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31. $\theta = s/r$

(a) Substitute 3.0 m and 1.5 m for s and r respectively in the above mentioned expression of angular position and solve for θ

$$\theta = \frac{3.0\,m}{1.5\,m}$$

Hence, the particles rotate at 2.0 rad

$$\omega = \frac{d\theta}{dt}$$

(b) Substitute 2.0 rad for $d\theta$ and 1.0 s for dt in the above mentioned exp. and solve for ω

$$\omega = \frac{2\,rad}{1.0\,s} = 2\,rad/s$$

Hence, the angular velocity of the particle in 1.0 s is 2.0 rad/s

Using $a_c = v^2/r$ and $v = s/t$

Substitute 3.0 m for s and 1.0 s for t in the exp. of linear speed as mentioned above and solve,

$$v = \frac{3.0\,m}{1.0\,s} = 3.0\,m/s$$

Thus, the linear speed of the particle is 3.0 m/s

Substitute 3.0 m/s for v and 1.5 m for r in the above exp. of ~~radial~~ radial acc. and solve,

$$a_c = \frac{(3.0\ m/s)^2}{1.5\ m} = 6.0\ m/s^2$$

Hence, the acceleration of the particle is 6.0 m/s²

35. $$\alpha = \frac{d\omega}{dt} = \frac{\omega_f - \omega_i}{t_f - t_i}$$

(a) Using $\omega = (25.0t)$ rad/s

Substitute 2.0 s for t in the above function and solve

$$\omega = (25.0)(2.0\ s)\ rad/s = 50.0\ rad/s$$

Hence, the instantaneous angular velocity of the propellor at t = 2.0 s is 50.0 rad/s

(b) Substitute 50.0 rad/s for ω_f, 0.0 rad/s for ω_i, 2.0 s for t_f and 0.0 s for t_i in the above mentioned exp. for α and solve,

$$\alpha = \frac{(50.0\ rad/s) - (0.0\ rad/s)}{(2.0\ s) - (0.0\ s)} = \frac{50.0\ rad/s}{2.0\ s}$$

$$= 25.0\ rad/s$$

Hence, the angular acceleration of the propellors is 25.0 rad/s

37. $\omega_f^2 = \omega_0^2 + 2\alpha(\Delta\theta)$

(a) Substitute 0 rad/s for ω_0, 5.0 rad/s² for α and 300 rad for $\Delta\theta$ in the above mentioned expression and solve,

$$\omega_f^2 = (0 \text{ rad/s})^2 + 2(5.0 \text{ rad/s}^2)(300 \text{ rad})$$
$$= 3000 \text{ rad}^2/\text{s}^2$$

Further solve for ω_f,

$$\omega_f = \sqrt{3000 \text{ rad}^2/\text{s}^2} = 54.8 \text{ rad/s}$$

Hence, the final angular velocity of the wheel is 54.8 rad/s

$\omega_f = \omega_0 + \alpha t$

(b) Substitute 54.8 rad/s for ω_f, 0 rad/s for ω_0 and 5.0 rad/s² for α in the above mentioned expression and solve,

$$54.8 \text{ rad/s} = 0 \text{ rad/s} + (5.0 \text{ rad/s}^2)t$$

$$t = \frac{54.8 \text{ rad/s}}{5.0 \text{ rad/s}^2} = 11 \text{ s}$$

Hence, the time elapse for the wheel to turn through 300 rad is 11s.

39. $\omega_f = \omega_0 + \alpha t$

(a) Convert the units of initial and final angular velocity into rad/s

$$\omega_0 = 500\left(\frac{\text{rev}}{\text{min}}\right)\left(\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right) = 52.3\ \text{rad/s}$$

$$\omega_f = 1500\left(\frac{\text{rev}}{\text{min}}\right)\left(\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right) = 157\ \text{rad/s}$$

Substitute 157 rad/s for ω_f, 52.3 rad/s for ω_0 and 120 s for t in the above mentioned equation and solve,

$$157\ \text{rad/s} = 52.3\ \text{rad/s} + \alpha(120\ \text{s})$$
$$104.7\ \text{rad/s} = \alpha(120\ \text{s})$$

Further solve for α,

$$\alpha = \frac{104.7\ \text{rad/s}}{120\ \text{s}} = 0.8\cancel{0}7\ \text{rad/s}^2$$

Hence, the angular acceleration of the rotating body is $0.87\ \text{rad/s}^2$

$$\omega_f^2 = \omega_0^2 + 2\alpha(\theta_f - \theta_0)$$

Substitute 157 rad/s for ω_f, 52.3 rad/s for ω_0, 0.87 rad/s^2 for α and 0 rad for θ_0 in the above exp. and solve,

$$(157\ \text{rad/s})^2 = (52.3\ \text{rad/s})^2 + 2(0.87\ \text{rad/s}^2)(\theta_f - 0\ \text{rad})$$

$$24649\ \text{rad}^2/\text{s}^2 = 2735.29\ \text{rad}^2/\text{s}^2 + (1.74\ \text{rad/s}^2)\theta_f$$

$$21913.7\ \text{rad}^2/\text{s}^2 = (1.74\ \text{rad/s}^2)\theta_f$$

Further solve for θ_f,

$$21913.7\ \text{rad}^2/\text{s}^2 = (1.74\ \text{rad/s}^2)\theta_f$$

$$\theta_f = \frac{21913.7\ \text{rad}^2/\text{s}^2}{1.74\ \text{rad/s}^2}$$

$$= 12594.1\ \text{rad}$$

Hence, the angle the rigid body turns is 12594.1 rad.

44. $\omega = \frac{d\theta}{dt}$

$d\theta = \omega dt$

(a) $m = \tan\theta$

$$= \frac{(400-0)\left(\frac{\text{rev}}{\text{min}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right)}{(8-0)\text{s}} = 0.83\ \text{rev/s}^2$$

$w = (0.83\ rev/s^2)t + 0$

$= (0.83\ rev/s^2)t$

Now, integrate the expression $d\theta = w\,dt$ and solve,

$$\int_{\theta_1}^{\theta_2} d\theta = \int_{t_1}^{t_2} w\,dt$$

Substitute 0 rev for θ_1, $(0.83\ rev/s^2)t$ for w, 0 s for t_1 and 8 s for t_2 in the expression

$$\int_{\theta_1}^{\theta_2} d\theta = \int_{t_1}^{t_2} w\,dt$$

$$\int_{\theta_1}^{\theta_2} d\theta = \int_{t_1}^{t_2} (0.83\ rev/s^2)t \cdot dt$$

$$\theta_2 - 0 = \left((0.83\ rev/s^2)\,t^2/2\right)_0^{8s}$$

$$\theta_2 = (0.417\ rev/s^2)(64 s^2 - 0 s)$$

$$= 26.56\ rev$$

Now, change the final angular displacement into rad.

$$\theta_2 = 26.67\ rev\left(\frac{2\pi\ rad}{1\ rev}\right) = 167.4$$

Hence, the final angular displacement of the fan blades is 167.4

$w_f = w_i + \alpha t$ —— (1)

$\theta_f = \theta_1 + w_0 t + \frac{1}{2}\alpha t^2$ —— (2)

Substitute 400 rev/min for ω_f, 0 rev/min for ω_i and 8 s for t in (1) and solve,

$$400 \text{ rev/min} = 0 \text{ rev/min} + \alpha(8 s)$$

$$400 (\text{rev})\left(\frac{2\pi \text{ rad}}{1 \text{ rev}}\right)\left(\frac{1 \text{ min}}{60 s}\right) = \alpha(8 s)$$

$$41.87 \text{ rad/s} = \alpha(8 s)$$

$$\alpha = \frac{41.87 \text{ rad/s}}{8 s} = 5.23 \text{ rad/s}^2$$

Substitute 0 rad for θ_i, 0 rad/s for ω_o, 8 s for t and 5.23 rad/s² for α in (2) and solve,

$$\theta_f = 0 \text{ rad} + (0 \text{ rad/s})(8 s) + \tfrac{1}{2}(5.23 \text{ rad/s}^2)(8 s)^2$$

$$= \tfrac{1}{2}(5.23 \text{ rad/s}^2)(64 s^2) = 167.4 \text{ rad}$$

Hence, the angle through which the fan blades rotate in 8 s is 167.4 rad.

45. $\omega_f = \omega_o + \alpha t$ — (1)

$v_t = r\omega$ — (2)

Substitute 0 rad/s for ω_o and 7 s for t in the above equation (1) and solve,

$$\omega_f = (0 \text{ rad/s}) + \alpha(7 s)$$

$$= \alpha(7 s) \quad \ldots (3)$$

Substitute 20 m/s for v_t, $\alpha(7s)$ for angular velocity of the bead in 7s from equation (3) and 10 cm for r in equation (2) and solve,

$$20\ m/s = (10\ cm)\left(\frac{1m}{100\ cm}\right)(\alpha(7s))$$

$$20\ m/s = (0.1m)(\alpha(7s))$$

Further solve for α,

$$\alpha = \frac{20\ m/s}{(0.1m)(7s)} = 28.57\ rad/s^2$$

Hence, the angular acceleration of the rod to achieve the tangential speed of 20 m/s is 28.57 rad/s²

47. $|\vec{a}| = \sqrt{(a_c)^2 + (a_t)^2}$ — (1)

$a_c = \frac{v_t^2}{r}$ (2) and $a_t = r\alpha$ - (3)

$v_t = r\omega$ —(4)

Substitute 2.5 rad/s for ω in (4) and solve,

$v_t = r(2.5\ rad/s)$

Substitute r(2.5 rad/s) for v_t in exp. (2) and solve,

$$a_c = \frac{(r(2.5\ rad/s))^2}{r} = (6.25)r$$

Therefore, the total acceleration of the merry-go-round is $(6.25s^{-2})$ as the tangential acc. is 0.

$F = ma$

Substitute $(6.25\,s^{-2})r$ for a in the above mentioned exp. of force and solve,

$F = m((6.25)r)\,N$

$F_{friction} = \mu_s N$

Substitute 0.5 for μ_s, mg for N., $9.81\,m/s^2$ for g in the above exp. of $F_{friction}$ and solve,

$$F_{friction} = (0.5)(mg)$$
$$= (0.5)\,m\,(9.81\,m/s^2)$$
$$= (4.9\,m)\,N$$

Equate both the forces,

$$(4.9\,m) = m((6.25)r)$$
$$4.9 = (6.25)r$$
$$r = \frac{4.9}{6.25} = 0.78\,m$$

Hence, the man can stand 0.78 m from the axis of rotation without sliding.

49. $w_f = w_o + \alpha t$

(a) Convert the units of initial angular velocity into rad/s

$$\omega_0 = 0.5\left(\frac{rev}{s}\right)\left(\frac{2\pi\, rad}{rev}\right) = 3.14\ rad/s$$

Substitute 0 rad/s for ω_f, 3.14 rad/s for ω_0 and 10 s for t in above equation and solve,

$$0\ rad/s = (3.14\ rad/s) + \alpha(10\ s)$$

$$\alpha(10\ s) = -3.14\ rad/s$$

Further solve for α,

$$\alpha = \frac{-3.14\ rad/s}{10\ s} = -0.314\ rad/s^2$$

Hence, the angular acceleration of the turbine is $-0.314\ rad/s^2$

$a_c = v_t^2/r$ and $v_t = r\omega$

(b) Substitute 20 m for r and 3.14 rad/s for ω in the exp. for v_t and solve,

$$v_t = (20\ m)(3.14\ rad/s) = 62.8\ m/s$$

Substitute 62.8 rad/s for v_t and 20 m for r in above exp. for a_c and solve,

$$a_c = \frac{(62.8\ m/s)^2}{(20\ m)} = \frac{3943.84\ m^2/s^2}{20\ m} = 197.2\ m/s^2$$

Hence, the centripetal acc. of the tip of the blades at $t = 0$ is $197.2\ m/s^2$

The magnitude of the total linear acc. on the tip of the blade is given by,

$$|\vec{a}| = \sqrt{a_c^2 + a_t^2}$$

$$a_t = r\alpha$$

(c) Substitute $-0.314\ rad/s^2$ for α and $20\ m$ for r in above exp. for a_t and solve,

$$a_t = (20\ m)(-0.314\ rad/s^2) = -6.28\ m/s^2$$

Substitute $197.2\ m/s^2$ for a_c and $-6.28\ m/s^2$ for a_t in the above mentioned of total acc. and Solve,

$$|\vec{a}| = \sqrt{(197.2\ m/s^2)^2 + (-6.28\ m/s^2)^2}$$

$$= \sqrt{38887.8\ m^2/s^4 + 39.44\ m^2/s^4}$$

$$= \sqrt{38927.24\ m^2/s^4} = 197.3\ m/s^2$$

Hence at $t = 0\ s$, the total linear acc. of the tip of the blades is $197.3\ m/s^2$

55. $K.E._{(ROT)} = \frac{1}{2} I\omega^2$

(a) $I_{(Earth)} = \frac{2}{5} Mr^2$

Substitute, 6×10^{24} kg for M and 6.4×10^6 m for r

$$I = \frac{2}{5} (6 \times 10^{24} \text{ kg})(6.4 \times 10^6 \text{ m})^2$$

$$= 98.3 \times 10^{36} \text{ kg} \cdot \text{m}^2$$

$$\omega = \frac{2\pi}{24 h \times \frac{3600 s}{h}} \text{ rad/s} = 7.27 \times 10^{-5} \text{ rad/s}$$

$$K.E._{(ROT)} = \frac{1}{2} (98.3 \times 10^{36} \text{ kg} \cdot \text{m}^2)\left(7.27 \times 10^{-5} \frac{\text{rad}}{\text{s}}\right)^2$$

$$= 2.59 \times 10^{29} \text{ J}$$

So, the rotational kinetic energy of the Earth is 2.59×10^{29} J.

(b) $K.E._{(ROT/SUN)} = \frac{1}{2} I_{(EARTH/SUN)} \omega^2$

$I_{(EARTH/SUN)} = \frac{2}{5} Mr^2 + MR^2$

Substitute 6×10^{24} kg of M and 6.4×10^6 m for r and 150×10^9 for R

$$I_{(EARTH/SUN)} = \left(\left(2/5\right)\left(6 \times 10^{24}\ kg\right)\left(6.4 \times 10^{6}\ m\right)^{2} \right) +$$

$$\left(\left(6 \times 10^{24}\ kg\right)\left(150 \times 10^{9}\ m\right)^{2} \right)$$

$$= \left(98.3 \times 10^{36}\ kg \cdot m^{2}\right) + \left(13.5 \times 10^{46}\ kg \cdot m^{2}\right)$$

$$= 1.35 \times 10^{47}\ kg \cdot m^{2}$$

$$\omega = \frac{2\pi}{365 \times 24 \times 3600} = 1.99 \times 10^{-7}\ rad/sec$$

$$K.E._{(ROT/SUN)} = \frac{1}{2} I_{(EARTH/SUN)}\, \omega^{2}$$

Substitute, the values of $I_{(EARTH/SUN)}$ and ω in,

$$K.E._{(ROT/SUN)} = \left(\frac{1}{2}\right)\left(1.35 \times 10^{47}\ kg \cdot m^{2}\right)\left(1.99 \times 10^{-7}\ \frac{rad}{?}\right)^{2}$$

$$= 2.67 \times 10^{33}\ J$$

So, the rotational kinetic energy of the Earth in its orbit around the Sun is 2.67×10^{33} J.

57.

$$\omega_{(forearm)} = \frac{V_{(ball)}}{r}$$

~~Where, $v_{(ball)}$~~ Substitute 20.0 m/s for $v_{(ball)}$ and 0.480 m for r.

$$\omega_{(forearm)} = \frac{20}{0.48} \text{ rad/s} = 41.67 \text{ rad/s}$$

$$I_{(forearm)} = 0.500 \text{ kg}\cdot\text{m}^2$$

$$K.E._{(ROT/FOREARM)} = \tfrac{1}{2} I_{(forearm)} \omega^2_{(forearm)}$$

Substitute $0.500 \text{ kg}\cdot\text{m}^2$ for $I_{(forearm)}$ and 41.67 rad/s for $\omega_{(forearm)}$

$$K.E._{(ROT/FOREARM)} = \tfrac{1}{2}(0.500 \text{ kg}\cdot\text{m}^2)\left(41.67 \frac{\text{rad}}{\text{s}}\right)^2$$

$$= 434 \text{ J}$$

So, the rotational kinetic energy of the forearm is 434 J

67. Using

$PE = mgh$ and $K.E._{rotational} = \tfrac{1}{2} I\omega^2$

$I = \dfrac{mL^2}{3}$ and $v_t = r\omega$

Using
$h = L/_2 \sin\theta$

Substitute 2.0 m for L and 60° for θ in the above exp. of h and solve,

$$h = \frac{2.0 \text{ m}}{2} \sin 60° = 0.866 \text{ m}$$

Substitute 1.0 kg for m and 2.0 m for L in I and solve,

$$I = \frac{(1.0\ kg)(2.0\ m)^2}{3} = \frac{4.0}{3}\ kg \cdot m^2$$

$$PE = KE_{rotational}$$

Substitute mgh for PE and $\frac{1}{2} I\omega^2$ for $K.E._{rotational}$ in the above eq. and solve

$$mgh = \frac{1}{2} I\omega^2$$

Further substitute 0.866 m for h, 1.0 kg for m, 9.8 m/s² for g, $\frac{4.0}{3}$ kg·m² for I in the ~~ex~~ exp. $mgh = \frac{1}{2} I\omega^2$ and solve,

$$(1.0\ kg)(9.8\ m/s^2)(0.866\ m) = \frac{1}{2}\left(\frac{4.0}{3}\ kg \cdot m^2\right)\omega^2$$

$$8.49\ kg \cdot m^2/s^2 = (0.67\ kg \cdot m^2)\omega^2$$

$$\omega^2 = \frac{8.49\ kg \cdot m^2/s^2}{0.67\ kg \cdot m^2}$$

Further solve for ω,

$$\omega = \sqrt{12.67\ rad/s^2} = 3.56\ rad/s$$

Substitute 2.0 m for r and 3.56 rad/s for ω in V_t and solve,

$$V_t = (2.0\ m)(3.56\ rad/s)$$

$$= 7.12\ m/s$$

Hence, the speed of the tip of the rod as it passes the horizontal position is 7.12 m/s

71. $|\vec{\tau}| = r_{\perp} F$

Substitute 50 cm for r and F for the force in the above mentioned exp. and solve,

$|\vec{\tau}| = (50\ \text{cm})\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)F = (0.5\ \text{m})F$

Substitute 30 cm for r and 50N for the force in the above mentioned exp. and solve,

$|\vec{\tau}| = (30\ \text{cm})\left(\frac{1\ \text{m}}{100\ \text{cm}}\right)(50\ \text{N})$

$= (0.3\ \text{m})(50\ \text{N}) = 15\ \text{N}\cdot\text{m}$

Equate both the torque's

$(0.5\ \text{m})F = 15\ \text{N}\cdot\text{m}$

$F = \frac{15\ \text{N}\cdot\text{m}}{0.5\ \text{m}} = 30\ \text{N}$

Hence, the pulling force applied to the cord connecting to the larger flywheel is 30 N.

75. Using

$|\vec{\tau}| = r_{\perp} F$

Substitute 20 cm for $r_\perp$ and $(5.0\text{ kg})g\sin 30^\circ$ for F in the above exp. and solve,

$$|\vec{\tau}|_1 = (20\text{ cm})\left(\frac{1\text{ m}}{100\text{ cm}}\right)(5.0\text{ kg})g\sin 30^\circ$$

$$= (0.2\text{ m})(24.5\text{ N}) = 4.9\text{ N}\cdot\text{m}$$

Substitute 30 cm for $r_\perp$ and Mg for F in the above exp. and solve,

$$|\vec{\tau}|_2 = (30\text{ cm})\left(\frac{1\text{ m}}{100\text{ cm}}\right)(Mg) = 0.3\text{m}\,(Mg)$$

Equate the torques,

$$|\vec{\tau}|_1 = |\vec{\tau}_2|_2$$

Substitute 4.9 N·m for $|\vec{\tau}|_1$ and 0.3m (Mg) for $|\vec{\tau}|_2$ in the exp. $|\vec{\tau}|_1 = |\vec{\tau}|_2$ and solve,

$$4.9\text{ N}\cdot\text{m} = 0.3\text{ m}\,(Mg)$$

$$M = \frac{4.9\text{ kg}\cdot\text{m/s}^2\cdot\text{m}}{(0.3\text{ m})(9.81\text{ m/s}^2)}$$

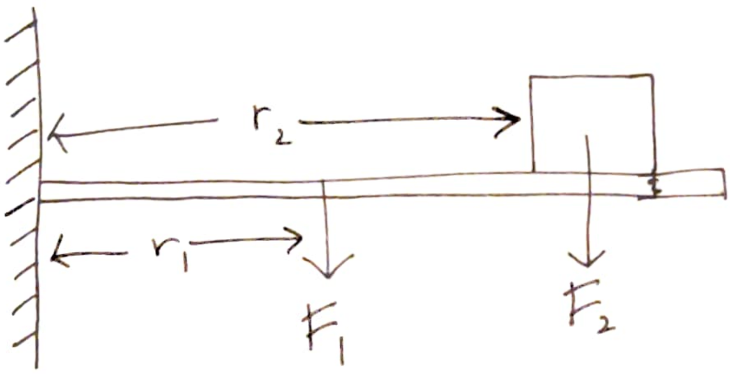
$$= \frac{4.9}{2.943}\text{ kg} = 1.67\text{ kg}$$

Hence, the hanging mass is 1.67 kg.

81. $\vec{\tau}_{net} = \sum_i |\vec{\tau}_i|$

$\vec{\tau} = \vec{r} \times \vec{F}$

The following figure shows the different forces acting on the system.



$\vec{\tau}_1 = \vec{r}_1 \times \vec{F}_1 = \vec{r}_1 \times m_1 g$

Calculate the value of $\vec{r}_1$.

$\vec{r}_1 = 3/_2 \text{ m} = 1.5 \text{ m}$

Substitute 1.5 m for $\vec{r}_1$, and 2.0 kg for m_1 and 9.8 m/s² for g

$\vec{\tau}_1 = (1.5 \text{ m})(2.0 \text{ kg})(9.8 \text{ m/s}^2)$
$= (29.4 \text{ N}\cdot\text{m})$

$\vec{\tau}_2 = \vec{r}_2 \times \vec{F}_2 = \vec{r}_2 \times m_2 g$

Calculate $\vec{r}_2$

$\vec{r}_2 = \left(3 - \frac{0.2}{2}\right) \text{m} = 2.9 \text{ m}$

Substitute 2.9 m for $\vec{r_2}$ and 1.0 kg for m_2 and 9.8 m/s^2 for g

$$\vec{\tau}_2 = (2.9\,m)(1.0\,kg)(9.8\,m/s^2)$$

$$= 28.42\,N\cdot m$$

$$\vec{\tau}_{net} = \vec{\tau}_1 + \vec{\tau}_2$$

Substitute 29.4 N·m for $\vec{\tau}_1$ and 28.42 N·m for $\vec{\tau}_2$

$$\vec{\tau}_{net} = (29.4\,N\cdot m + 28.42\,N\cdot m)$$

$$= 57.82\,N\cdot m$$

Thus, the torque of the system about the support of the wall is 57.82 N·m

83. $\vec{\tau} = \vec{r} \times \vec{F}$

Substitute $(-2\hat{i} + 4\hat{j})$N for $\vec{r}$ and $(5\hat{i} - 2\hat{j} + 4\hat{k})$ m for $\vec{F}$ in above torque equation.

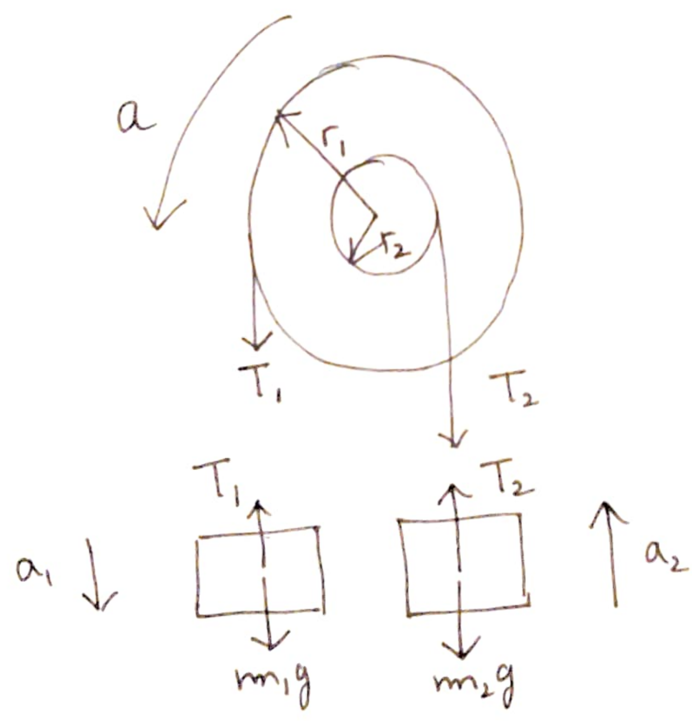
$$\vec{\tau} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2 & 4 & 0 \\ 5 & -2 & 1 \end{vmatrix} = \begin{matrix} (4-0)\hat{i} - (-2-0)\hat{j} + (4-20)\hat{k} \\ (4\hat{i} + 2\hat{j} - 16\hat{k})\,N\cdot m \end{matrix}$$

Therefore the torque about the origin of the force is $(4\hat{i} + 2\hat{j} - 16\hat{k})$ N·m

92. $\vec{\tau}_{net} = \sum_{i=1}^{n} |\vec{\tau}_i|$

$a = r \times \cancel{\alpha} \alpha$

The figure shows the various forces acting on the system along with its components



$\tau_1 = r_1 \times T_1$

$\tau_2 = r_2 \times T_2$

$\tau = r_1 \times T_1 - r_2 \times T_2$

$\tau = I\alpha$

Therefore,

$$\alpha = \frac{r_1 \times T_1 - r_2 \times T_2}{I}$$

$$a_1 = r_1 \times \alpha$$

$$a_2 = r_2 \times \alpha$$

From F.B.D of block 1

$$m_1 g - T_1 = m_1 a_1$$

$$T_1 = m_1 g - m_1 r_1 \alpha$$

From F.B.D of block 2

$$T_2 - m_2 g = m_2 a_2$$

$$T_2 = m_2 g + m_2 r_2 \alpha$$

Solve for α.

$$\alpha = \frac{r_1 \times (m_1 g - m_1 r_1 a) - r_2 \times (m_2 g + m_2 r_2 \alpha)}{I}$$

$$= \frac{m_1 r_1 g - m_2 r_2 g}{m_1 r_1 + m_2 r_2 + I}$$

(a) Convert cm to m for r_1

$$r_1 = (50\text{ cm})\frac{(1\text{ m})}{(100\text{ cm})} = 0.5\text{ m}$$

Convert cm to m for r_2

$$r_2 = (20\text{ cm})\frac{(1\text{ m})}{(100\text{ cm})} = 0.2\text{ m}$$

Substitute $9.8\ m/s^2$ for g, $0.5\ m$ for r_1, $0.2\ m$ for r_2, $1.0\ kg$ for m_1, $2.0\ kg$ for m_2, and $2.0\ kg\cdot m^2$ for I

$$\alpha = \frac{(1\ kg)(0.5\ m)(9.8\ m/s^2) - (2\ kg)(0.2\ m)(9.8\ m/s^2)}{(2.0\ kg\cdot m^2) + (1\ kg)(0.5\ m)^2 + (2\ kg)(0.2\ m)^2}$$

$$= 0.42\ rad/s^2$$

Thus, the angular acceleration of the pulley is $0.42\ rad/s^2$

(b) Solve for a_1

Substitute $0.42\ rad/s^2$ for α, and $0.5\ m$ for r_1

$$a_1 = (0.42\ rad/s^2)(0.5\ m) = 0.21\ m/s^2$$

Solve for a_2

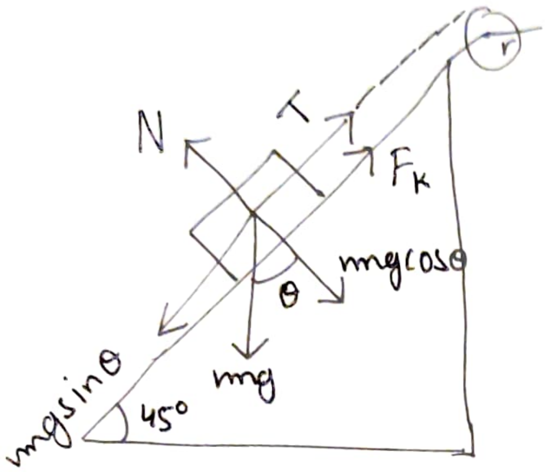
Substitute $0.42\ rad/s^2$ for α, and $0.2\ m$ for r_2

$$a_2 = (0.42\ rad/s^2)(0.2\ m)$$

$$= 0.084\ m/s^2$$

Thus, the linear acc. of the weights 1 and 2 are $0.21\ m/s^2$ and $0.084\ m/s^2$ respectively.

93. The figure shows the various forces acting on the system along with its components.



From F.B.D,

$N = mg\cos\theta$

Using $F_K = \mu_K N$, substitute $mg\cos\theta$ for N

$F_K = \mu_K mg\cos\theta$

Substitute 0.4 for μ_K, 3 kg for m, 9.8 m/s² for g and 45° for θ.

$F_K = 0.4(3\,kg)(9.8\,m/s^2)\cos 45° = 8.32\,N$

From F.B.D of the block,

$T = mg\sin\theta - F_K - ma$

Substitute 8.32 N for F_K, 3 kg for m, 9.8 m/s² for g and 45° for θ.

$T = (3\,kg)(9.8\,m/s^2)\sin 45° - (8.32\,N) - (3\,kg)\times a$

$= 12.47 - 3a\ N\cdot m$

Using $I = \frac{Mr^2}{2}$ and $\alpha = a/r$ and $\tau = I\alpha$

$$\tau = \left(\frac{Mr^2}{2}\right)\left(a/_r\right) \quad — (1)$$

$$= \frac{Mr \times a}{2}$$

Also $\tau = r \times T$. Substitute in eq. (1)

$$r \times T = \frac{Mr \times a}{2}$$

$$a = \frac{2T}{M}$$

Substitute $12.47 - 3a$ N·m for T and 1 kg for M.

$$a = \frac{2(12.47 - 3a \text{ N·m})}{(1 \text{ Kg})} = 24.94 - 6a$$

$$a + 6a = 24.94$$

Further solve,

$$7a = 24.94$$

$$a = \frac{24.97}{7} = 3.6 \text{ m/s}^2$$

Thus, the acceleration of the block is 3.6 m/s^2