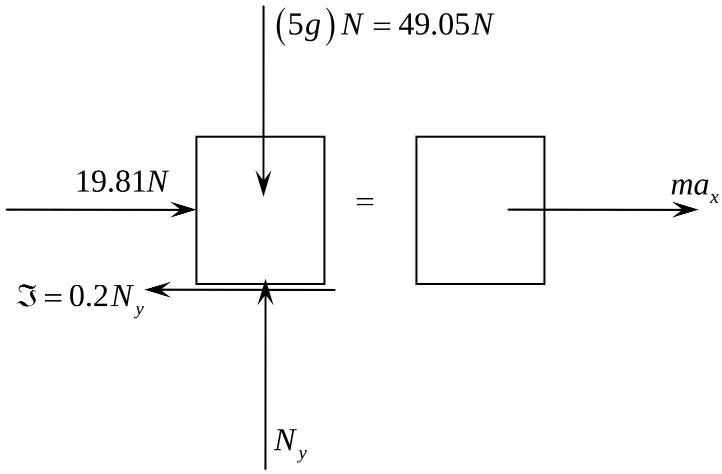
Problem 1. Free Body Diagram and inertial Force Diagram (Denote normal force by N_y)



$\sum F_y = 0$

$N_y - 49.05N = 0$

$N_y = 49.05N \uparrow$

$\Im = 0.2N_y = 9.81N \leftarrow$

$\overset{+}{\longrightarrow}\sum F_x = ma_x$

$19.81N - 9.81N = (5kg)a_x$

$\underline{a_x = 2\frac{m}{s^2} \rightarrow}$

Answer: C

Problem 2. $v = (s^2 - 6s + 13)\frac{m}{s}$

$$\frac{dv}{ds} = (2s - 6)s^{-1}$$

When $s = 2m$

$$v = [2^2 - 6(2) + 13]\frac{m}{s} = 5\frac{m}{s}$$

$$\frac{dv}{ds} = [2(2) - 6]s^{-1} = -2s^{-1}$$

$$a = v\frac{dv}{ds} = \left(5\frac{m}{s}\right)(-2s^{-1}) = -10\frac{m}{s^2}$$

Answer: C

Problem 3. When acceleration and velocity have the same sign, speed increases. Beause velocity has a negative sign, position is getting more negative, so position decreases.

Answer: C

Problem 4. $(100\,rpm)\left(2\pi\frac{rad}{rev}\right)\left(\frac{1\min}{60\,s}\right)=10.5\frac{rad}{s}$

$$\omega^2=\omega_o^2+2\alpha(\theta-\theta_o)$$

$$\left(10.5\frac{rad}{s}\right)^2=0+2\left(3\frac{rad}{s^2}\right)(\theta-0)$$

$$\theta=18.3\,rad\left(\frac{1\,rev}{2\pi\,rad}\right)=2.91\ rev$$

Answer: B

Alternative solution:

$$\omega=\omega_o+\alpha t$$

$$10.5\frac{rad}{s}=0+\left(3\frac{rad}{s^2}\right)t$$

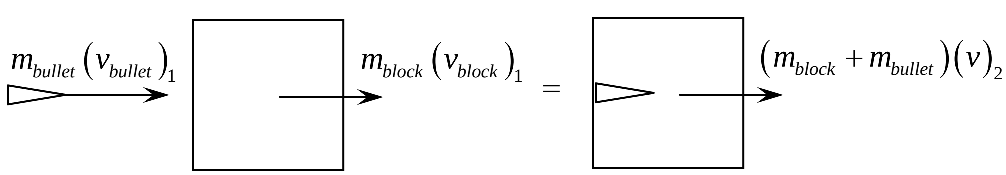
$$t=3.49\,s$$

$$\theta=\theta_o+\omega_o t+\frac{1}{2}\alpha t^2$$

$$\theta=0+0+\frac{1}{2}\left(3\frac{rad}{s^2}\right)(3.49s)^2$$

$$\theta=18.3\,rad\left(\frac{1\,rev}{2\pi\,rad}\right)=2.91\ rev$$

<u>Problem 5</u>. Impulse Momentum Diagram (conservation of Linear Momentum)



Conservation of Momentum

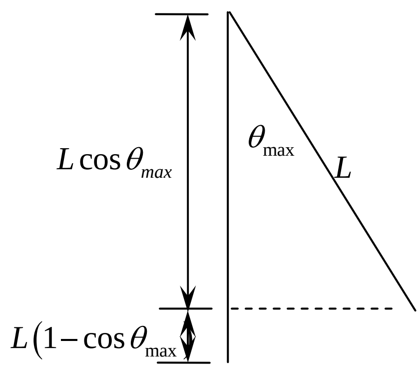
$$\overset{+}{\longrightarrow}\sum m_i(v_i)_1=\overset{+}{\longrightarrow}\sum m_i(v_i)_2$$

$$(0.020kg)\left(500\frac{m}{s}\right)+(100kg)(0)=(100kg)v_2$$

$$v_2=0.10\frac{m}{s}\rightarrow$$

Answer: B

Problem 6. When wires achieve the maximum angle with the horizontal block has risen a distance $L(1-\cos\theta_{max})$ where L denotes the length of the cables.



To find θ_{max}, let's use Conservation of Energy, selecting the datum for weight as the initial position of the block.

$$T_1 + V_1 = T_2 + V_2$$

$$\frac{1}{2}mv_1^2 + 0 = 0 + mgL(1-\cos\theta_{max})$$

$$\frac{1}{2}(100kg)\left(0.1\frac{m}{s}\right)^2 = (100kg)\left(9.81\frac{m}{s^2}\right)(2m)(1-\cos\theta_{max})$$

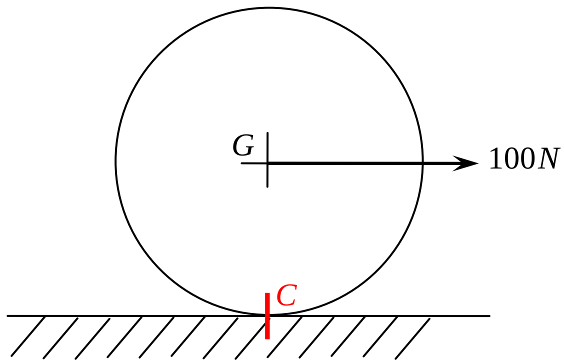
$$1-\cos\theta_{max} = 0.255\times10^{-6}$$

$$\cos\theta_{max} = 0.9997$$

$$\underline{\theta_{max} = 1.29^o}$$

Answer: C

Problem 7. Let C denote the point of contact between the wheel and the rough surface.



Use work-energy:

$$T_1 + U_{1\to 2} = T_2$$

$$0 + Fd = \frac{1}{2} I_C \omega_2^2$$

$$0 + (100N)(4m) = \frac{1}{2}(20kg)\left[(0.3m)^2 + (0.4m)^2\right]\omega_2^2$$

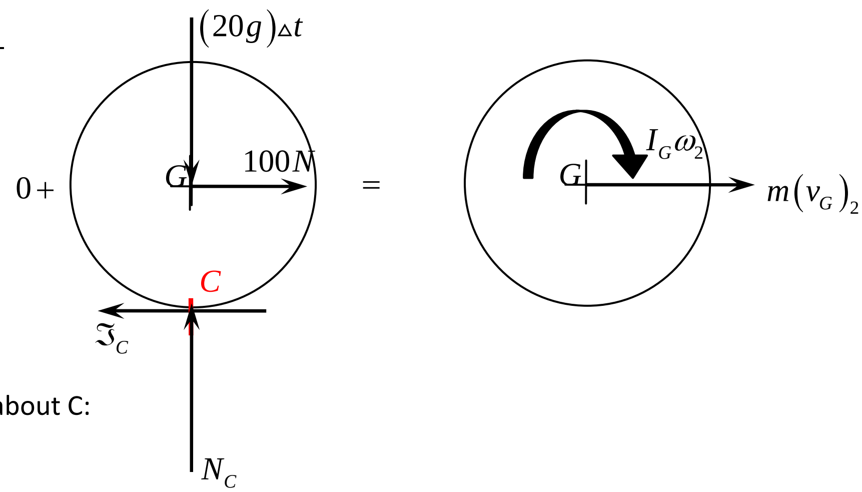
$$\omega_2 = 12.6\frac{rad}{s}$$

$$v_2 = r\omega_2 = (0.4m)\left(12.6\frac{rad}{s}\right) = 5.06\frac{m}{s} \rightarrow$$

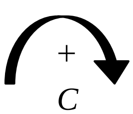
Answer: C

Problem 8. Use Impulse Momentum

Impulse Momentum Diagram:



Summing Angular Momentum Components about C:



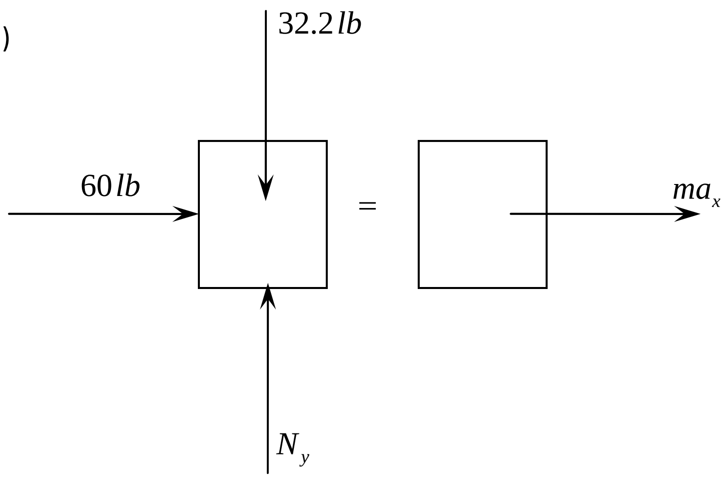
$$0 + (100N)(0.4m)(4s) = (20kg)\left[(0.3m)^2 + (0.4m)^2\right]\omega_2$$

$$\omega_2 = 32\frac{rad}{s}$$

$$v_2 = r\omega_2 = (0.4m)\left(32\frac{rad}{s}\right) = 12.8\frac{m}{s} \rightarrow$$

Answer: D

Problem 9: Free Body Diagram and Inertial Force Diagram (When compressed $0.5\,ft$, spring force is $120\frac{lb}{ft}(0.5\,ft)=60\,lb$)



$$\overset{+}{\longrightarrow}\sum F_x = ma_x$$

$$60\,lb = \frac{32.2\,lb}{32.2\,\frac{ft}{s^2}}a_x$$

$$a_x = 60\frac{ft}{s^2}$$

Answer: B

Problem 10. Use conservation of energy. Let State 1 denote initial position at which block is released from rest and State 2 denote position at which block attains its maximum velocity, that is, when it has moved $0.5\,ft$ and spring is at its unstretched length.

$$T_1 + V_1 = T_2 + V_2$$

$$0 + \frac{1}{2}kx^2 = \frac{1}{2}mv_{\max}^2 + 0$$

$$\frac{1}{2}\left(120\frac{lb}{ft}\right)(0.5\,ft)^2 = \frac{1}{2}\left(1\frac{lb\cdot s^2}{ft}\right)v_{\max}^2$$

$$v_{max} = 5.48\frac{ft}{s}$$

Answer: D