

Dodgy motorcycling

The cylinder problem involved a quantity called angular momentum. This is the equivalent for rotational motion of linear momentum for linear motion. It is also a vector quantity, and is conserved in the same way, and can be changed by changing its magnitude or direction (remember billiard ball collisions and gun recoil).

By convention, the vector for angular momentum is along the axis of rotation and points in the direction given by the right hand screw rule relative to the direction of the rotation (i.e. the vector points in the direction that a right hand threaded screw would move when turned in the direction of rotation).

Now consider the problem of going round a curve on a motorbike. As you will know if you ride an ordinary bike, you need to lean over into the curve to provide the necessary force to produce the change in direction of the overall linear momentum vector required to go round the curve. This description ignores the angular momentum involved in the rotation of the wheels, particularly the front wheel, whose direction needs to change when going round a curve. This is usually negligible in the case of an ordinary bike, due to the low speed and low masses usually involved. But with a motorbike, the speed will generally be higher, as will the mass of the wheels, so we need to consider the effect of turning the front wheel to steer round the curve.

Remember that angular momentum is conserved so, if the rider does something to change the angular momentum of the wheels of the motorbike, like turning the handle-bars, the system of the rider and the motorbike will try to change it back.

Assuming that the motorcyclist does not change speed on entering a curve, use the triangle rule for the addition of vectors to show that, if the front wheel is just steered into the curve, this will tend to make the bike lean in the opposite direction to that required to go safely round the curve.

If you watch motorcycle racing carefully, you will see that the riders initially turn the front wheel in the opposite direction in order to lean over. In racing, the situation with regard to the whole system becomes complicated because of the way that riders move around relative to the bike to change the overall mass distribution to enable them to go round curves faster without sliding, which is prevented by the friction provided by the tyres. Ideally, they need to be in a situation where the bike is just about to slide (rather than me!)