Forces, Motion & Energy Grade 8

Assessment Packet

Continue the adventure in physics under Newton's work on the three laws of motion. Students get a crash-course in projectile motion as they build g-force accelerometers, float hovercraft on both land and water, build a rocket car, and measure the Earth's magnetic pulse.

Created by Aurora Lipper, Supercharged Science

www.SuperchargedScience.com

This curriculum is aligned with the National State Standards and STEM for Science.

Educational Goals

A comprehensive course that continues the science adventure in physics under Newton's work on the three laws of motion. Students get a crash-course in projectile motion as they build g-force accelerometers, float hovercraft on both land and water, build a rocket car, and measure the Earth's magnetic pulse.

Here are the scientific concepts:

- The velocity of an object is the rate of change of its position.
- To describe the velocity of an object one must specify both direction and speed.
- Changes in velocity can be changes in speed, direction, or both.
- Position is defined relative to some choice of standard reference point and a set of reference directions.
- Average speed is the total distance traveled divided by the total time elapsed. The speed of an object along the path traveled can vary.
- A force has both direction and magnitude.
- When an object is subject to two or more forces at once, the effect is the cumulative effect of all the forces.
- When the forces on an object are balanced, the motion of the object does not change.
- How to identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.
- The greater the mass of an object the more force is needed to achieve the same change in motion.
- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.
- Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.
- Forces that act at a distance (electric and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively).

- Motion energy is called kinetic energy, and is proportional to the mass of the moving object and grows with the square of the speed.
- A system of objects may also contain stored (potential) energy depending on its location.
- When two objects interact, each exerts a force on the other that can cause energy to be transferred between the objects.

By the end of the labs in this unit, students will be able to:

- Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- Design an experiment that shows when the arrangements of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- Show that when the motion energy of an object changes, energy is transferred to or from the object.
- How to solve problems involving distance, time, and average speed.
- How to interpret graphs of position versus time and speed versus time for motion in a single direction.
- Apply Newton's Third Law to design an experiment involving the motion of two colliding objects.
- Design and build an experiment that shows how the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- Determine the factors that affect the strength of electric and magnetic forces.
- Show that gravitational interactions are attractive and depend on the masses of the objects.
- Design and build an experiment that shows that fields exist between two objects that are not touching.
- Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.
- Measure and estimate the length and volume of objects.
- Formulate and justify predictions based on cause-and-effect relationships.
- Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.
- Construct and interpret graphs from measurements.
- Follow a set of written instructions for a scientific investigation.

Forces, Motion and Energy Grade 8 Evaluation

Teacher Section

Overview: Kids will demonstrate how well they understand important key concepts from this section.

Suggested Time: 45-60 minutes

Objectives: Students will be tested on the key concepts:

- Understand concepts of force, motion, energy, position, velocity, acceleration, momentum and impulse.
- Design experiments that demonstrate Newton's Three Laws of Motion and Maxwell's Four Equations.
- Know the nature of different forces, fields, and how they work in the real world.

Students will also demonstrate these principles:

1. Collecting and interpreting data from an experiment
2. Making valid observations based on their actions in lab

Materials (one set for entire class)

- Balloon
- Ping pong ball
- Hammer
- Paper clips (small)
- Small compass
- Confetti
- Nail wrapped in magnet wire
- Sandpaper
- 12V DV motor
- Bi-polar LED
- D-cell battery
- Thick magnet (not to be broken)
- Magnet that can be broken easily in half (one per student)

Lab Preparation

1. Print out copies of the student worksheets, lab practical, and quiz.
2. Have a tub of the materials in front of you at your desk. Kids will come up when called and demonstrate their knowledge using these materials.

Lesson

The students are taking two tests today: the quiz and the lab practical. The quiz takes about 20 minutes, and you'll find the answer key to make it easy to grade.

Forces, Motion & Energy Grade 8 Evaluation

Student Worksheet

Overview: Today you're going to take two different tests: the quiz and the lab practical. You're going to take the written quiz first, and the lab practical at the end of this lab. The lab practical isn't a paper test – it's where you get to show your teacher that you know how to do something.

Lab Test & Homework

1. Your teacher will call you up so you can share how much you understand about forces, motion and energy. Since science is so much more than just reading a book or circling the right answer, this is an important part of the test to find out what you really understand.
2. While you are waiting for your turn to show your teacher how much of this stuff you already know, you get to get started on your homework assignment. The assignment is due next week, and half the credit is for creativity and the other half is for content, so really let your imagination fly as you work through it. Choose one:
    a. Write a short story or skit about velocity, acceleration, force and energy from the perspective of being on a roller coaster. You'll read this aloud to your class.
    b. Make a poster that teaches the main concepts of Newton's Three Laws of Motion. When you're finished, you'll use it to teach to a class in the younger grades and demonstrate each of the principles that you've learned.
    c. Write and perform a poem or song about one (or all) of the different types of magnets. This will be performed for your class.

Forces, Motion & Energy Grade 8 Quiz

Teacher's Answer Key

1. _____ is the rate of change of an object's position, and contains both speed and direction. (velocity)
2. A force has both _____ and _____. (direction, magnitude)
3. Average speed is the total distance traveled _____ the total _____ elapsed. (divided by, time)
4. Change in velocity can be a change in _____, direction, or both. (speed)
5. The greater the mass of an object, the _____ force is needed to achieve the same change in motion. (greater)
6. Newton's First Law: _____
(Objects in motion tend to stay in motion unless acted upon by an external force.)
7. Newton's Second Law: _____
(Momentum is conserved. Momentum can be defined as inertia in motion.)
8. Newton's Third Law: _____
(For every action, there is an equal and opposite reaction..)
9. Electric and magnetic forces can be attractive or _____. (repulsive)
10. Motion energy is called _____ energy. (kinetic)
11. Kinetic energy is proportional to the mass of the moving object and grows with the _____ of the speed. (square)
12. _____ energy is the energy stored in a system. (potential)
13. Gravitational forces are always _____. (attractive)
14. Forces that act at a distance can be explained by _____ that extend through space. (fields)
15. When two objects interact, each exerts a _____ on the other than can cause energy to be transferred between the objects. (force)
16. The four fundamental forces are: (strong nuclear force, weak nuclear force, electromagnetism, gravity)
_____
17. The electromagnetic field is caused by either a _____ field or an _____ field moving. (magnetic, electric)
18. Two balls released from the exact same height, one thrown horizontally and one released from rest, _____ hit the ground at the exact same moment. (will)
19. _____ is the force between one object rubbing against another object. (friction)
20. Inertia is an object's _____ to a change in its state of motion. (resistance)
21. A moving magnetic field creates an _____ field. (electric)
22. Acceleration is the rate that an object changes its _____. (velocity)
23. Momentum is mass in motion, and is defined with the equation: _____ (p = mv)
24. A _____ is the metric unit of work or energy, and is found using the equation: **F· d**.(Joule)
25. Power is the _____that work is done over _____.(rate, time)
26. A lever has three parts: the load, the effort and the _____ (fulcrum)
27. Pendulums have high _____ energy at the base of the arc of its swing. (kinetic)
28. Potential energy stored in a spring or rubber band is called _____ (elastic potential energy)
29. Pendulums have high _____ energy at the base of the arc of its swing. (kinetic)
30. _____ is how hard it is to get something to stop or to change directions. (momentum)

Forces, Motion & Energy Grade 8 Quiz

Student Quiz Sheet

Name_____

Fill in the blank:

1. _____ is the rate of change of an object's position, and contains both speed and direction.
2. A force has both _____ and _____.
3. Average speed is the total distance traveled _____ the total _____ elapsed.
4. Change in velocity can be a change in _____, direction, or both.
5. The greater the mass of an object, the _____ force is needed to achieve the same change in motion.
6. Newton's First Law:

   _____

   _____
7. Newton's Second Law:

   _____

   _____
8. Newton's Third Law:

   _____

   _____
9. Electric and magnetic forces can be attractive or _____.
10. Motion energy is called _____ energy.
11. Kinetic energy is proportional to the mass of the moving object and grows with the _____ of the speed.

12. _____ energy is the energy stored in a system.
13. Gravitational forces are always _____.
14. Forces that act at a distance can be explained by _____ that extend through space.
15. When two objects interact, each exerts a _____ on the other than can cause energy to be transferred between the objects.
16. The four fundamental forces are:

    _____

    _____

    _____

    _____
17. The electromagnetic field is caused by either a _____ field or an _____ field moving.
18. Two balls released from the exact same height, one thrown horizontally and one released from rest, _____ hit the ground at the exact same moment.
19. _____ is the force between one object rubbing against another object.
20. Inertia is an object's _____ to a change in its state of motion.
21. A moving magnetic field creates an _____ field.
22. Acceleration is the rate that an object changes its _____.
23. Momentum is mass in motion, and is defined with the equation: _____
24. A _____ is the metric unit of work or energy, and is found using the equation: **F· d**.
25. Power is the _____that work is done over _____.

26. A lever has three parts: the load, the effort and the _____ .

27. Pendulums have high _____ energy at the base of the arc of its swing.

28. Potential energy stored in a spring or rubber band is called _____

29. Pendulums have high _____ energy at the base of the arc of its swing.

30. _____ is how hard it is to get something to stop or to change directions.

Forces, Motion & E**n**ergy **8 Lab Practical**

Teacher's Answer Key

This is your chance to see how well your students have picked up on important key concepts, and if there are any holes. Your students also will be working on their homework assignment as you do this test individually with the students.

Materials:

- Balloon
- Ping pong ball
- Magnet kids can break in half
- Hammer
- Paper clips (small)
- Small compass
- Confetti
- Nail wrapped in magnet wire
- Sandpaper
- 12V DV motor
- Bi-polar LED
- D-cell battery
- Thick magnet (not to be broken)

Lab Practical: *Note: Answers given in italics!*

1. Design an experiment that demonstrates each of Maxwell's four equations, and explain each principle as you demonstrate it.

Maxwell's 4 Equations explained in everyday language are:

a. *Maxwell's First Equation*
   - *Like charges repel; opposites attract*
   - *The proton has a positive charge, the neutron has no charge (neutron, neutral get it?) and the electron has a negative charge. These charges repel and attract one another kind of like magnets repel or attract. Like charges repel (push away) one another and unlike charges attract one another. Generally things are neutrally charged. They aren't very positive or negative, rather have a balance of both.*
   - *Experiment: Rub your head with a balloon and hold the charged balloon near your head so that your hair sticks to the balloon. Is there glue on the balloon? Why does your hair stick to the balloon? Answer: The positively charged hair sticks to the negatively charged balloon.*

b. *Maxwell's Second Equation*
   - *All magnets have two poles*
   - *Magnets are called dipolar which means they have two poles. The two poles of a magnet are called north and south poles. The magnetic field comes from a north pole and goes to a south pole. Opposite poles will attract one another. Like poles will repel one another.*
   - *Experiment: What happens if you cut (or break) a magnet in half? The new magnets will each sport their own North-South poles!*

c. *Maxwell's Third Equation*
   - *Invisible magnetic fields exert forces on magnets AND invisible electrical fields exert forces on objects*
   - *A field is an area around an electrical, magnetic or gravitational source that will create a force on another electrical, magnetic or gravitational source that comes within the reach of the field. In*

fields, the closer something gets to the source of the field, the stronger the force of the field gets. This is called the inverse square law.

- *Experiment: To see how magnetic fields exert forces, play with a couple of magnets and see where the magnetic field is. Where on the magnet do paper clips attach? Use a compass to show you the direction of the lines of force.*
- *Experiment: Notice how your hair sticks up when you build up a static electrical charge. You can build up a charge on dry days by rubbing your hair with a balloon, and bringing the balloon next to a ping pong ball on a smooth, flat surface and you'll find the objects follow the balloon when placed near an electrical field.*

d. *Maxwell's Fourth Equation*

- *Moving electrical charges (fields) generate magnetic fields AND changing magnetic fields generate electrical fields (electricity).*
- *Refer to "Maxwell's Fourth Equation" experiment for experiment ideas. You want the student to show you two things: how a moving magnet creates an electrical field (spinning the shaft of a motor that has an LED connected to the terminals is one way to do this), and also that a moving electrical charge creates a magnetic field (hooking up a wire-wrapped nail to a battery will turn the nail into an electromagnet is one demonstration of this principle).*

Forces, Motion & Energy Grade 8 Lab Practical

Student Exam

This is your chance to see how well your students have picked up on important key concepts, and if there are any holes. Your students also will be working on their homework assignment as you do this test individually with the students.

Materials:

- Balloon
- Ping pong ball
- Magnet kids can break in half
- Hammer
- Paper clips (small)
- Small compass
- Confetti
- Nail wrapped in magnet wire
- Sandpaper
- 12V DV motor
- Bi-polar LED
- D-cell battery
- Thick magnet (not to be broken)

Lab Practical:

1. Design an experiment that demonstrates each of Maxwell's four equations, and explain each principle as you demonstrate it.