A circular platform is mounted on a frictionless vertical axle. Its radius R=2 m and its moment of Inertia about the axle is 200 Kg m^2 .It is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of 1 m/s relative to the ground. Time taken by the man to complete one revolution is

1) π s

2) 3π/2 s

3) 2π s

4) π/2 s

The law of conservation of angular momentum states that when no external torque acts on an object or a closed system of objects, no change of angular momentum can occur. Therefore:

$$L_{system} = const = L_{man} + L_{platform} = 0, \quad => \quad L_{man} = -L_{platform}$$

$$L_{man} = mvR$$

m – mass of the man, v – speed of the man relative to the ground, R – radius of the platform.

$$L_{platform} = I\omega$$

I – moment of inertia, ω – angular velocity

Therefore, $\omega = \frac{L_{platform}}{I} = -\frac{L_{man}}{I}$

So, speed of man relative to the platform equals:

$$v_{pl} = v - \omega R = v + \frac{mvR}{I}R = v\left(1 + \frac{mR^2}{I}\right)$$

Therefore, time taken by the man to complete one revolution is

$$t = \frac{2\pi R}{v_{pl}} = \frac{2\pi R}{v\left(1 + \frac{mR^2}{I}\right)} = 2 * \frac{2}{1\,(1+1)}\pi = 2\pi \text{ s}$$

Answer: 3) 2π s