1. (4 pts) Dr. Anf's husband tries to tighten a nut by pulling down as shown. What is the general direction of the moment vector?

A. -i - j 
B. i + j 
C. k 
D. -k 

2. (4 pts) Prof. Schleeter stands at the center of a rotating circular platform and then starts walking towards the outside. What happens?

A. The rotation speed is unchanged 
B. The rotation speed decreases 
C. The rotation speed increases 

3. (4 pts) An object is rolling down a hill. For a given starting height, the speed at the bottom of the hill is a function of:

A. Only the mass of the object 
B. Only the shape of the object 
C. Only the radius of the object 
D. All of the above. 

4. (4 pts) Which situation causes the greatest torque about the door hinges?

A. Situation A 
B. Situation B 
C. Both cause an equal amount of torque

5. (14 pts) A long time ago Dr. Bennett flew on a DC-3 to Spunkly Puddles, Ohio to attend a masonry conference. One engine on the antique airplane delivered 850 hp to the propeller while it spun at a steady 2100 rpm. What was the torque exerted by air resistance on the propeller? (1 hp = 560 ft-lbs/see) 

\[
\begin{align*}
2130 \text{ ft} \cdot \text{lb} \\
\frac{850 \text{ hp}}{\text{sec}} \cdot \frac{550 \text{ ft} \cdot \text{lb}}{\text{rev}} = 2100 \text{ rev/min}, \quad \text{min} \cdot \frac{2\pi \text{ rad}}{\text{rev}} \\
\end{align*}
\]

6. (14 pts) Dean wants to show off his pizza eating and balancing skills by cutting an 8 inch diameter hole in a 12 inch diameter pizza so that the center of mass of the result is at \(x=1.5\), \(y=0\). At what \(x, y\) location should the center of the hole be located?

\[
\begin{align*}
(1.875, 0) \\

\text{By symmetry, } y = 0 \\
\end{align*}
\]
7. (14 pts) Patrick attaches a block (m=8 kg) to a spring (k=22 N/m) by a rope that hangs over a pulley (m=8 kg, r=6 cm). Treat the pulley as a solid cylinder and neglect any friction at the axle. The system starts from rest with the spring at its undeformed position. Recall that the potential energy stored in a spring is \( \frac{1}{2} k x^2 \). The rope rotates the pulley without slipping. What is the speed of the block after it falls 1.5 meters?

\[ mgh = \frac{1}{2} kx^2 + \frac{1}{2} mv^2 + \frac{1}{2} Iw^2 \]

\[ 4(8)(9.81)(1.5) = \frac{1}{2} (3.14)^2 (1.5)^2 + \frac{1}{2} (4)(4.9) v^2 + \frac{1}{2} (\frac{1}{2} \times 8 \times 6^2) w^2 \]

\[ 58.86 = 36 + 2v^2 + 2w^2 \]

\[ v = 2.39 \text{ m/s} \]

8. (14 points) Isaac and Houston remove one of the wheels from the Dodge chassis in the basement of Elabrook and attach it to the wall so that it can spin freely. They apply forces as shown to start it spinning. The mass moment of inertia of the wheel is 22 slugs\(^2\) ft. What is the angular acceleration of the wheel at the instant shown? (Use CCW as positive)

\[ -3.72 \text{ rad/s}^2 \]

8. (14 points) Paul’s PhD research is on the dynamics of motorcycles and merry-go-rounds. He lays a motorcycle on its side and places the back wheel of the bike in contact with the base of the ride in order to start it spinning. If the ride starts with a speed of 3.0 rad/sec and accelerates at a constant rate of 1.6 rad/sec\(^2\), what is the angular speed of the ride after it has completed 5 revolutions?

\[ \omega = 3.14 \text{ rad/sec} \]

\[ \theta = 5 \text{ rev.} \quad \frac{2\pi \text{ rad}}{1 \text{ rev.}} = 31.416 \text{ rad} \]

\[ \theta = \theta_1 + \omega \tau + \frac{\omega^2 - \omega_1^2}{2} \]

\[ 31.416 \text{ rad} = 0 + \frac{3.0^2 - (3.0^2)}{2} \]

\[ \omega = 10.46 \text{ rad/sec} \]

9. (14 points) Abby (63 kg) is helping with Paul’s research by running with a speed of 3.2 m/s toward the outer edge of a merry-go-round (1.5m radius) and then jumping on. The ride is initially at rest and it has a rotational speed of 1.3 rad/s immediately after she jumps on. Treat Abby like a point mass and assume the ride is a solid disk with a low-friction bearing. What is the mass of the merry-go-round?

\[ 22.7 \text{ kg} \]

\[ \omega = 1.3 \text{ rad/sec} \]

\[ L_1 = mvr = 52 \text{ kg}(6.2 \text{ m/s})(1.5 \text{ m}) = 483.6 \text{ kgm}^2/ \text{s} \]

\[ L_2 = Iw = \left( \frac{52 \text{ kg}(1.5 \text{ m}^2)}{2} \right) \frac{1}{2} \text{ m}(1.5^2) \]

\[ L_1 = L_2 \]

\[ 483.6 \text{ kgm}^2/ \text{s} = 483.6 \text{ kgm}^2/ \text{s} \]

\[ m = 226.7 \text{ kg} \]

\[ m = 250 \text{ kg} \]