6-2017

Forces and Motion (Rube Goldberg PBL)

Joy Lindig Brush
Trinity University, jlindig@trinity.edu

Unit: Forces & Motion (Rube Goldberg PBL)
Grade: Middle School (6-8)

Stage 1: Desired Results

Understandings

Students will understand that…

- Forces affect us in every instance of our lives
- We rely on simple machines to apply and multiply force every day
- We can use laws and equations to explain physical phenomena

Essential Questions

- How do forces affect me?
- How can I use simple machines to simplify tasks? (How have I used simple machines in my life to simplify tasks?)
- How can I use my understanding of forces to inform my decisions?
- How can I use scientific laws and equations to make sense of the world around me?
- In engineering, what is the balance between efficiency and effectiveness? Is a balance necessary?

Knowledge & Skills

Standards based on AERO Science Framework (2012, by Grade Band)

- Simple Machines
  - PS.6.4A Examine simple machines and the forces (pushes and pulls) involved.
  - Perform experiments with simple machines to demonstrate the relationship between forces and distance.
  - Illustrate quantitatively mechanical advantage of simple machines
- Balanced & Unbalanced Forces
  - PS.5.6 Describe variables that change an object's speed, direction, or both and identify and describe the forces that cause the change in motion.
  - Use data to determine or predict the overall (net) effect of multiple forces (e.g., friction, gravitational, magnetic) on the position, speed, and direction of motion of objects.
- Newton's 1st Law: Law of Inertia
  - PS.6.8A Demonstrate that an object in motion that is unaffected by a force will continue to move at a constant speed and in a straight line.
  - Explain that when a force is applied to an object, it reacts in one of three ways: the object either speeds up, slows down, or goes in a different direction.
- Newton's 2nd Law: Force = Mass x Acceleration
  - Investigate and describe how the acceleration of a body is dependent on its mass and the net applied force
- Newton's 3rd Law: Every action has an equal and opposite reaction
  - Describe the relationship between the strength of a force on an object and the resulting effect, such as the greater the force, the greater the change in motion.
- Potential & Kinetic Energy
  - PS.4.7. Differentiate between kinetic energy, which is the energy of motion and potential energy, which depends on relative position. 8. Compare the potential and kinetic energy within a system at various locations or times.
- Speed
  - PS.5.8A Students will measure distance and time for a moving object and using those values as well as the relationship s=d/t to calculate speed and graphically represent the data.

Stage 2: Assessment Evidence

Performance Task:

Rube Goldberg Machine

- *Task:* A small group of 3-4 students will create a complex machine that fulfills a simple task, inspired by the work of cartoonist Rube Goldberg. The machine should have 6 or more unique steps and utilize at least 4 different types of simple machines (must include pulley, inclined plane and lever).
- *Audience:* Each group will work with school or community members to design a machine specifically for their client's needs. The client(s) might be a member of the community or someone from the school. (Ex: Mr. P's 4th grade class requested a machine to close their classroom door. Ms. C, head of marketing, needs a machine to display flyers and other advertisements).
- *Assessment:* Upon completion of the machine, each student will individually create a digital infographic (or other type of report) explaining and applying each topic of the unit to their machine. Students will add a new section to their report as they finish learning about the each topic. These topics include: simple machines, balanced & unbalanced forces, Newton's three laws, potential and kinetic energy, and calculating speed.
  - Report description / requirements
  - Rube Goldberg Rubric

Other evidence:

- *Exit-Tickets aligned to daily objective*
- *F=m x a practice problems*
- *mid-unit quiz*
- *unit test*
- *peer and self-evaluation surveys for during and after machine construction (accountability for collaboration)*

Stage 3: Learning Activities

Lessons are based on 70 minute classes, 3 times a week.

- **Simple Machines**
  - Lesson 1: Introduction to Simple Machines (BrainPOP)
  - Lesson 2: Simple Machines: Lab Stations (provide examples of each SM for students to explore). Example: Lab Exploring Mechanical Advantage (Other Resources: Pulley Simulation)
  - Rube Goldberg Project: Provide 1-2 weeks for students to create machines for their clients
    - Lesson 3: Introduce project and expectations, show examples
    - Lesson 4: Groups create a design plan that meets all criteria for machine
    - Lessons 5 -8: Collect materials and construct machines
    - Lesson 9: Begin Rube Goldberg Report (Part 1)
- Balanced & Unbalanced Forces
  - Lesson 10: NearPod Activity: Forces with PhET simulation: Forces and Motion Basics
  - Lesson 11: Apply to Rube Goldberg Report (Part 2)

- Newton's Laws
  - Lesson 12: NearPod Activity: Newton's Laws with Science Channel Interactive
  - Lessons 13 & 14: Newton's Laws Activity: Design a Lesson
  - Lesson 15: Force=mass x acceleration practice
  - Lesson 16: Apply to Rube Goldberg Report (Part 3)
- Potential & Kinetic Energy
  - Lesson 17: Potential and Kinetic Energy (BrainPOP, Rollercoaster interactive)
  - Lesson 18: Apply to Rube Goldberg Report (Part 4)
- Speed
  - Lesson 19: Lab: Calculating Speed and Speed: Practice Problems
  - Lesson 20: Apply to Rube Goldberg Report (Part 5)
- Summative Assessments
  - Lesson 22: Review for unit test, finalize and turn in reports
  - Lesson 23: Unit Test: Forces and Motion

FINAL REPORT: RUBE GOLDBERG

Directions: Throughout the rest of our unit, you will apply your learning to your Rube Goldberg machine. You will show your learning on an individual final report.

Format: Infogram, Piktochart, Canva or other infographic

Requirements: The requirements for your report will be updated below throughout the unit. Your final report will be scored on the Rube Goldberg rubric. Take a look at Mrs. B's infogram to see an example of what your report should include so far.

Part 1: Introduction

- Picture: Include a picture of your machine (you will need to update the picture if you make any changes)
- Description: Briefly describe your machine. What is the purpose of your machine? (ex: turn off a light) What are the different steps in your machine?
- Bonus: Label each step of your machine on the picture of the machine.

Part 2: Simple machines

- Inclined Plane
- Pulley
- Lever
- Wheel and axle, screw, or wedge

For each simple machine:

- **Explain:** What type of simple machine is this and why? (Ex: This is a lever because…) Imagine you are explaining to someone who has never seen that simple machine before. Your description should prove that you understand exactly what each type of simple machine is.
- **Apply:** How did you use each type of simple machine in your project? How does it function (work) in your machine?
    - Bonus: Explain which type of lever you used in your project (is it a first, second, or third class lever?) You may need to do some research for this.
    - Bonus: Include a close-up picture for each of the simple machines in your project. Add this picture next to each of your explanations.

Part 3: Forces and Motion

Topics:

- Balanced and Unbalanced Forces
- Newton's First Law
- Newton's Second Law
- Newton's Third Law

For each topic, include the following:

- **Explain:** Briefly explain what this topic is. Assume the reader has never heard of this topic before. Include at least **one example** from everyday life.
  - Bonus: Fully explain the topic in detail in a full paragraph.
  - Bonus: Give multiple examples and include visuals for each example.

- **Apply:** Apply each topic to your machine. Give one or more examples from your Rube Goldberg machine for each topic. Be specific and justify WHY these are examples of that topic. "An example of Newton's First Law from my machine is… because…"
  - Bonus: Give examples from two or more steps in your machine. Justify how each step is an example of the topic.
  - Bonus: Demonstrate balanced / unbalanced forces by calculating the net force on an object. Use a spring scale (borrowed from your teacher) to find the forces.
  - Bonus: Use Newton's second law to calculate the force of an object in your machine. (Ex: a marble rolling down an inclined plane). Assume the acceleration is the same as gravity.

Part 4: Energy

Topics:

- Potential Energy
- Kinetic Energy

For each topic, include the following:

- **Explain:** Briefly explain what this topic is. Assume the reader has never heard of this topic before. Include at least **one example** from everyday life.
  - Bonus: Fully explain the topic in detail in a full paragraph.
  - Bonus: Give multiple examples and include visuals for each example.

- **Apply:** Apply each topic to your machine. Give one or more examples from your Rube Goldberg machine for each topic. Be specific and justify

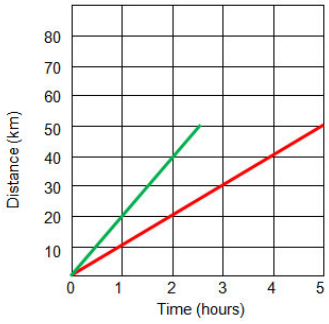
WHY these are examples of that topic. "An example of kinetic energy in my machine is… because…"

- Bonus: Give examples from two or more steps in your machine. Justify how each step is an example of each topic.
- Bonus: Calculate the potential energy of an item in your machine using the following formula: **PE = mgh**
  - PE = potential energy
  - m = mass of the item in kg
  - g = force of gravity (9.8 m/s^2)
  - h= height of the object in meters (height is from the tallest to lowest points that the object travels)
- Bonus (Challenge): Calculate the kinetic energy of an item in your machine using the following formula: **KE = ½ (mv^2)**
  - KE = kinetic energy
  - m = mass of the item in kg
  - v = velocity of item in meters per second (m/s)

Part 5: Speed

In class you calculated the speed of an item going down an inclined plane on your machine.

- Include the speed of this item AND explain how you found the speed. (What formula did you use? What data did you collect to find the speed?)
- Explain whether the speed shows that the item has KINETIC or POTENTIAL energy. Remember to justify your answer.
  - Bonus: Include the speed of several items in your machine. Remember that you can calculate the speed of any item (ex: an item falling or a pulley moving) as long as you can find the time it takes for it to travel a certain distance.



  - Bonus: Include a graph showing the speed of each item you calculate. Your graph should show Time on the X axis and Distance on the Y axis. The speed of each item should be shown in a different color and include a key. (Hint: For each item you will need at least two data points to create your graph - the beginning and the end)

RUBE GOLDBERG RUBRIC

Category	4. Exemplary	3. Accomplished	2. Developing
I. Machine	The Rube Goldberg Machine completes the client's required task using at least 10 steps with at least 4 different simple machines. The Machine demonstrates exemplary effort and creativity, and is constructed with high quality.	The Rube Goldberg Machine usually the client's required task using at least 8 steps with at least 3 different simple machines. The Machine some effort and creativity and is constructed with quality.	The Rube Goldberg Machine rarely or never complete's the client's required task, uses less than 8 steps with less than 2 different simple machines. The Machine shows little effort and creativity and is constructed with low quality.
II. Collaboration	The student always contributes equally to the project, helps their peers and asks for help when needed. They contribute equally and professionally to all client interactions. The student always stays on task, perseveres, and uses feedback from others to improve.	The student usually contributes equally to the project, helps their peers and asks for help when needed. They often contribute equally and professionally to client interactions. The student typically stays on task, perseveres, and uses feedback from others to improve.	The student rarely contributes equally to the project, helps their peers or asks for help when needed. They sometimes contribute equally and professionally to client interactions. The student sometimes stays on task and perseveres, and rarely uses feedback from others to improve.
III. Final Report	All required information is included and completely correct; student demonstrates an exemplary understanding of the topic and goes above and beyond with effort and creativity.	Most required information is included and mostly correct. Student demonstrates an accomplished understanding of the topic and shows some effort and creativity	Somewhat inaccurate or incomplete information. Student demonstrates a developing understanding of the topic and shows little effort.

Name: _____ Period:_____ Date: _____ R

Unit 4 Assessment: Forces and Motion
7th Grade Science

Show your work when relevant. Write your final answer on the answer sheet (on the last page).

Matching: Pair each simple machine with the correct definition.

1. Lever	a. An object with at least one slanting side ending in a sharp edge. Used to cut or split material apart.
2. Wedge	b. A circular object with a rod through the center, allowing it to spin freely. Can be used to transport or roll items more easily.
3. Wheel and Axle	c. A bar or other surface that rests on a turning point called a fulcrum. Can be used to raise or turn objects more easily.
4. Screw	d. A grooved wheel with a string around it. Can change the direction of force needed and is used to lift or lower items.
5. Inclined Plane	e. An angled surface that is used to roll items down it or to slide a heavy load up it more easily.
6. Pulley	f. An inclined plane wrapped into a spiral

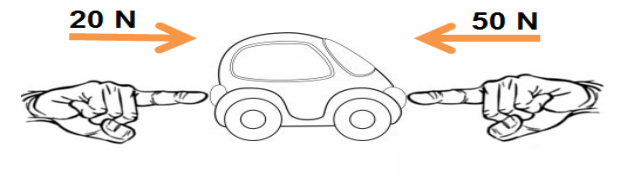
7. In science, any type of push or pull is called --

a. Force
b. Acceleration
c. Mass
d. Friction

8. During a tug-of-war competition, the rope stays still and neither team is able to gain an advantage (win). Which of the following explains the forces in this situation?

a. The forces are un-balanced
b. The forces are overcome by friction from the air
c. The mass of the rope stops forces from acting on it
d. The forces are balanced

9. Joe pushes a toy car with a force of 20 N to the right. Ann pushes the same car from the opposite side with a force of 50 N to the left. What will be the result? The car will move --



a. to the right with a force of 20 N
b. to the right with a force of 70 N
c. to the left with a force of 30 N
d. to the left with a force of 50 N

10. When an unbalanced force acts on an object, that object will --

a. Speed up, slow down or change speed
b. Remain still
c. Become smaller or increase in size
d. Stay the same speed

11. A book is sitting on a desk. According to Newton's Laws, which statement best explains why the book stays still?

a. Energy is never created or destroyed, only transformed.
b. For every action there is an equal and opposite reaction.
c. An object will keep doing what it is doing unless acted on by an unbalanced force
d. Greater mass means you will need more force to accelerate the object.

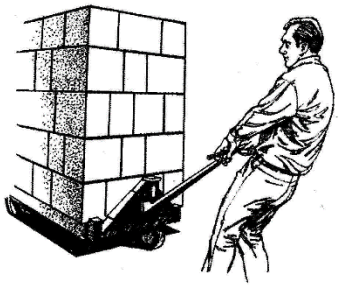
12. If you threw a baseball in outer space, it could keep moving forever. The tendency of objects to remain in constant motion unless acted on by an outside force is called:

a. Inertia
b. Acceleration
c. Mass
d. Force

13. You are standing on a skateboard. When you jump backward, the skateboard moves forward. According to Newton's Laws, which statement best explains why this happens?

a. Energy is never created or destroyed, only transformed.
b. For every action there is an equal and opposite reaction.
c. An object will keep doing what it is doing unless acted on by an unbalanced force
d. Greater mass means you will need more force to accelerate the object.

14. According to Newton's 2nd Law, how could this man move the bricks more quickly?



a. Increase the friction
b. Reduce acceleration
c. Add more bricks
d. Use more force

15. Based on Newton's 2nd Law, how much force would you need to accelerate a 10 kg bowling ball at a rate of 5 m/s^2? Show your work.

a. 0.5 N
b. 2 N
c. 50 N
d. 5 N

16. A car was accelerating at 10 m/s^2 and required 2,000 N to make it stop. What is the mass of the car in kg? Show your work.

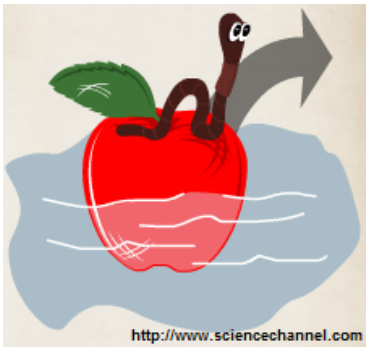
a. 10 kg
b. 200 kg
c. 10,000 kg
d. 20 kg

17. Your friend throws a 2 kg object at you with a force of 50 N. What is the acceleration of the object? Show your work.

a. 25 m/s^2
b. 2 m/s^2
c. 100 m/s^2
d. 5 m/s^2

18. According to Newton's 3rd Law, if you push on a wall with a force of 10 Newtons, the force of the wall acting back on you is --

a. 0 Newtons
b. 10 Newtons
c. 20 Newtons
d. 40 Newtons



19. An apple is floating in a pond. The worm jumps off the apple as shown in the picture. Based on Newton's 3rd Law, what will most likely happen to the apple?

a. It will move towards the worm
b. It will move away from the worm
c. It will stay completely still
d. It will sink and be eaten by sharks

20. Newton's 1st Law states that things in motion will stay in motion unless acted on by a force. Despite this, when Sam rolls a marble on the ground, it always seems to eventually stop rolling on its own. On Earth, what force is causing these objects to stop?

a. Weight
b. Friction
c. Acceleration
d. Mass

21. The energy related to the relative position or condition of an object is called -

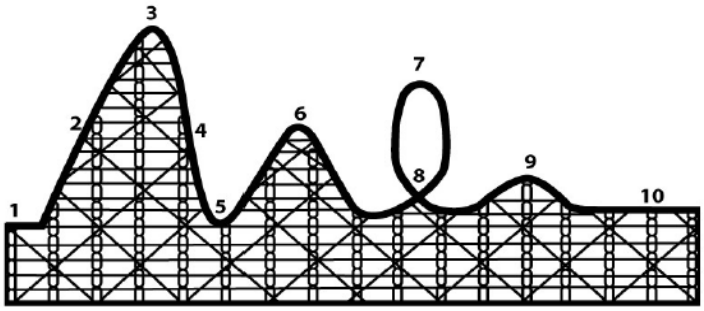
a. Kinetic energy
b. Electrical energy
c. Potential energy
d. Chemical energy

22. The energy related to the motion or speed of an object is called -

a. Kinetic energy
b. Electrical energy
c. Potential energy
d. Chemical energy

Use the diagram of a roller coaster to answer the next two questions.

Use the following model of a roller coaster for the next two questions.



23. At what point would the roller coaster have the most kinetic energy?

a. 2
b. 3
c. 5
d. 7

24. At what point would the roller coaster have the most potential energy?

a. 2
b. 3
c. 5
d. 7

25. A student who was training for a race jogged for 2.0 hours and covered a distance of 14.0 kilometers. What was the average speed of the student? Show your work.

a. 1.5 km/h
b. 7.0 km/h
c. 14.0 km/h
d. 28.0 km/h

26. You see a cheetah 90 meters away from you. If the cheetah runs at a speed of 30 m/s, how long would it take for the cheetah to reach you? Show your work.

a. 3 seconds
b. 90 seconds
c. 300 seconds
d. 2,700 seconds

Simple machines!

1. Explore: Experiment with each type of simple machine on the game!

Next use the Simple Machines Information to help you answer each question:

2. What is a machine?

3. Include information about each type of simple machine below:

Simple Machine	Definition	Picture(s)	Examples
Inclined Plane			
Lever			
Pulley			
Screw			
Wedge			
Wheel & Axle			

4. What are three ways that a machine can make work easier?

a.

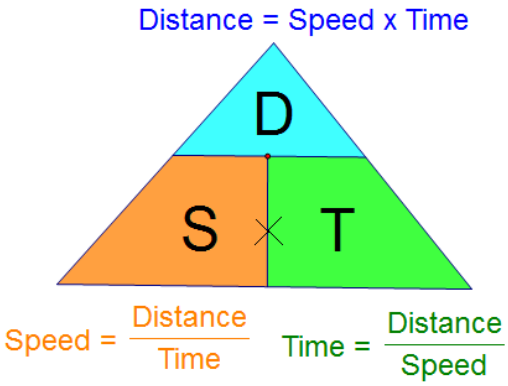
b.

c.

5. Next, try quizzing yourself on the “What type of machine” game (one of the last slides on the ppt)

6. Finished early? Go back to the first game and keep exploring...OR go back to the BrainPOP videos for each type of machine and try out the quizzes and games related to each video.

Lab: Calculating Speed



What is speed? Watch the video to learn more.

Speed = Distance / Time

Can be measured in: m/s (meters per second), km/h or kph (kilometers per hour), & so on…

Materials: Stopwatch, Ruler, Rube Goldberg Machine

Procedure / Questions:

1. Choose an inclined plane on your machine. You will find the speed of an item going down this ramp.

a. To find the speed, what TWO measurements will you need to find?

Speed = _____ divided by _____

2. Using the ruler, measure the distance of the ramp in cm.

Distance: _____

3. Using the timer, measure how many seconds it takes for object to roll the entire distance of the ramp. Take at least 3 time measurements and calculate the average time. This will help ensure your measurement is accurate.

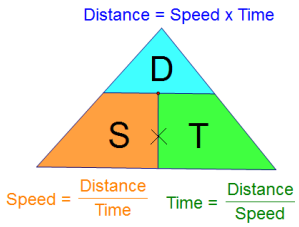
Time 1: _____ Time 2: _____ Time 3: _____ **Average Time:** _____

4. Using your data for distance and average time, calculate the speed of your item in cm/s (centimeters per second).

Speed =

5. Go back to your seat and use this information to finish part 5 of your Rube Goldberg report.

HW: Calculating Speed



Speed = Distance / Time

Can be measured in: m/s (meters per second), km/h or kph (kilometers per hour), & so on...

Practice: Show your work for each problem. Highlight or circle your final answer.

1. A really fast armadillo can cross a road that is 20.00 meters long in 10.0 seconds. What is the speed of the armadillo in m/s?

S=_____

D=_____

T= _____

2. Riley can run 100 meters in 30 seconds. What is his speed in m/s?

S=_____

D=_____

T= _____

3. Data taken from the liftoff of the space shuttle shows that in the first 10.00 seconds, the shuttle travels a distance of 311 meters. What is the shuttle's average speed during this time period in m/s?

S=_____

D=_____

T= _____

4. A speedboat can, at full throttle, go 105.0 km in 1.5 hours. What is the average speed of the boat in km/h?

S=_____

D=_____

T= _____

5. You are taking a road trip to Otavalo. Otavalo is 88.5 km away and it takes you 1.5 hours to arrive. What was your average speed on the trip in km/h?

S=_____

D=_____

T= _____

6. Your friend makes the same trip to Otavalo. She travels the 88.5 km at an average speed of 44.25 km/h. How long will it take her to arrive?

S=_____

D=_____

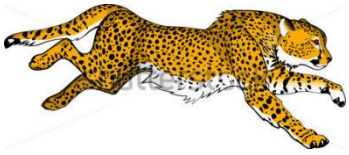
T= _____

7. A cheetah can run at a speed of 33 m/s. At this speed, how far could the cheetah travel in 10 seconds?

S=_____

D=_____

T= _____



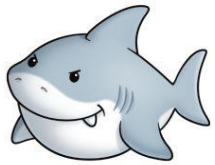
8. You see a cheetah 100 meters away from you. If the cheetah runs at a speed of 30 m/s, how long would it take for the cheetah to catch you?

S=_____

D=_____

T= _____

9. You've had enough terrifying experiences with cheetahs, so you decide to go scuba diving instead. You see a great white shark which can swim at a speed of 11 m/s. How long will it take for the shark to reach if you are 540 meters away?



S=_____

D=_____

T= _____

10. Enough with large predators...you decide to hang with the sloths instead. If a sloth can travel at a max speed of 0.025 m/s on the ground, how far could the sloth travel in 60 seconds?

S=_____

D=_____

T= _____

11. **On the ground, sloths move at about 0.025 m/s. However, sloths can travel at a faster speed 0.075 m/s if they are in the trees. A sloth is 100 meters away from you. How long would it take for the

sloth to reach you if he travels for 60 meters in the trees and 40 meters on the ground?

In the trees:	On the ground:	Total time:
S=_____	S=_____	
D=_____	D=_____	
T= _____	T= _____	T= _____

12. **Your friend hikes up Volcan Pichincha. He claims he hiked the 5 km in only 2.5 hours. However, you notice his fitbit says he hiked at a pace of 1.25 km/h. How long did it actually take your friend to hike the volcano?

S=_____

D=_____

T= _____

13. **A car travels from Academia Cotopaxi to Cumbaya, a distance of 28 km in 45 minutes. It remains in Cumbaya for 30 minutes at rest. The car then travels from Cumbaya to Tumbaco, a distance of 8 km, in 55 minutes.

a. What was the speed for each part of the trip in km/min? (kilometers per minute)

AC to Cumbaya:

At Cumbaya:

Cumbaya to Tumbaco:

b. What was the total time elapsed for the entire trip?

c. What was the average speed for the trip (total distance/ total time)?

Potential and Kinetic Energy

Learn:

1. Watch the BrainPOP video about Kinetic Energy. (Optional: Try taking the quiz!) Username: cotopaxi Password: cougars

a. Based on the video, what is kinetic energy?

b. How can kinetic energy be measured? (How can you know if something has more kinetic energy?)

c. How can kinetic energy be transferred or transformed?

d. Draw or add a picture below to show what kinetic energy is. (Cite your source if you use a picture you find online)

2. Watch the BrainPOP video about Potential Energy. (Optional: Try taking the quiz!) Username: cotopaxi Password: cougars

a. Based on the video, what is potential energy?

b. How can you know if something has more potential energy? (How can you increase the potential energy of something?)

c. How can potential energy be changed to kinetic energy? (And vice versa). Give examples.

d. Draw or add a picture below to show what potential energy is. (Cite your source if you use a picture you find online)

Practice:

3. Launch the Rollercoaster interactive. Press play, then watch it step by step.

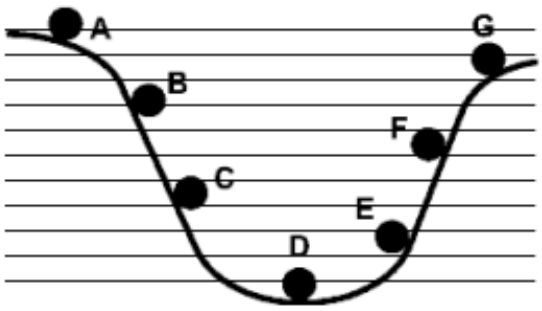
a. At what points does the rollercoaster have mostly potential energy?

b. At what points does the rollercoaster have mostly kinetic energy?

c. How does the SPEED of the coaster relate to the amount of energy it has? Use potential or kinetic for each statement:

i. When the coaster is moving very fast, it has lots of _____ energy
ii. When the coaster is moving very fast, it has very little _____ energy
iii. When the coaster is moving slowly (or not at all) at the top of a hill, it has lots of _____ energy
iv. When the coaster is moving slowly (or not at all), it has very little _____ energy

4. The picture shows a ball that starts at point A and rolls to point G.



a. Which letter shows when the ball has the maximum potential energy? _____

b. When does the ball have the least kinetic energy? _____

c. When does the ball have the least potential energy? _____

d. When does the ball have the greatest kinetic energy? (The highest possible speed) _____

5. Why is point G slightly lower than point A? (In other words, why couldn't the ball go back to the same height that it started at?)

6. Based on the picture above, how do you think gravity relates to potential and kinetic energy? (How might potential and kinetic energy be different without gravity?)

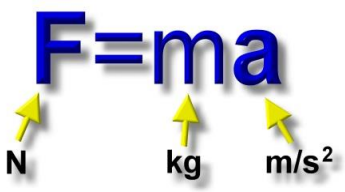
Explore:

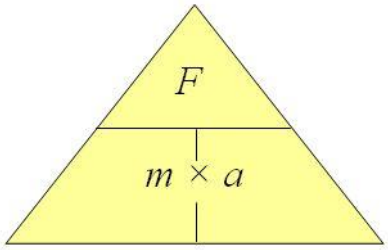
7. Think about Potential and Kinetic energy while you explore the following interactive websites. (Think about: What is each type of energy? What are examples of each type of energy? How is each type of energy related?)

a. Types of Energy (Hint: Stored energy is the same as potential energy)
b. Coaster Creator
c. Pendulum
d. Trampoline Physics
e. Energy Skate Park
f. Whoahler Coaster

Newton's Second Law

Force = Mass x Acceleration





Force = mass x Acceleration

Mass = Force / Acceleration

Acceleration = Force / Mass

We measure Force in Newtons (N), Mass in kilograms (kg), and Acceleration in m/s^2 (meters per second squared)

Practice: Show your work for each problem. Highlight or circle your final answer.

1. What net force is required to accelerate a car at a rate of 5 m/s^2 if the car has a mass of 2,000 kg?

F=_____

m=_____

a= _____

2. How much force would you need to accelerate a 12 kg bowling ball down an alleyway at a rate of 3 m/s^2?

F=_____

m=_____

a= _____

3. Riley has a car that accelerates at 10 m/s^2. If the car has a mass of 2000 kg, how much force does the car produce?

F=_____

m=_____

a= _____

4. How much force would you need to accelerate a 15 kg bowling ball down an alleyway at a rate of 5 m/s^2?

F=_____

m=_____

a= _____

5. What is the mass of a falling rock if it produces a force of 200 N?
(Hint: remember that the acceleration due to gravity is 9.8 m/s^2)

F=_____

m=_____

a= _____

6. What is the mass of a truck if it produces a force of 18,000 N while accelerating at a rate of 4.6 m/s^2?

F=_____

m=_____

a= _____

7. What is the acceleration of a softball if it has a mass of 0.5 kg and hits the catcher's glove with a force of 25 N?

F=_____

m=_____

a= _____

8. Your own car has a mass of 2500 kg. If your car produces a force of 12,000 N, how fast will it accelerate?

F=_____

m=_____

a= _____

9. Your friend's car has a mass of _____ kg. If your car produces a force of _____ N, how fast will it accelerate? (You choose the numbers)

F=_____

m=_____

a= _____

10. You kick a soccer ball that has a mass of 3kg. If you kick with a force of 4.5 N, how fast will the soccer ball accelerate toward the goal?

F=_____

m=_____

a= _____

11. Riley wants to accelerate even faster than in problem #3, so he removes 500 kg of mass from his car. How fast will his 1500 kg car accelerate if it produces 5,150 N of force?

F=_____

m=_____

a= _____

12. Riley challenges you to a race. Your car produces 5000 N of force, and accelerates at 2 m/s^2. What is the mass of your car?

F=_____

m=_____

a= _____

13. Compare your car (question #12) and Riley's car (question #11).

a. Which car has the greatest mass?

b. Which car has the greatest force?

c. When you race each car, which car will have the greatest acceleration?

Activity: Newton's Laws
Design a Lesson

Directions: Your group will be assigned to teach an activity about Forces or Newton's Laws. Topics:

1. **Newton's First Law** (Law of Inertia)
2. **Newton's Second Law** (Force, Mass, Acceleration)
3. **Newton's Third Law** (Action / Reaction)
4. **Balanced and Unbalanced Forces** (Calculate Net Force)

Format: Your lesson must have a visual component to it. This could be hand-made (ex: a poster) or digital (ex: powerpoint) that you show on your computer. Or you could come up with your own idea!

Requirements: You will teach a 10 minute mini-lesson about your topic. The lesson should include:

1. **Information** - briefly explain/review the topic. What are the main ideas? What vocabulary should your students understand? *(1-2 minutes)*
2. **Activity** - plan one or more activities for your students that will explain or reinforce your topic. The activities could be an online simulation, a lab, a mini-project, etc. *(4-8 minutes)*
3. **Assessment** - design a mini-assessment to see what your students understood. It could be a traditional assessment like an exit-ticket or you can get creative! Note: Your assessment should allow everyone to answer independently so you can see everyone's learning. *(1-2 minutes)*

Resources: Use any or all of these websites to help you find the information you need.

- Assessment: StudyStack, Kahoot, Quizlet, etc
- Nearpod: Balanced / Unbalanced Forces and Newton's Laws
- BrainPOP: Forces and Motion (username: cotopaxi / password: cougars)
- List of online simulations or pHet physics simulations
- Newton's Laws Activities: Science Spot, Southwood, Sciencing, Sonoma
- Forces Activities: Ideas, Stations, Physics Classroom, PBS