Quiz 4 (Rotational motion and force)

In this quiz you will get the same questions but with different numbers.

You will not get all 7 questions but will get a selection of 4 of them. You, therefore, need to understand how to solve them all.

1) An electrical motor spins at a constant 2695.0 rpm. If the armature radius is 7.165 cm, what is the acceleration of the edge of the rotor?

Solution:

$$2695\ \frac{rev}{min} = 2695\ \frac{rev}{min}\ \frac{2\pi\ rad}{1\ rev}\ \frac{1\ min}{60\ s} = 282\ \frac{rad}{s}$$

$$a_{rad} = \omega^2 r = 282^2(7.165 \times 10^{-2}) = 5,698\ m/s^2$$

2) Through what angle in degrees does a 33 rpm record turn in 0.33 s?

Solution:

$$33\ \frac{rev}{min}\ \frac{2\pi}{60} = 3.46\ \frac{rad}{s}$$

$$\Delta(\theta) = \omega\Delta t = 3.46 \times 0.33 = 1.14\ rad$$

$$1.14\ rad\ \frac{360}{2\pi} = 65^\circ$$

3) While spinning down from 500.0 rpm to rest, a solid uniform flywheel does 3.4 kJ of work. If the radius of the disk is 1.2 m, what is its mass?

Solution:

Here we can use the idea that work done is energy transferred. In this case the work done is transferred to the rotational kinetic energy of the flywheel.

$$
\begin{aligned}
3.4 \times 10^3 &= \frac{1}{2}\ I\ \omega^2 \\
&= \frac{1}{2}\left(\frac{1}{2}\ M\ R^2\right) \quad \omega^2 \\
3.4 \times 10^3 &= \frac{1}{2}\frac{1}{2}\ M\ 1.2^2\ 52.4^2 \\
M &= 3.4\ kg
\end{aligned}
$$

4) A wheel accelerates from rest to 59 rad/s at a rate of 69 rad/s^2. Through what angle (in radians) did the wheel turn while accelerating?

Solution:

$$\omega_0 = 0\ rad/s,\ \ \omega = 59\ rad/s,\ \ \alpha = 69\ rad/s^2, \Delta\theta = ?$$

$$
\begin{aligned}
\omega^2 &= \omega_0^2 + 2\ \alpha\ \Delta\theta \\
59^2 &= 0^2 + 2\ (69)\ \Delta\theta \\
\Delta\theta &= 25\ rad
\end{aligned}
$$

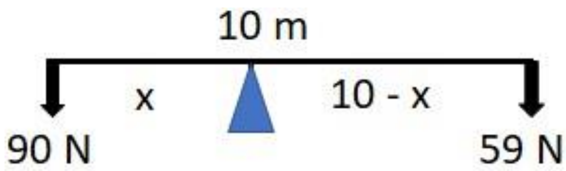
5) A torque of 12 N.m is applied to a solid, uniform disk of radius 0.5 m. If the disk accelerates at 6.3 rad/s^2, what is the mass of the disk?

Solution:

$$\sum \tau = I \ \alpha$$
$$12 = \frac{1}{2} \ M \ R^2 \ \alpha$$
$$12 = \frac{1}{2} \ M \ (0.5)^2 \ 6.3$$
$$M = 15.2 \ kg$$

6) An irregularly shaped object 10 m long is placed with each end on a scale. If the scale on the right reads 59 N and the scale on the left reads 90 N, how far from the left is the center of gravity

Solution:

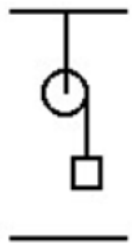


$$\tau = F \ d$$
$$90 \ x = 59 \ (10 - x)$$
$$90 \ x = 590 - 59 \ x$$
$$149 \ x = 590$$
$$x = 3.96 \ m$$

7) In the Figure below, a mass of 58.00 kg is attached to a light string which is wrapped around a cylindrical spool of radius 10 cm and moment of inertia 4.00 kg.m^2. The spool is suspended from the ceiling, and the mass is then released from rest a distance 1.90 m above the floor. How long does it take to reach the floor?

Solution:

This question is difficult. First, we look at the linear equation and realise we need the acceleration.
We then find an acceleration question and realise we need the mass. We then use the equation for inertia to find the mass.
Once we have the mass, we can substitute it back into the equations to find what we need.



$$r = 10 \times 10^{-2},\ I = 4\ kg.m^2,\ \omega_o = 0\ rad/s,\ \Delta y = 1.90\ m,\ t = ?$$

Linear:

$$\Delta y = v_0\ t + \frac{1}{2}\ a\ t^2$$
$$1.9 = 0 + \frac{1}{2}\ a\ t^2$$

Need a:

$$a = \frac{g}{1 + \frac{M}{2m}} = \frac{9.8}{1 + \frac{M}{2(58)}}$$

Need M

$$I = \frac{1}{2}\ M\ R^2$$
$$4 = \frac{1}{2}\ M\ (10 \times 10^{-2})^2$$
$$M = 800\ kg$$

We now substitute this to find a and then to find t.

$$a = \frac{9.8}{1 + \frac{800}{2(58)}} = 1.24\ m/s^2$$

$$1.9 = 0 + \frac{1}{2}\ (1.24)\ t^2$$
$$t = 1.75\ s$$