I now want to discuss the perpendicular axis theorem. The perpendicular axis theorem allows you to calculate a moment of inertia, but it only applies to thin sheets.

I place the thin sheen into plane xy. Here is my thin sheet-- you've seen it before in separate segments-- with width a, length b, uniform mass distribution, and mass m. I can choose any axis x and y in the plane through the sheet-- they are perpendicular to each other. What the perpendicular axis theorem tells me is that the moment of inertia about the z axis, which is perpendicular to the paper, is the moment of inertia about the x-axis-- which I can choose in this plane-- plus the moment of inertia about the y-axis, which I can choose also in this plane, but x and y are perpendicular to each other.

You can choose x and y in crazy ways, but I will not do that: I will choose the y-axis right through the center. I will also choose the x-axis right through the center c, right through the center of this sheet. I will call this x, I will call this one y, and z is the one that is perpendicular to the paper. I'm going to rotate it about an axis perpendicular to the paper-- I call this axis 1, and I call this axis 2.

I of 1-- you can either look up in a table, or you derive it as we did in a different segment. I of 1 equals 1/12 times ma squared, and I of 2 about this rotational axis, equals 1/12 mb squared. What this perpendicular axis theorem is was telling you that this is a thin sheet that the moment of inertia-- rotation about the z-axis perpendicular to the paper-- equals 1/12 m times a squared plus b squared. If you're lucky, you may find this result in a table. If not, you may have to the derive it as I just did.

Suppose we didn't want to know the moment of inertia about the axis c, as you see here, but suppose we wanted to know the moment of inertia about point P here, axis through P perpendicular to the paper, and that this separation between P and c is bd. You guessed it: I already know the moment of inertia about c. If I want to know the moment of inertia about the axis point P, and these two axes are parallel, now I can apply the parallel axis theorem again. I know the vertical axis about point c, and so therefore the moment of inertia about point P-- a vertical axis perpendicular to the paper-- is now the moment of inertia about point c about this axis plus m times d squared. I will write that m divided by 12 a squared plus b squared plus m d squared.

I want you to remember this, because I'm going to use it later when I'm going to calculate the oscillation of a ruler with a pin through point P. It's going to oscillate back and forth in a gravitational field.

Remember this and keep this in mind: that's the moment of inertia about an axis through P of this uniform flat sheet which has width a and length b, and the separation to the center of mass is d. That's the separation.