I. A flywheel experiences a braking torque of 4.0 N·m. The flywheel turns through 2.0 revolutions as it slows from a rotational speed of 13 rad/s to a stop.

a) Assuming a constant rotational acceleration, find the rotational acceleration

b) Find the time for it to come to rest.

c) How much does the kinetic energy change in this process?
II. The mobile depicted in the picture is in balance. You decide to increase the mass of the square to \(m_{\text{square}}=32\) kg but want to keep the mobile in balance.

![Image of a mobile with 20 kg, 8 kg, and 3 kg weights]

a) What must the mass \(m_{\text{tri}}\) of the triangle and the mass \(m_{\text{star}}\) of the star be changed to in order to keep the mobile in balance if the \(m_{\text{square}}\) is increased to 32 kg? Show all your work. If no change is necessary, indicate “no change.”

\[
m_{\text{tri}} =
\]

\[
m_{\text{star}} =
\]

b) What must the mass \(m_{\text{face}}\) of the smiley face be changed to in order to keep the mobile in balance? Show all your work. If no change is necessary, indicate “no change.”

\[
m_{\text{face}} =
\]
3. How much torque, exerted steadily on a disk of mass $M$ and radius $R$, is required to speed up the disk from an angular speed of $\omega_1$ to $\omega_2$ as it rotates through an angle $\theta$?

   a) $\frac{4QMR^2}{(\omega_2^2 - \omega_1^2)}$

   b) $\frac{MR^2}{4Q(\omega_2^2 - \omega_1^2)}$

   c) $\frac{MR^2(\omega_2 - \omega_1)}{2Q}$

   d) $\frac{2(\omega_2^2 - \omega_1^2)}{QMR^2}$

   e) $\frac{MR^2(\omega_2^2 - \omega_1^2)}{4Q}$

4. Steering wheel knobs are handles that make it easier to apply a torque to a steering wheel. Below are top down views of designs for three different steering wheels (simplified as disks) and knobs (positioned at the X). In each case a same force $F$ is used to turn the wheel, applied tangentially at the X. Rank the wheels according to the resulting angular accelerations of the wheel, from GREATEST to LEAST.

   a) A, B, C
   b) C, A=B
   c) A=C, B
   d) A, C, B
   e) C=B, A

5. A large wooden turntable in the shape of a flat disk has a radius of 2.0 m and a total mass of 120 kg. The turntable is initially rotating freely at a speed of 4.0 rad/s about a frictionless vertical axis through the center. Suddenly a 70 kg parachutist makes a soft landing onto the turntable at a point near the outer edge. Which of the following is closest to the angular speed of the turntable just after the parachutist lands?

   a) 2.6 rad/s
   b) 0.95 rad/s
   c) 3.5 rad/s
   d) 1.8 rad/s
   e) 1.4 rad/s
6. Three points: A, B and C on a rotating disk are shown in the top-view picture at right. The disk rotates clockwise about a pivot at its center, and is neither speeding up nor slowing down. Each point moves in a circle as the disk rotates: The radius of the circle for point A is one meter; for point B it is two meters; and for point C it is 3 meters.

In one second, point B travels 3 meters along the circle it is moving in. What distance does Point C travel through in one second?

a) 4.5 m  
b) 1.5 m  
c) 4 m  
d) 2 m  
e) none of these answers is correct

7. A horizontal plank that weighs 50.0 N supports a sign as shown below. The sign weighs 150 N. The tension in the supporting cable is approximately

a) 303 N  
b) 350 N  
c) 550 N  
d) 450 N  
e) 272 N

8. A man weighing 800 N stands 2/3 of the weigh up a 200N ladder as shown below. Assume that there is no friction between the ladder and the wall, but there is friction between the ladder and the ground. The wall pushes against the ladder with a force of approximately

a) 250 N  
b) 550 N  
c) 480 N  
d) 320 N  
e) 410 N