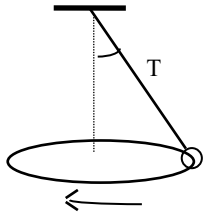
Tutorial Sheet 6 2020/21

Motion in a Circle

01*. A belt runs on a wheel of radius 44 cm. During the time the wheel takes to coast uniformly to rest from an initial speed of 1.6 rev/s, 29.5 m of belt length passes over the wheel. Find the deceleration of the wheel and the number of revolutions it turns while stopping. [$\alpha = -0.12\,rev/s^2$ $\theta = 67\,rad = 10.7\,rev$]

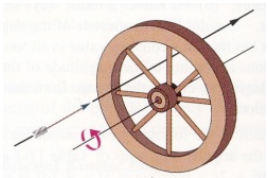
02. A carton of eggs sits on the horizontal seat of a car as the car rounds a 26 m radius bend at 16.5 m/s. What minimum coefficient of friction must exist between carton and seat if the eggs are not to slip? [$\mu = 1.07$]

03. A string of length 30 cm has one end attached to a fixed point and the other to a mass of 100 g which revolves in a horizontal circle 80 times per minute. Calculate (i) the angle of inclination of the string to the vertical, and (ii) the tension *T* in the string. [$\theta = 62.18^0$ $T = 2.10\text{N}$]



04*. A 450 g ball at the end of a cord is whirled in an almost horizontal circle of radius 1.25 m. Its tangential speed in the circle is 8.5 m/s. *Do not* neglect the weight of the ball; the string cannot be perfectly horizontal. (a) What must the tension in the cord be? (b) What angle does the cord make with the horizontal? [$T = 26.4\text{N}$ $\theta = 9.62^0$]

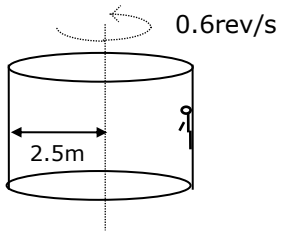
05*. A wheel of radius 25cm has eight spokes. It is mounted on a fixed axle and is rotating at a constant angular speed ω. You shoot a 20cm long arrow parallel to the axle through the wheel at a speed of 6m/s. The arrow and the spokes are supposed to be thin. Calculate the maximum value of ω (in rad/second and in rev/second) so that the arrow just goes through without hitting any of the spokes. Does it matter where between the axle and the rim of the wheel you aim? If so, what is the best location? [$\omega = 23.79\,rad/\sec = 3.79\,rev/\sec$]



06*. A train is travelling at 50 km/h on a curve, the radius of which is 500 m. If the distance between the rails is 1.5 m, find how much the outer rail must be raised above the inner, so that there may be no lateral thrust on the rails. [6 cm]

07*. A satellite orbits the earth in about 87 minutes if its orbital radius is 6500 km. Use these data to find the mass of the earth. Given $G = 6.67 \times 10^{-11}$ [$5.97¥ 10^{24} kg$]

08. A person is held stationary in a rotating drum against the wall by the static friction force exerted on him by the wall as shown.
Find the required coefficient of static friction between the man and the surface of the drum to keep him from slipping downward. The radius of the drum is 2.5m, and it is rotating at 0.6rev/s. [$m = 0.28$]



09*. A particle is to slide along the horizontal circular path on the inside of the funnel. The surface of the funnel is frictionless. How fast must the particle be moving, in terms of *r* and θ, if it is to execute this motion? [$v = \sqrt{\frac{rg}{\tan\theta}}$]