Exam 2 - 012

Detailed solution by Dr. M. S. Kariapper

(13)

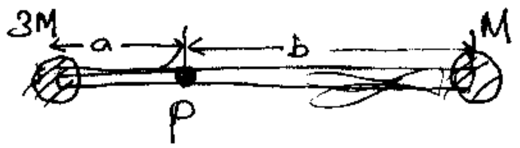
$$\left.\begin{aligned} \omega &= 98 \text{ rad/s} \\ \Delta\theta &= 37 \text{ rev} \\ t &= 3.00 \text{ s} \end{aligned}\right\} \quad \omega_0 = ?$$

$$\Delta\theta = \frac{1}{2}(\omega + \omega_0)\, t$$

$$37 \text{ rev}\left(\frac{2\pi \text{ rad}}{1 \text{ rev}}\right) = \frac{1}{2}(98 + \omega_0)(3.00)$$

$$\boxed{\omega_0 = 57 \text{ rad/s}}$$

(14)



One can't use the definition $W = \int \tau\, \Delta\theta = \tau\, \Delta\theta$ (for constant τ), here because τ and $\Delta\theta$ are unknown. So let us use Work-Energy theorem ~~for rotation~~

$$W_{net} = \Delta K$$

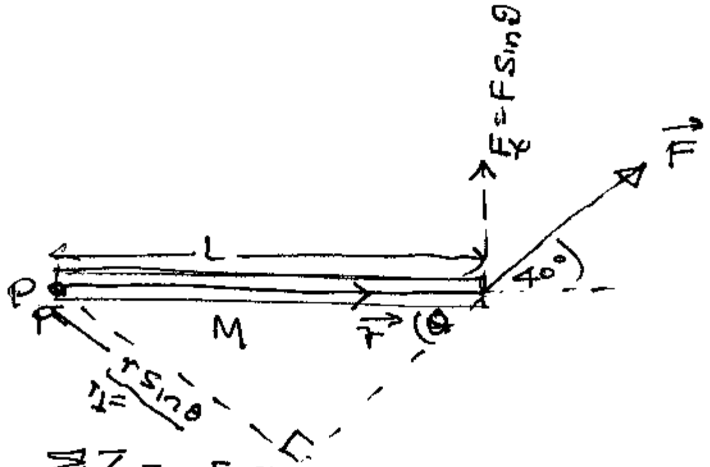
$$W = \frac{1}{2} I (\omega^2 - 0^2)$$

$$= \frac{1}{2}\left\{(3Ma^2 + Mb^2)\right\}(5)^2$$

$$= \frac{1}{2}\left\{3(0.4)(0.3)^2 + (0.40)(0.5)^2\right\} 25$$

$$\boxed{W = 2.6\ J}$$

(15)



$$\underbrace{\Sigma\tau}_{\downarrow} = I\alpha$$

$$\underbrace{\vec{r}\wedge\vec{F}}_{\downarrow} = I\vec{\alpha}$$

$$\underset{\substack{\parallel \\ (L)}}{r}F\sin 40 = \left(\tfrac{1}{3}ML^2\right)\alpha$$

Note:

$$\vec{r}\wedge\vec{F} = r\underbrace{F\sin\theta} = rF_t = 1$$

$$= \underbrace{r\sin\theta}F = r_\perp F$$

& $$I_p = I_{com} + Mh^2 = \frac{1}{12}ML^2 + M\left(\frac{L}{2}\right)^2 = \frac{1}{3}ML^2$$

$$\Rightarrow (0.80)(5.0)\sin 40 = \left(\tfrac{1}{3}(1.2)(0.80)^2\right)\alpha$$

$$\boxed{\alpha = 10\ rad/s^2}$$

(16)

$$L_i = L_f$$

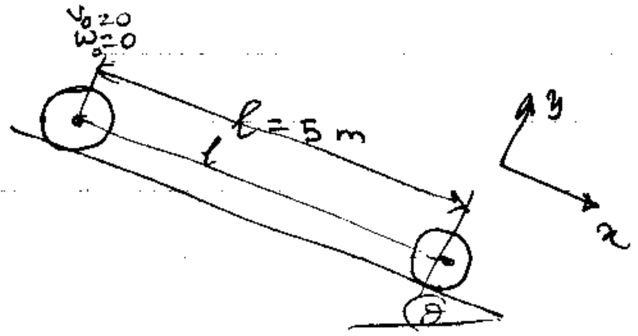
$$I_i \omega_i = I_f \omega_f$$

when he stretch the arm I_f increases

so $\boxed{\omega_f \text{ decreases}}$

to keep $I_f \omega_f = I_i \omega_i$

(17)



$$a_{com} = \frac{g \sin\theta}{1 + \frac{I_{com}}{mR^2}}$$

refer to my solution in 021 Q18 for more details

$\frac{I_{com}}{mR^2} = \frac{1}{2}$ for cylinder

$$a_{com} = \frac{(9.80) \sin 30}{1 + 0.5} = 3.27 \ m/s^2$$

Now this is motion with constant 'a' with the following given:

$a = 3.27 \ m/s^2$

$V_0 = 0$

$\Delta x = 5 \ m$

find V ?

$\cancel{\Delta x = \frac{1}{2}(v+}$

$v^2 = v_0^2 + 2a(\Delta x)$

$v^2 = 0 + 2(3.27)(5)$

$\boxed{v = 5.7 \ \ m/s}$

(18) $\vec{F} = \langle 2, -3, 0 \rangle$

$\vec{r} = \langle 0.5, +2, 0 \rangle$

$\cancel{\vec{\tau} = \vec{r} \wedge \vec{F} = \langle 2, -3, 0 \rangle \wedge \langle 0.5, +2, 0 \rangle}$

$= \cancel{2\hat{i} \wedge \langle 0.5, 2, 0 \rangle}$

$\cancel{+ 3\hat{j} \wedge \langle 0.5, 2, 0 \rangle}$

$= \cancel{2\hat{i} \wedge 2\hat{j} - 3\hat{j} \wedge 0.5\hat{i}}$

$\cancel{= 4\hat{k} - 1.5(-\hat{k})}$

$\vec{\tau} = \vec{r} \wedge \vec{F} = \langle 0.5, 2, 0 \rangle \wedge \langle 2, -3, 0 \rangle$

$= 0.5\hat{i} \wedge \langle \cancel{2}, -3, \cancel{0} \rangle + 2\hat{j} \wedge \langle 2, \cancel{-3}, \cancel{0} \rangle$

$= (0.5\hat{i} \wedge (-3\hat{j})) + (2\hat{j} \wedge 2\hat{i})$

$= -1.5\hat{k} + 4(-\hat{k})$

$\boxed{\vec{\tau} = -5.5\hat{k}}$