PHYS 1107 (003/004) | Wednesday September 27

Today | Types of Forces and Applications of Newton's Laws
Lab This Week | Projectile Motion

Todays "Handouts":

- **Worksheet #4: Forces and Newton's Laws**

This worksheet covers material from last class, this class, and next class!

Upcoming Due Date Reminders:

- Written Homework (#3): **Friday September 29 @ Start of Class**
- Online Homework (#3): **Sunday October 1 @ 11:59 PM**
- Pre-Reading (Week Five): **Tuesday October 3 @ 11:59 PM**

Test One

Wednesday October 11 (during class time)
will cover up to end of Circular Motion
(class next Wednesday)

Please see the “Test One” folder in the *Tests and Exam* section of Blackboard (which will be available soon) for more information. This will likely answer many of the questions you have!

There will be a thread on Piazza for all other test questions you have after reading this information on Blackboard.

Test One – Wednesday October 11

Will be a **two-stage tests:**

85% of overall mark

1. write test on your own [~75 min]
2. write test in groups of four [~30 min]

15% of overall mark

your mark **cannot** decrease due to group portion

You will be put into groups of **4** and will work with your group to answer the same multiple-choice questions you saw during the individual test.

There may also be some new multiple-choice questions that are based on the written answer questions from the individual portion.

You will answer the questions using a **scratch card.**

You can bring a 3 inch x 5 inch cue card with anything you want written on **one side**

Newton's Three Laws

1) Consider a body on which no net force acts. If the body is at rest, it will remain at rest. If the body is moving with a constant velocity, it will continue to do so

2) $$\sum \vec{F} = m\vec{a}$$

3) When one body exerts a force on another, the second exerts a force on the first. These two forces are always equal in magnitude and opposite in direction

Solving Problems – The Four Steps

For all problems that involve forces, you should **always** follow these four steps when you start the problem:

1. Draw and label a clear free body diagram for each object in the problem

For each of the FBDs that you draw:

2. Break all forces into their components

3. Sum up the forces along each axis

$$\Sigma\vec{F} = m\vec{a}$$

4. Apply Newton's Second Law
(make a statement about the acceleration along each axis)

… then apply your equations from step 4 to solve the problem.

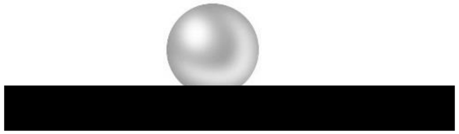
The Steel Ball Problem… Worked Out!

Assume the steel ball has a mass of 0.950 kg, is dropped from rest from a height of 1.80 m, and bounces to a height of 0.230 m. If the ball is in contact with the ground for 0.150 s and experiences a constant force during this time, what is the net force on the ball, and the force exerted on the ball due to the ground (i.e., the normal force due to the ground)?

A steel ball (with mass M) is bounced off a hard surface.

What is the **net force** acting on the ball when it is in contact with the surface? Ignore friction and air resistance.

in contact with surface



up = positive

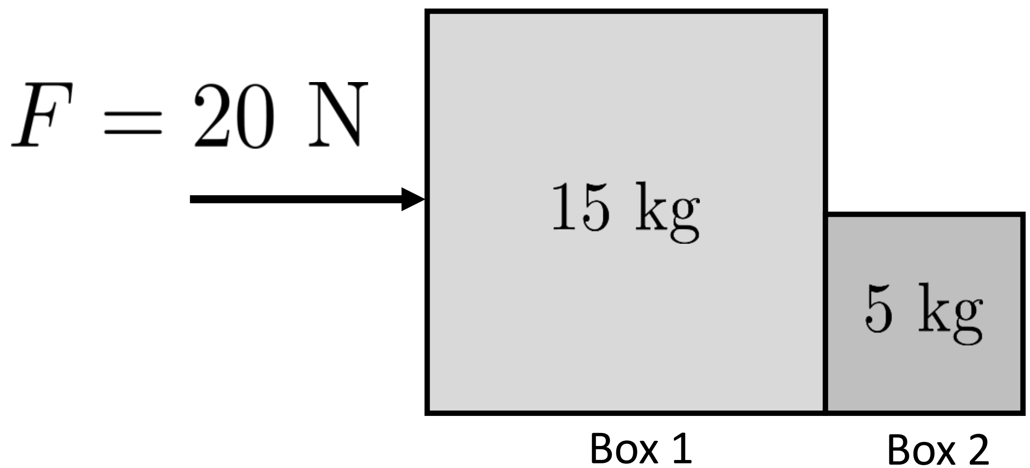
The Steel Ball Problem… Worked Out!

Assume the steel ball has a mass of 0.950 kg, is dropped from rest from a height of 1.80 m, and bounces to a height of 0.230 m. If the ball is in contact with the ground for 0.150 s and experiences a constant force during this time, what is the net force on the ball, and the force exerted on the ball due to the ground (i.e., the normal force due to the ground)?

Two Boxes

Two boxes are pushed with a force of 20 N on a frictionless surface. The boxes always stay in contact .

What is the acceleration of the boxes?

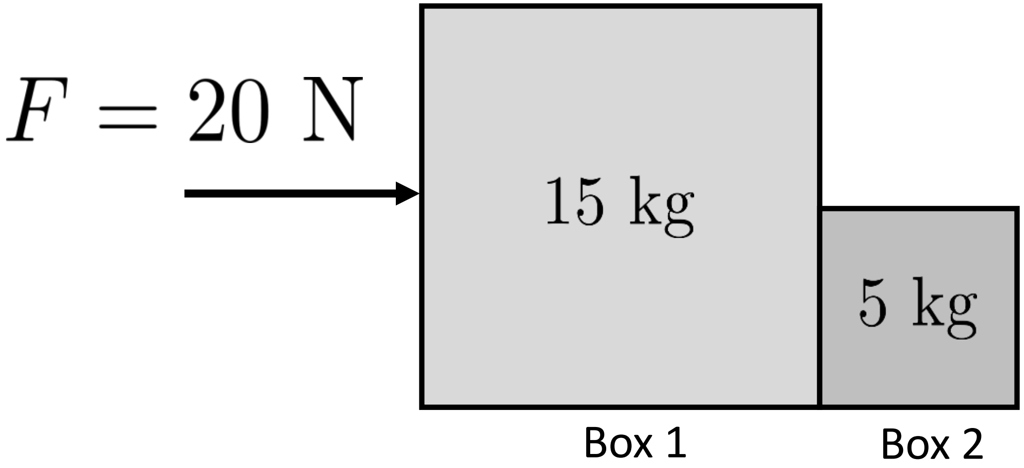


Hint: In this case, we can treat both boxed as one large object, since they are always in contact.

Two Boxes - Clicker

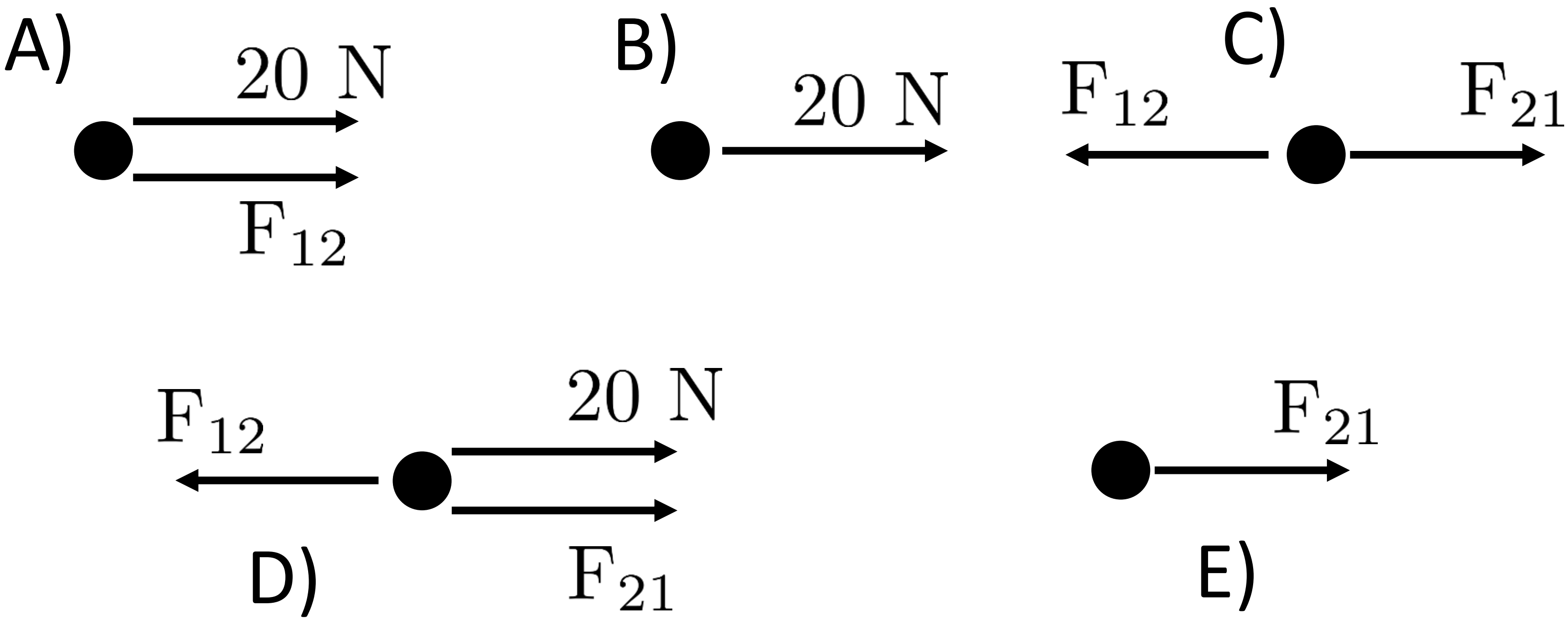
Two boxes are pushed with a force of 20 N on a frictionless surface. The boxes always stay in contact .

What is the **magnitude** of the force on box 1 due to box 2?

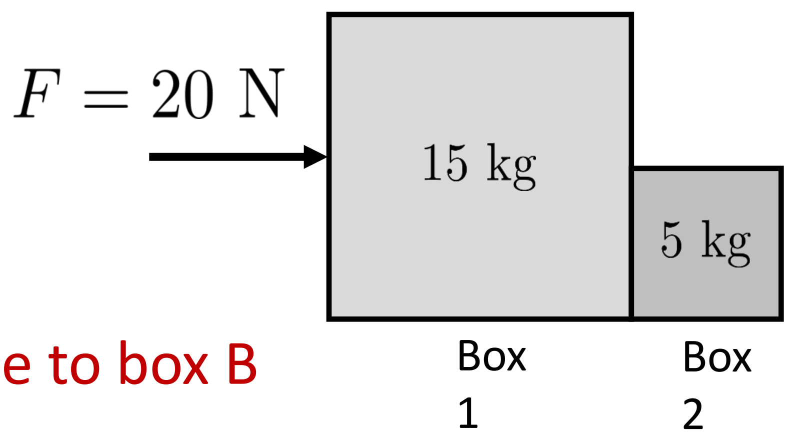


Two Boxes - Clicker

Which of these is the correct free body diagram from box 2?



Note: these free body diagrams only show the horizontal forces.

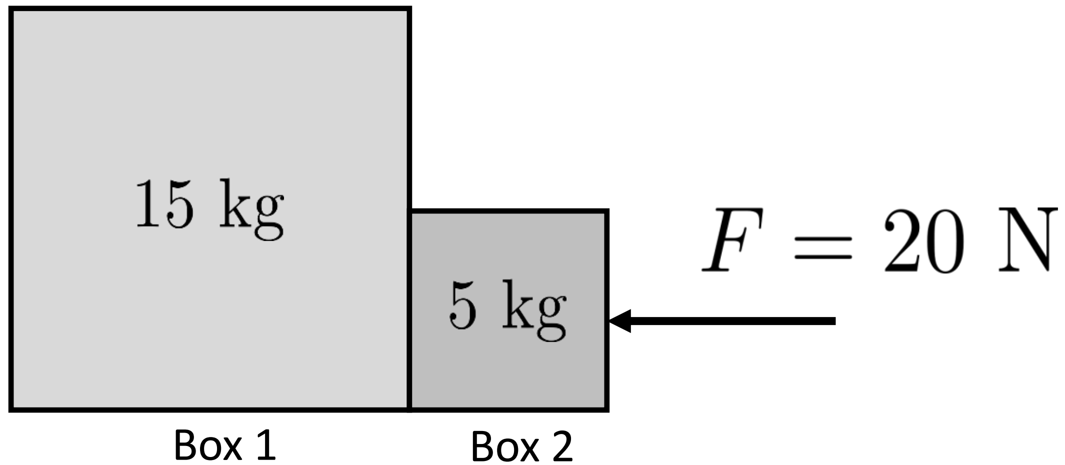


F_{AB} means the force on box A due to box B

Two Boxes – Additional Practice!

Two boxes are pushed with a force of 20 N on a frictionless surface. The boxes always stay in contact .

What is the **magnitude** of the force on box 1 due to box 2?



You should work out the solution problem as review some time today after class!

Ans: 15 N

Types of Forces

Field Forces

- gravity

Gets its own class soon!
("Force of Gravity and Circular Motion")

For now: $F_{\mathrm{g}} = mg$

Contact Forces

- normal *(but we still need to make the distinction between mass, weight, and apparent weight)*
- tension
- spring
- friction

Mass, Weight, Apparent Weight

mass | a measure of the amount of matter [kg]

weight |the gravitational force on a mass [N]

apparent weight | the normal force experienced by a mass

In Example 3 (which starts on page 302 in Section 4.8), a person stands on an scale in an elevator. Carefully read through the example, and then answer this question: In which of the following situations will the scale read less than than the weight of the person?

- ○ the elevator is moving up at a constant speed
- ○ the elevator is moving down at a constant speed
- ○ the elevator is accelerating upwards at a constant rate
- ○ the elevator is accelerating downwards at a constant rate
- ○ the elevator is not moving

Weight vs Apparent Weight

Consider a person in an elevator. Let’s look at two different situations:

1. When the elevator accelerates upwards

2. When the elevator accelerates downwards.

Weight vs Apparent Weight

Consider a person in an elevator. Let's look at two different situations:

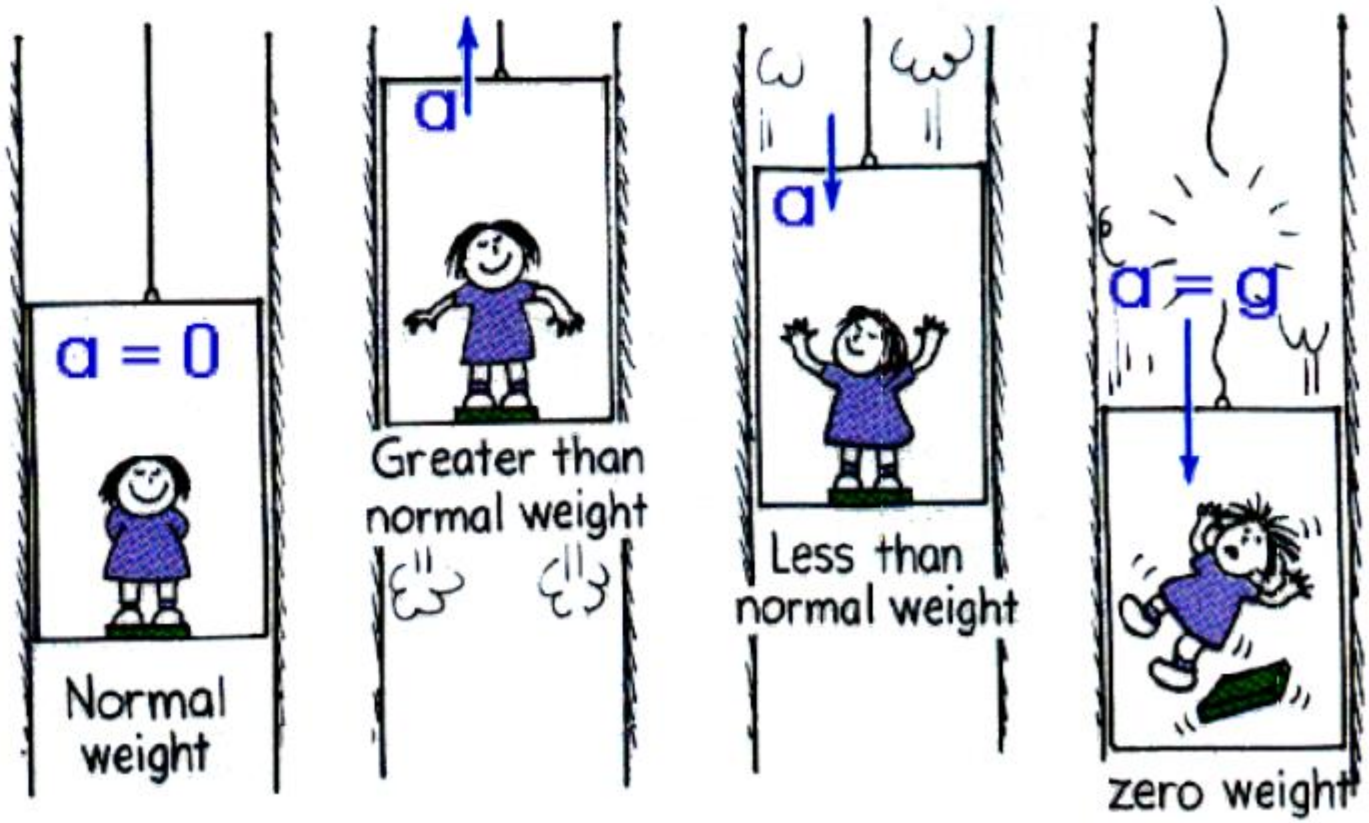
1. When the elevator accelerates upwards

Weight vs Apparent Weight

Consider a person in an elevator. Let's look at two different situations:

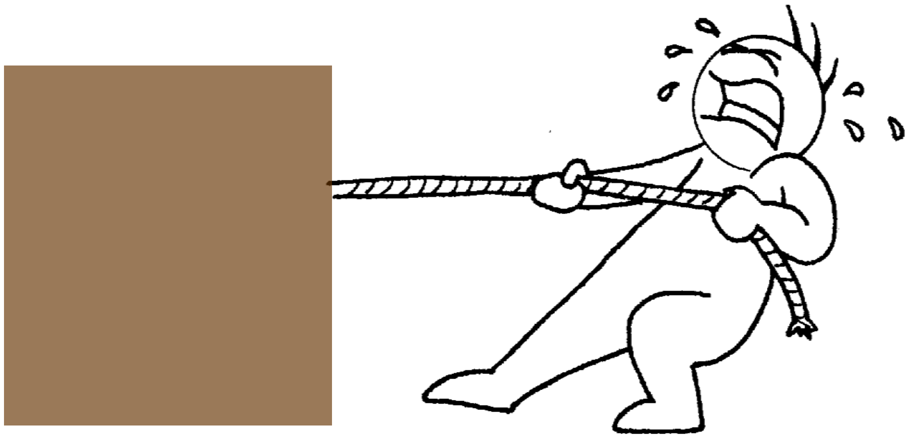
2. When the elevator accelerates downwards.

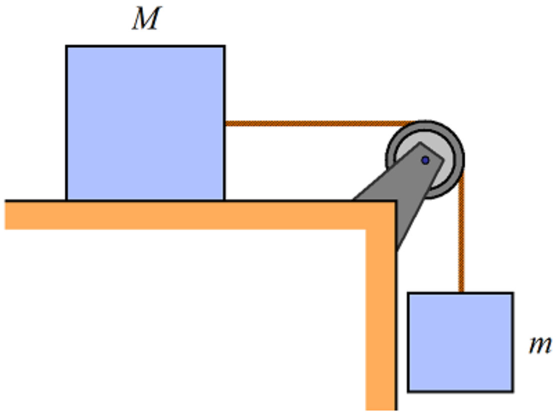
Apparent Weight



Tension Force

➡ a pulling force transmitted by a string or rope





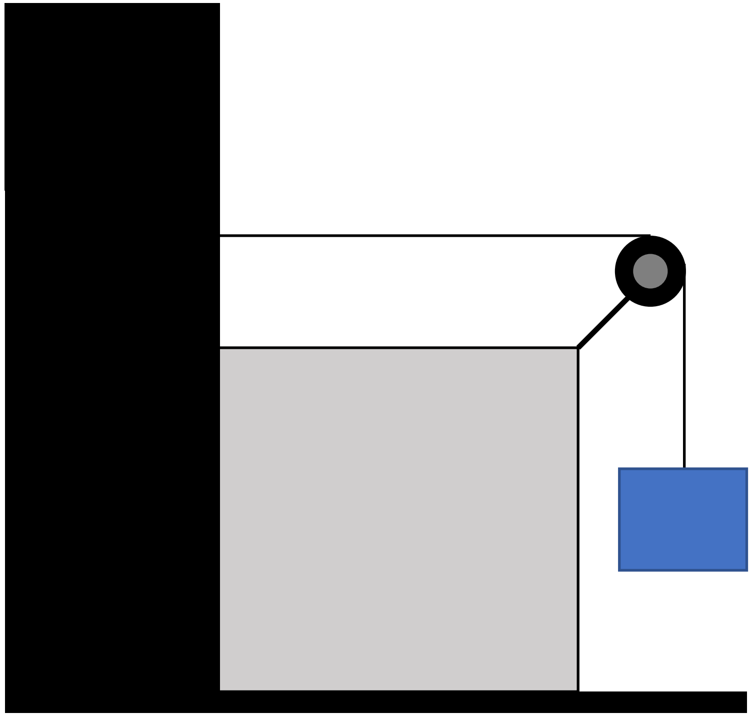
<u>Two key things:</u>

1. It is **always** a pulling force
2. The tension in a rope is the **same everywhere.**

Tension Force

If the mass of the block is 10 kg, what is the tension force in the rope?

Assume g = 10 m/s²



A) 50 N
B) 100 N
C) 150 N
D) 200 N
E) Need to know the acceleration of the blocks

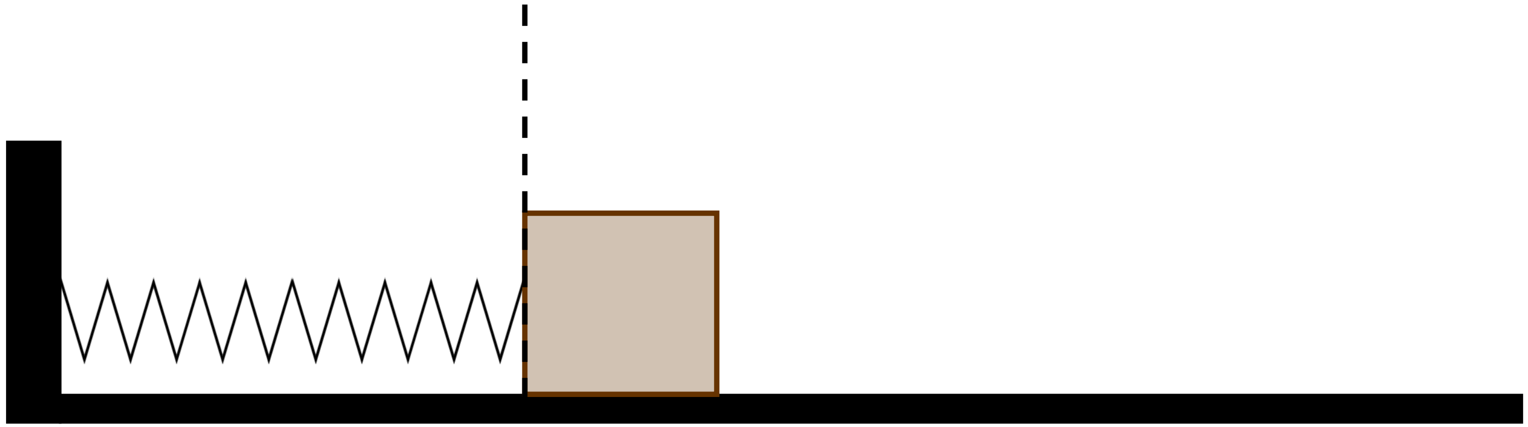
Tension Force

Two 10 kg blocks hang off the side of a table, connected by a rope. What is the tension force in the rope?

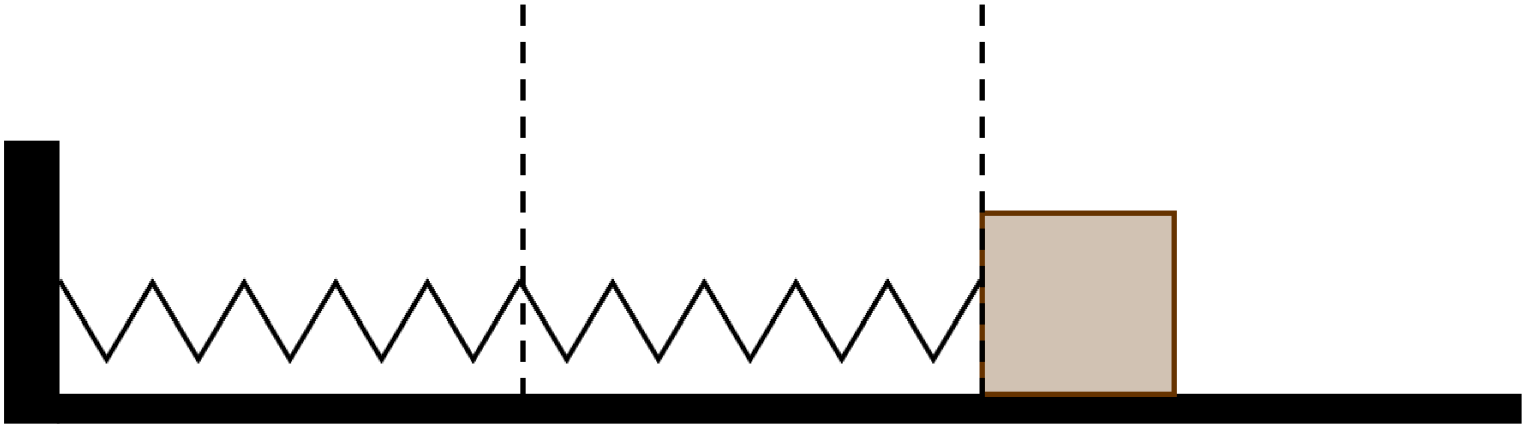
Assume g = 10 m/s²

A) 50 N
B) 100 N
C) 150 N
D) 200 N
E) Need to know the acceleration of the blocks

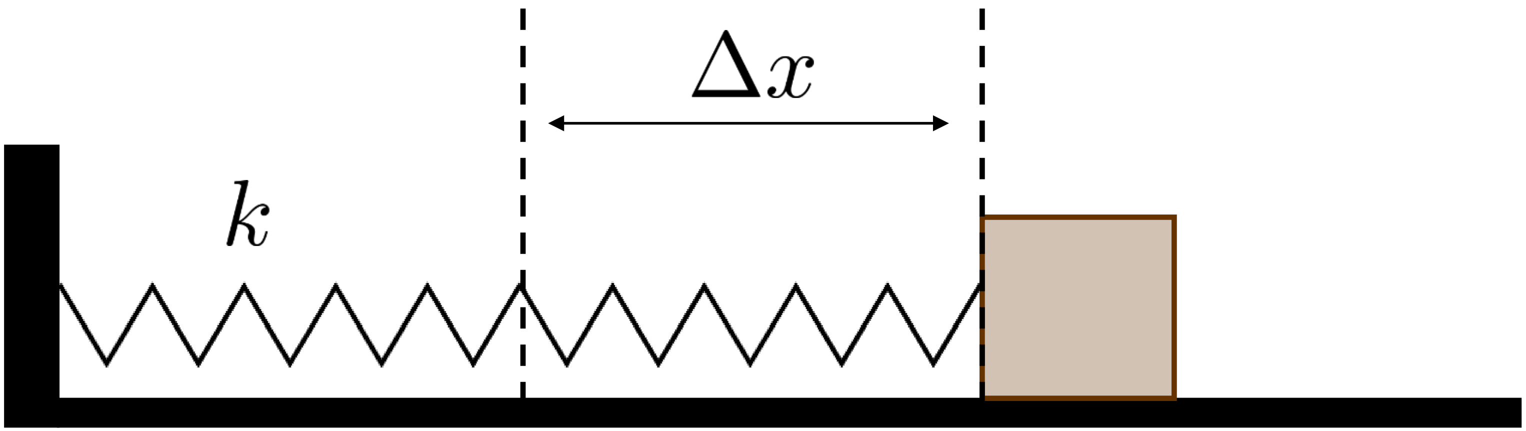
Spring Force



Spring Force



Spring Force (Hooke’s Law)

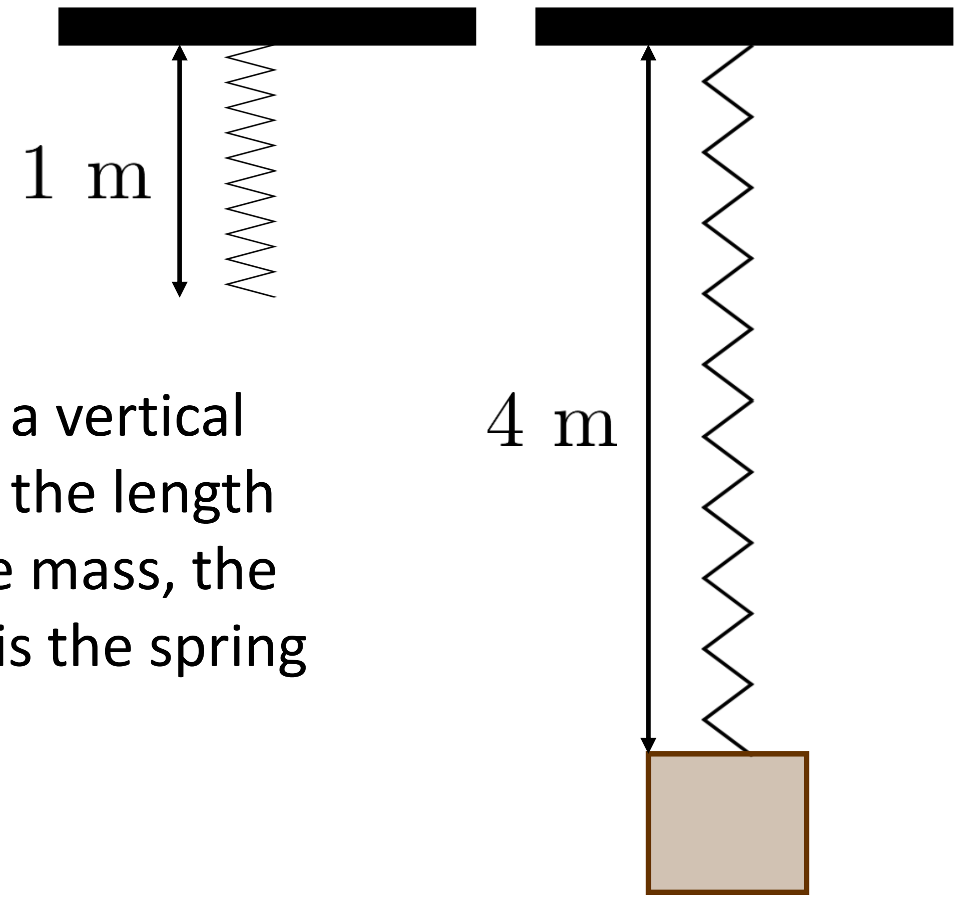


$$k \rightarrow \text{ spring constant } [\mathrm{N/m}]$$

When a spring is stretched (or compressed), is exerts a restoring force towards the equilibrium of the spring.

$$|F_{\text{spring}}| = k|\Delta x| \quad \text{or} \quad F_{\text{spring}} = -k\Delta x$$

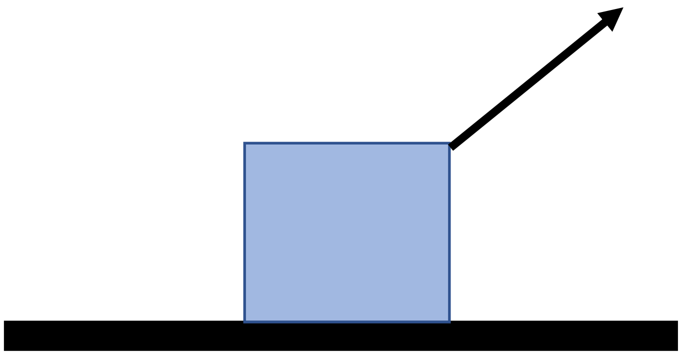
Spring Force - Clicker



A 10 kg mass at rest hangs from a vertical spring. With the mass attached, the length of the spring is 4 m. Without the mass, the length of spring was 1 m. What is the spring constant?

A) 98 N/m
B) 33 N/m
C) 25 N/m
D) 10 N/m

Example Problem



You pull a 12 kg box along the (frictionless) ground by applying a force of 25 N at an angle of 35^0 from the horizontal.

a) What is the acceleration of box?

b) What is the normal force acting on the box?