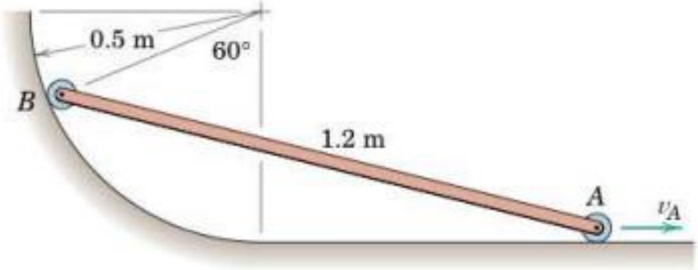
ESCUELA SUPERIOR POLITECNICA DEL LITORAL
FACULTAD DE INGENIERIA MECANICA Y CIENCIAS DE LA PRODUCCION
SEGUNDA EVALUACION DE MECANICA VECTORIAL SEGUNDO TERMINO 2024

Paralelo: Fecha: 25 de enero del 2024 Profesor:

Nombre……………………………………CI.:…………………………Firma:……………………

PRIMER TEMA: Cinemática plana (20%)

La barra AB tiene una velocidad contante en el punto A de 3 m/s hacia la derecha. Determine a) la aceleración tangencial del punto B, b) la aceleración angular de la barra.



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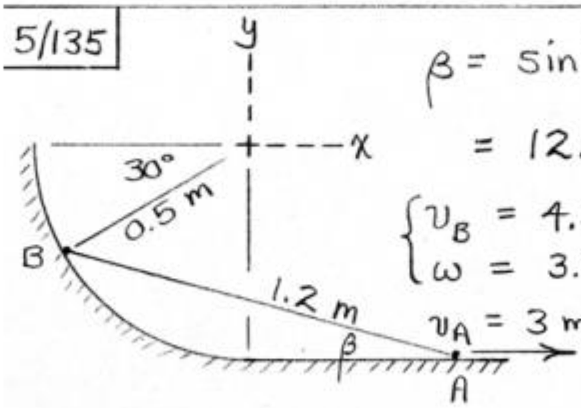


$$\beta = \sin^{-1}\frac{0.5 - 0.5\sin 30^\circ}{1.2} = 12.02^\circ$$

$$\begin{cases} v_B = 4.38 \text{ m/s} & (\text{Prob. } 5/68) \\ \omega = 3.23 \text{ rad/s} \end{cases}$$

$$v_A = 3 \text{ m/s} = \text{constant}$$

$$\underline{a}_B = \underline{a}_A + \underline{a}_{B/A} = \underline{a}_A + \underline{\alpha} \times \underline{r}_{B/A} - \omega^2 \underline{r}_{B/A}$$

$$a_{B_t}(\sin 30^\circ \underline{i} - \cos 30^\circ \underline{j}) + \frac{4.38^2}{0.5}(\cos 30^\circ \underline{i} + \sin 30^\circ \underline{j})$$
$$= \underline{0} + \alpha \underline{k} \times 1.2(-\cos 12.02^\circ \underline{i} + \sin 12.02^\circ \underline{j})$$
$$- 3.23^2 (1.2)(-\cos 12.02^\circ \underline{i} + \sin 12.02^\circ \underline{j})$$

Carry out vector algebra & equate coefficients:

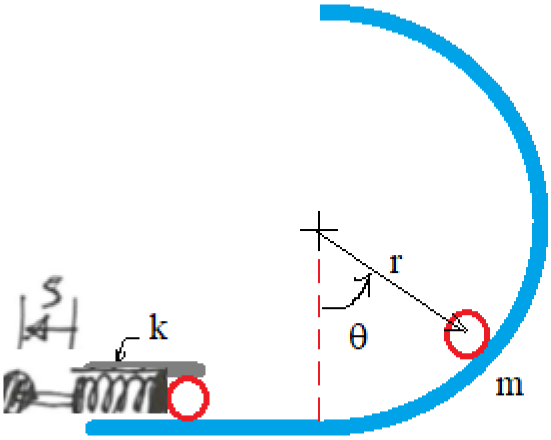
$\underline{i}$: $\frac{1}{2}a_{B_t} + 33.3 = -0.250\alpha + 12.28$

$\underline{j}$: $-\frac{\sqrt{3}}{2}a_{B_t} + 19.21 = -1.174\alpha - 2.61$

Solution: $\underline{a_{B_t} = -23.9 \text{ m/s}^2}$, $\underline{\alpha = -36.2 \text{ rad/s}^2}$

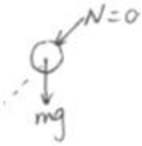
SEGUNDO TEMA: Conservación de la energía (20%)

El resorte del mecanismo de disparo se tira hacia atrás una distancia s desde su posición neutra y luego se suelta. Se empuja hacia adelante una bola con masa m y rueda por una pista circular con radio r. Supóngase que no hay fricción y desprecie el peso del resorte, determine el ángulo máximo θmax que recorre la pelota por la pista antes de perder contacto.



Solution: $h = r + r \cdot \sin(\theta - 90^\circ) = r + r\sin\phi$.

When the ball loses contact, it still has velocity.



$$mg\sin\phi = m\frac{V^2}{r}$$

$$mV^2 = mgr\sin\phi$$

$$T_1 + V_1 = T_2 + V_2$$

$$0 + \tfrac{1}{2}ks^2 = mgh + \tfrac{1}{2}mV^2$$

$$\tfrac{1}{2}ks^2 = mgr(1+\sin\phi) + \tfrac{1}{2}mgr\sin\phi$$

$$\frac{ks^2}{mgr} = 2 + 2\sin\phi + \sin\phi$$

$$3\sin\phi = \frac{ks^2}{mgr} - 2$$

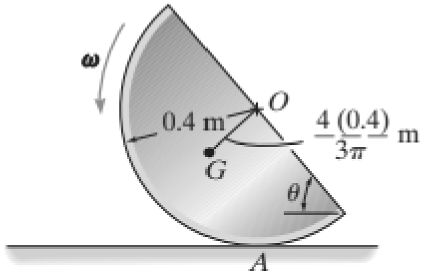
$$\sin\phi = \frac{ks^2}{3mgr} - \frac{2}{3}$$

$$\phi = \sin^{-1}\left(\frac{ks^2}{3mgr} - \frac{2}{3}\right)$$

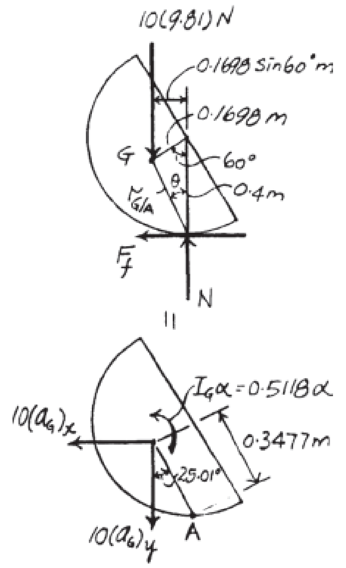
$$\boxed{\theta = \phi + \frac{\pi}{2} = \sin^{-1}\left(\frac{ks^2}{3mgr} - \frac{2}{3}\right) + \frac{\pi}{2}}$$

TERCER TEMA: Cinética (30%)

El disco semicircular de masa de 10 kg está rodando a ω= 4 rad/s en el instante θ= 60º. Si el coeficiente de fricción estática en A es μ_s= 0.5, determine si el disco rueda desliza en este instante



Equations of Motion: The mass moment of inertia of the semicircular disk about its center of mass is given by $I_G = \frac{1}{2}(10)\left(0.4^2\right) - 10\left(0.1698^2\right) = 0.5118\ \text{kg}\cdot\text{m}^2$. From the geometry, $r_{G/A} = \sqrt{0.1698^2 + 0.4^2 - 2(0.1698)(0.4)\cos 60^\circ} = 0.3477$ m Also, using law of sines, $\frac{\sin\theta}{0.1698} = \frac{\sin 60^\circ}{0.3477}$, $\theta = 25.01^\circ$. Applying Eq. 17–16, we have

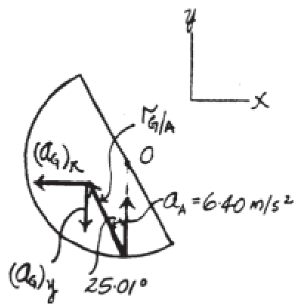


$$\zeta + \Sigma M_A = \Sigma(M_k)_A;\qquad 10(9.81)(0.1698\sin 60^\circ) = 0.5118\alpha + 10(a_G)_x\cos 25.01^\circ(0.3477) + 10(a_G)_y\sin 25.01^\circ(0.3477) \qquad \textbf{(1)}$$

$$\overset{+}{\leftarrow}\Sigma F_x = m(a_G)_x;\qquad F_f = 10(a_G)_x \qquad \textbf{(2)}$$

$$+\uparrow F_y = m(a_G)_y;\qquad N - 10(9.81) = -10(a_G)_y \qquad \textbf{(3)}$$

Kinematics: Assume that the semicircular disk does not slip at A, then $(a_A)_x = 0$. Here, $\mathbf{r}_{G/A} = \{-0.3477\sin 25.01^\circ\mathbf{i} + 0.3477\cos 25.01^\circ\mathbf{j}\}$ m $= \{-0.1470\mathbf{i} + 0.3151\mathbf{j}\}$ m. Applying Eq. 16–18, we have



$$\mathbf{a}_G = \mathbf{a}_A + \alpha\times\mathbf{r}_{G/A} - \omega^2\mathbf{r}_{G/A}$$

$$-(a_G)_x\mathbf{i} - (a_G)_y\mathbf{j} = 6.40\mathbf{j} + \alpha\mathbf{k}\times(-0.1470\mathbf{i} + 0.3151\mathbf{j}) - 4^2(-0.1470\mathbf{i} + 0.3151\mathbf{j})$$

$$-(a_G)_x\mathbf{i} - (a_G)_y\mathbf{j} = (2.3523 - 0.3151\,\alpha)\,\mathbf{i} + (1.3581 - 0.1470\alpha)\mathbf{j}$$

Equating **i** and **j** components, we have

$$(a_G)_x = 0.3151\alpha - 2.3523 \qquad \textbf{(4)}$$

$$(a_G)_y = 0.1470\alpha - 1.3581 \qquad \textbf{(5)}$$

Solving Eqs. (1), (2), (3), (4), and (5) yields:

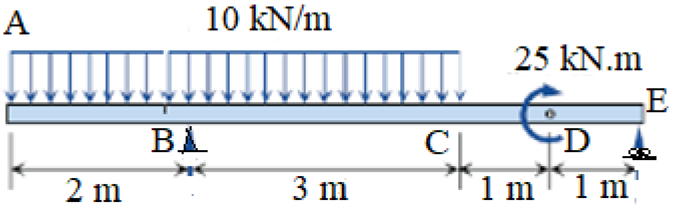
$$\alpha = 13.85\ \text{rad/s}^2 \qquad (a_G)_x = 2.012\ \text{m/s}^2 \qquad (a_G)_y = 0.6779\ \text{m/s}^2$$

$$F_f = 20.12\ \text{N} \qquad N = 91.32\ \text{N}$$

Since $F_f < (F_f)_{max} = \mu_s N = 0.5(91.32) = 45.66$ N, then the semicircular **disk does not slip**. **Ans.**

CUARTO TEMA: Fuerza en vigas (30%)

Dibuje los diagramas de fuerza cortante y momento flector para la viga especificada en la siguiente figura. Dé valores numéricos en todos los puntos de cambio de fuerza cortante y momento flector.



$\circlearrowleft + \ \Sigma M_B = 0 \quad -0.5(50) - 25 + 5(R_E) = 0 \Rightarrow R_E = 10\ kN \uparrow$

$+\uparrow \ \Sigma F_y = 0 \quad R_{By} + R_E = 50 \Rightarrow R_{By} = 40\ kN \uparrow$

$\xrightarrow{+} \ \Sigma F_x = 0 \quad R_{Bx} = 0$

Grafica M vs x

$A_1 = -\frac{1}{2}(2)(20) = -20\ kN.m$

$A_2 = \frac{1}{2}(2)(20) = +20\ kN.m$

$A_3 = \frac{1}{2}(1)(10) = -5\ kN.m$

$A_4 = 1(10) = 10\ kN$

$A_5 = 1(10) = 10\ kN$