Chapter C1 (focus on 1.4, 1.6, 1.7, 1.8, 1.9)

Props: air track

The macroscopic interactions that we will be considering in this course can be conveniently classified as either:

(a) long-range or short-range

(b) normal or frictional

(c) good or evil

(d) long-range or contact

[start w/ C1.6] (Moore)

[Particle physicists talk about 4 forces:]

Gravity
Electromagnetism } Long range

Strong Nuclear
Weak Nuclear } short range

Macroscopic interactions

1. Long range:
   a) gravity
   b) electrostatic
   c) magnetic

2. Contact
   a) compression (normal)
   b) tension
   c) friction

- **Forces are a result of an interaction between a pair of objects**

The forces on each object are equal (in magnitude) and opposite (in direction)

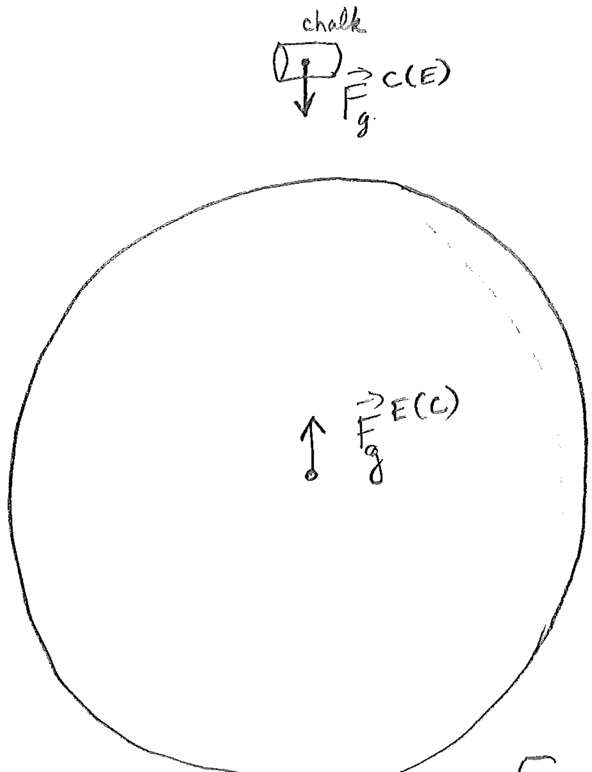
Define $\vec{F}^{1(2)}$ = force on 1 (by 2)

$$\vec{F}^{1(2)} = -\vec{F}^{2(1)}$$

(Newton's 3rd law)

[Demonstrate this w/ air track, 2 equal masses w/ magnets, burn the rubber band to see them go off in opp directions]

Gravity



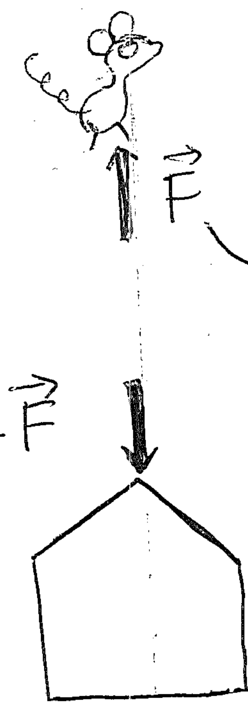
[the chalk is acted on by all parts of the earth but for a spherical object, acts as if the mass were all located at the center of the earth

$$\vec{F}_g^{E(C)} = -\vec{F}_g^{C(E)}$$

[Q: An empty boat ...]

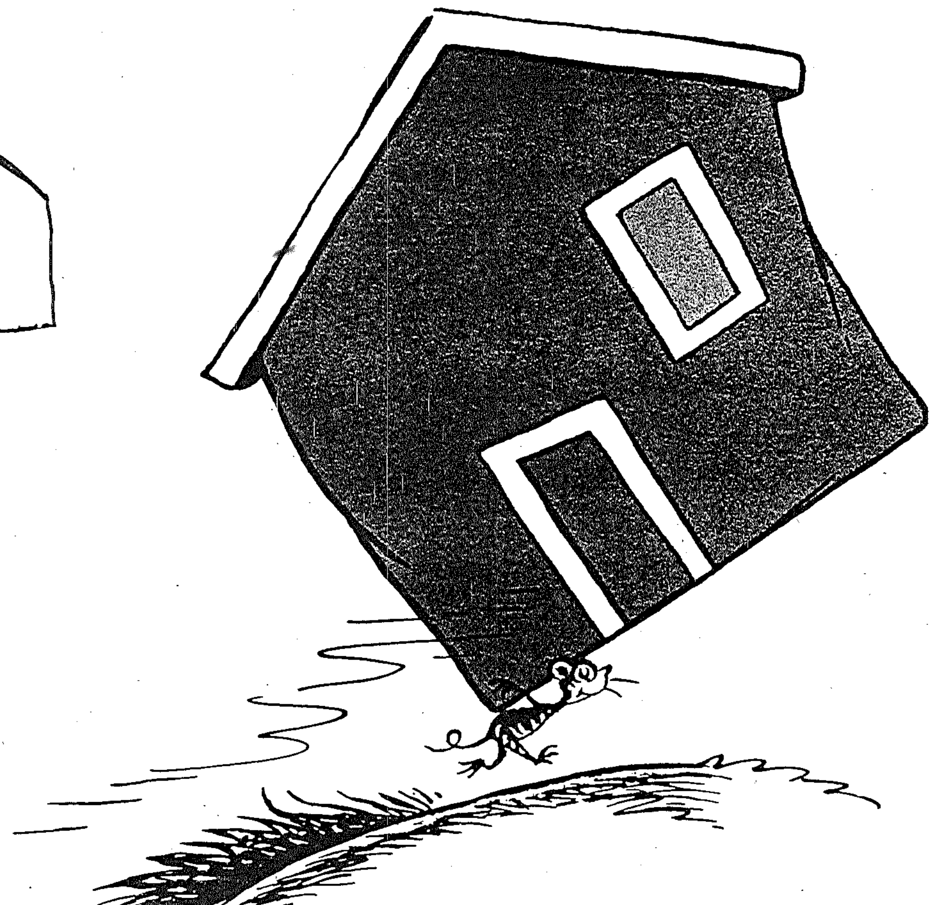
MOUSE
HOUSE

Mouse on house.



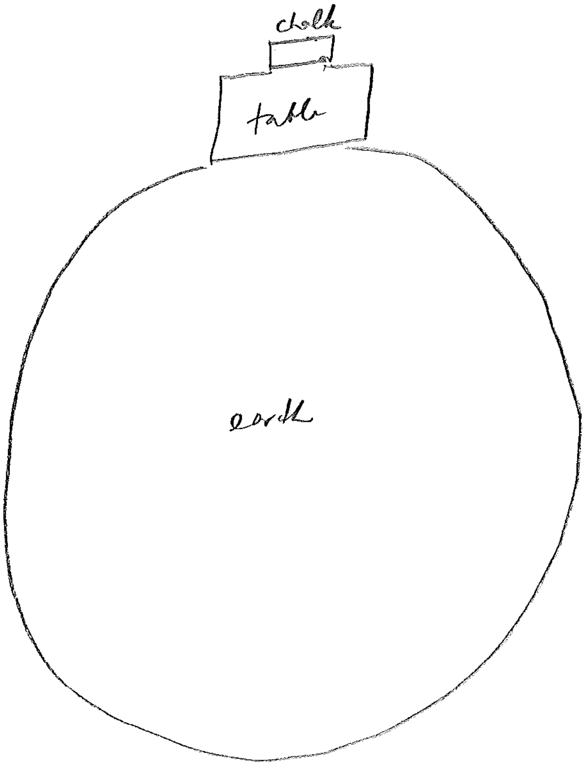
HOUSE
MOUSE

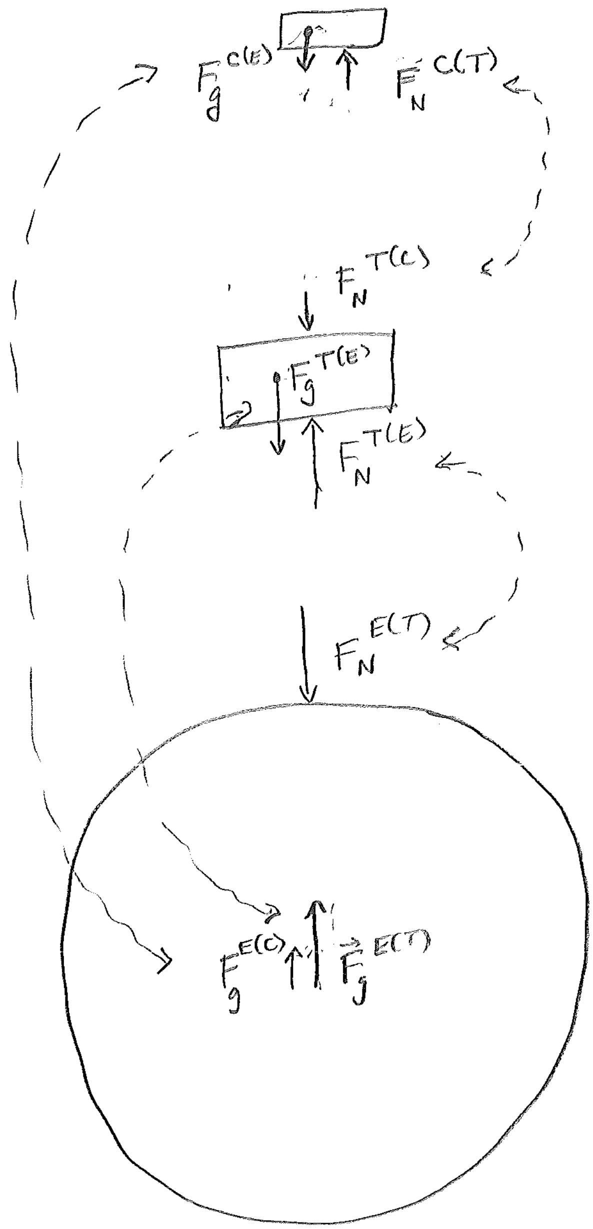
House on mouse.



C1T.8 An empty floating boat interacts gravitationally with the earth. A different interaction with something else keeps the boat from responding to the gravitational interaction by sinking. What is the other object that interacts with the boat? What is the *type* of macroscopic interaction involved? (Choose one from each column.)

A. The surrounding water.	A. A tension interaction.
B. The atmosphere.	B. A electrostatic interaction.
C. The earth.	C. A friction interaction.
D. The lake floor.	D. A compression interaction.





Everything At rest

F_{net}^{chalk}: $F_g^{C(E)} = F_N^{C(T)}$

F_{net}^{table}: $F_g^{T(E)} + F_N^{T(C)} = F_N^{T(E)}$

F_{net}^{earth}: $F_N^{E(T)} = F_g^{E(C)} + F_g^{E(T)}$

[first do chalk, then do table & ~~any~~ $F_g^{T(E)}$ & $F_N^{T(E)}$ & ask if any other forces then ask for all the forces on the earth]

then

[strictly speaking: $F_g^{C(T)}$ + $F_g^{T(C)}$ too]

[Moore]
[C1-4?] [What role do interactions play in motion?]

pre-Newtonian: forces cause motion [natural state = rest]
"commonsense"

[Air track: reduce friction ⇒ no force, const speed]
[motion is just as natural as rest]

forces ~~cause~~ change motion

Newton's 1st law: An object experiencing no interactions (isolated)
or no net interactions (forces cancel)
moves w/ constant speed (possibly zero)
in a straight line.

| no net force ⟺ const velocity |

(in an inertial reference frame)

velocity is a vector $\vec{V}$ (magnitude + direction) [in common speech speed + velocity are the same thing]
magnitude = speed

$v = |\vec{V}| = \text{speed} \geq 0$

Newton's 2nd law: Net force changes an object's velocity

[optional from here on]

change in velocity $\Delta\vec{V} = \vec{V}_f - \vec{V}_i$

[Q: A car rounds...]$_F$

[Q: A baseball player hits] $_A$

[Q: A baseball player slides]$_D$

A car rounds a corner at constant speed. Because the speed is constant, we may infer that there are no (net) external interactions (i.e. forces) acting on the car.

T or F?

(1) An object moving at a constant speed must have a force acting on it to maintain its motion. (T or F).

(2) ... A baseball player hits a line drive toward third base. What (if anything) keeps the ball moving after it leaves the bat (according to the newtonian model)?

A. No force is required to keep the ball moving
B. The force of the ball's inertia
C. The force of the ball's momentum
D. The force of the hit
E. Something else (specify)

(3) A baseball player slides into third base. Why (according to the newtonian model) does the player eventually come to rest?

CI T.3 in 2nd yd

A. All moving objects naturally come to rest
B. Friction overcomes the player's force of motion
C. The force of the player's motion eventually wears out
D. Friction interactions change the player's motion

optional

Exercise C2X.1: A bicyclist coasts without pedaling on a level road. Why does the cyclist eventually come to rest?

A. all moving objects naturally come to rest
B. friction forces steadily slow the bike down
C. friction forces eventually overcome the bike's force of motion
D. the force of the bike's initial motion eventually wears out
E. *D* and *B*
F. *D* and *C*

mostly B's; a very few C's + F

Mostly B
Some C

Exercise C2X.2: A child throws a baseball into the air. *After* the ball leaves the child's hand, it moves vertically upward for a while, reaches a certain maximum height, and then falls back toward the ground. Ignoring air resistance, the force(s) acting on the ball during this time is (are)

A. The constant downward force of gravity alone.
B. The constant force of gravity and a steadily decreasing upward force.
C. The constant force of gravity and a steadily decreasing upward force that acts only until the ball reaches its maximum height.
D. A decreasing upward force before the ball reaches its maximum height, and an increasing downward force of gravity afterward.
E. No forces act on the ball: it returns to the ground naturally.

mostly A, one B, a handful of C's

Mostly A
Some B + C

Exercise C2X.3: Imagine that you throw a rock eastward at a speed of 10 m/s from the top of a high cliff. It falls for a long time before hitting the water. If we ignore air friction, what is the rock's eastward speed when it hits the water?

A. The rock's motion is entirely downward; it does not move eastward at all.
B. The rock is moving eastward much slower than 10 m/s when it hits.
C. The rock is still moving eastward at exactly 10 m/s when it hits.
D. Since it has picked up speed, the rock is moving faster than 10 m/s eastward

C's, also B + D

optional

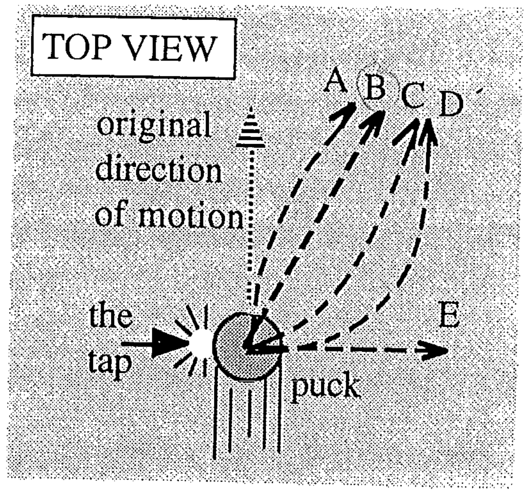


Figure C2.1.

Exercise C2X.4: A hockey puck sliding due north on a frictionless plane of ice is given a very brief eastward "tap" by a hockey player. What path on Figure C2.1 will the hockey puck follow after the tap is over (circle one)?

Exercise C2X.5: Imagine that a small car rear-ends a large truck that is initially at rest. During the collision, the force that the *truck* exerts on the car is

A. zero (the truck is just sitting there)
B. smaller than the force the *car* exerts on the truck.
C. equal to the force the *car* exerts on the truck.
D. greater than the force the *car* exerts on the truck.

didn't get to these in F'01