Q- A torque of 50 N.m accelerates a wheel from rest to 100 rev/min in 5 seconds.
(a) What is the angular displacement of the wheel in 5 second?
(b) What is the angular acceleration of the wheel?
(c) What is the moment of inertia of the wheel?

Corresponding to the second law of motion F = ma the equation of rotational motion is given by

$$\tau = I\alpha$$

Here τ is the torque and I is the moment of inertia of the body.

Here τ = 50 N.m
t = 5 s
ω = 100 rev/min = 100*2 π/60 rad/s = 10π/3 rad/s

(a)

As the angular acceleration of the wheel is constant

Angular displacement = average angular velocity* time

Or $$\theta = \left(\frac{\omega_0 + \omega}{2}\right) * t$$

Or $$\theta = \left(\frac{0 + 10\pi/3}{2}\right) * 5$$

Or $$\theta = \left(\frac{5\pi}{3}\right) * 5 = \frac{25\pi}{3} rad = 26.18 \text{ rad}$$

(b)

Using first equation of rotational motion we have

$$\omega = \omega_0 + \alpha t$$

Or 10π/3 = 0 + α*5

Gives α = 2 π /3 rad/s^2 = 2.09 rad/s^2

(c)

The moment of inertia of the wheel is given by

$$I = \frac{\tau}{\alpha} = \frac{50}{2.09} = 23.87 \text{ kg.m}^2$$