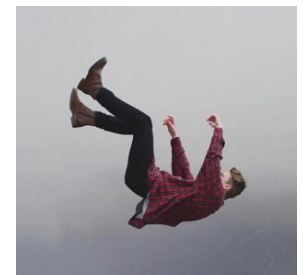
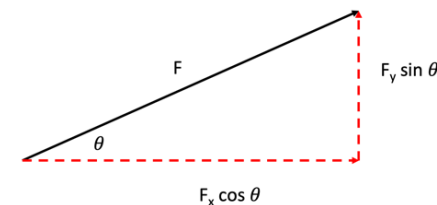
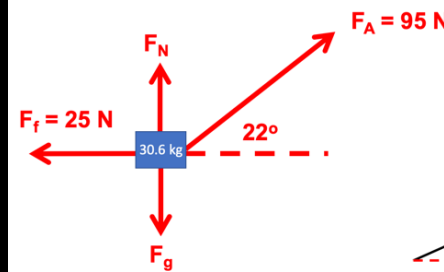
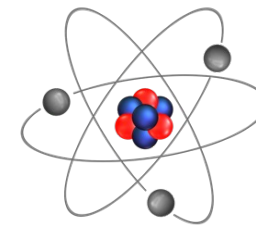
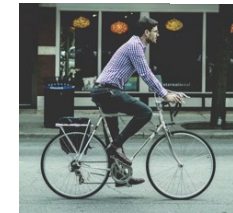
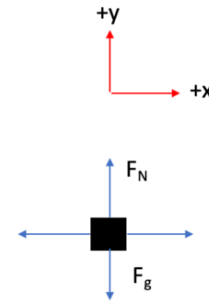


Force Introduction

- What is a Force?
- The Four Fundamentals Forces
 - Gravitational, Strong Nuclear, Electromagnetic, Weak Nuclear
- Force of Gravity
- Everyday Forces
 - Normal Force, Friction, Tension
- Action at a Distance Forces
- Measuring Force
- Free Body Diagrams
- Net Force
- Force Vectors
- Finding F_{net}



Preview File

Please enjoy this preview of your Student Version of the presentation. Please note within this sample file:

- Some slides appear blank because they have been removed
- Student versions have portions of the text removed which is given in the teacher version and appear as _____ which the students are to fill in
- Other slides may have on them, this represents writing that has been removed on this sample

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Force Overview

- _____
- _____
- Unbalanced forces result in the acceleration, compression, stretching, or twisting of objects
- Force is measured in Newtons ($\text{kg} \cdot \text{m/s}^2$) with the symbol (N)

What is a Force?

- Come up with a definition of a force



1

- After watching the video, revise your definition

Check Your Understanding

State an everyday life example in which a force causes an object to

- a) decrease its speed.
- b) become compressed.
- c) become stretched.



2



3

The Four Fundamental Forces

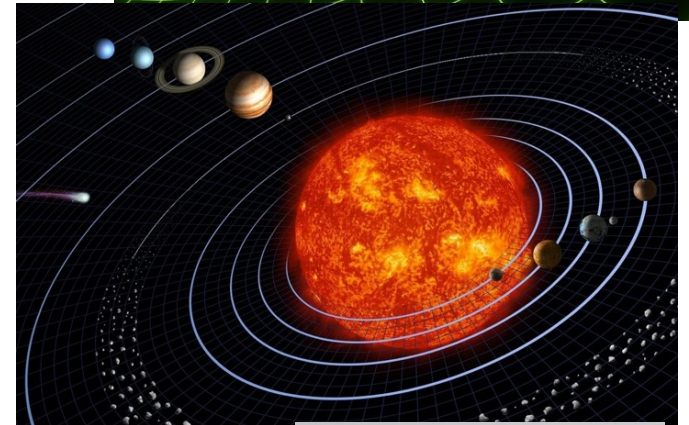
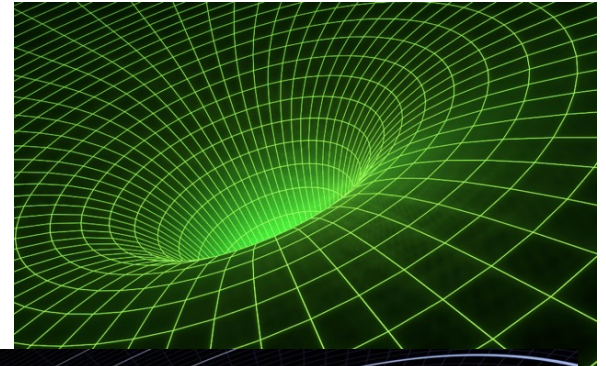
- There are four forces that act in nature
- Put these forces in order of relative strength (make one of the forces have a strength of 1 and the others as a multiple of that 1)
- Provide a multiple for the strengths

- ☐ Gravitational
- ☐ Strong Nuclear
- ☐ Electromagnetic
- ☐ Weak Nuclear

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Gravitational Force

- The force of attraction (not repulsion) between all objects in the universe
- Keeps us from floating away into space
- Keeps the planets in orbit
- Is a relatively weak force unless one or both of the objects is very large
- _____



Check Your Understanding

1. How much weaker is the gravitational force between two objects if they are moved from 1 meter apart to 3 meters apart?
2. How much stronger is the gravitational force between two objects if the distance between them is halved?

Finding the Force of Gravity (F_g)

- The units for F_g are ($\text{kg} \cdot \text{m}/\text{s}^2$)
- One of these laws is Force = Mass x Acceleration

Therefore,

$$F_g = \text{Mass (kg)} \times \text{Acceleration due to gravity}$$

- The mass must ALWAYS be in kg
-

Check Your Understanding

If a person weighs 41.6 kg, what Force of Gravity (F_g) will he produce on the ground?

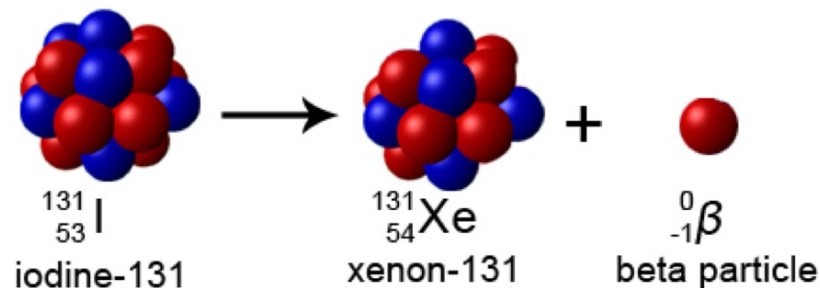
Check Your Understanding

A Hummer weighs 3018.0 kg, what Force of Gravity (F_g) will it direct towards the ground? What force will the ground direct up to the Hummer?



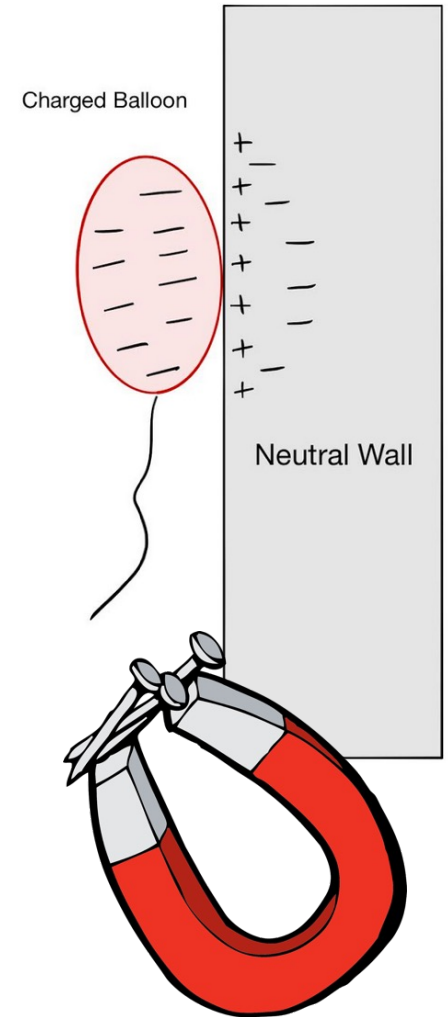
The Weak Nuclear Force

- _____
- Works at very short distances: $10^{-18} \rightarrow 10^{-17}$ m
- Works at the nuclear level
- Causes beta decay in atoms
- Allows the Sun to undergo nuclear fusion
- Responsible



Electromagnetic Force

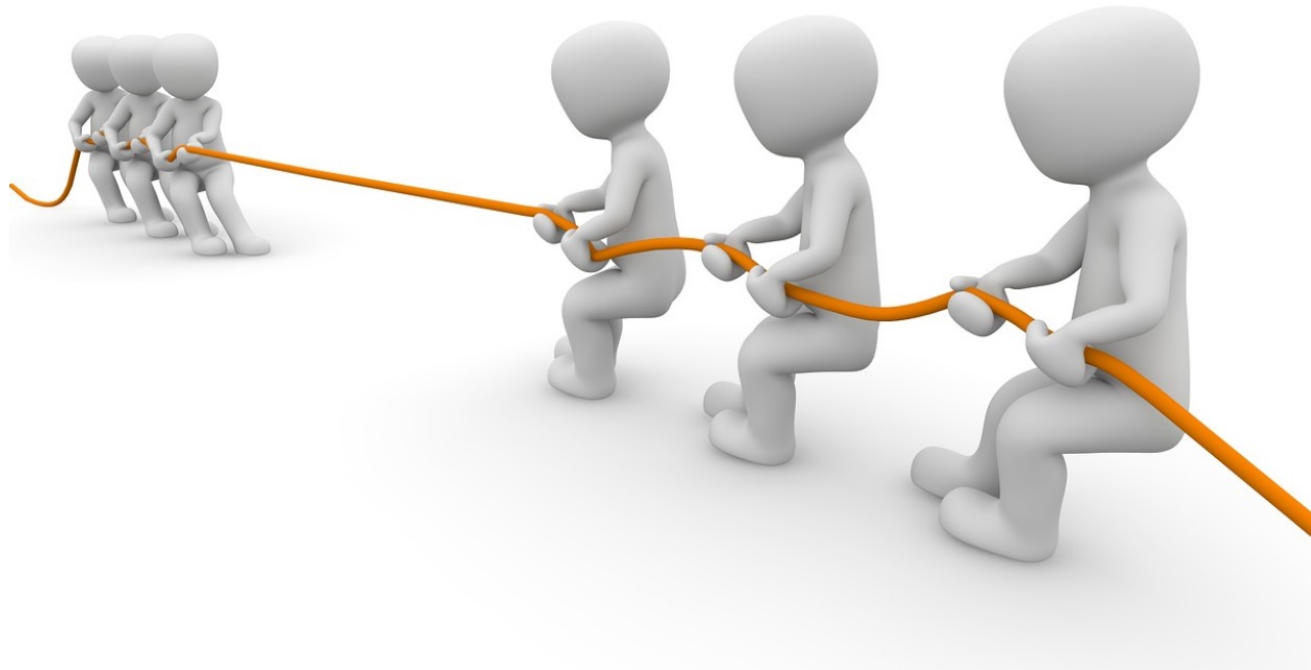
- The force caused by electric charges
- Includes electric forces (static electricity) and magnetic forces (such as a compass)
- Stronger than the force of gravity $\rightarrow \times 10^{36}$
- Can either be attraction or repulsion.
 - The forces generally cancel each other out and objects are neutral
- _____
- Gets weaker quickly as the distance increase ($1/x^2$)



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Forces All Around Us

What happens when forces are in equilibrium?



Consider The Pen On Your Desk

Determine which of the four fundamental forces are acting on it and how.

- Gravitational Force:
- Weak Force:
- Electromagnetic Force:
- Strong Nuclear Force:



Consider The Pen On Your Desk

- Gravitational Force: _____
- Weak and Strong Nuclear Forces: Yes, there are many forces acting at the nuclear level keeping the pen together.
- Electromagnetic Force: There is an interaction between the subatomic particles of the desk and the pen. This helps keep the pen stationary.

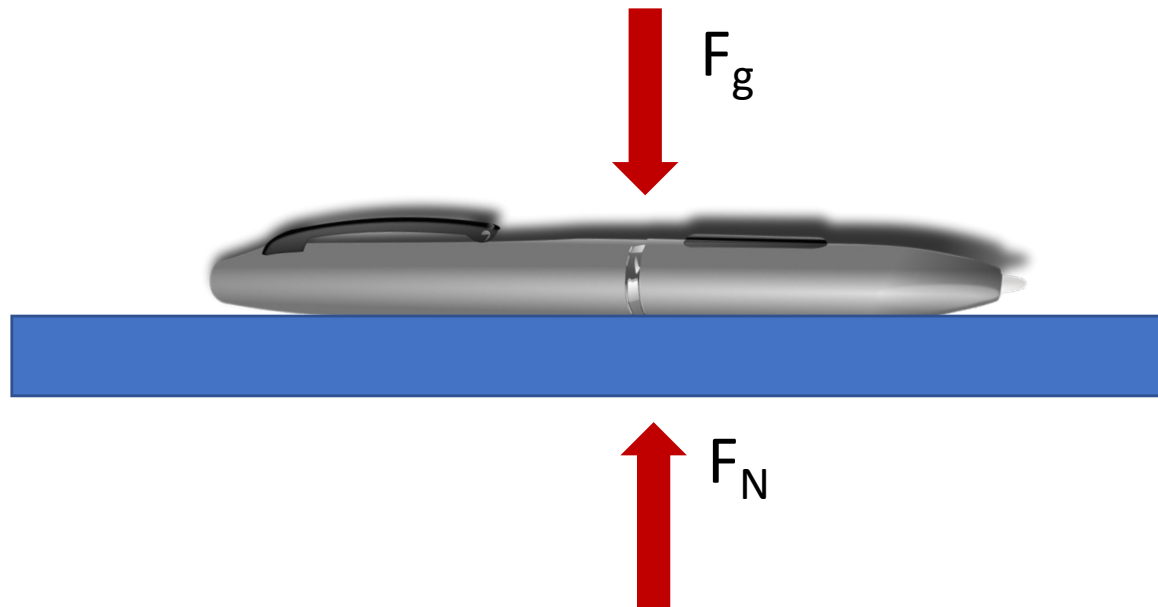
Everyday Forces

- In everyday life, we experience the result of the four fundamental forces acting on us and the objects around us
- We
- List as many everyday forces acting on you as you can. Think of names of forces you've heard before

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The Normal Force (F_N)

- _____
- It is ALWAYS equal and OPPOSITE
- What would happen if $F_N > F_g$?



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SAMPLE



Check Your Understanding

An average male weighs approximately 84 kg. If the man is standing on one leg, what normal force is being produced by the ground upwards on the leg.

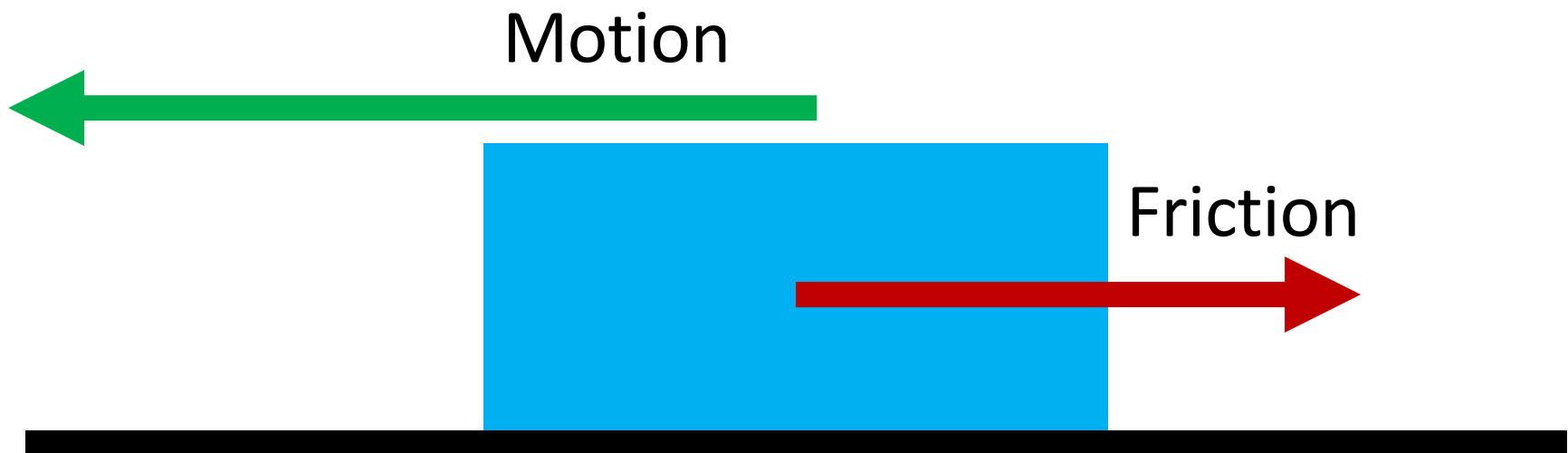
Think About It & Try It

1. If you push an object across the desk, what will happen and why?
2. Does the type of materials matter? Why?
3. Does the mass of the object matter? Why?

Try it

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The Force of Friction (F_f)



Check Your Understanding

1. Which direction is friction acting in the following picture?
2. What kind



Check Your Understanding

1. Which direction and where is friction acting in the following picture?
2. Which kind of friction is acting on the wheel assuming it is in motion?



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Contact vs. Action at a Distance Forces

- The normal force, friction, and tension are all contact forces, in other words, forces that exist when objects are in direct contact with each other

- _____

Common Forces Review

Force	Symbol	Function
Gravity	F_g	Force of attraction between all objects
Normal	F_N	Force perpendicular to the surfaces of objects in contact
Tension	F_T	Force exerted by materials, such as ropes, fibres, springs, and cables, that can be stretched
Friction	F_f	Force that resists motion or attempted motion between objects in contact
Kinetic Friction	F_K	Force that acts against an object's motion
Static Friction	F_S	Force that tends to prevent a stationary object from starting to move
Air Resistance	F_{air}	_____
Applied Force	F_{app}	_____

Air Resistance

- _____

- As large rocky objects enter Earth's atmosphere, they encounter more air molecules = greater air resistance = increased friction = shooting stars as the rock burns up



Measuring Force

Let's look at how you can measure force:

- Newton Meters (spring scale)
- Force Sensor
 - Digital spring scale

What is the relationship between mass and the force of gravity pulling on it?

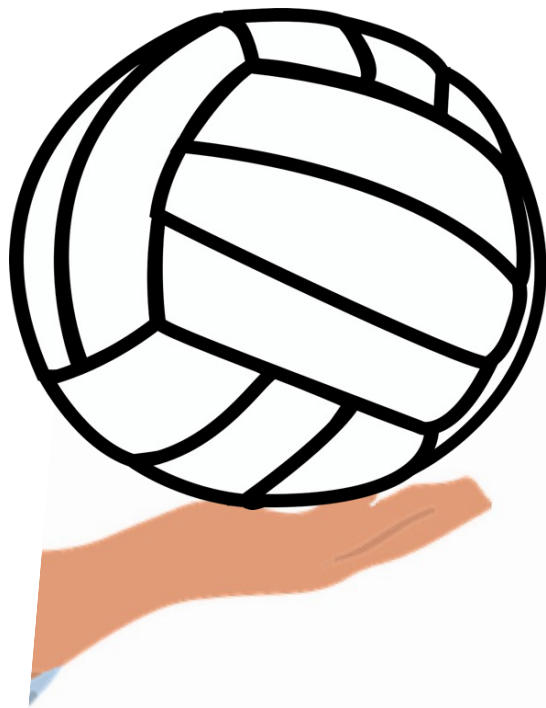


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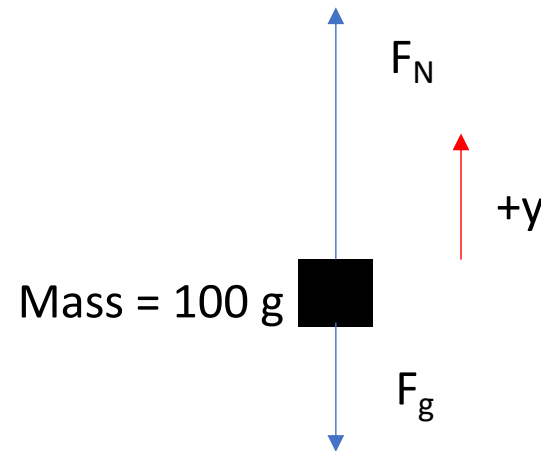
System Diagrams and FBD

- A system diagram is a sketch of all of the objects involved in a situation
- _____
 - *Always indicate the +x and +y directions*
- All force vectors need to be included in a FBD (and labelled) with

System Diagrams vs. FBD



System Diagram



FBD Diagram

Check Your Understanding

You toss a 100 g ball vertically upward. Draw an FBD of the ball just before it leaves your hand.

Check Your Understanding

A child is pushing with a horizontal force against a chair that remains stationary. Draw a FBD of the chair.

Check Your Understanding

Draw a FBD for the following:

- a) Your textbook resting on a desk.
- b) A tennis ball falling through the air from the server's hand (neglect air resistance).
- c) A fully loaded dog sled, moving at a constant, slow pace along a flat, snowy trail, is being pushed horizontally by the sled owner while being pulled horizontally by dogs attached to it by a rope.

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Check Your Understanding

A weightlifter holds a weight above his head by exerting a force of 1800 N [up]. The force of gravity acting on the weight is 1600 N [down].

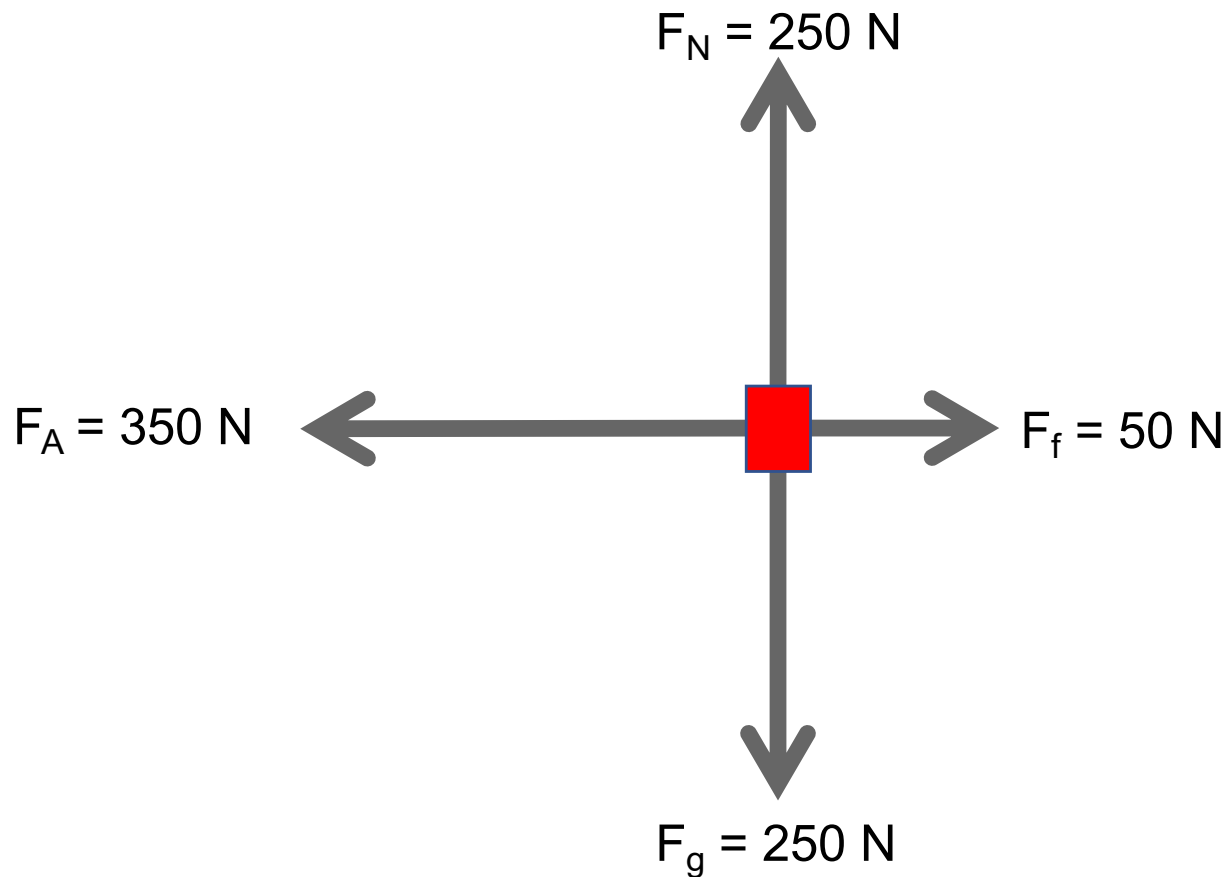
- a) Draw a FBD of the weight
- b) State the net force at that instant.

Check Your Understanding: Simple F_{net} Questions

Team Red

Check Your Understanding

What is the net force in the following situation?



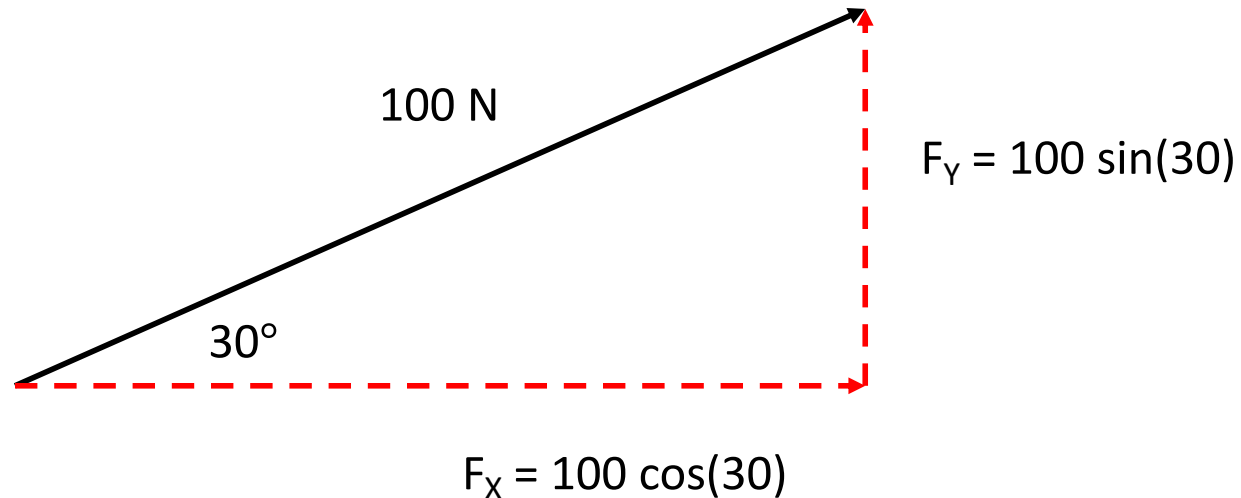
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Force Vectors

If $F = 100$ and $\theta = 30^\circ$

$$F_x = 50 \text{ N}$$

$$F_y = 87 \text{ N}$$



Check Your Understanding

In hitting a volleyball, a player applies an average force of 9.9 N [33° above the horizontal] for 0.01 s . The force of gravity on the ball is 2.6 N [down]. Determine the net force on the ball as it is being struck.



Steps

In hitting a volleyball, a player applies an average force of 9.9 N [33° above the horizontal] for 0.01 s. The force of gravity on the ball is 2.6 N [down]. Determine the net force on the ball as it is being struck.

1. Draw a FBD for the situation and assign positives.
2. Find all the forces in the x and y-directions.
3. Find the sum of the x and y components.
4. Create your right-triangle (as we did with 2D-motion).
5. Find your F_{net} , it will be the hypotenuse.
6. Don't forget the angle!

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In hitting a volleyball, a player applies an average force of 9.9 N [33° above the horizontal] for 0.01 s. The force of gravity on the ball is 2.6 N [down]. Determine the net force on the ball as it is being struck.

4. Create your right-triangle (as we did with 2D-motion).
5. Find your F_{net} , it will be the hypotenuse.
6. Don't forget the angle and your therefore statement!

Check Your Understanding

A sailboat is secured to a dock with two horizontal ropes. A wind is blowing offshore. The tensions in the ropes are $F_1 = 48 \text{ N [E } 16^\circ \text{ N]}$ and $F_2 = 48 \text{ N [E } 16^\circ \text{ S]}$.

- a) Use a vector diagram to determine the sum of the tension forces in the two ropes (combined x-components).
- b) Assuming that the net horizontal force on the boat is zero, determine the force of the wind on the boat.

Check Your Understanding

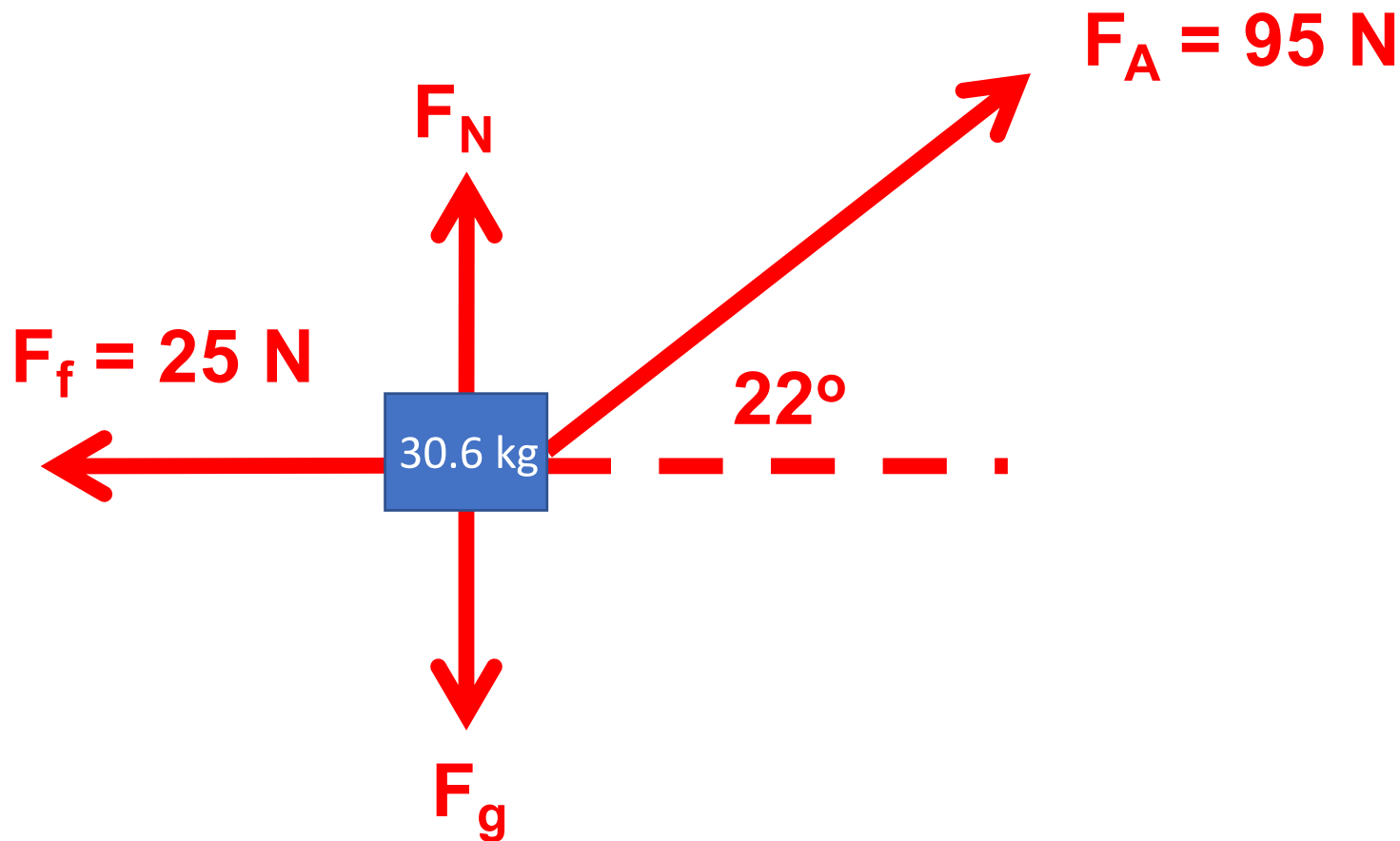
Draw a FBD and determine the net force:

At a particular instant, a soaring bird travelling east is subject to an upward lift of 3.74 N, a downward gravitational force of 3.27 N, and a horizontal air resistance force of 0.354 N [Left].

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Check Your Understanding

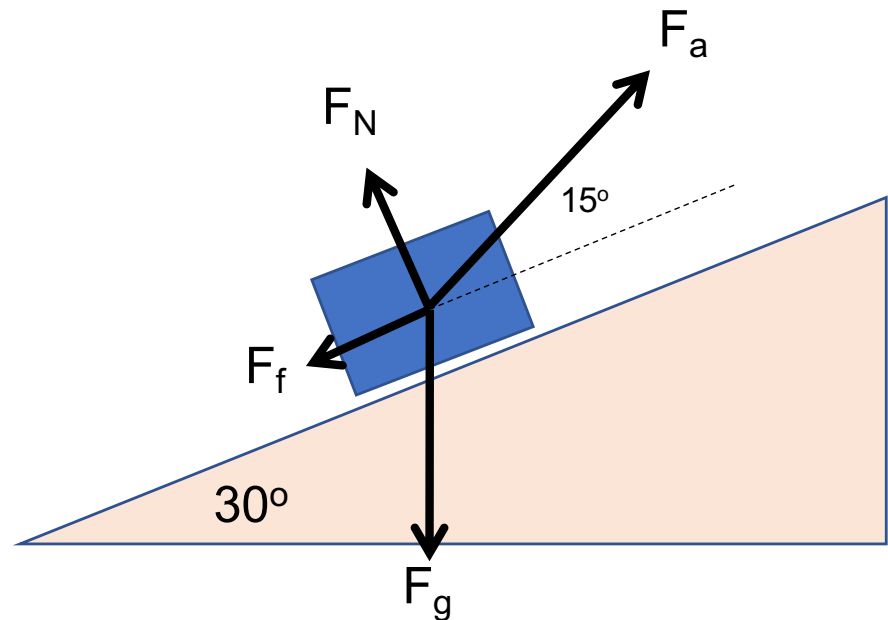
The mass of the cart is 30.6 kg. Find all the forces and the net force.



Ramps – Finding F_{net}

- Recall: When analyzing a problem involving forces acting on an object, you must find the sum of all the forces acting on that object
- You still need to designate a “+” x and y value by rotating the axis so that it’s aligned with the ramp

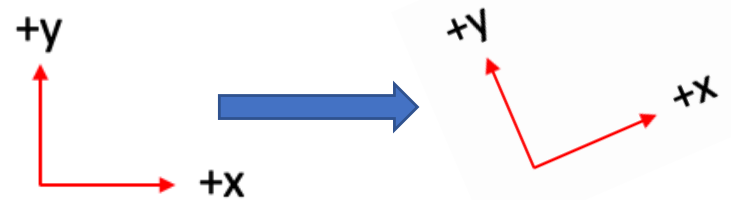
$$\vec{F}_{\text{net}} = \sum \vec{F}$$



Check Your Understanding

– More Difficult

A child pulls a sleigh up a snow-covered hill at a constant velocity at an angle (Θ) with a force parallel to the hillside. Draw a FBD of the sleigh.



Steps

- 1) Rotate the axis to align with the ramp
- 2) Equate the ramp angle (Θ) with the angle formed by the components of F_g
- 3) Include all forces

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Check Your Understanding

Fill in the blanks and determine the net force in the following situation. The object has a mass of 35.7 kg.

