Answer on Question #51833-Physics-Other

1) A record turntable rotating at 34 rev/min slows down and stops in 30s after the motor is turned off

a) Find its (constant) angular acceleration in revolution per minute-squared

b) How many revolutions does it make in this time?

Solution

a) An angular acceleration is

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{\omega - 0}{\Delta t} = \frac{34\frac{\text{rev}}{\text{min}}}{0.5\,min} = 68\frac{\text{rev}}{\text{min}^2}.$$

b)

$$N = \omega\Delta t - \frac{\alpha\Delta t^2}{2} = \omega\Delta t - \frac{\omega\Delta t}{2} = \frac{\omega\Delta t}{2} = \frac{34\frac{\text{rev}}{\text{min}}\cdot 0.5\,min}{2} = 8.5\,rev.$$

Answer: a) $68\frac{\text{rev}}{\text{min}^2}$ b) 8.5.

2) A uniform solid ball rolls smoothly along a floor, then up a ramp inclined at 30.0^(o).It momentarily stops when it has rolled 1.0m along the ramp. What was its initial speed?

Solution

According to the conservation of energy law:

$$E_{translation} + E_{rotation} = E_{potential},$$

where $E_{translation} = \frac{mv^2}{2}$ is initial translational kinetic energy of the ball, $E_{rotation} = \frac{I\omega^2}{2}$ is initial rotational kinetic energy of the ball, $E_{potential} = mgh = mgl\sin 30$ is final gravitational potential energy of the ball.

For a solid ball:

$$I = \frac{2}{5}mr^2,$$

where m is a mass of ball, r is a radius of ball. So,

$$E_{rotation} = \frac{I\omega^2}{2} = \frac{1}{2}\frac{2}{5}mr^2\omega^2 = \frac{mv^2}{5}.$$

Thus,

$$\frac{mv^2}{2} + \frac{mv^2}{5} = mgl\sin 30.$$

$$\frac{7}{10}v^2 = gl\cdot\frac{1}{2}.$$

The initial speed is

$$v = \sqrt{\frac{5gl}{7}} = \sqrt{\frac{5 \cdot 9.8 \cdot 1.0}{7}} = 2.6 \frac{m}{s}.$$

Answer: $\mathbf{2.6}\,\frac{m}{s}$.