.29E+16	1.04E+16	5.34E+16	1.56E+14
3.36E+00	8.67E+15	-5.31E+16	6.53E+15	5.38E+16	9.82E+13
3.52E+00	9.60E+15	-5.35E+16	3.69E+15	5.44E+16	5.55E+13
3.68E+00	9.73E+15	-5.36E+16	2.06E+15	5.45E+16	3.10E+13
3.84E+00	9.07E+15	-5.39E+16	6.53E+15	5.47E+16	9.82E+13
4.00E+00	8.01E+15	-5.48E+16	1.03E+16	5.54E+16	1.56E+14
4.16E+00	6.17E+15	-5.55E+16	1.50E+16	5.58E+16	2.26E+14
4.32E+00	3.92E+15	-5.74E+16	1.73E+16	5.75E+16	2.61E+14
4.48E+00	1.81E+15	-5.89E+16	1.96E+16	5.90E+16	2.94E+14
4.64E+00	-6.94E+14	-6.16E+16	2.36E+16	6.16E+16	3.55E+14
4.80E+00	-2.67E+15	-6.50E+16	2.46E+16	6.51E+16	3.69E+14
4.96E+00	-4.25E+15	-6.86E+16	2.64E+16	6.87E+16	3.97E+14
5.12E+00	-5.56E+15	-7.30E+16	2.83E+16	7.32E+16	4.26E+14
5.28E+00	-6.22E+15	-7.74E+16	2.82E+16	7.77E+16	4.24E+14
5.44E+00	-6.34E+15	-8.19E+16	2.77E+16	8.22E+16	4.16E+14
5.60E+00	-5.81E+15	-8.63E+16	2.75E+16	8.65E+16	4.14E+14
5.76E+00	-5.14E+15	-9.07E+16	2.77E+16	9.08E+16	4.17E+14
5.92E+00	-3.55E+15	-9.49E+16	2.57E+16	9.49E+16	3.86E+14
6.08E+00	-1.83E+15	-9.82E+16	2.28E+16	9.82E+16	3.43E+14
6.24E+00	2.92E+14	-1.01E+17	2.28E+16	1.01E+17	3.43E+14
6.40E+00	3.07E+15	-1.04E+17	2.02E+16	1.04E+17	3.04E+14
2.88E+00	3.25E+15	-5.04E+16	2.06E+16	5.05E+16	3.09E+14
3.04E+00	5.63E+15	-5.18E+16	1.57E+16	5.21E+16	2.36E+14
3.20E+00	7.61E+15	-5.29E+16	1.04E+16	5.34E+16	1.56E+14
3.36E+00	8.67E+15	-5.31E+16	6.53E+15	5.38E+16	9.82E+13
3.52E+00	9.60E+15	-5.35E+16	3.69E+15	5.44E+16	5.55E+13
3.68E+00	9.73E+15	-5.36E+16	2.06E+15	5.45E+16	3.10E+13
3.84E+00	9.07E+15	-5.39E+16	6.53E+15	5.47E+16	9.82E+13
4.00E+00	8.01E+15	-5.48E+16	1.03E+16	5.54E+16	1.56E+14
4.16E+00	6.17E+15	-5.55E+16	1.50E+16	5.58E+16	2.26E+14
4.32E+00	3.92E+15	-5.74E+16	1.73E+16	5.75E+16	2.61E+14
4.48E+00	1.81E+15	-5.89E+16	1.96E+16	5.90E+16	2.94E+14
4.64E+00	-6.94E+14	-6.16E+16	2.36E+16	6.16E+16	3.55E+14
4.80E+00	-2.67E+15	-6.50E+16	2.46E+16	6.51E+16	3.69E+14
4.96E+00	-4.25E+15	-6.86E+16	2.64E+16	6.87E+16	3.97E+14
5.12E+00	-5.56E+15	-7.30E+16	2.83E+16	7.32E+16	4.26E+14
5.28E+00	-6.22E+15	-7.74E+16	2.82E+16	7.77E+16	4.24E+14
5.44E+00	-6.34E+15	-8.19E+16	2.77E+16	8.22E+16	4.16E+14
5.60E+00	-5.81E+15	-8.63E+16	2.75E+16	8.65E+16	4.14E+14
5.76E+00	-5.14E+15	-9.07E+16	2.77E+16	9.08E+16	4.17E+14
5.92E+00	-3.55E+15	-9.49E+16	2.57E+16	9.49E+16	3.86E+14
6.08E+00	-1.83E+15	-9.82E+16	2.28E+16	9.82E+16	3.43E+14
6.24E+00	2.92E+14	-1.01E+17	2.28E+16	1.01E+17	3.43E+14
6.40E+00	3.07E+15	-1.04E+17	2.02E+16	1.04E+17	3.04E+14
6.56E+00	5.32E+15	-1.05E+17	1.58E+16	1.05E+17	2.37E+14
6.72E+00	6.77E+15	-1.07E+17	1.21E+16	1.07E+17	1.83E+14
6.88E+00	8.49E+15	-1.07E+17	9.98E+15	1.08E+17	1.50E+14
7.52E+00	9.42E+15	-1.08E+17	7.21E+15	1.08E+17	1.08E+14
7.84E+00	5.85E+15	-1.08E+17	NaN	1.09E+17	#VALUE!
7.20E+00	1.05E+16	-1.08E+17	3.33E+15	1.09E+17	5.00E+13
7.36E+00	1.07E+16	-1.08E+17	3.40E+15	1.09E+17	5.12E+13
7.04E+00	9.68E+15	-1.08E+17	6.67E+15	1.09E+17	1.00E+14
7.68E+00	8.49E+15	-1.09E+17	1.13E+16	1.09E+17	1.69E+14

massa_cm					
t	x	y	v	v (aj lin)	resídos
1.60E-01	1.24E+14	-3.69E+14	7.74E+14	5.38E+28	5.38E+28
6.40E-01	3.73E+14	-2.22E+15	5.83E+14	1.62E+29	1.62E+29
1.12E+00	5.11E+14	-1.15E+16	4.56E+14	2.22E+29	2.22E+29
1.60E+00	6.48E+14	-2.05E+16	4.05E+14	2.82E+29	2.82E+29
2.08E+00	1.03E+15	-2.83E+16	4.95E+14	4.48E+29	4.48E+29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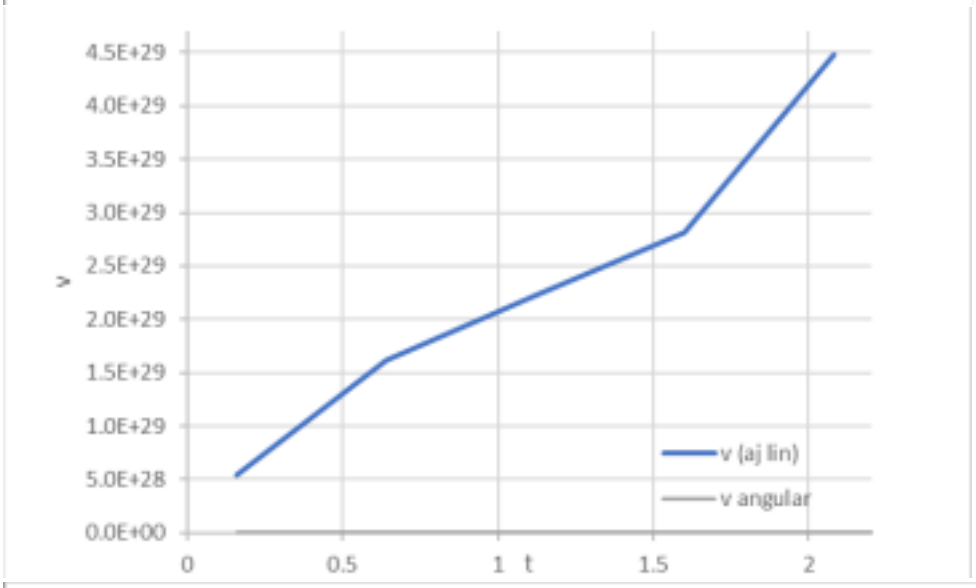
8.E+16
6.E+16
4.E+16
2.E+16
0.E+00
r
0
1
2
3
4
5
6
7
8
t
rCM
rA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4.0E+29
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3.0E+29
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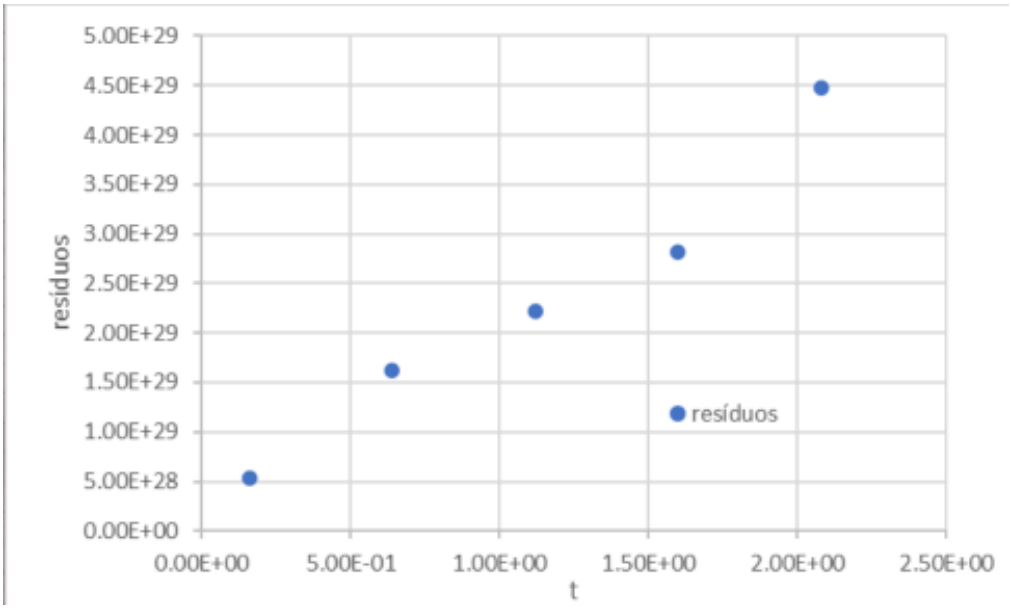
2.0E+29
1.5E+29
1.0E+29
5.0E+28
0.0E+00
v
0
0.5
1
t
1.5
2
v (aj lin)
v angular


5.00E+29
4.50E+29
4.00E+29
3.50E+29
3.00E+29
2.50E+29
2.00E+29
1.50E+29
1.00E+29
5.00E+28
0.00E+00
resíduos
0.00E+00
5.00E-01
1.00E+00
1.50E+00
2.00E+00
2.50E+00
t
resíduos