Physics is Fun!!

Grade Level: Eighth Grade Science
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Length of Unit: Four-six weeks

I. ABSTRACT

This unit provides students with information and hands-on experiences with physics; specifically, the concepts of force and motion. The classroom lessons and activities associated with the unit will prepare students to construct a roller coaster ride that will demonstrate these concepts, including Newton's Three Laws of Motion.

II. OVERVIEW

A. Concept Objectives

1. Students will understand the concepts of speed and velocity and be able to apply the mathematical formula to real-life situations.
2. Students will understand the concept of a force and explain how and where forces apply to a roller coaster ride.
3. Students will understand Newton's Three Laws of Motion and design and construct a roller coaster ride to demonstrate the laws in practice.
4. Students will distinguish between a question and a hypothesis.
5. Students will draw a conclusion based on a set of experimental data.
6. Students will design and conduct an experiment using the scientific method.
7. Students will organize and construct a graphical representation of data.

B. Content from the *Core Knowledge Sequence* (p.198)

1. **Motion**: Velocity and Speed. The velocity of an object is the rate of change of its position in a particular direction. Speed is the magnitude of velocity expressed in distance covered per unit of time. Changes in velocity can involve changes in speed or direction or both. Average speed=total distance traveled divided by the total time elapsed. Formula: Speed=Distance/Time (S=D/T). Familiar units for measuring speed: miles or kilometers per hour.
2. **Forces**. The concept of force as a push or pull that produces a change in the state of motion of an object. A force has both direction and magnitude. Measuring force; expressed in units of mass, pounds in English system, newtons in metric system. Unbalanced forces cause changes in velocity. If an object is subject to two or more forces at once, the effect is the net effect of all forces. The motion of an object does not change if all the forces on it are in balance, having net effect zero. The motion of an object changes in speed or direction if the forces on it are unbalanced, having net effect other than zero. To achieve a given change in the motion of an object, the greater the mass of the object, the greater the force required.

C. Skill Objectives

1. Students will design experiments using the scientific method.
2. Students will determine average speed using the formula: speed =distance/time.
3. Students will graph scientific data.
4. Students will design and construct rocket cars that demonstrate Newton's Third Law of Motion.
5. Students will analyze car design and predict (based on learned scientific principles) which will be most successful.
6. Students will design and construct a roller coaster ride that demonstrates the concepts of Newton's Laws of Motion, velocity, speed, air resistance, friction, braking, acceleration, deceleration, and gravity.

7. Students will orally present their roller coaster project and explain how the above concepts are demonstrated in their ride.
8. Students will compare mass and weight and discover how the force of gravity can vary with the object's distance from the center of Earth.
9. Students will investigate how shape affects an object's rate of falling.
10. Students will design and build a model to demonstrate air resistance.
11. Students will demonstrate how an object will only change its motion when an unbalanced force acts upon it.
12. Students will investigate how friction affects motion and demonstrate how different substances can increase or decrease friction.
13. Students determine velocity using the formula (V = G x T) Velocity = Acceleration of gravity multiplied by time.
14. Students will show why a change in direction produces acceleration.
15. Students will determine distance by using the formula ($D=gT^2/2$) Distance in feet equals acceleration of gravity multiplied by time squared, divided by two.
16. Students will predict, observe, and record the rate at which objects with different masses fall.
17. Students will find that the time it takes each object to fall varies according to its surface area rather than its mass.
18. Students will discover how gravitational force and friction affect the motion of falling objects.
19. Students will explore how mass affects movement.
20. Students will infer the relationship between mass and force.
21. Students will understand the formula F=m x a.
22. Students will demonstrate resiliency and elasticity.
23. Students will compare mass and weight and discover how the force of gravity can vary with the object's distance from the center of Earth.
24. Students will design and build a model to demonstrate air resistance.

III. BACKGROUND KNOWLEDGE

A. For Teachers
   1. Knowledge of Newton's Three Laws of Motion
   2. Knowledge of speed, velocity, and acceleration.
   3. Knowledge of mass and weight.

B. For Students
   1. Simple Machines (grade 2)

IV. RESOURCES

1. Shevick, Edward. *Science Action Labs: Physical Science, Matter and Motion*. Illinois; Teaching and Learning Company, 1998. 1-57310-144-3.
2. Silver, Burdett, Ginn Science, *Discovery Works.* New Jersey; Silver Burdett Ginn, 1999. 0-382-41677-5.
3. Teacher Created Materials, Inc. *Force and Motion.* California; Teacher Created Materials, Inc., 1994. 1-55734-647-X.
4. Van Cleave, Janice. *Physics for Every Kid.* New York; John Wiley & Sons, Inc., 1991. 0-471-52505-7.

V. LESSONS

Lesson One: Velocity and Speed (3 days)

A. *Daily Objectives*
   1. Concept Objective(s)

a. Students will understand the concepts of speed and velocity and be able to apply the mathematical formula to real-life situations.

2. Lesson Content
   a. Motion: Velocity and Speed. The velocity of an object is the rate of change of its position in a particular direction. Speed is the magnitude of velocity expressed in distance covered per unit of time. Changes in velocity can involve changes in speed or direction or both. Average speed=total distance traveled divided by the total time elapsed. Formula: Speed=Distance/Time (S=D/T). Familiar units for measuring speed: miles or kilometers per hour
3. Skill Objective(s)
   a. Students will design experiments using the scientific method.
   b. Students will determine average speed using the formula Speed=Distance/Time

B. *Materials*
1. Stopwatches
2. Yardstick
3. Marbles
5. Masking Tape

C. *Key Vocabulary*
1. Speed-the distance traveled in a certain amount of time; rate of movement

D. *Procedures/Activities*
1. Ask the question, "What information do we need to figure out the speed of an object?" Students should come up with distance and time.
2. In a hallway, measure off a distance of 25m from a wall. Mark it with masking tape.
3. Stand 2m behind the tape. While one student holds a stopwatch, roll a marble at the wall. The timer should record the time for the marble to hit the wall. Record the time on chart students created before the activity. Repeat two times, trying to roll the marbles at about the same speed.
4. Repeat step 2, this time trying to roll the marble at a *slower* speed than the first trial. Record the times.
5. Repeat step 2, this time trying to roll the marble at a consistently *faster* speed. Record the times.
6. For each of the trials, calculate the speed by dividing the distance (25m) by the time it took the marble to hit the wall. Record the speed for each trial in meters per second.

E. *Assessment/Evaluation*
1. Determine if students accurately calculated distance using the given formula.
2. Discussion questions-"How would the speed be affected if the distance were decreased but the time remained the same?" "How would the speed be affected if the time were increased but the distance remained the same?"
3. Students will design their own experiment to compare the speed of an object using variables. For example, the speed of a bike on grass compared to the speed of a bike on cement, or the speed of a baseball thrown underarm compared to over-arm. Students will follow the steps of the scientific method in the design of their experiment. Students will record the data in a graph and present the results to the class.

Lesson Two: Acceleration (2 days)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand the concepts of speed and velocity and be able to apply the mathematical formula to real-life situations.
   b. Students will understand the term acceleration and how it relates to velocity.
2. Lesson Content
   a. Motion

3. Skill Objective(s)
    a. Students will determine velocity using the formula: (V=g x T) Velocity = acceleration of gravity multiplied by time.
    b. Students will graph scientific data.
    c. Students will show why a change in direction produces velocity.

B. *Materials*
1. Science Action Lab #22
2. Force and Motion lab activity book #647
3. Ball
4. Stopwatch
5. Small fishbowl
6. Marble

C. *Key Vocabulary*
1. Speed-How fast an object is moving.
2. Velocity-The rate of motion in a particular direction.
3. Acceleration-The rate at which velocity changes over time.
4. Acceleration of Gravity-"g."-The Earth's gravitational force causes a falling object to continue to speed up or accelerate. This acceleration of gravity is called "g" and is equal to about 32 feet per second every second.

D. *Procedures/Activities*
1. The teacher will provide notes and vocabulary to the students.
2. The teacher will review the lab instructions and hand out materials.
3. The students will find a partner.
4. One partner will throw the ball in the air as high as he or she can.
5. Students will observe the ball's motion from the highest point back to the ground.
6. Students will observe if the ball speeds up or slows down as it nears the ground.
7. One partner will throw the ball in the air, as high as they can again.
8. The other partner will use the stopwatch to time the ball from its highest point back to the ground.
9. Students will record how many seconds it took for the fall.
10. Students will find the final velocity of the ball by using the velocity formula V=g x T.
11. Students will now determine the distance of the falling ball based on the formula for distance (distance = acceleration of gravity multiplied by time squared, divided by 2).
12. The teacher will record the results on the board and have the class compare velocity and distance.
13. The teacher will review acceleration and Newton's First Law of Motion.
14. The students will get into small groups and get their materials for the acceleration experiment.
15. Students will place a marble into the fishbowl and hold the bowl upright and at the end of their outstretched arm.
16. That student will turn in "controlled" circles. The other group members will observe the action of the marble and record the information.
17. Groups will share their information with the rest of the class.
18. The class will discuss why a change in direction produces acceleration.

E. *Assessment/Evaluation*
1. The teacher will observe group work and question students about objectives during the time of lab work.
2. The teacher will observe students as they present their information to the class.

Lesson Three: Air Resistance (2 days)

A. *Daily Objectives*
1. Concept Objective(s)

a. Students will understand the concept of a force and explain how forces work on a roller coaster ride

2. Lesson Content
   a. Changes in velocity can involve changes in speed or direction or both.
3. Skill Objective(s)
   a. Students will investigate how shape affects an object's rate of falling.
   b. Students will design and build a model to demonstrate air resistance.

B. *Materials*
1. Two pieces of paper
2. Stopwatch
3. Eggs
4. General building supplies (students can bring "trash" from home)
5. Appendix A Worksheet

C. *Key Vocabulary*
1. Air resistance-the force exerted by air against objects that are moving through the air.

D. *Procedures/Activities*
1. Review with students Galileo's finding that all objects fall to earth at the same rate.
2. Take two pieces of paper, one flat and one crumpled and ask students to predict what will happen if you drop them both at the same time. Drop them and ask students what they observed. Ask why did one paper take longer to reach the floor? Students should come up with the factor of air resistance working on the flat piece of paper.
3. Have students work in pairs to design a model to transport an egg safely to the ground from a height of 12 feet (it is best to do this outside as broken eggs can be very messy!). Students should bring in supplies from home to construct the model.
4. Students should look at all the egg-carrying models and predict which ones will transport the eggs safely and why.
5. Drop each model one at a time. Record the time it took for the model to reach the ground and whether the egg remained intact (Appendix B).

E. *Assessment/Evaluation*
1. Discuss why some models were successful and why some failed. How would they improve their design if they did it again. Discuss if there is any correlation between the time it took for the egg to reach the ground and the success of the model. (Longer time =more air resistance=slower ride?)

Lesson Four: Gravity and Galileo (1day)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand the concept of force.
   b. Students will draw a conclusion based on a set of experimental data.
2. Lesson Content
   a. Force
   b. Motion
3. Skill Objective(s)
   a. Students will design experiments using the scientific method.
   b. Students will predict, observe, and record the rate at which objects with different masses fall.
   c. Students will find that the time it takes each object to fall varies according to its surface area rather that its mass.
   d. Students will discover how gravitational force and friction affect the motion of falling objects.
   e. Students will understand that the pull of gravity on all objects varies such that all objects fall at the same rate in a vacuum.

B. *Materials*
   1. Discovery Works textbook
   2. Science Action Lab #21
   3. Spring Scale and mesh bag
   4. A heavy ball and a light ball
   5. Deck of cards
   6. *Force and Motion*, p. 24

C. *Key Vocabulary*
   1. Mass-the amount of matter in an object.
   2. Force-A push or pull on an object that causes motion or change in motion.
   3. Gravity-the force that pulls objects towards earth.
   4. Air Resistance-Friction caused by surface area of an object coming in contact with air, causing the object to slow down.
   5. Friction-The force of resistance between two moving objects.

D. *Procedures/Activities*
   1. The teacher will explain Galileo's "Leaning Tower of Pisa" experiment. (See *Force and Motion*, p. 24 for details).
   2. The teacher will review vocabulary.
   3. The teacher will weigh the two balls.
   4. Students will hypothesize which ball will hit the ground first.
   5. The teacher will let go of the two balls at the same time. This will be repeated 3-4 times.
   6. Students will observe and discuss the results of the two balls.
   7. The teacher will pull one card out of the box of cards as the class guesses which object will hit the ground first.
   8. The teacher holds the box of 51 cards and the single card horizontally and drops them at the same time.
   9. Students discuss why these results are different than the balls. What is the key factor? (air resistance)
   10. Students discuss different ways to drop the cards so air resistance isn't a factor.
   11. Students discuss different materials that might be affected by air resistance.

E. *Assessment/Evaluation*
   1. Teacher observation of student discussions
   2. Student notes

Lesson Five: The Difference Between Mass and Weight (or The Best Way to Lose Weight! - 1 day)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Students will understand the concept of a force and explain how forces work on a roller coaster ride.
   2. Lesson Content
      a. To achieve a given change in the motion of an object, the greater the mass of an object, the greater the force required (Newton's Second Law).
   3. Skill Objective(s)
      a. Students will compare mass and weight and discover how the force of gravity can vary with the object's distance from the center of Earth.

B. *Materials*
   1. Spring Scale
   2. Objects of different size and mass
   3. Worksheet (Appendix B)
   4. Bag to hold objects and attach spring scale
   5. Balance scale

6. Appendix C
7. Appendix D

C. *Key Vocabulary*
1. Mass-a measure of how much stuff there is in an object
2. Weight-a measure of the force of gravity on an object
3. Gravity-the attractive force exerted by a body on all other objects
4. Force-a push or pull

D. *Procedures/Activities*
1. Hold two objects, one in each hand. Which object feels the heaviest? Place the object you think is heavier on the balance and measure its mass in kilograms. Record the results on your chart (Appendix E).
2. Repeat this procedure with each object.
3. Now place the object you think is heavier in the bag and hang the bag from the spring scale. Record the reading on your chart under the column Force of Gravity.
4. Repeat this procedure with each object.
5. Calculate the ratio of the force of gravity acting upon each object (force of gravity/mass) and record this on the chart.
6. Read Appendix C "Mass and Weight-The Greatest Diet!"

E. *Assessment/Evaluation*
1. Describe how does the force of gravity affects objects of different masses? (Answer: it differs)
2. Describe the relationship between an object's mass and the force of gravity acting upon it (the greater the mass, the greater the force of gravity acting upon it).
3. What do the numbers in the right-hand column represent? (Answer: the ratio of the force of gravity to mass, which is about 10 to 1 and remains constant for all objects)
4. Complete Appendix D "Comparing Mass and Weight"
5. What is the difference between mass and weight?

Lesson Six: Inertia (Newton's First Law of Motion-1 day)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand Newton's Three Laws of Motion.
2. Lesson Content
   a. Unbalanced forces cause changes in velocity. If an object is subject to two or more forces at once, the effect is the net effect of all forces. The motion of an object does not change if all the forces on it are in balance, having net effect zero. The motion of an object changes in speed or direction if the forces on it are unbalanced, having net effect other than zero. To achieve a given change in the motion of an object, the greater the mass of the object, the greater the force required.
3. Skill Objective(s)
   a. Students will demonstrate how an object will only change its motion when an unbalanced force acts upon it.

B. *Materials*
1. Toy car

C. *Key Vocabulary*
1. Inertia-the tendency of an object to remain at rest or in motion unless a force acts upon it.

D. *Procedures/Activities*
1. Place a toy car on a table top. Tell the students that they are going to stare at the car until it moves. After a few confused minutes, ask the students why the car has not moved. Lead the discussion to the understanding that the car will only move if a force (your hand, wind, earthquake, etc) is applied to it.

2. Set the car in motion. Ask the students whether the car will continue in motion indefinitely. What forces could act to slow it down? (friction, brakes, a brick wall, etc)
3. Students should work in small groups to write paragraphs demonstrating examples of inertia from sports, vehicles, or anything involving motion.

E. *Assessment/Evaluation*
1. Students share paragraphs with the rest of the class.

Lesson Seven: Newton's Second Law of Motion (1 day)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand Newton's three law's of motion.
   b. Students will understand the concept of force.
   c. Students will draw a conclusion based on a set of experimental data.
2. Lesson Content
   a. Force
   b. Motion
3. Skill Objective(s)
   a. Students will explore how mass affects movement.
   b. Students will observe Newton's Second Law of Motion.
   c. Students will infer the relationship between mass and force.
   d. Students will understand the formula F= m x a.

B. *Materials*
1. Discovery Works textbook
2. Lab sheet (Appendix E)
3. 2 identical toy trucks (one with a heavy load)
4. Small wooden board
5. Metric ruler
6. Long wooden board
7. Books
8. Block of wood

C. *Key Vocabulary*
1. Force-A push or pull on an object that causes motion or change in motion.
2. Mass-the amount of matter in an object.
3. Acceleration-The rate at which velocity changes over time.
4. Newton-the force needed to accelerate a 1kg. object by 1 meter per second every second.

D. *Procedures/Activities*
1. The teacher will review Newton's First Law of Motion and discuss Newton's Second Law of Motion.
2. The teacher will use the formula F= m x a, and have the class solve different problems.
3. The teacher will introduce the lab and divide the class into groups of 4-6.
4. Students will place two toy trucks on a level floor.
5. Students will place the small wooden board behind both trucks.
6. Students will predict how the trucks will move if you apply equal force to each. They will use the board to give both trucks a sudden, sharp push.
7. Students will measure the distance that each truck moved and record the information.
8. Students will repeat this experiment twice and then calculate the average distance moved by each truck.
9. Students will build a ramp by propping up one end of the long wooden board on a stack of books.
10. Students will place the lighter truck at the top of the ramp and the block of wood at the bottom.
11. Students will release the truck so that it hits the bock of wood squarely.

12. Students will measure how far the truck travels after hitting the block and record the measurement.
13. Students will repeat steps 10-12, using the heavier truck.
14. Students will answer the three questions on their lab sheets.
15. As a whole class, the students will discuss their findings.

E. *Assessment/Evaluation*
1. The teacher will grade and evaluate the lab sheets (Appendix E).
2. The teacher will observe the students ability to follow directions and discuss how motion of objects with different masses is affected by equal forces.

Lesson Eight: Friction is Freaky (1 day)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand the concept of a force and explain how and where forces apply to a roller coaster ride.
2. Lesson Content
   a. Changes in velocity can involve changes in speed or direction or both.
   b. The motion of an object changes in speed or direction if the forces on it are unbalanced, having net effect other than zero.
3. Skill Objective(s)
   a. Students will investigate how friction affects motion and demonstrate how different substances can increase or decrease friction.

B. *Materials*
1. Ramp (about 4 feet long)
2. Toy cars
3. Wax paper, sandpaper, towels, foil
4. Tape measure
5. Books to support one end of the ramp

C. *Key Vocabulary*
1. Friction-the force that occurs between surfaces that are in contact with one another.

D. *Procedures/Activities*
1. Review the concept of inertia. According to the principle of inertia, an object in motion should remain in motion forever. So, what causes an object to slow down and stop?
2. Students should make a chart in which they will record the results of their experiment
3. Students should support one end of the ramp with a stack of books.
4. Test one friction surface at a time by releasing the car at the top of the ramp and measuring how far it travels once it hits the friction surface at the base of the ramp.
5. Record measurements on charts.

E. *Assessment/Evaluation*
1. Rank the different friction surfaces according to how far the car traveled on each surface. What material applied the most/least force? Why?
2. Students could design an athletic shoe using what they have learned about friction. They should be able to scientifically justify their design.

Lesson Nine: Momentum (1-2 days)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand Newton's Three Laws of Motion.
   b. Students will draw a conclusion based on a set of experimental data.
2. Lesson Content
   a. Motion

b. Force

3. Skill Objective(s)
   a. Students will demonstrate resiliency and elasticity.
   b. Students will state Newton's Third Law of Motion.
   c. Students will graph scientific data.

B. *Materials*
1. Science Action Lab #4
2. Meter stick
3. Variety of balls (rubber, beach, tennis, Ping-Pong, etc.)
4. Table
5. Various surfaces

C. *Key Vocabulary*
1. Resiliency-when an object springs back to its original form.
2. Elasticity-when an object reverts to an original shape after distortion; highly flexible
3. Third Law of Motion-for every action there is an equal and opposite reaction.
4. Action force-the initial force exerted in a force pair.
5. Reaction force-the force exerted in response to an action force.

D. *Procedures/Activities*
1. Teacher will provide notes and vocabulary to the students.
2. Teacher will demonstrate Newton's Third Law of Motion.
3. Students will tape a meter stick to a table (desk).
4. Students will drop a ball from the 100-centimeter mark. The bottom of the ball should line up with the 100 mark.
5. Students will measure the bounce to the nearest centimeter. They should make sure to adjust eye level to measure the top of the ball's bounce.
6. Students should drop each ball three times to improve accuracy and find the average bounce.
7. Students will record data.
8. Class will come together and discuss the results.
9. Students will drop the "best ball" on various surfaces such as tile, rugs, plastic, concrete, bricks, etc.
10. Students will record results.
11. Students will determine what surface gave the best and the least bounce.
12. Class will come together and discuss results.
13. Teacher will obtain a large and small ball. It is important that the bottom ball is at least twice the diameter of the top ball.
14. Teacher will drop both balls, the small ball on the top.
15. Class will discuss the results and how Newton's Third Law is demonstrated.

E. *Assessment/Evaluation*
1. The teacher will observe and evaluate student's ability to complete lab and their ability to verbalize Newton's Third Law of Motion.
2. The teacher will grade and evaluate the lab sheet.

Lesson Ten: Newton's Third Law (2 days)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students will understand the concept of a force and explain how and where forces apply to a roller coaster ride.
   b. Students will understand Newton's Three Laws of Motion.
2. Lesson Content
   a. The concept of force as a push or pull that produces a change in the state of motion of an object. A force has both direction and magnitude.

b. The motion of an object changes in speed or direction if the forces on it are unbalanced, having net effect other than zero. To achieve a given change in the motion of an object, the greater the mass of the object, the greater the force required.

3. Skill Objective(s)
   a. Students will design and construct rocket cars that demonstrate Newton's Third Law of Motion.
   b. Students will analyze car design and predict (based on learned scientific principles) which will be most successful.

B. *Materials*
1. 4 pins (per student or group)
2. Styrofoam meat tray
3. Tape
4. Flexi-straw
5. Compass
6. Small balloon
7. Ruler
8. Fine sandpaper

C. *Key Vocabulary*
1. Newton's Third Law of Motion-Every action has an equal and opposite action.

D. *Procedures/Activities*
1. Tell students they are going to build a rocket car that will illustrate Newton's Third Law.
2. Brainstorm ideas about design specifications. Students should then make a sketch of their design before building.
3. Draw a rectangle approximately 3x7in, and circles 3 in. in diameter on the meat tray (this is just a guideline; students should be allowed creativity for the design they think will be most effective). Cut out and smooth edges with fine sandpaper.
4. Push one pin into the center of each wheel and then into the edge of the main car body. The pins are axles for the wheels.
5. Inflate the balloon a couple of times to stretch it out. Put the balloon over the end of the straw nearest the bendy part. Secure with tape (no air should escape).
6. Tape the straw to the car.
7. Inflate the balloon and pinch the straw to hold the air. Release the car on a flat surface and watch it fly!
8. Ask students how this demonstrates the 3rd law.
9. You can invite a panel of judges and have a competition for whose car travels the straightest/furthest, best design, etc.

E. *Assessment/Evaluation*
1. Class discussion about which design was the most effective and why.

VI. CULMINATING ACTIVITY (2-4 weeks)

A. At the conclusion of the in class portion of the unit, the students will have an opportunity to design and construct a roller coaster ride. (Appendix F).

VII. HANDOUTS/WORKSHEETS

A. Appendices A-F

VIII. BIBLIOGRAPHY

A. Lafferty, Peter. *Eyewitness Book: Force and Motion*. New York; DK Publishing, Inc., 1992. 0-7894-4882-3

B. Shevick, Edward. *Science Action Labs: Physical Science, Matter and Motion*. Illinois; Teaching and Learning Company, 1998. 1-57310-144-3.

C. Silver, Burdett, Ginn Science, *Discovery Works.* New Jersey; Silver Burdett Ginn, 1999. 0-382-41677-5.
D. Teacher Created Materials, Inc. *Force and Motion.* California; Teacher Created Materials, Inc., 1994. 1-55734-647-X.
E. Van Cleave, Janice. *Physics for Every Kid.* New York; John Wiley & Sons, Inc., 1991. 0-471-52505-7.

Appendix A-Air Resistance Worksheet

Name of Model	Drop Time	Mission Successful?

Appendix B-Comparing Mass and Weight (0r The Greatest Diet!!)

Diets not working for you? Walk to the top of the nearest mountain and you will instantly weigh less! Need to put on a few pounds? Hike down to the bottom of the nearest valley, and that scale reading will be rising. Sounds strange right? Well, when you understand the difference between mass and weight it all makes sense.

The term "mass" describes how much stuff an object contains. Think about the difference between a ping-pong ball and a golf ball. Which one has more mass? Mass is usually measured in grams or kilograms.

Weight describes the force with which gravity is pulling on an object. Weight is commonly measured in pounds (lbs) and newtons (n).

Let's say you had a pile of rocks with a mass of 100kg and a weight of 980 newtons. If you took that same pile of rocks to the top a mountain and weighed it, you would find that the weight was slightly less than at the bottom of the mountain. If you took the pile of rocks to the bottom of a valley, you would find that they weighed slightly more. How could this be, you ask?

Well, remember we said that weight is a measure of the force with which gravity is pulling on an object? As you climb the mountain with your pile of rocks (why are you doing that, exactly?!), you are moving further from the center of Earth. Earth is not able to pull as strongly on the rocks as it did at the bottom of the mountain. The mass has not changed and never will (you cannot change how much stuff an object contains), but the weight has decreased slightly.

So the next time someone is complaining that they cannot lose weight, tell them to go hike a mountain!

Appendix C-Comparing Mass and Weight Worksheet

1. Underline the correct word or phrase within the parentheses to complete the paragraph.

The bars of gold in your backpack will weigh (more, less) as you climb Mount Everest and (more, less) as you come down the other side. This is because as you climb the mountain, you get (closer to, further from) the center of Earth, and (friction, gravity) is not able to (push, pull) as strongly on the gold. When you are at the peak of the mountain (phew, you made it!! How's the view from up there?), the gold will have the same (mass, weight) as it did at the base of the mountain.

2. Write a paragraph explaining the difference between mass and weight.

_____
_____
_____
_____
_____
_____

3. Draw three pairs of objects. Circle the one with the greater mass (e.g., a soccer ball and a bowling ball)

Appendix D-Measuring The Pull of Gravity Worksheet

Name of Object	Mass (kg)	Force of Gravity (newtons)	Force of Gravity/Mass

Appendix E-Newton's Second Law of Motion

Procedure

Write your prediction of how trucks will move if you apply equal force to each.

_____

_____

Truck Descriptions	Trial 1 Distance	Trial 2 Distance	Trial 3 Distance
1			
2			

Make your calculations of the average distance each truck moved in the space below. For each truck, add the three distances and then divide by three.

Truck 1:_____

Truck 2:_____

Record your measurement of the distance the lighter truck travels after hitting the block.

_____

Record your measurement of the distance the heavier truck travels after hitting the block.

_____

Questions:

1. Based on your observations, how does an equal force applied to two objects of different mass affect the acceleration of each?

   _____

   _____

   _____

2. What forces were acting to stop the truck as they came down the ramp?

   _____

   _____

   _____

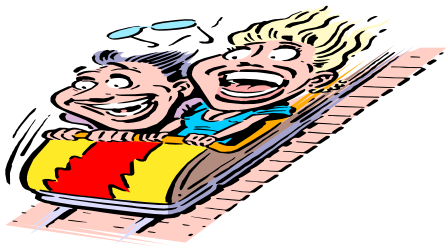
3. In which case was a greater force required to stop the truck? How do you know?

   _____

   _____

   _____

Appendix F



Roller Coaster Project

Objective: Working in groups, you will design and build roller coaster rides that demonstrate the concepts of physics you are learning in science.

You are learning that roller coaster rides are designed by physicists who use what they know about gravity, force, and motion, as well as other concepts, to create the most exciting rides they can. Now, it is your turn to be the physicists! You will design and build a working ride that demonstrates the following concepts: gravity, air resistance, friction, braking, acceleration, deceleration, motion, and Newton's Three Laws of Motion.

Your passengers will not be people, but marbles (due to strict safety regulations).

You will name your ride. You may want to think of a theme, such as Star Wars, space, animals, etc. Include the theme into the design of the ride, e.g., a space ride could be called The Galaxy Blaster, have space designs on it, and pass through a black hole tunnel! **Be creative in your design.**

You will use everyday materials to build your ride, e.g., cardboard tubes, string, plastic bags, rubber bands, ketchup cups, plastic tubing, etc. (no Legos or pre-made tracks). You will have some class time to work on this, but you should anticipate that most work will be done at home.

You will present your rides to the class by explaining how each physics concept is demonstrated and by showing us how they work. You will also determine the speed of your rides using the formula S=D/T.

Your ride is due _____
NO LATE PROJECTS WILL BE ACCEPTED!!
You will be graded as follows:

One working ride demonstrating all the above concepts	25 points
Single-page paper (**Typed**)	15 points
Group Cooperation	10 points
Creativity and Appearance	10 points
	Total 60 points

Appendix F Con't.

PROJECT CHECKLIST

Signed Project Slip (**Due _____**) _____

Physics concepts demonstrated:

Gravity _____
Air Resistance _____
Friction _____
Braking _____
Acceleration _____
Deceleration _____
Newton's First Law of Motion _____
Newton's Second Law of Motion _____
Newton's Third Law of Motion _____

Single-page typed paper _____