Chapter 4: More Newtonian Physics (Mechanics)

– why things move

Outline of today's class (apart from quizzes – won't count because clicker system didn't work):

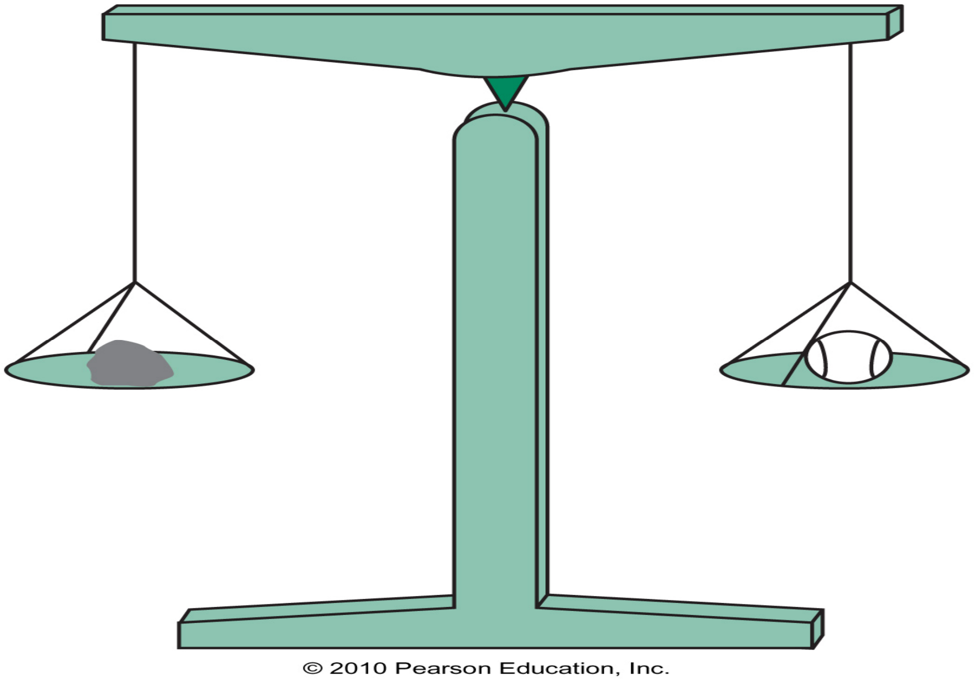
Back to where we stopped last time (*particularly Quiz 14*)

……and again weight vs. mass

Review of 1st half of chapter 4 ($F_{net} = m\,a$)

Newton's 3rd Law: action & reaction

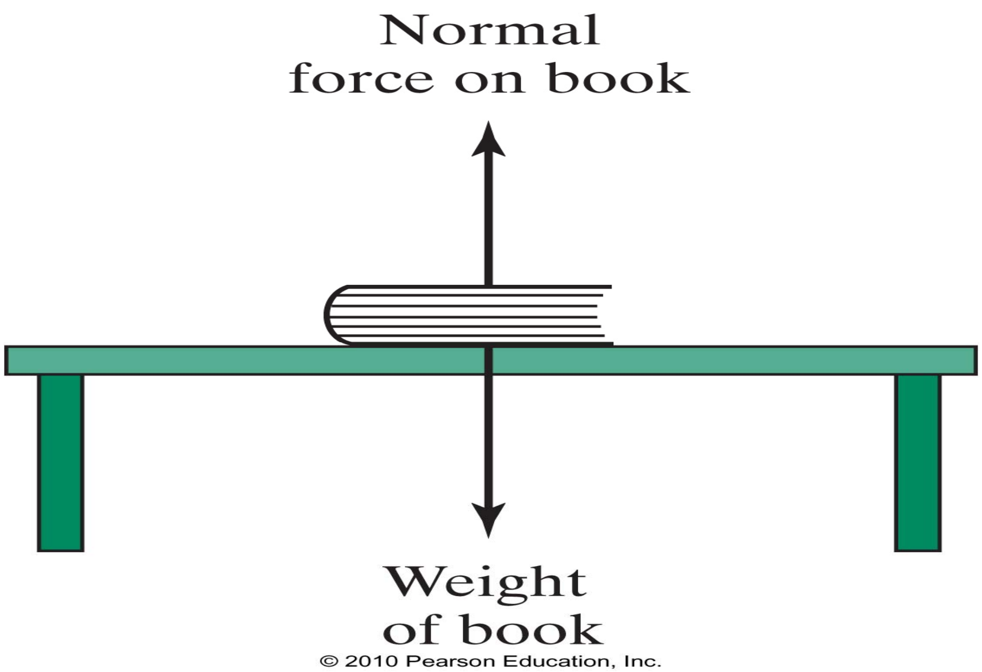
Examples of Newton's Laws in action



Important reminder:

What is weight?
A: the force of gravity, i.e. W=mg

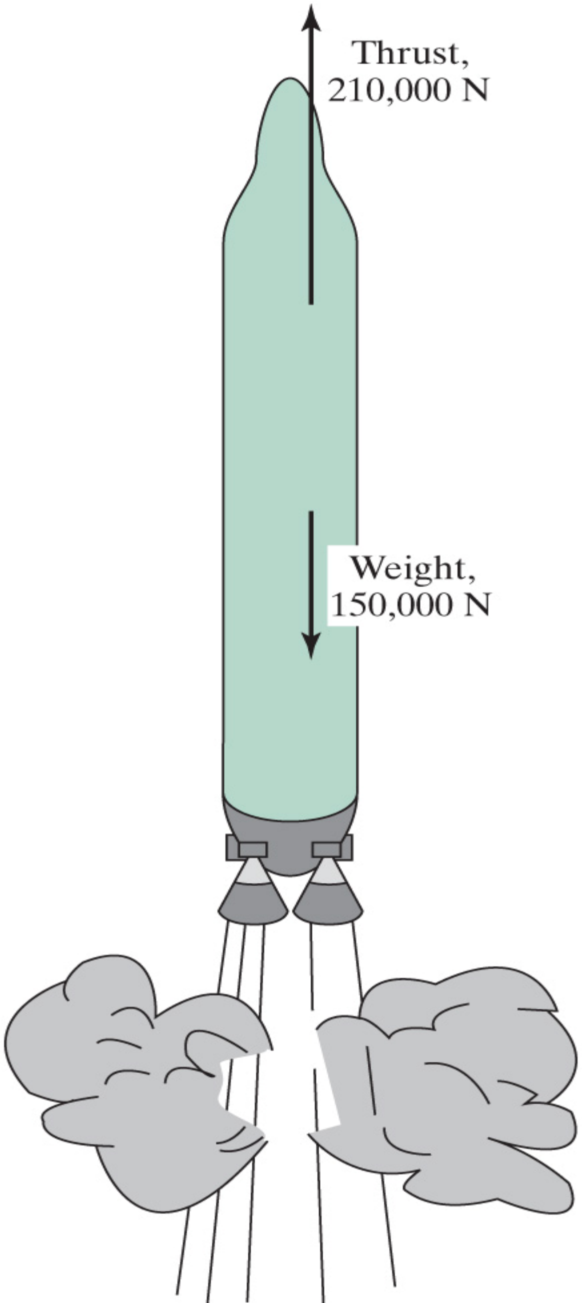
Therefore:
At the same place two objects of equal mass also have equal weight!
That's why we can get away with…
…what?



Weight & "normal force"
&force diagram

Demo: mirror & laser on desk

Comment on "weight loss"



Quiz # 15:

m_{rocket} = 15,000 kg; suppose thrust is only 180,000 N.
Acceleration is then

(a) 2 m/s^2 (b) 1 m/s^2 (c) 3 m/s^2 (d) 0 m/s^2

Quiz # 16:

Consider the apple (weight = 2 N) thrown upward in quiz # 14, again ignoring friction. At the top of its trajectory (instantaneous speed = 0) the strength and direction of the net force on the apple is

(a)zero (b) 2 N downward (c) 2 N upward
(d) none of the above

Study problem 4-9: important to understand the solution, incl. the direction of the forces involved.

Problem 4-10: clearly $m_{black} = 4\, m_{white}$ due to $F_{net} = m\, a$

C.E. 17: air resistance must balance gravity/weight

Quiz # 17:
In the preceding question, what would be Ned's acceleration if there were no air and he would have a mass of 80 kg instead of 60 kg?

(a) Zero (b) 9.8 m/s^2 down (c) 80/60 times 9.8 m/s^2 (d) none of the above

Enjoy Newton's Laws: (turn on some of the graphs of force, acceleration, velocity, position – quite instructive)

http://phet.colorado.edu/en/simulation/forces-and-motion

http://phet.colorado.edu/en/simulation/forces-1d

Review: the importance of $F_{net} = m \times a$

Problem 8: m = 2 kg, w = 20 N, a = 8 m/s^2. Air resistance?

$F_{net, down} = m\, a = 2\text{ kg} \times 8\text{ m/s}^2 = 16\text{ N}$

But $F_{net, down} = w - F_{air, up} = 16\text{ N}$

Therefore $F_{air,up} = w - 16\text{ N} = 20\text{ N} - 16\text{ N} = 4\text{ N}$

Quiz # 18:

Neglecting friction & air resistance & vertical forces, where would it be easier to set an object into horizontal motion at 5 m/s

(a) on Earth (b) on the moon (c) in outer space (d) same for all three

Quiz # 19:

A boy lifts a ball (w = 20 N, m = 2 kg) via a string. The string exerts a 30 N force on the ball. a_{Ball} = ?

(a) 15 m/s^2 (b) 10 m/s^2 (c) 25 m/s^2 (d) 5 m/s^2 (e) zero

Newton's 3rd Law: "action = reaction"

Modern Physicist's view: Force = Interaction between 2 objects ("can't touch without being touched")

Demos: slap, push off wall

The Law of Force Pairs[6]

Every force is an interaction between two objects. Thus, forces must come in pairs: Whenever one body exerts a force on a second body, the second exerts a force on the first. Furthermore, the two forces are equal in strength but opposite in direction.

Important: 2 forces in a pair act on *<u>*different*</u>* objects!

CONCEPT CHECK 9 Your hands push a heavy box across the floor. The other member of the force pair is (a) friction pushing backward on the box; (b) gravity pulling downward on the box; (c) the box pushing backward against your hands; (d) the box pushing downward against the floor.

The Automobile – what a great application of Newtonian principles. Example: car, straight level highway, steady 80 km/hr.

F_{net} = ? (magnitude & direction) $F_{drive} = 0$?

What if speeding up? Slowing down?