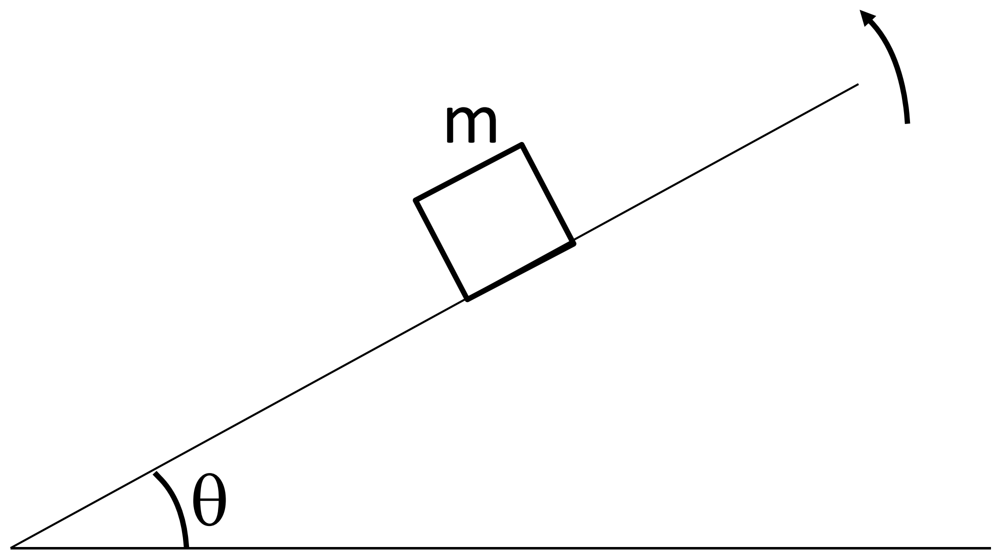
Class 18: Work

Test 2

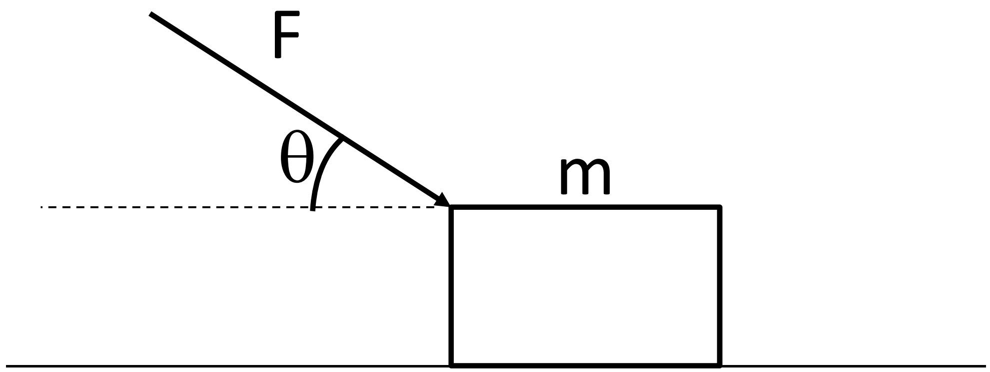
1. Next Wednesday (March 4) 11:00-11:50 in this class room.
2. Newton's Law of gravitation, Hooke's Law, Newton's Law of motion.
3. No formula or cheat sheet.
4. 8 multiple choice problems (5 points each) and 2 long (30 points each) problems. Total 100 points.
5. Calculators allowed, but not the program function (though I don't think it will help).
6. Please bring photo ID.
7. No reschedule of test even though you have more than two tests that day.
8. Classwork Monday will be 8 multiple choices on the test materials.

Example



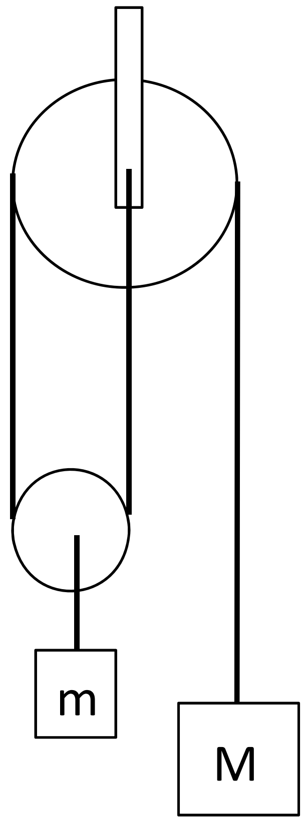
If coefficient of static friction is μ_s, at what angle will the block start sliding down?

Example



The brick is moving forward in the direction as shown. If coefficient of kinetic friction is μ_k, calculate the acceleration and the normal force from the floor to the brick.

Last example before leaving Newton's Laws of Motion



Find acceleration of the blocks and tension in the string.

Problem solved?

$$\Sigma F_x = m \frac{d^2}{dt^2} x$$

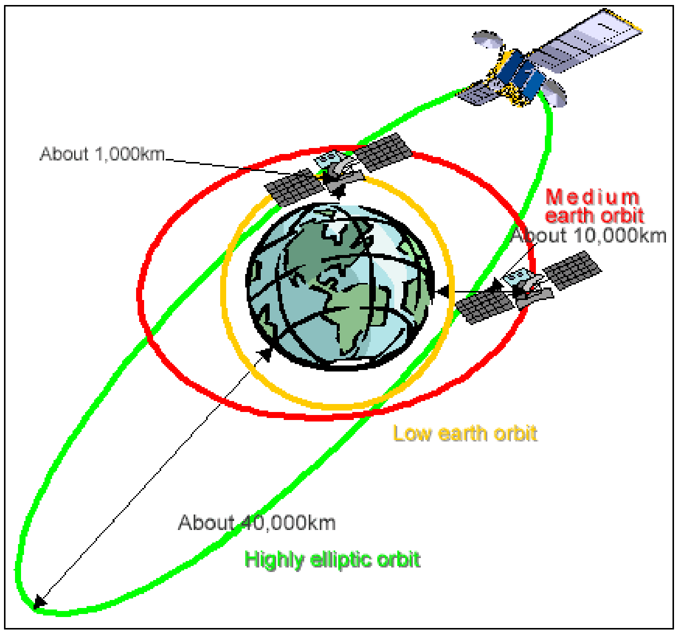
$$\Sigma F_y = m \frac{d^2}{dt^2} y$$

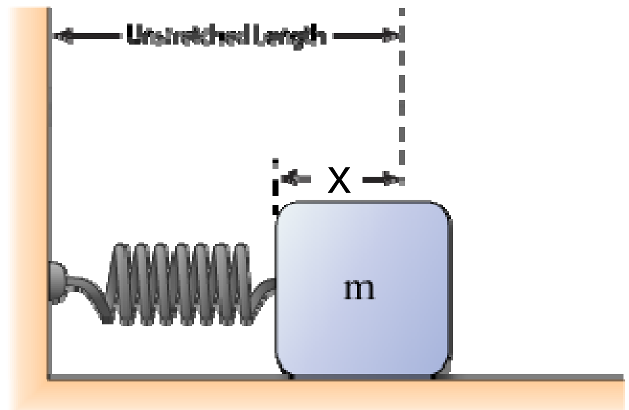
$$\Sigma F_z = m \frac{d^2}{dt^2} z$$

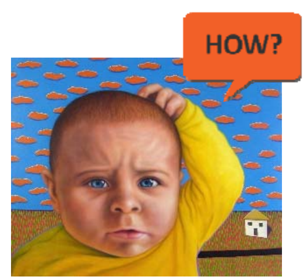
Problem is solve if we know ΣF as a function of time. If we can solve the differential equations, we will know the position and velocity of the particle at any time.

The problem

In most cases we live in a “force field” – there is always a force acting on us and this force depends on where we are.







$$\Sigma F_x = m \frac{d^2}{dt^2} x$$

$$\Sigma F_y = m \frac{d^2}{dt^2} y$$

$$\Sigma F_z = m \frac{d^2}{dt^2} z$$

Acceleration by chain rule (1D)

If we know the velocity as a function of time, we can differentiate it w.r.t. time and find out how the acceleration depends on time:

$$a_x = \frac{dv}{dt}$$

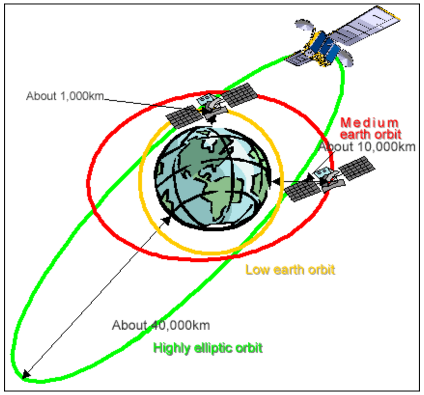
However, very often we only know the velocity as a function of position (i.e. coordinate x). What to do in this case?

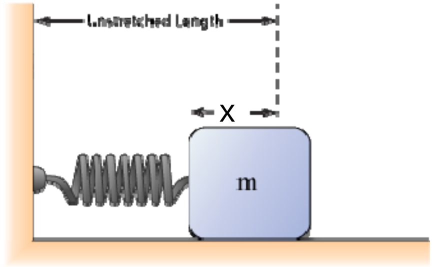
$$a_x = \frac{dv}{dt} = \frac{dx}{dt}\frac{dv}{dx}$$

$$\therefore \boxed{a_x = v\frac{dv}{dx}}$$

The answer

In most cases we live in a "force field" – there is always a force acting on us and this force depends on where we are.





$$\Sigma F_x = m \frac{d^2}{dt^2} x \quad \Rightarrow \Sigma F_x = m \frac{d}{dx} v_x$$

$$\Rightarrow m v_x \frac{d}{dx} v_x = F_{1x} + F_{2x} + F_{3x} + \cdots$$

$$\Rightarrow \left(\frac{1}{2} m v_{xf}^2 - \frac{1}{2} m v_{xi}^2 \right) = \int_{x_i}^{x_f} F_{1x}\, dx + \int_{x_i}^{x_f} F_{2x}\, dx + \int_{x_i}^{x_f} F_{3x}\, dx + \cdots$$