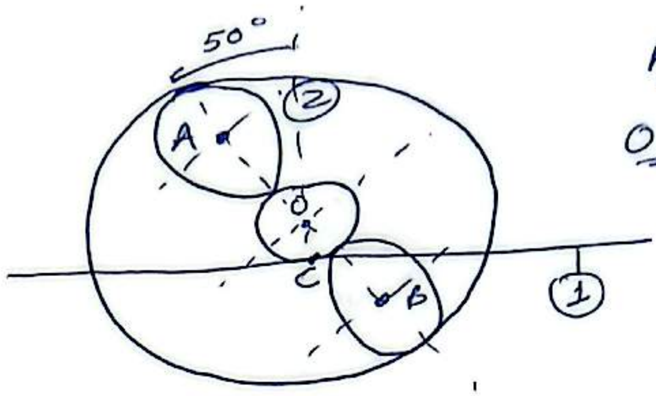
PROBLEM 2



Ring: mass m y 3R

O y B: mass m y R

A: mass 1,5m y R

$\mu_G = 0{,}1$; $\mu_D = 0{,}1$

a) ¿ α ? Initial position

$$M_{TOTAL} = m + m + m + 1{,}5m = 4{,}5m$$

We calculate de center of mass C(CM)

We place a longitudinal axis (y') with origin in C and positive direction to A

$y'_O = R$

$y'_A = 3R$

$y'_{Ring} = R$

$y'_B = -R$

$$\Rightarrow y'_{CM} = \frac{1{,}5m\cdot(3R) + m(R) + m(R) + m(-R)}{4{,}5m} = \frac{11}{9}R$$

Now, we calculate ~~de~~ ~~moment momentum~~ the moment of inertia with respect to the point C

$$I_C = I_{CM,local} + m\cdot d^2 \quad \text{(Th Steiner)}$$

Ring: $I_{C,Ring} = m(3R)^2 + m(R)^2 = 10mR^2$

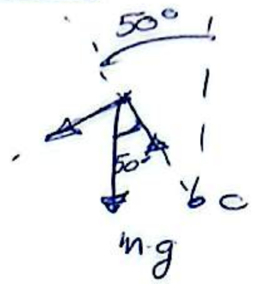
Disk O: $I_{C,O} = \frac{1}{2}mR^2 + mR^2 = 1{,}5mR^2$

Disk A: $I_{C,A} = \frac{1}{2}(1{,}5m)R^2 + 1{,}5m(3R)^2 = 14{,}25\,mR^2$

Disk B: $I_{C,B} = \frac{1}{2}mR^2 + mR^2 = 1{,}5mR^2$

$I_C = \sum_{i=1}^{n} I_{Ci}$; $\boxed{I_C = 27,25\, m R^2}$

$\sum M_C = I_C \cdot \alpha$



$\Rightarrow M \cdot g \cdot d_{cm} \cdot \sin 50° = I_C \cdot \alpha$

Then, we can obtain α that is the angular acceleration

b) The reaction force with the ground when the system is at 90° from the vertical

To resolve it we need the angular velocity (ω) and the angular acceleration (α)

We calculate the angular velocity at 90° with conservation of energy if we suppose that the disk doesn't slide

So $\quad W_{Fext} = \Delta E_c$

W_{Fext} are only due to the weight of the system so

$W_{Fext} = mgh \qquad \Delta E_c = E_{c2} - \cancel{E_{c1}}$ 0 (Initially rest)

$h_0 = d_{cm} \cdot \cos 50°$ y $h_f = 0$

$\Rightarrow Mg\, d_{cm} \cdot \cos 50° = \frac{1}{2} I_C \omega^2$

Then:

$$\omega^2 = \frac{2(4,5m)g\left(\frac{11}{9}R\right)\cos 50^\circ}{27,25 mR^2} = \frac{44 g \cos 50^\circ}{109 R}$$

To obtain the angular acceleration we use dynamics equation from momentum

$$\Sigma M_c = I_c \cdot \alpha \; ; \quad M_{TOTAL} \cdot g \cdot d_{cm} = I_c \cdot \alpha_{90^\circ}$$

$$\alpha_{90^\circ} = \frac{5,5 mgR}{27,25 m R^2} \; ; \quad \boxed{\alpha_{90^\circ} = \frac{22 g}{109 R}}$$

The components from the acceleration of the CM at 90°

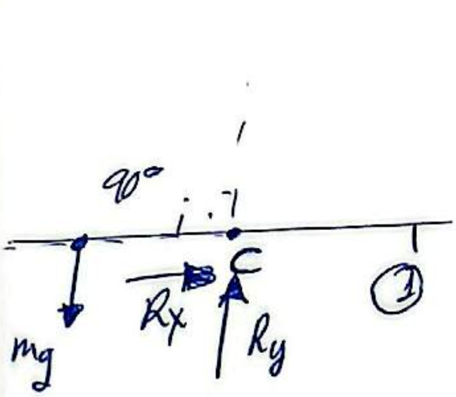
an (normal acceleration) direction to C

(It's important to mind that we suppose that C is a point that doesn't have velocity, so we could refer the velocity of everything from this point)

So, $a_n = \omega^2 \cdot d_{cm} = \left(\frac{11}{9}R\right) \frac{44 g\cos(50^\circ)}{109 R}$

a_t (direction ↓) $= \alpha_{90^\circ} \cdot d_{cm} = \left(\frac{11}{9}R\right) \cdot \frac{22 g}{109 R}$

DCL



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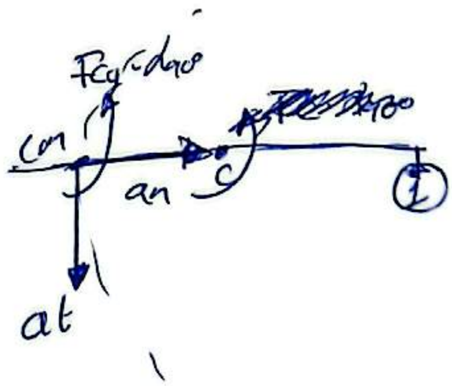

Newton's equations $\qquad R = 2\,cm$ (if we look the exercise)

$\Sigma F_x = m\vec{a}_{Gx}$; $\quad R_x = M(-a_n)$; $\quad \underline{R_x = -24{,}26\,m\ (N)}$

$\Sigma F_y = m\vec{a}_{Gy}$; $\quad R_y - Mg = M(-a_t)$; $\quad \underline{R_y = 33{,}89\,m\ (N)}$

$\|R\| = \sqrt{R_x^2 + R_y^2}$; $\quad \boxed{\|R\| \approx 36{,}77\,m}\ (N)$

Our F_r is R_x so $\underline{F_r = 24{,}26\,m}$

And the maximum F_r that we ~~can~~ ~~have~~ could have would be $F_{r\,max} = \mu_E \cdot N = \mu_E \cdot R_y = 6{,}78\,m$

So $F_r > F_{r\,max}$ and our hypothesis is incorrect;

I don't know how to do it knowing that now the disk slide and the F_r is $\mu_d \cdot N$