PHYS 1901 – Physics 1A (Advanced)
Mechanics module

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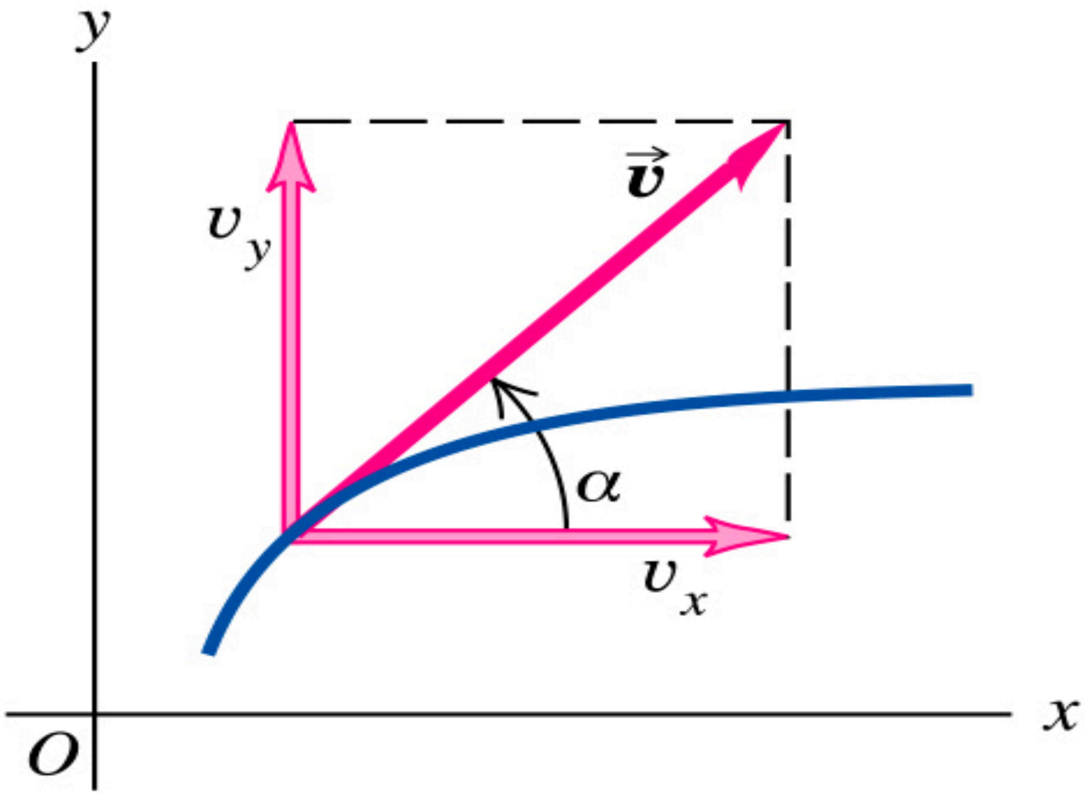
More than one dimension: vectors

The kinematic equations can be applied in each direction separately.

You decide the coordinate system



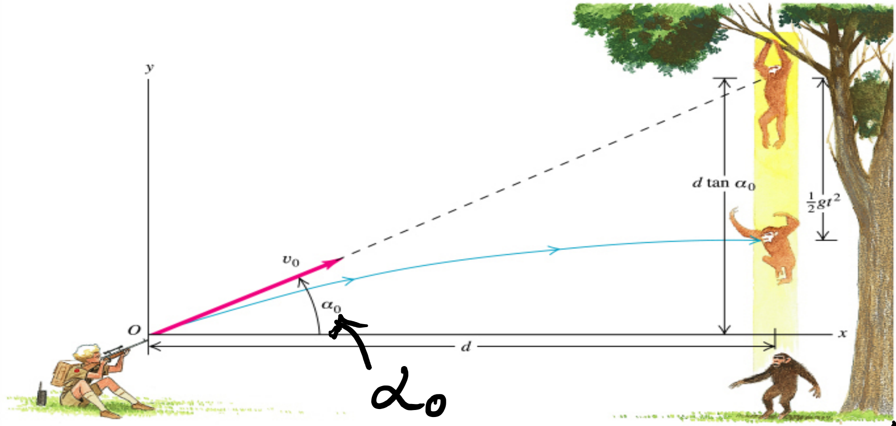
Vectors have a length & direction. To use them we need to decompose the vector into its components.

$$v_x = |v| cos\ \alpha$$

$$v_y = |v| sin\ \alpha$$

(this is important!)

Monkey and Hunter



α_0

Monkey motion

$x_m = d$ at all times

$y_m = y_{0m} - \frac{1}{2}gt^2$

$= d\tan\alpha_0 - \frac{1}{2}gt^2$

Evaluate at $t = \frac{d}{v_0 \cos\alpha_0}$

$y_m = d\tan\alpha_0 - \frac{1}{2}g\frac{d^2}{v_0^2\cos^2\alpha_0} = y_d$

Dart motion

x-motion

$x_d = 0 + v_{0dx}t = (v_0\cos\alpha_0)t$

At what time is $x_d = d$?

$t = \frac{d}{v_0\cos\alpha_0}$

y-motion

$y_d = 0 + v_{0dy}t - \frac{1}{2}gt^2$

$= (v_0\sin\alpha_0)t - \frac{1}{2}gt^2$

Evaluate at $t = \frac{d}{v_0\cos\alpha_0}$

$y_d = \frac{\cancel{v_0}\sin\alpha_0 \cdot d}{\cancel{v_0}\cos\alpha_0} - \frac{1}{2}g\frac{d^2}{v_0^2\cos^2\alpha_0}$

$\tan\alpha_0$

Newton's Laws of Motion

Chapter

4

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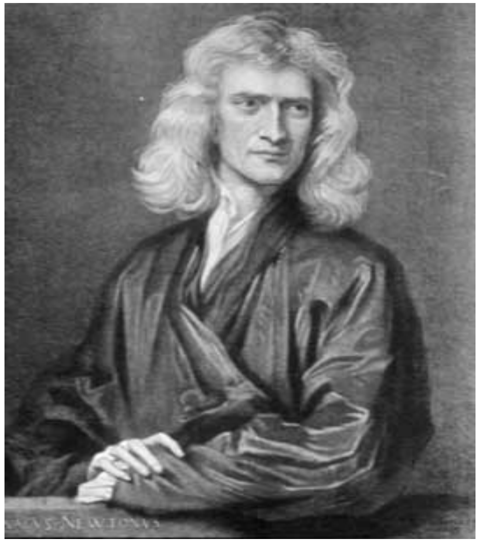
Isaac Newton



Developed concept of **Dynamics**

Considered the motion of a body as it is being influenced by something.

Developed three fundamental laws of motion.

Amongst the most powerful scientific laws

"In order to use Newton's laws, we have to find some formula for the force; these laws say *pay attention to the forces.* If an object is accelerating, some agency is at work; find it"

Richard Feynman

Lectures on Physics

Newton's First Law

"A body acted on by no net force moves with constant velocity (which may be zero) and zero acceleration"

This just reiterates Galileo's ideas of inertia.

Newton’s Second Law

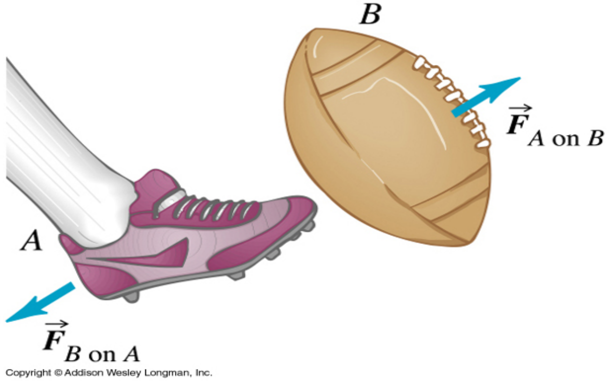
“If a net external force acts on a body, the body accelerates. The direction of the acceleration is the same as the direction of the net force. The net force vector is equal to the mass of the body times its acceleration”

$$\sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}$$

Newton's Third Law

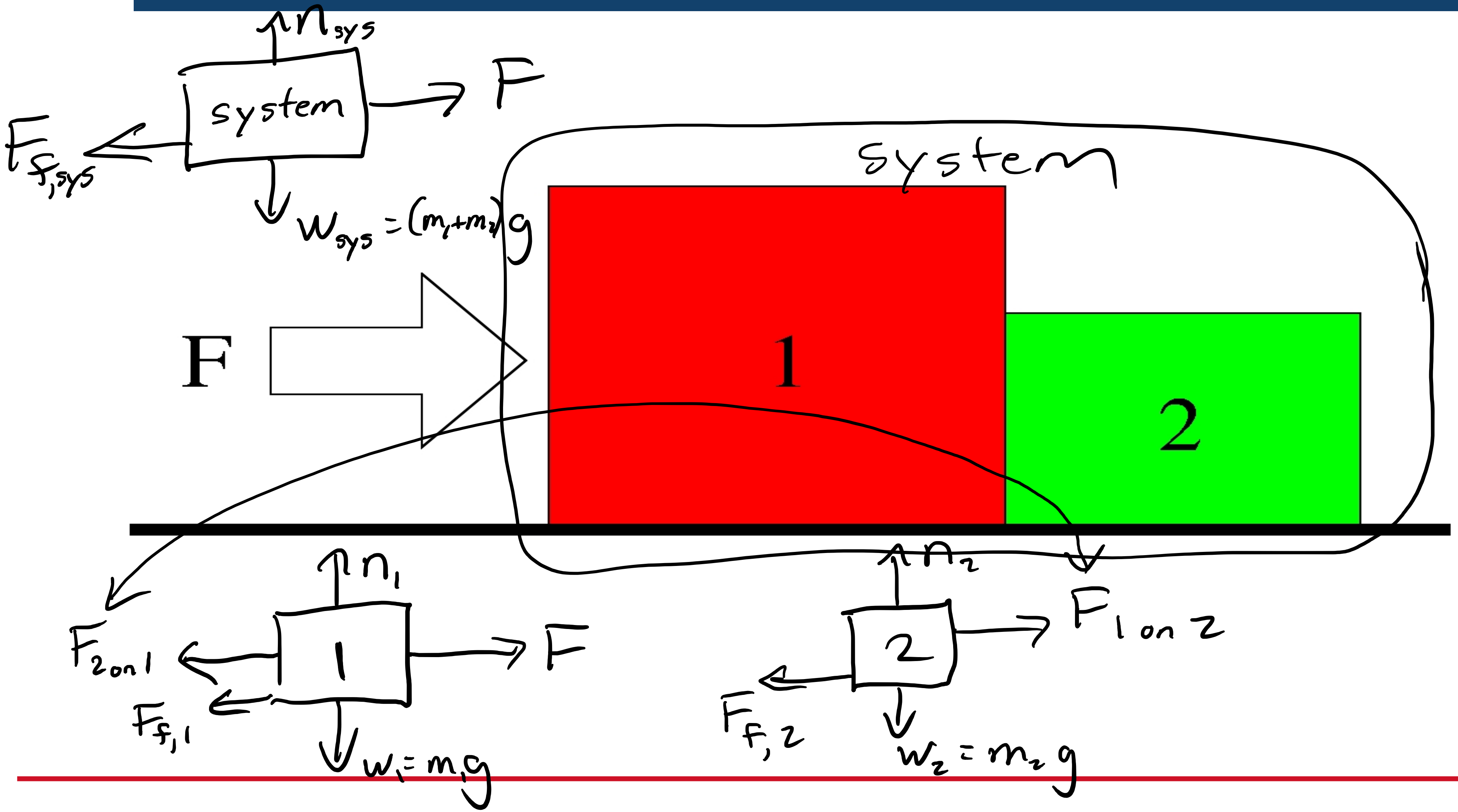
"If body A exerts a force on body B (an 'action'), then body B exerts a force on body A (a `reaction'). These two forces have the same magnitude but are opposite in direction. These two forces act on *different* bodies"

$$\vec{\mathbf{F}}_{A\ on\ B} = -\vec{\mathbf{F}}_{B\ on\ A}$$

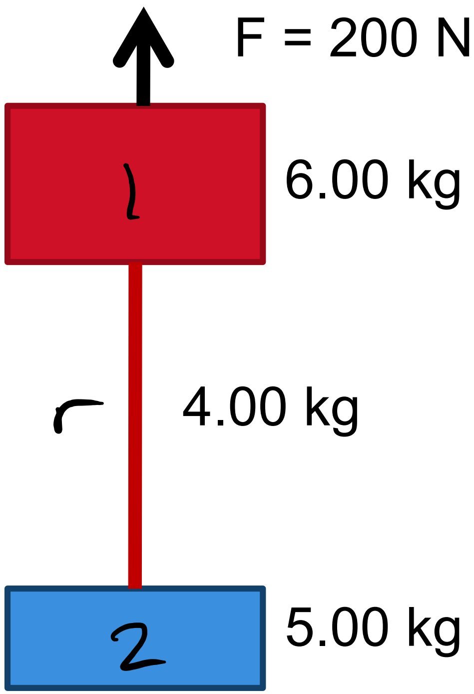


(A vector equation. Be careful with the minus sign!)

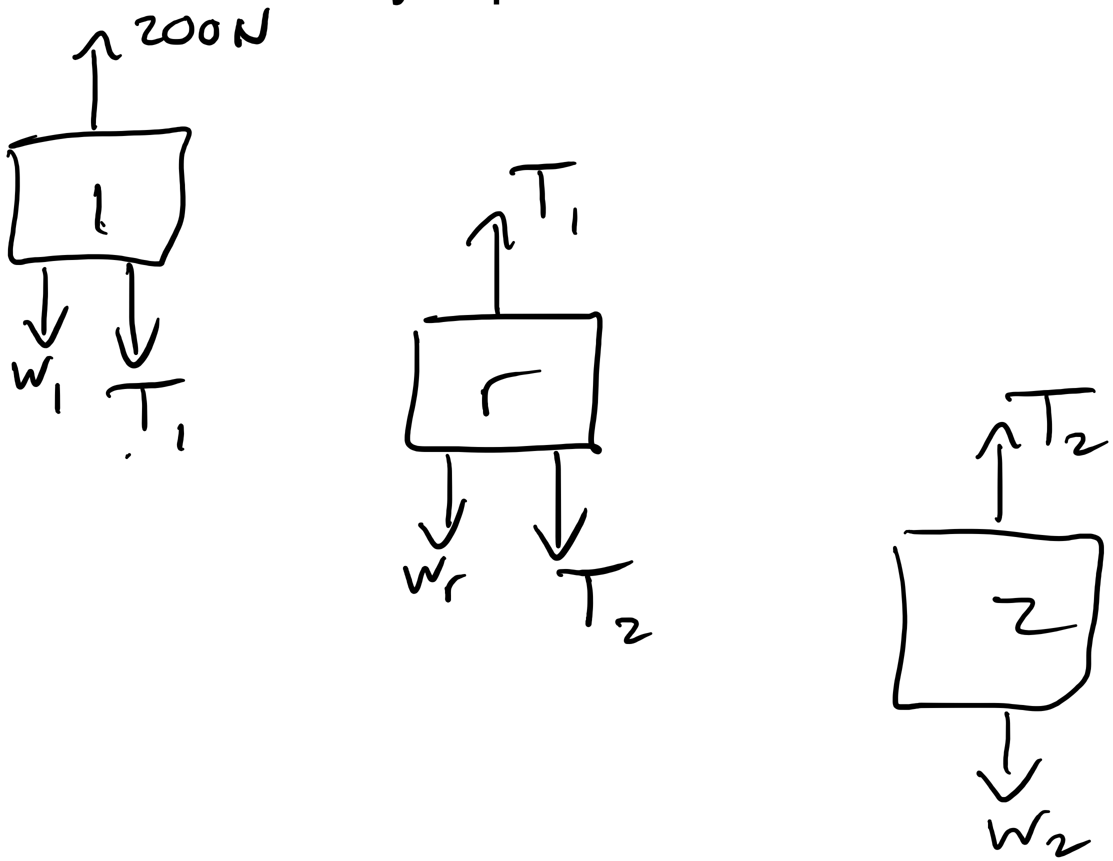
Free-Body Diagram



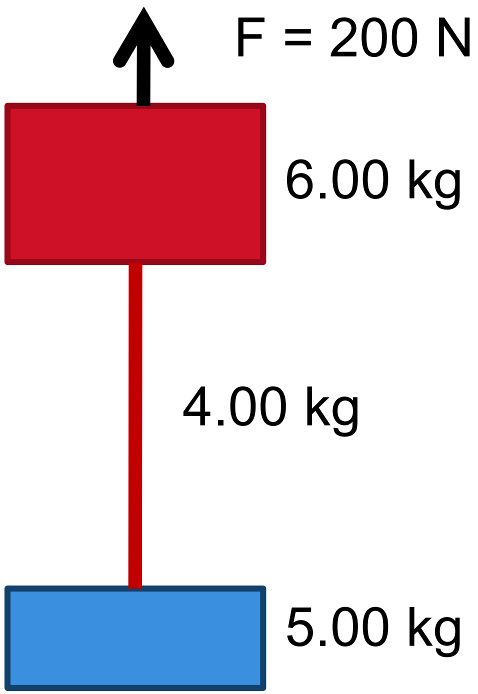
Problem 4.54



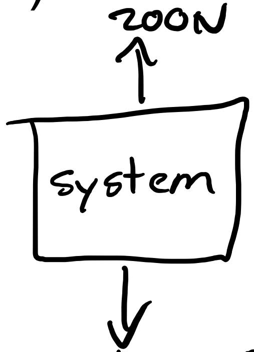
a) Draw free-body diagrams for both masses, and for the heavy rope.



Problem 4.54



b) What's the acceleration of the system?



$F_{net} = 52.8\ N$ (up)

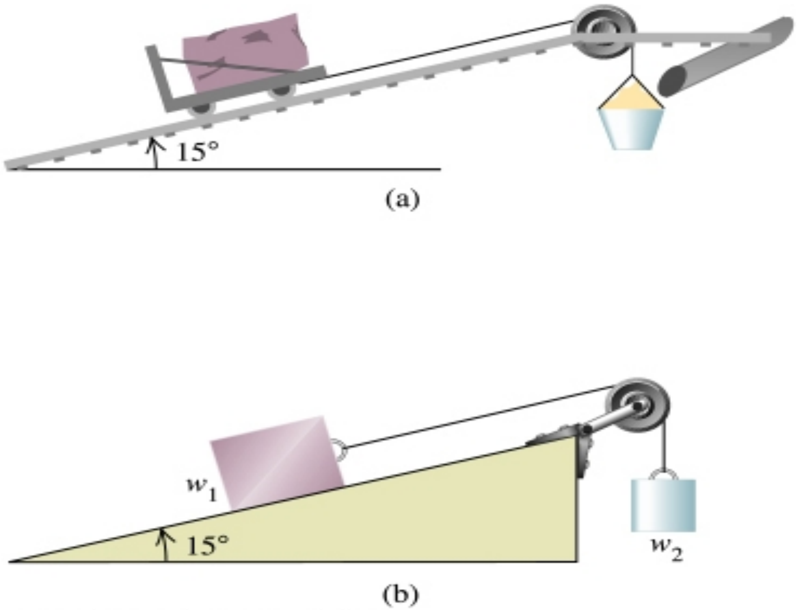
$F_{net} = ma \Rightarrow a = 3.52\ m/s^2$ (up)

$W_{sys} = m_{system}\, g = (15.00\,kg)(9.80\,m/s^2) = \cancel{147.2N}$ $147\ N$

c) What's the tension at the top of the rope?

d) At the mid-point?

Example



A trolley of mass m_1 is place on a slope inclined at 15^o. It is attached via a light string and pulley to a hanging sand bucket. What mass of sand m_2 is needed such that the trolley possesses uniform motion?

(Assume no friction)