PHY 116 From Newton to Einstein
Coursework Sheet 5: Rigid Bodies

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All questions are taken from Young and Freedman

A1) A turntable has a kinetic energy of 0.0250 J when turning at 45.0 rev/min. What is the moment of inertia of the turntable about the axis of rotation? [4]

A2) Small blocks, each with a mass m, are clamped at the ends and at the centre of a light rod of length L. Calculate the Moment of Inertia of the system about an axis perpendicular to the rod and passing through a point ¼ of the length from one end. You can ignore the moment of inertia of the rod. [5]

A3) A flywheel with a radius of 0.3m starts from rest and accelerates with a constant angular acceleration of 0.6 rad/s^2. Compute the magnitude of the tangential acceleration, the radial acceleration, and the resultant acceleration of a point on the rim a) at the start; b) after it has turned through 60° and c) after it has turned through 120°. [7]

A4) A cord is wrapped around the rim of a wheel 0.25m in radius, and a steady pull of 40.0 N is exerted on the cord. The wheel is mounted on a frictionless bearing on a horizontal shaft through its centre. The moment of inertia of the wheel about the shaft is 5.00 kg.m^2. Compute the angular acceleration of the wheel. [5]

B5) Under some circumstances a star can collapse into an extremely dense object made mostly of neutrons and called a neutron star. The density of the neutron start is roughly 10^{14} times as great as that of ordinary solid matter. Suppose we represent the start as a uniform solid rigid sphere, both before and after collapse. The star's initial radius was 7.0×10^5 km (comparable to the Sun); its final radius is 16 km. If the original star rotated once in 30 days, find the angular speed of the neutron star. [4]

B6) Occasionally, a rotating neutron star undergoes a sudden speedup called a *glitch*. One explanation is that a glitch occurs when the crust of the neutron start settles slightly, decreasing the moment of inertia about the rotation axis. A neutron star with angular speed $\omega_0 = 70.4$ rad/s underwent such a glitch in October 1975 that increased its angular speed to $\omega = \omega_0 + \Delta\omega$, where $\Delta\omega/\omega_0 = 2.01 \times 10^{-6}$. If the radius of the neutron star before the glitch was 11 km, by how much did the radius decrease in the starquake? Assume that the neutron star is a uniform sphere. [5]