Rotational Inertia, Torque, and Angular Momentum

The ROTATIONAL INERTIA (I_A) of a system of N rigidly-connected particles, about fixed axis A is $I_A \equiv \sum_i m_i r_i^2$ (with $\sum_i \equiv \sum_{i=1}^{N}$), in units of kg·m^2, where particle i, of mass m_i, is distance r_i from axis A.

The TORQUE (τ_{AF_i}), about axis A, due to a force $\underline{\mathbf{F}}_i$ acting on particle i, is $\tau_{AF_i} \equiv r_i F_{it}$, where F_{it} is the tangential component of $\underline{\mathbf{F}}_i$, and r_i is the distance from A to particle i. Units are N·m; CW or CCW for τ_{AF_i} agrees with F_{it}. Equivalent expressions for the size of torque are $r_i|F_{it}|$, $r_i|\underline{\mathbf{F}}_i|sin(\theta)$, and $|\underline{\mathbf{F}}_i|\ell$, where θ is the angle between $\underline{\mathbf{F}}_i$ and the radial direction for particle i, and ℓ is the LEVER ARM for force $\underline{\mathbf{F}}_i$. For a system of particles, the net torque always reduces to the sum of torques due to EXTERNAL forces only.

The ANGULAR MOMENTUM (L_{Ap_i}), about axis A, of particle i with momentum $\underline{\mathbf{p_i}}$, is $L_{AF_i} \equiv r_i p_{it}$, where p_{it} is the tangential component of $\underline{\mathbf{p_i}}$, and r_i is the distance from A to particle i. Units are kg·m^2/s; CW or CCW for L_{AF_i} agrees with p_{it}. For a system of rigidly-connected particles with angular velocity ω about fixed axis A, the total angular momentum always reduces to $I_A\omega$.