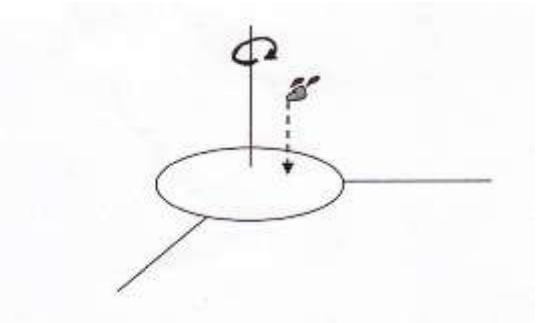
Q- A horizontal disk of mass 150g and radius 20 cm rotates at 10 rev/min about its axis, without any external torque. A flying bug of mass 15g lands vertically on the disk at a point half way to the centre and stick to it. Find the angular speed of the disk just after the collision.



(Considering that the bug remains stuck to the point at which it collides, perfectly inelastic collision).

As the bug falls vertically on the disk, the force on the disk due to the falling bug will be vertical i.e. parallel to the axis or rotation and the same for the weight of the bug. Thus the torque due to these two forces on the disk along the vertical axis of rotation will be zero and hence for this axis of rotation we can apply law of conservation of angular momentum.

Moment of inertia of the disk

$I = (½)\ MR^2 = 0.5*0.150*(0.2)^2 = 3*10^{-3}$ kg.m^2

Moment of inertia of the bug about the axis of rotation

$mr^2 = 0.015*(0.1)^2 = 1.5*10^{-4}$ kg.m^2

Initial angular velocity of the disk

$\omega = 10$ rev/m $= 10*(2\pi/60) = \pi/3$ radians/s

As there is no external torque on the system of the disk and the bug about the axis of rotation according to law of conservation of angular momentum we get

Final angular momentum = initial angular momentum

Or $(I + mr^2)*\omega_f = I*\omega$

Gives $\omega_f = \frac{I\omega}{I+mr2} = \frac{3*10^{-3}*(\pi/3)}{3*10^{-3}+1.5*10^{-4}} = \frac{20\,\pi}{63}\ rad/s$

Or $\omega_f = \frac{20\,\pi}{63} * \frac{60}{2\pi} = 9.52\ rev/min$