Science - - PHYSICAL SCIENCE GRADE 9

Unit 5: FORCES (3.5 WEEKS)

SYNOPSIS: Students will learn the different types of forces and their applications. They will also learn the relationships among forces and friction, normal and field forces, and force diagrams. At the end of the unit, students will create a learning tool to help younger students understand forces.

STANDARDS

III. FORCES AND MOTION

B. Forces

1. Force diagrams are used to determine net force and direction.
   a. in one-dimension (positive and negative) forces, net force can be determined by one-dimensional vector addition
   b. a force is an interaction between two objects; both objects experience an equal amount of force, but in opposite directions.
      (1) interacting force pairs are often confused with balanced forces; interacting force pairs can never cancel each other out because they always act on different objects
      (2) naming the force (e.g., gravity, friction) does not identify the two objects involved in the interacting force pair
2. Types of forces include gravity, normal, and tension; friction is "resistance" to motion [note: the standards document refers to friction as a type of "force"]
   a. force is a vector quantity, having magnitude and direction; a unit of force is a Newton;
      (1) 1 Newton of net force will cause a 1 kg object to experience an acceleration of $1 m/s^2$ or $1 N = kg \cdot m/s^2$
      (2) measure force in lab with a spring scale or a force probe
   b. gravitational force can be calculated from mass, but all other forces are quantified only from force diagrams
   c. friction is resistance to motion that opposes "sliding" between two surfaces
   d. the force on an object always points in a direction opposite to the relative motion of the object
   e. normal force is distinguishable from tension force
   f. normal force exists between two solid objects when their surfaces are pressed together due to other forces actin on one or both objects (e.g., a solid sitting on or sliding across a table, a magnet attached to a refrigerator); normal force is always a push directed at right angles from the surfaces of the interacting objects.
   g. tension force occurs when a non-slack rope, wire, cord, or similar device pulls on another object; it always points in the direction of the pull
3. Field models are used to describe forces at a distance.
   a. the stronger the field, the greater the force exerted on objects placed in the field; the field of an object is always there - - even if the object is not interacting with anything else
   b. gravitational force (weight) of an object is proportional to its mass (i.e., Weight , F_g, can be calculated from the equation $F_g = m g$, where g is the gravitational field strength of an object which is equal to *9.8 N/kg* (m/s^2) on the surface of the Earth

LITERACY STANDARDS: READING (RST) and WRITING (WHST)

RST.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*). Visually demonstrate the relationships among concepts in text: force-friction

WHST.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

VOCABULARY

force	vector	normal	vector quantity	mass	tension force
force diagram	interacting force pairs	tension	magnitude	quantified	field force
net force	balanced forces	friction	Newton	oppose	
one dimension	gravity	resistance	acceleration	normal force	

VOCABULARY: Post words in room and leave up for the unit. Create a word wall where students know to look for new words.

Address roots and affixes of new words
Use a diagram to show meaning of new words
Relate the new word to a similar and/or familiar word
In the course of teaching, define the word in the context of where if falls in the unit rather than in isolation
Throughout the teaching of the unit, use the word in conversation/discussion
Require students to use the word(s) in: discussion, investigations, and in 2-and 4-point response questions
Use new words in Rubric for the Authentic Assessments

MOTIVATION	TEACHER NOTES
1. All objects fall at the same rate. Ask students to predict what they think will happen in the following experiment: Have a student do the following: use a baseball, paper crumpled up, and tennis ball, and drop all at the same time, pushing them off the table with a ruler; have students watch which lands first. 2. Have a student drop a book from shoulder height and listen to the sound made. Then have a book dropped from over the student's head and notice that the sound is louder. Students explain why this might be. They need to realize that the force on the book is greater with the height. 3. Have students review the standards for the unit and identify words they need to know and where they are found in the text. Students keep referencing this as they go through the unit. 4. Students establish both academic and personal goals for this unit 5. Teacher previews the Authentic Assessments for the end of the Unit	

TEACHING-LEARNING	TEACHER NOTES
1. Have student read text page 246-247, and tell them that we are going to do a demo about this. Prior to demonstration, students hypothesize what will happen in lab with book and spring scale. Students work in groups to do lab for book and spring scale (see diagram attached to unit). Resources need per group: 3 spring scales, books, string; Text pages 252-253 explain the lab. Have students hypothesize and explain the application and results of **forces** and **vectors**. (**Note**: teacher will have to help students use the scientific terms such as force and vectors, distinguish between **positive and negative forces**; students might say "you pulled on it!" and they need to be asked additional questions to lead to the terms). See **worksheet for Spring Scales on the Force of Friction (attached pages 4-5) (IIIB1a; IIIB2a2) Sample OGT problems attached for practice on page 6.** 2. Teacher will need to define Newton as a unit of force; explain **Newton** by utilizing the spring scale that supports a vector being **magnitude** and direction; connect direction to north, south, east and west to help explain vector as change in magnitude of direction. **(IIIB1a; IIIB2a2)** 3. Students read article - - **Interaction and Force - - only page 107-108 (SENT AS PDF EMAIL; there are other activities in the article that teachers may find helpful)** to show relationship between force, friction, balance forces, and unbalanced forces. Students create a montage showing relationships among key terms - - force, friction, balanced forces, and unbalanced forces. **(RST.5)** 4. Teacher leads class discussion on **forces acting in pairs** and examples of force pairs in real-life (e.g., gravity opposed by air resistance (sky diving), pull force opposed by mass (tug of war), gravity opposed by lift (weight lifting), etc.); have students generate other examples of each of these. **(IIIB1b1,2)**	Frame of Reference Video

TEACHING-LEARNING	TEACHER NOTES
5. Teacher uses **http://phet.colorado.edu/en/simulation/gravity-force-lab** for gravitational forces **(teachers: use the "run now" button for this)** to explain gravity is a force; ask students what they know about gravity. Explain that **gravitational force** can be calculated. All matter has mass. Use website to explain the relationship of **gravity** to **mass** and **distance**. If the distance between two things is the same and the mass is increased, then the one you increase has more gravity. An increase in distance means a decrease in gravity. **(IIIB2b, d; IIIB3b)** 6. Teacher leads discussion on types of forces, to distinguish between **field forces** and **normal forces**. Normal forces **- -** in contact (box on floor, arm wrestling, magnet on refrigerator, sliding board); Field forces **- -** not in contact (**gravity** pulling a ball to the earth, electricity, the force in Star Wars, sunlight evaporating water). **(IIIB2)** Have students write **WHST.10** with the activities in Teaching Learning Activities #6 - #8. 7. Next move to **tension forces**: Teacher explain tension forces; give several examples for students to discuss as a group (tug of war, leash on a dog, using a rope to pull a heavy object); have students relate tension forces to both **normal and field forces** in terms of what is similar to normal, but different from field: both use force to move it; the string is the contact between force and the object; next how are tension forces different from normal, but like field (the force does not come into direct contact with the object); refer back to lab of pulling book with the string. **(IIIB2e, f, g)** 8. Teacher demonstrates a magnetic filed by outlining the **magnetic field** using a magnet and iron filings shaken onto an overhead film or Elmo. Arrange the magnets arranged in a variety of way, and have students make prediction of the magnetic field (in a T; end to end with like poles, and end-to-end with unlike poles). **(IIIB3a)** 9. Teacher gives examples of **friction - -** rubbing hands together; friction is resistance to motion that opposes "sliding" between two surfaces; have students site other examples (e.g., driving and going around turns, applying brakes, etc.). Cite examples when you would not want friction? (e.g., swimming in the Olympics, soapbox derby wheels, etc.) **(IIIB2c)** 10. Demonstrate how to **calculate the weight** of an object from the equation $F_g = mg$, where $g = 9.8$ *N/kg* *(ms²)***(IIIB2g)**	

TRADITIONAL ASSESSMENT	TEACHER NOTES
1. Multiple-Choice **Unit Test**	

TEACHER CLASSEOOM ASSESSMENT	TEACHER NOTES
1. Teacher Classroom Assessments	

AUTHENTIC ASSESSMENT	TEACHER NOTES
1. Students evaluate progress on their goals 2. Create a graphic organizer of information on forces (e.g. gravity, weight, friction, tension, compression, field forces, and normal forces). Students may pick a force or terms related to force and create the appropriate organizer. 3. Make a montage on types of friction showing examples of helpful friction and harmful friction. Write a paragraph explaining the montage. 4. Make a video (2-3 Minutes) showing how friction is helpful or harmful.	

T-L #1

II. THE FORCE OF FRICTION

Problem:

To demonstrate some of the effects of the force of friction.

Materials:

Cord, book, spring scale.

Procedure:

Attach a cord around a book as shown in the diagram. Attach the spring scale to the cord. Applying a constant pull to the spring scale, obtain several readings of the force necessary to start the book in motion.

Force necessary to overcome starting friction.

Observations:

1. Record your results____________________

2. Compare the magnitude of the applied force to the weight of the book. **Results:** _________

____

____

3. Explain the results obtain in question (2).

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4. Place the book on its end and record the force necessary to start it in motion. **Results:**

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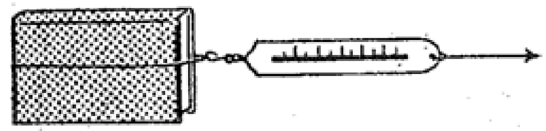

Force necessary to overcome starting friction.

What do you conclude by comparing the results of the force required to put the book in motion when placed flat on the table and when placed on edge? _________________________

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5. Determine the magnitude of the force required to keep the book moving after it is already in motion.

Force necessary to overcome sliding friction.

Applied force____________________________

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What do you conclude after comparing starting friction to sliding friction?__________________

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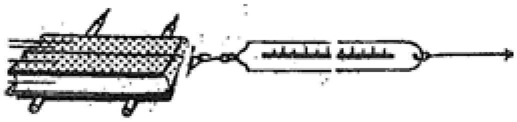
5. Determine the magnitude of the applied force needed to keep the book in motion after two or three pencils are placed below the book, and record the results.



Applied force ________________________
____

Compare the use of pencils in the above case with the use of machine ball bearings.

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7. Determine the magnitude of the force applied to the book without pencils, after another book has been placed on top of it. The force should be determined after the book is in motion.

Applied force________________________
____

What is the relationship between the frictional force and the force pressing the two books together? __________________
____

III. Resultant and Equilibrant Forces.

Problem:
To Illustrate resultant and equilibrant forces.

Materials:
Cord, Book, two scales.

Procedure:

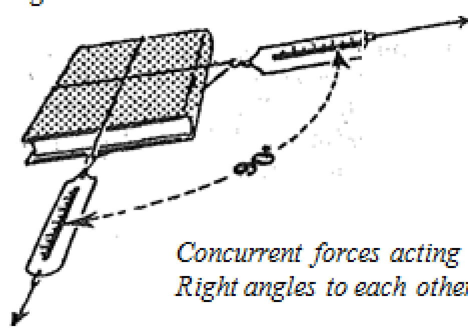
1. Place two cords around the book and attach a scale to each cord, as shown in the diagram. Apply two forces by pulling on both scales with a constant motion.

2. Record the magnitude of each applied force. Scale 1_________________Scale 2
____

3. What is the magnitude of the resultant?
____
____

4. What would be the magnitude and the direction of the equilibrant force needed to prevent motion?_____________________
____
____

5. Determine the direction and magnitude of the resultant by applying two forces at right angles to each other.



Concurrent forces acting at Right angles to each other.

6. Record the magnitude of force 1 _____
_________________Force 2___________

7. The resultant is equal to a force of ___
_______________ and is exerted in a direction_________________________________

Sample problems for T-L #6

When dropped from the same height, why does a flat sheet of paper fall more slowly than the same sheet when it is tightly crumpled into a ball?

A. The sheet of paper has less mass when it is flat than it does when it is crumpled.
B. The sheet of paper weighs less when it is flat than it does when it is crumpled.
C. The force of gravity has a greater effect on the crumpled paper than it does on the flat paper.
D. The flat sheet of paper has greater surface area and encounters more air resistance than when it is crumpled.

A teacher dropped one light ball and one heavy ball simultaneously from the roof of a school building. Both balls struck the ground at the same time.

The students correctly concluded from this experiment that falling objects:

A. lose mass as they fall.
B. are influenced by the height of the building.
C. do not accelerate under the influence of gravitational force.
D. accelerate at the same rate, regardless of mass, due to the force of gravity.

(The answer to each question is choice D.)