# Physics 1A, Lecture 7: Newton's Third Law and Solving Force problems

Summer Session 1, 2011

The quiz will commence at 9:33 AM.

<u>Key Questions: (Discuss with neighbors before quiz)</u>

1) What is a normal force?
2) What is the third law pair of the normal force?
3) How do you know when something is at equilibrium?
4) What happens to an Atwood machine with equal masses?
5) What is a contact force?
6) Do you weigh more going up or going down in an accelerating elevator?

# Reading Quiz #5-1

- What is a normal force?

A) A force that is perpendicular to the motion
B) A force that does not need to be broken up into components
C) The third law pair of the force of gravity
D) A force that opposes the force of gravity
E) A contact force between an object and the surface it is placed on

# Reading Quiz #5-2

- What is the third law pair of the normal force?

A) The force of gravity

B) The force of friction

C) The abnormal force

D) The parallel force

E) None of the above

# Reading Quiz #5-3

- How do you know when something is at equilibrium?

A) It does not have a force on it

B) It does not have a net force on it

C) The sum of the forces in the x direction equal the sum of the forces in the y direction

D) It has third law pairs for all of its forces

E) All of the forces on it are equal in magnitude

# Reading Quiz #5-4

- What happens to an Atwood machine with equal masses?

A) It moves so that the masses are at the same height

B) It moves so that the mass that is lower down falls to the ground

C) It moves so that the mass that is higher up falls to the ground

D) It does not move

E) An Atwood machine would never have equal masses

# Reading Quiz #5-5

- What is a contact force?

A) A force between two objects that are moving as one

B) A force between two objects that are connected by a rope

C) A force between two objects that are pulling on each other

D) A force between two objects that are pushing on each other

E) None of the above

# Reading Quiz #5-6

- Do you weigh more going up or going down in an accelerating elevator?

A) Going up

B) Going down

C) They are equal

D) It depends on whether you are speeding up or slowing down

# Announcements

- Check grade for First Quiz online
- Three office hours! (in Mayer Hall 5623)
  - M/W from 12-1pm
  - Tues from 5-6pm
- Homework #3 is posted, due Wednesday
- Extra problems are posted (also solutions to even numbered problems)
- Clicker grades will be up soon
- Pick up old homework from me in office hours or tomorrow

# Announcements

Boundaries for final grades (could go lower but not higher):

- 88% for an A
- 75% for a B
- 62% for a C
- 50% for a D

Lots of opportunities to improve grade:

- Drop lowest Quiz
- Drop lowest Homework
- Drop lowest 4 out of 14 Reading Quizzes
- Two alternate rubrics
- Up to 5% extra credit for Clickers

# Anonymous poll

Do you prefer to study with the textbook problems or the worksheet problems?

A) The textbook is better.

B) The worksheets are better.

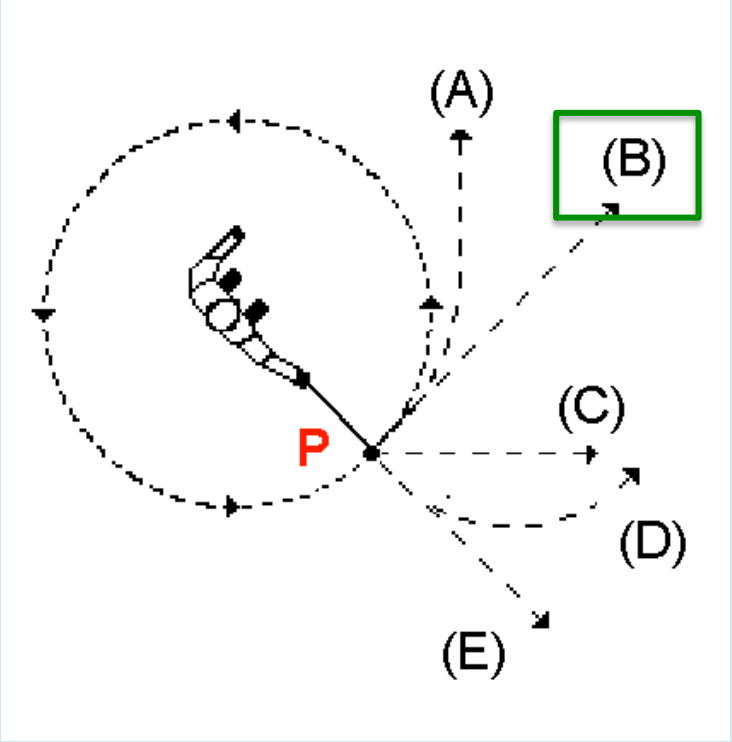
C) I like both of them, it's good to have a lot of practice.

D) I don't like either of them, and you're asking us to do too much.

E) I don't think either assignment helped me prepare for the first Quiz.

# Clicker question 7-1

- A steel ball is attached to a string and is swung in a circular path in a horizontal plane as illustrated in the figure. At the point P the string suddenly breaks near the ball . If these events are observed from directly above as in the figure, which path would the ball most closely follow after the string breaks?



# Clicker question 7-2

- Which of the following statements is correct?

A) A zero net force implies that an object will come to rest

B) A nonzero net force on an object implies that it will move

C) An object at rest could have a nonzero net force

D) An object in motion must have a net force on it

E) None of the above

# Clicker question 7-3

- A fly collides with a windshield. Which force is greater in magnitude?

A) The force the fly exerts on the windshield

B) The force the windshield exerts on the fly

C) The two forces are equal

# Newton's First Law

*An object continues in a state of rest or in a state of motion at a constant speed along a straight line, unless compelled to change that state by a net force.*

*-which means-*

*An object does not need need to be under the influence of a force to be in motion!*

# Newton's Second Law

*A net force ($\Sigma F$) on an object of mass ($m$) results in an acceleration ($a$) according to the following formula:*

$$\Sigma F = ma$$

# Newton's Third Law

*If two object interact, the force exerted by object 1 on 2 is equal in magnitude and opposite in direction to the force exerted by object 2 on 1 :*

$$\mathcal{F}_{12} = -\mathcal{F}_{21}$$

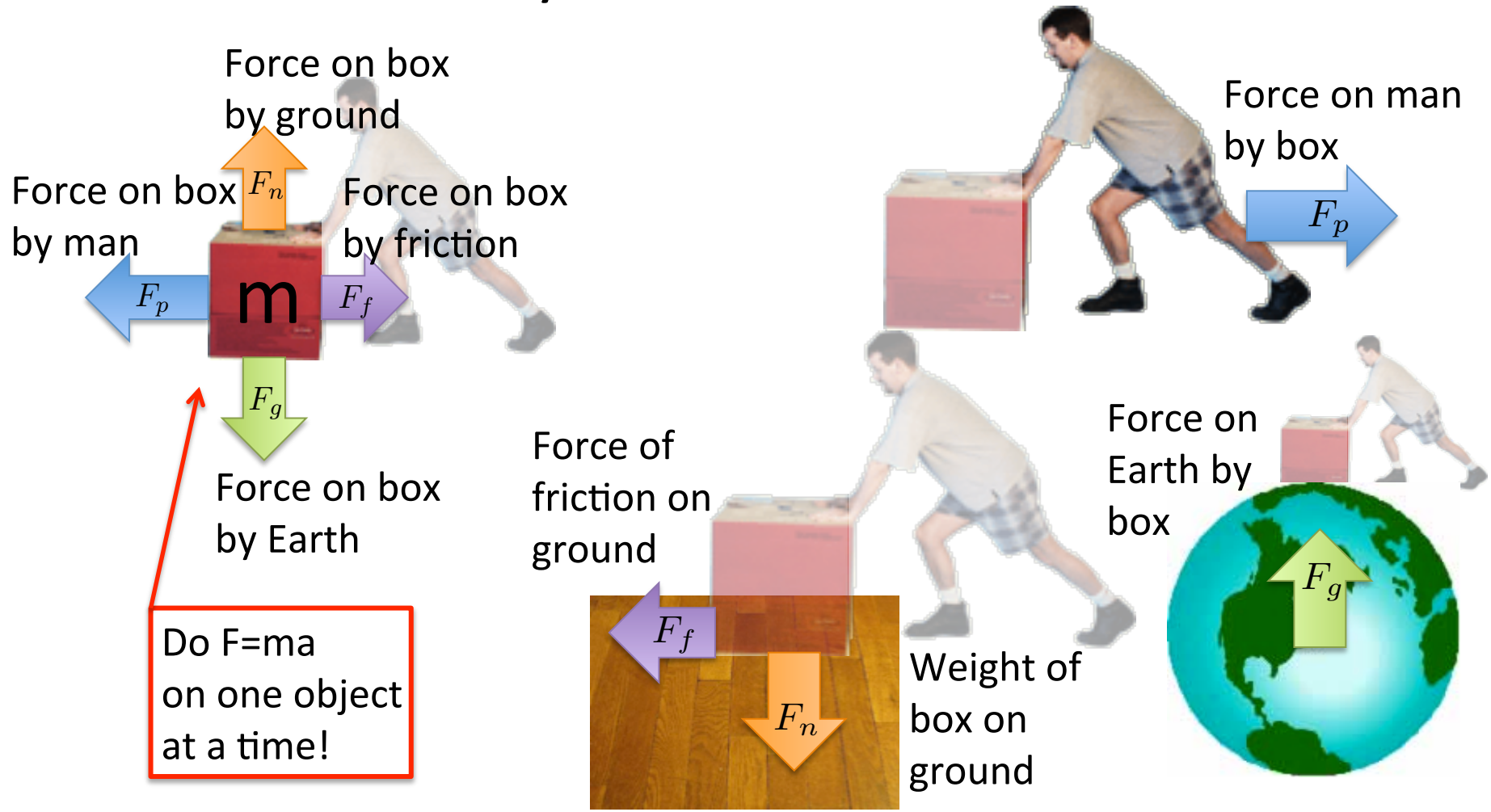
*-In other words-*

*For every action there is an equal and opposite reaction.*

# Newton's Third Law

C Concept

- All forces obey Newton's Third Law:

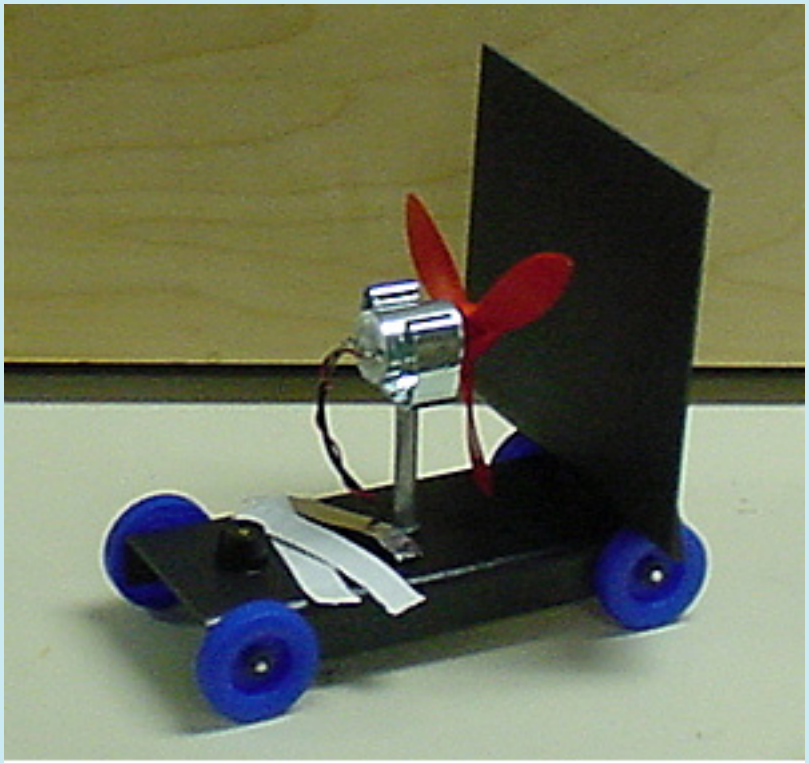


# Clicker Question 7-4
# **“Newton’s sailboat”**

What happens when an object exerts a force on itself?

A) It will move in the direction of the force

B) It will stand still

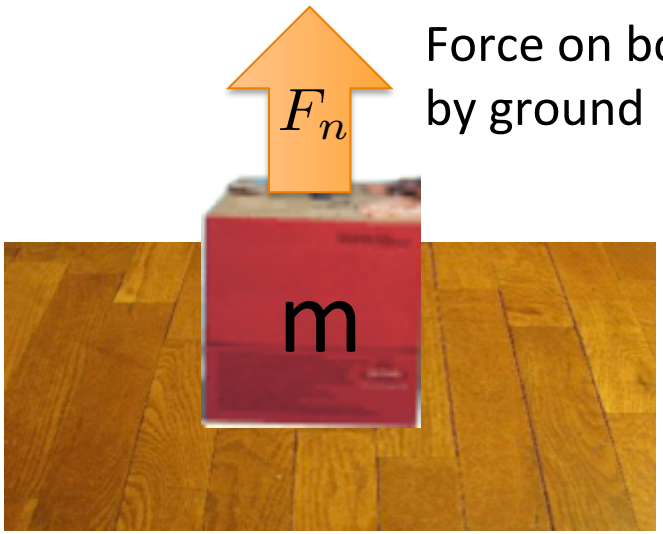


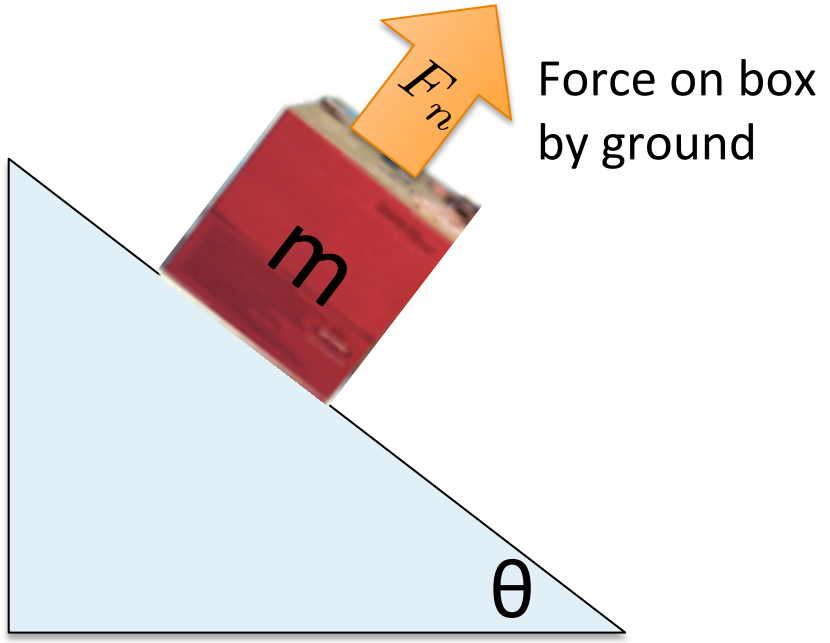
# The normal force

C Concept

- In mathematics “normal” and “perpendicular” are synonyms.

  → The normal force is always perpendicular to the surface it is in contact with.

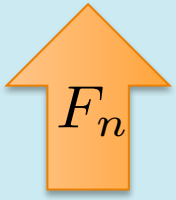


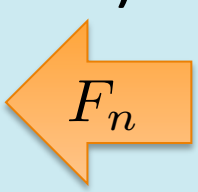
# Clicker Question 7-5

A box is being pushed up against a wall. Which vector shows the direction that the *normal* force is pointing?

A)

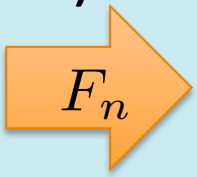



B)



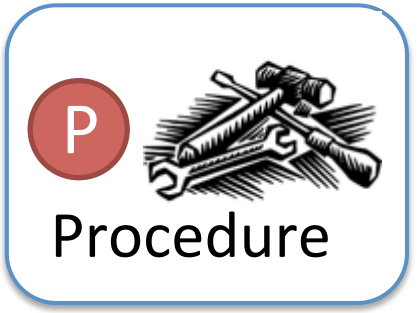

C)


D)

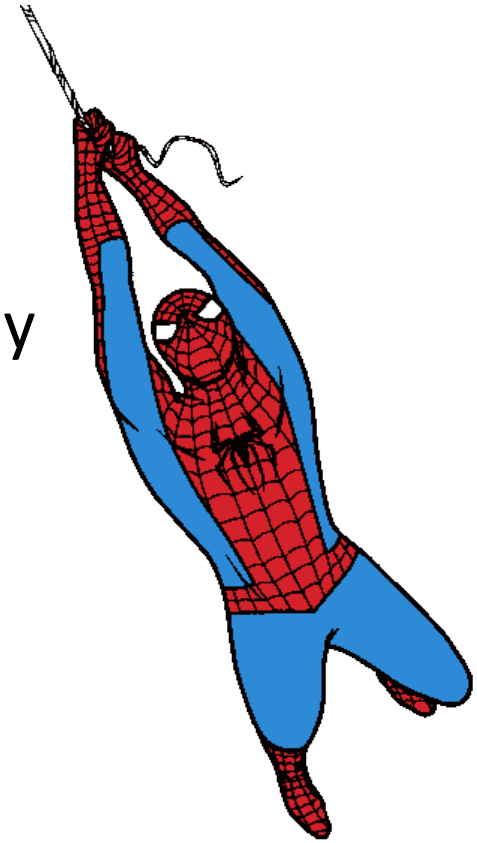


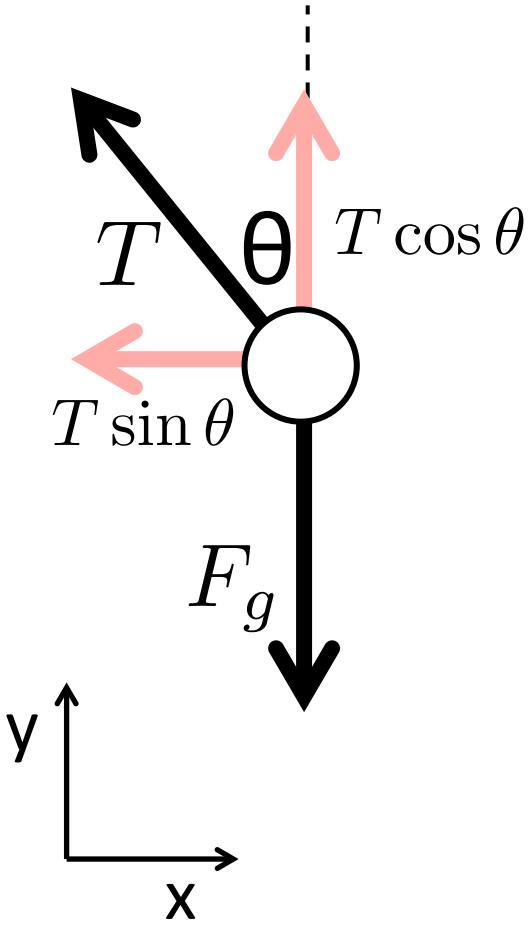

E)

# Drawing Free Body Diagrams



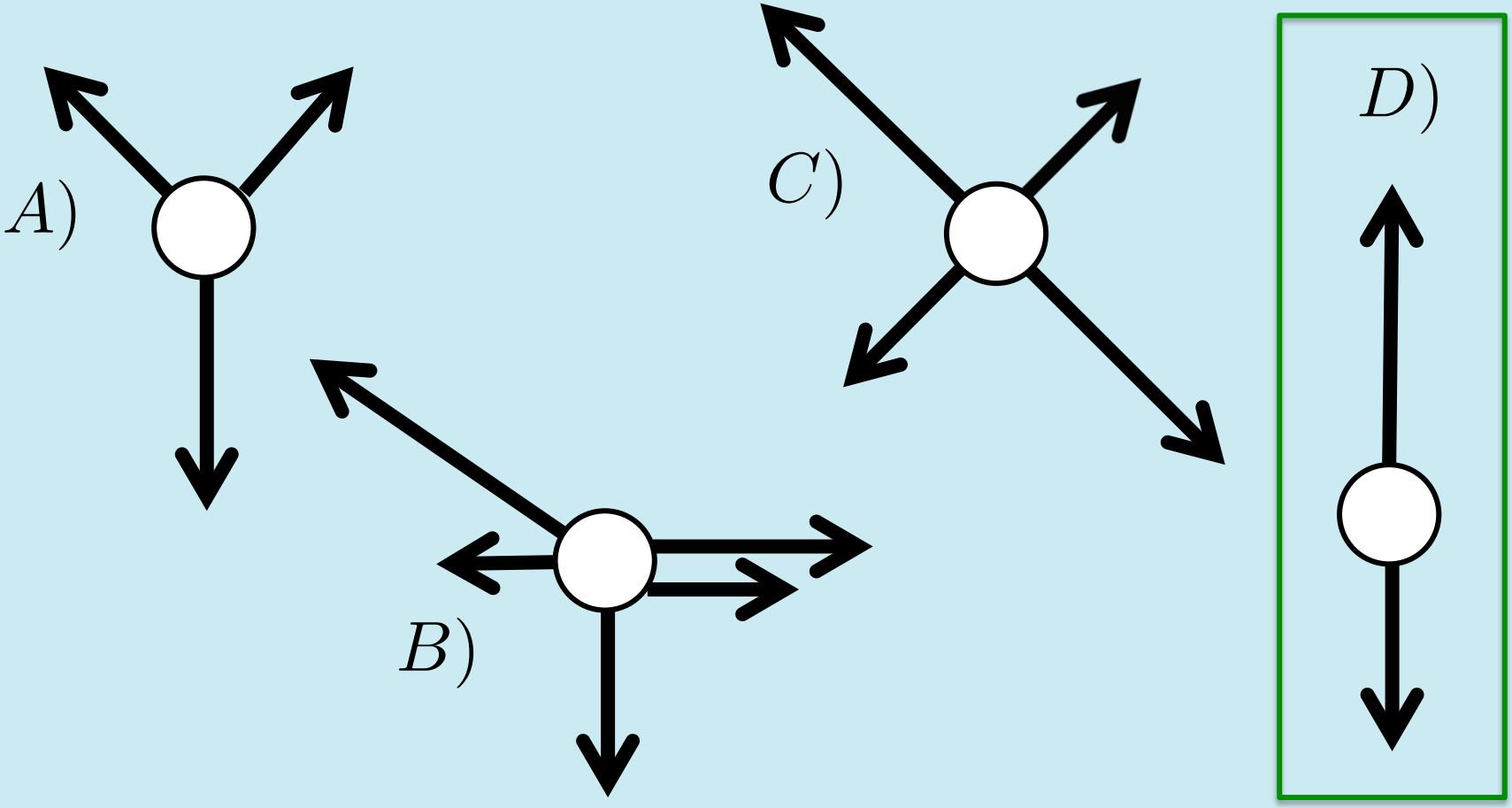

- Draw a picture with a coordinate system (represent object as point mass)
- Draw arrows going away from the object to represent the forces, label them
- Try to make length of arrow correspond to strength of force
- Break up into components if necessary





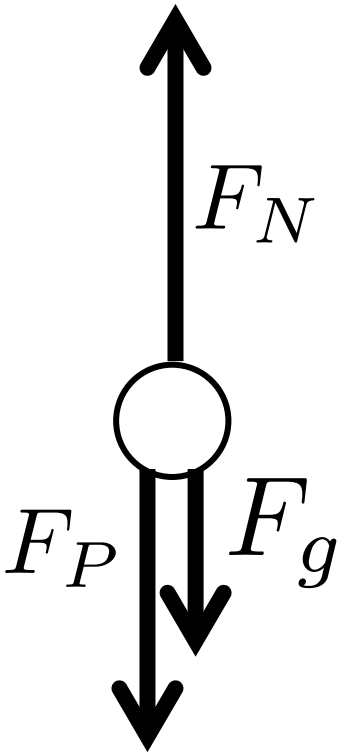
# Clicker question 7-1

- Which of these is probably not in equilibrium?

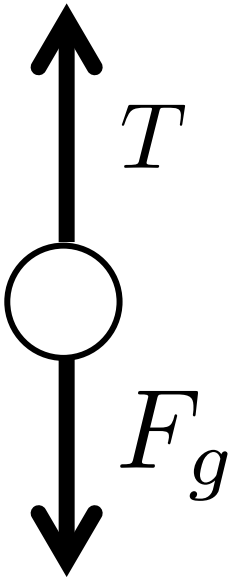


# Practice drawing FBDs

- You push a book down vertically on a table

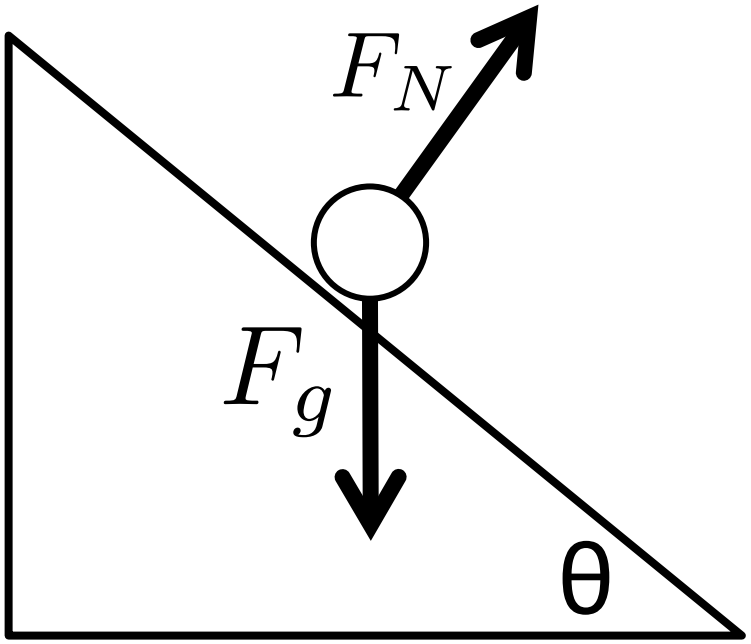


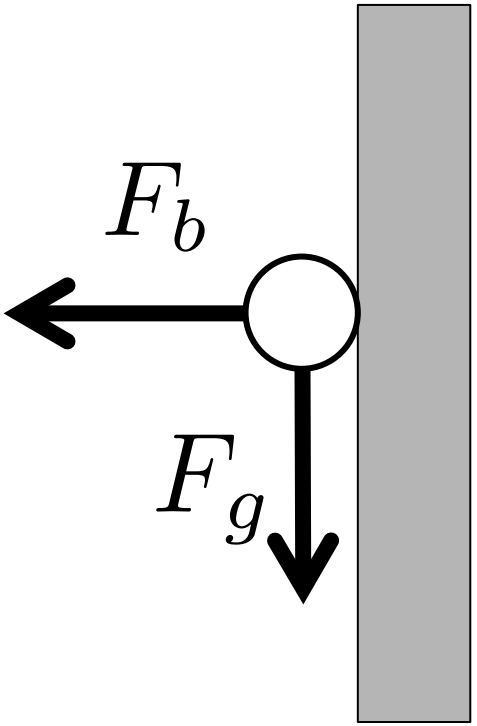

- A rope pulls an elevator up at a constant velocity



# Practice drawing FBDs

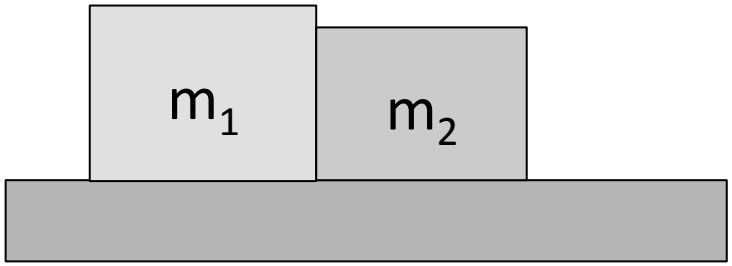
- A box slides down a frictionless ramp
- You bounce a ball off of a wall

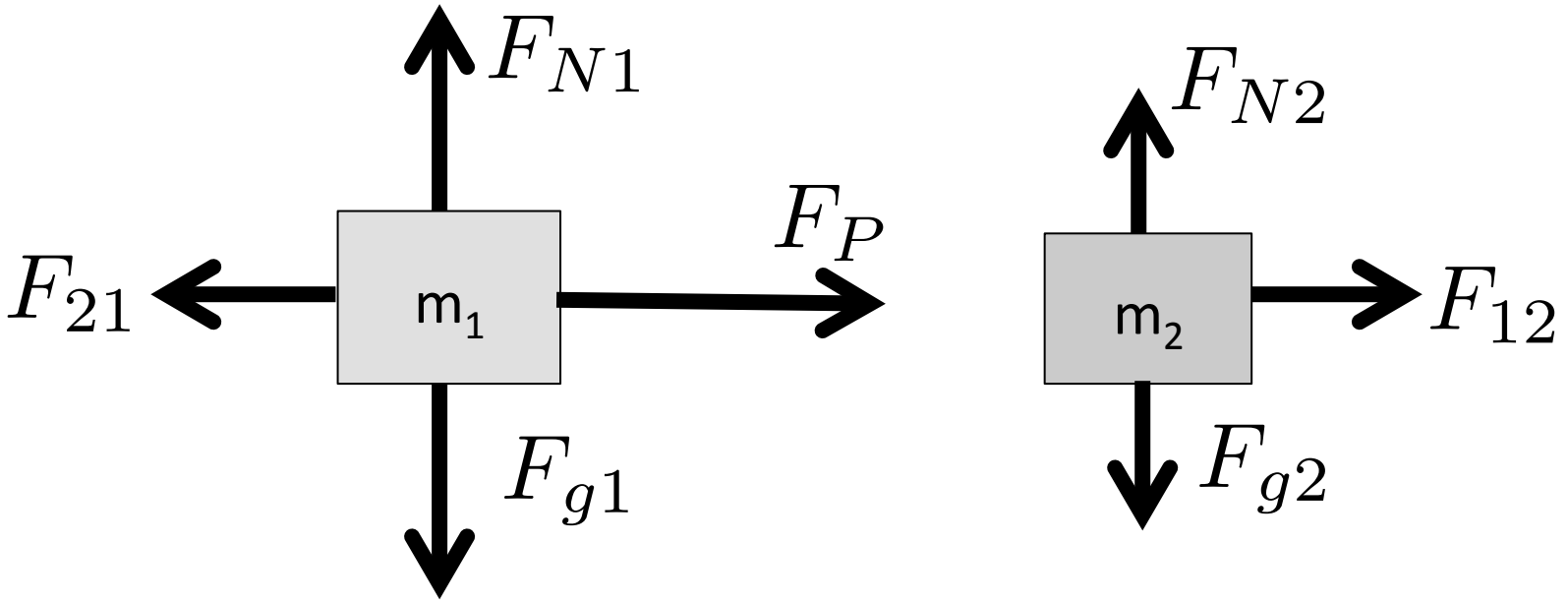


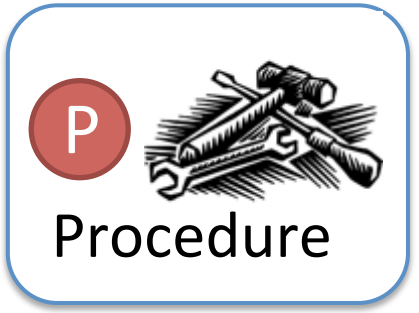
# Practice drawing FBDs

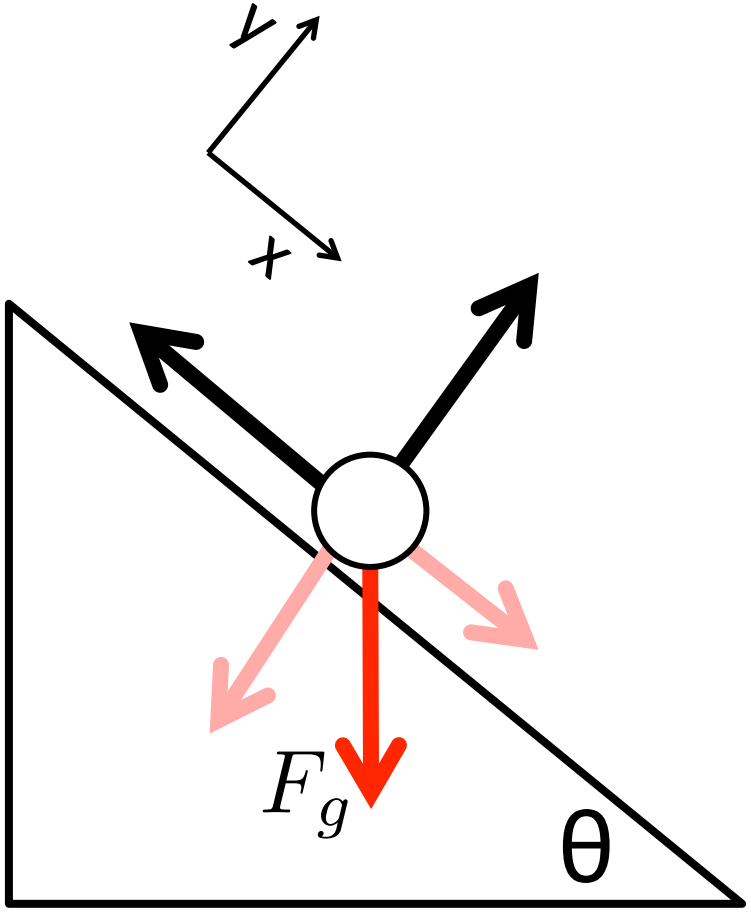
- You push a box that pushes another box on a frictionless surface

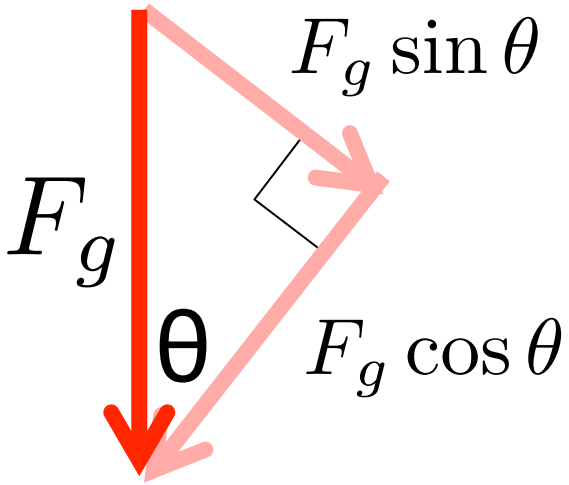


# Breaking up forces into components on an incline



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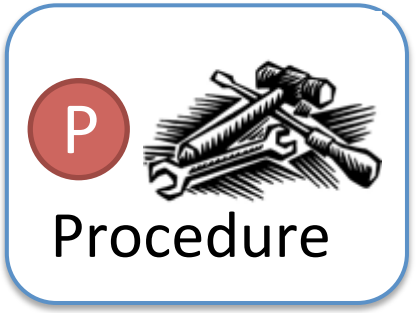
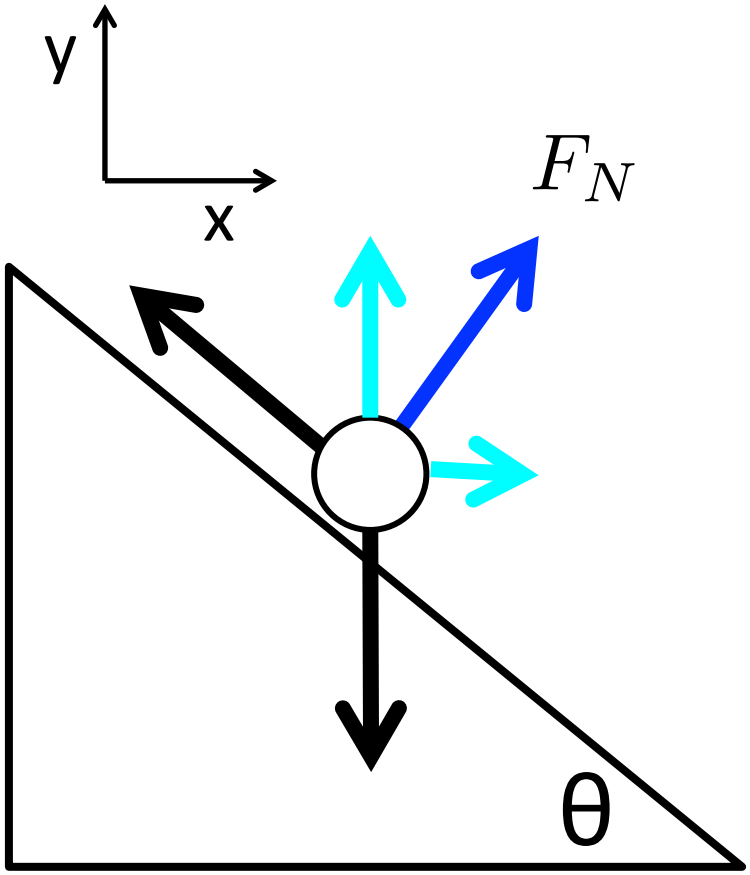
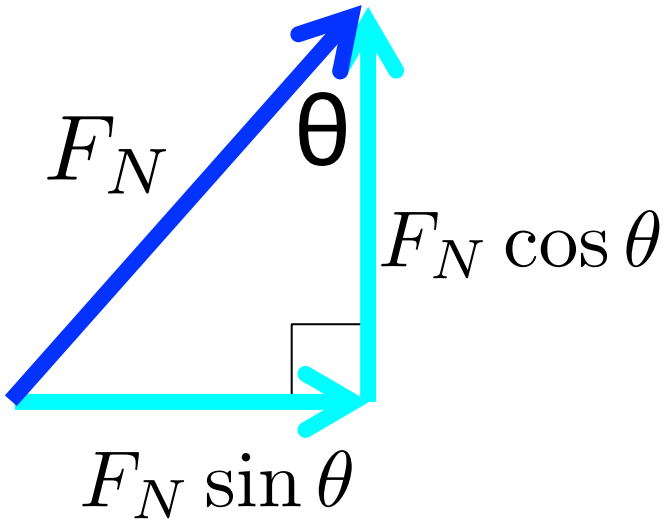
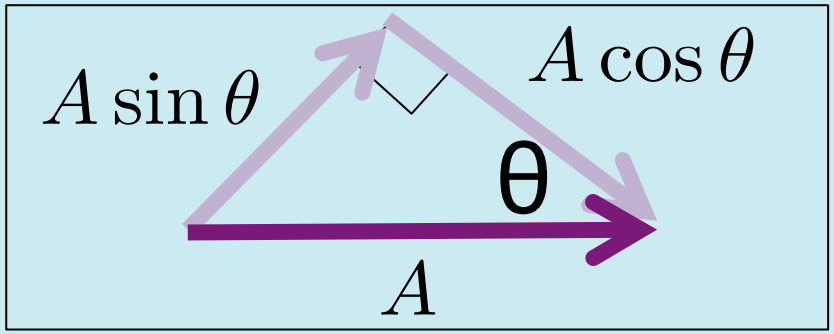


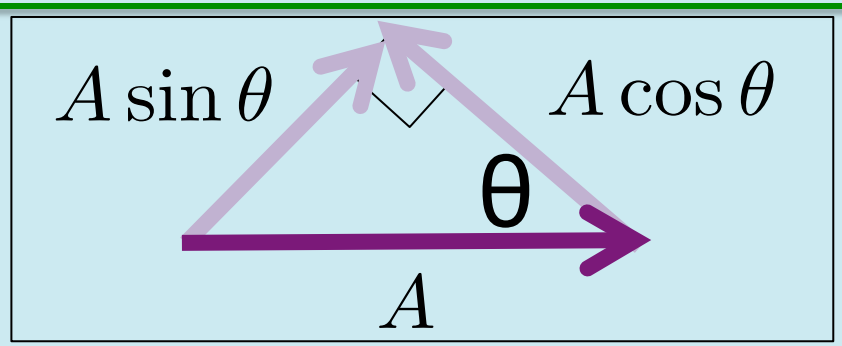



# Clicker Question 7- components on an incline

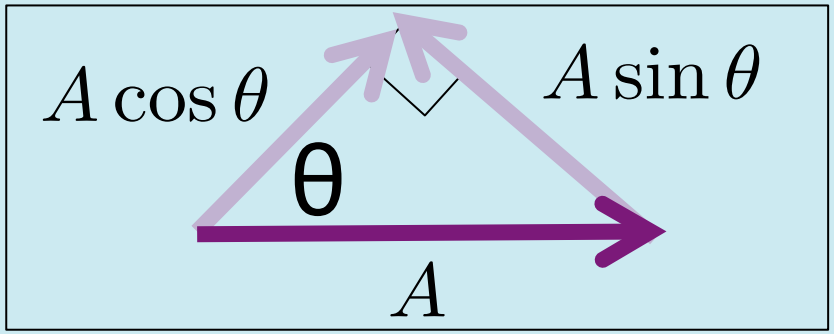
A)

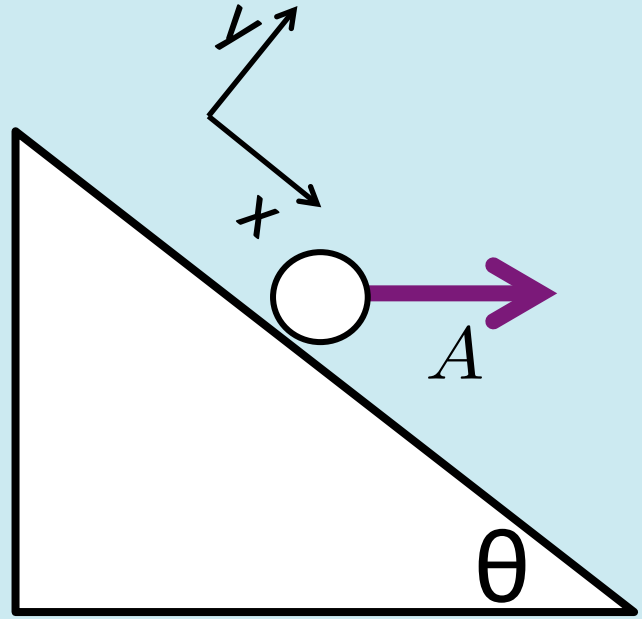



B)

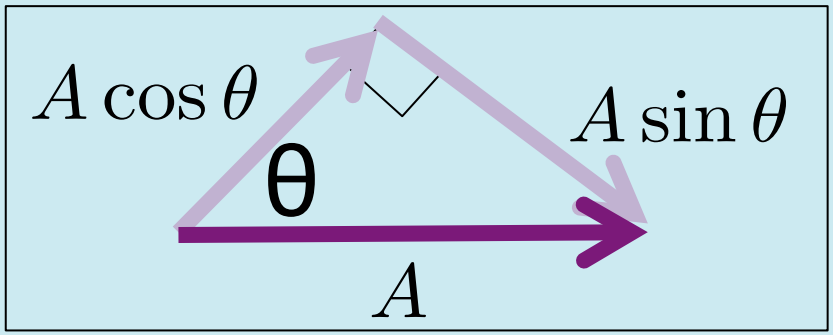



C)



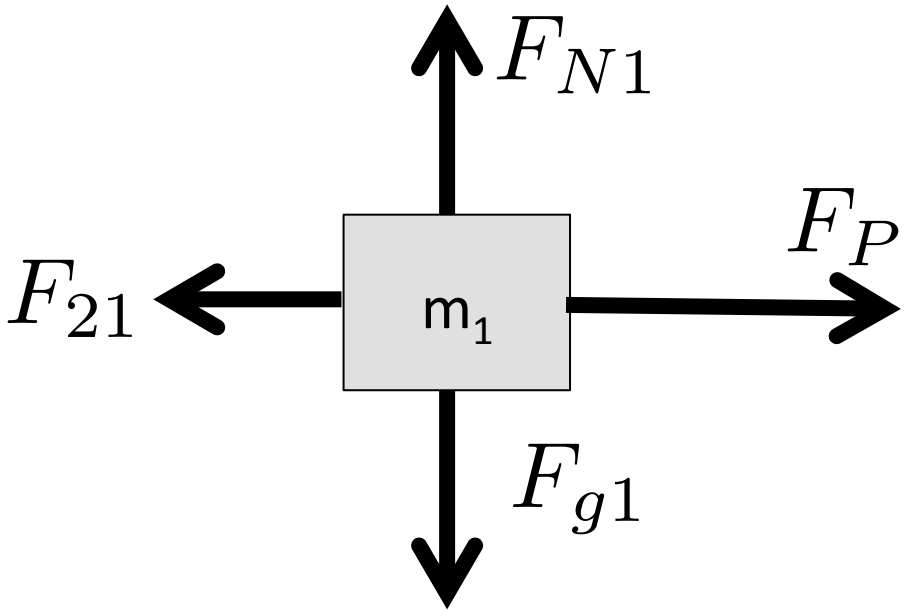



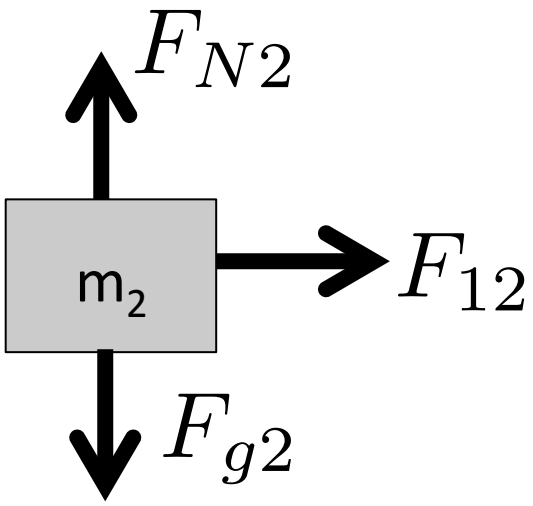

D)



# Given cause of motion, predict it!

- How long will it take to push two blocks a distance *d* if you push on block 1 with $F_P$?




$$\sum F_{x1} = F_P - F_{21} = m_1 a \qquad \sum F_{x2} = F_{12} = m_2 a$$

# Given cause of motion, predict it!

- How long will it take to push two blocks a distance *d* if you push on block 1 with $F_P$?

$$\sum F_{x1} = F_P - F_{21} = m_1 a$$

$$\sum F_{x2} = F_{12} = m_2 a$$

$$|F_{12}| = |F_{21}|$$

$$F_P = (m_1 + m_2)a$$

$$\boxed{a = \frac{F_P}{(m_1 + m_2)}}$$

$$d = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2d}{a}}$$

$$\boxed{t = \sqrt{\frac{2d(m_1 + m_2)}{F_P}}}$$

# Homework

- Reading quiz tomorrow
- Homework #3 is posted, due Wednesday
- Extra problems are posted (also solutions to even numbered problems)

- Office hours today at noon, ask about the first Quiz.