Step 3: Find P

Part a) of the problem asks for the magnitude of P.

- The roll itself is not moving or accelerating, so the net force is not equal to mass times acceleration.
- n is the force between the roll and the wall ($P\sin 30°$), not the upward force ($P\cos 30°$).

$$\Sigma F = 0$$

$$mg + F + \mu_k P\sin 30° = P\cos 30°$$

$$16 \cdot 10 + 40 + 0.25P\sin 30° = P\cos 30°$$

$$200 = P(\cos 30° - 0.25\sin 30°)$$

$$\frac{200}{\cos 30° - 0.25\sin 30°} = P$$

$$P = 270\ N$$

Step 4: Find α

Part b) of the problem asks for of the roll.

- Don't substitute a/r for α, since we are solving for α.
- If clockwise is (+), f exerts a (-) torque and F exerts a (+) torque.

$$\Sigma T = I\alpha$$

$$\tau_{pull} - \tau_{fric} = 0.260\alpha$$

$$P \cdot R - n \cdot \mu_k \sin 30° \cdot R = 0.260\alpha$$

$$40 \cdot 0.18 - 270 \cdot 0.25 \cdot \sin 30° \cdot 0.18 = 0.260\alpha$$

$$\alpha = 4.327\ rad/s^2$$