Answer on Question #66425-Physics-Mechanics-Relativity

Q. 1 An automobile travelling at 80 km hr 1 has tyres of radius 80 cm. On applying brakes, the car is brought to a stop in 30 complete turns of the tyres. What is the magnitude of the angular acceleration of the wheels? How far does the car move while the brakes are applied?

Solution

$$v = \frac{80000}{60(60)} = \frac{200}{9}\frac{m}{s}.$$

$$\omega_0 = \frac{v}{r} = \frac{\frac{200}{9}}{0.8} = \frac{250}{9}\frac{rad}{s}.$$

$$\omega^2 = \omega_0^2 - 2\alpha\theta = 0.$$

$$\alpha = -\frac{\omega_0^2}{2\theta} = -\frac{\left(\frac{250}{9}\right)^2}{2(2\pi)30} = -2\frac{rad}{s^2}.$$

Q. 2 The position vector of two particles of mass 4.0 kg and 2.0 kg are, respectively, r1 = 3t i^ + t j^ +2t2 k^ and r2 = 3 i^ +(t2-1)j^ +4t k^ where t is in seconds and the position in meters. Determine the position vector of the center of mass of the system, the velocity of the cm and the net force acting on the system

Solution

The position vector of the center of mass of the system is

$$\boldsymbol{r} = \frac{m_1\boldsymbol{r_1} + m_2\boldsymbol{r_2}}{m_1 + m_2} = \frac{1}{4+2}(4(3t) + 2(3); 4t + 2(\mathrm{t}^2 - 1); 4(2t^2) + 2(4t))$$
$$= \left(2t + 1; \frac{1}{3}(t^2 + 2t - 1); \frac{4}{3}(t^2 + t)\right)m.$$

The velocity of the cm:

$$\dot{\boldsymbol{r}} = \left(2; \frac{1}{3}(2t + 2); \frac{4}{3}(2t + 1)\right)\frac{m}{s}$$

The acceleration of cm:

$$\ddot{\boldsymbol{r}} = \left(0; \frac{2}{3}; \frac{8}{3}\right)\frac{m}{s^2}$$

The net force acting on the system is

$$\boldsymbol{F} = (m_1 + m_2)\ddot{\boldsymbol{r}} = 6\left(0; \frac{2}{3}; \frac{8}{3}\right) = (0; 4; 16)\ N.$$