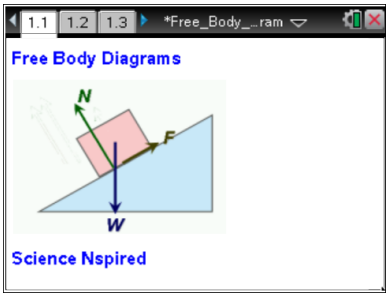
Science Objectives

- Students will explore the force due to weight and the normal force.
- Students will determine the relationship between weight, normal and the force parallel to an incline.
- Students will explore friction force and its relationship to weight, normal, and the parallel force.



Vocabulary

- force
- weight
- normal force
- parallel force
- force of friction

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Use a minimized slider

About the Lesson

- Students will be exploring the relationships of the different forces on an object such as weight, normal force, parallel force, and friction.
- As a result, students will:
  - Be able to determine weight.
  - Understand the relationship between weight and normal force on a surface.
  - Be able to determine the relationship between weight, normal, and parallel forces.
  - Determine the effect of friction on the system.

Tech Tips:

Make sure students know how to grab and move points. When the cursor is over the point, press ctrl .

Lesson Materials:

Student Activity

- Free_Body_Diagrams_Student.doc
- Free_Body_Diagrams_Student.pdf

TI-Nspire document

- Free_Body_Diagrams.tns

TI-Nspire™ Navigator™

- Send out the *Free_Body_Diagrams.tns* file.
- Monitor student progress using Screen Shots.
- Use Live Presenter to spotlight student answers.
- Collect the student tns file and evaluate the student understanding.

Activity Materials

- *Free_Body_Diagrams*.tns document
- TI-Nspire™ Technology

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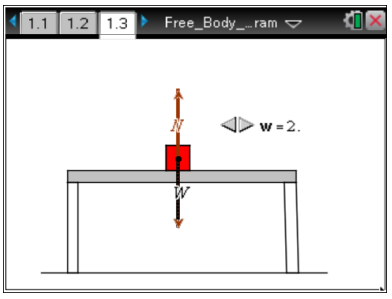
Discussion Points and Possible Answers

Move to pages 1.2–1.3.

1. Students will read about weight and the normal force. On page 1.3, they will adjust a weight vector to determine the relationship between weight and the normal force.



Move to pages 1.4–1.7.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q1. What happens to the weight vector when the *W* slider goes from 1 to 2?

Answer: B. The vector doubles in length.

Q2. What happens to the normal force when the weight *W* is doubled?

Answer: The normal force is also doubled.

Q3. The weight *W* of an object is the force of gravity on it. This force produces an acceleration *g* on an object of mass *m,* where *g* is the acceleration due to gravity. What then is the equation relating the weight, mass, and acceleration?

Answer: $W = mg$

Q4. If gravity exerts the downward force described by the *W* vector, what exerts the normal force *N*?

Answer: the table

TI-Nspire Navigator Opportunities

Most students will not be in the same place at this point, but some may be ahead and some behind. It is a good opportunity to have one student demonstrate the force of weight and talk about the normal force.

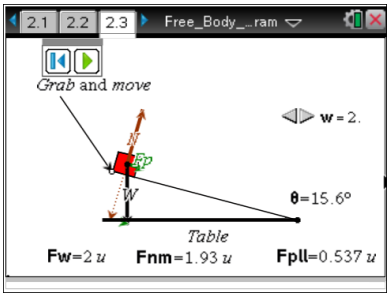
Force on an Incline

Move to pages 2.1–2.2.

2. Students read to prepare for the simulation on page 2.3.

Move to page 2.3.

3. Students can grab the point and change the angle of the ramp. The parallel force will appear as the ramp increases in angle. If the students press the play button, the block will accelerate down the ramp. Press the stop button and the reset to put the block back at the top of the ramp.



Tech Tip: Students can press the play button on the animation and see if the block begins to slide down the ramp. To reset, press .

Move to pages 2.4–2.11.

Have students answer the questions on either the handheld, on the activity sheet, or both before moving on to Problem 3.

Q5. Does the normal force increase or decrease as the incline becomes closer to vertical?

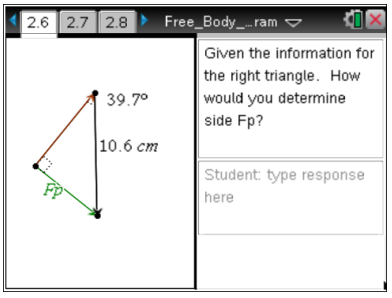
Answer: A. decreases.

Q6. How is the parallel force related to the normal force and the force of gravity?

Answer: It is the vector sum of the normal force and the weight vector.

Q7. Given the information shown for the right triangle, how would you determine side *Fp* from the given side and angle?

Answer: $F_p = (10.6 \text{ cm}) \sin(39.7°)$



Q8. Given the information shown for the right triangle, how would you determine side F_p instead using the Pythagorean theorem?

Answer: $F_p = \sqrt{(10.6 \text{ cm})^2 - (8.16 \text{ cm})^2}$

Q9. Write the equation for the parallel force (y) for an angle of θ and a weight (W).

Answer: $y = W \cdot \sin(\theta)$

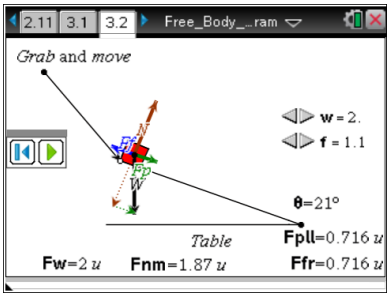
Q10. If the weight is 5.0 N and the angle is 30°, then what is the parallel force?

Answer: 2.5 N

Q11. What angle is needed to produce a parallel component of 2.5 N for a weight of 6.00 N?

Answer: 24.6°

Friction Force on an Incline



Move to pages 3.1.

4. Students read to prepare for the simulation on page 3.2.

Move to page 3.2.

5. Students can change the angle of the ramp by grabbing the point and moving it up and down. They will also adjust the friction slider f. Students should observe the friction force (F_f) and the parallel force (F_p) to determine when the block will first slide down the ramp. The sliding block will move in the positive direction to slide down the ramp.

Move to pages 3.3–3.9.

Have students answer the questions on either the handheld, on the activity sheet.

Q12. What vectors appear when the angle became greater than zero?

Answer: F_f (the force of friction) and F_p (the parallel force)

Q13. The block will slide down the ramp when the forces are related by

Answer: $F_f < F_p$

Q14. What does F_f stand for, and why is it in the opposite direction of F_p?

Answer: F_f is force of friction, which always opposes the relative motion.

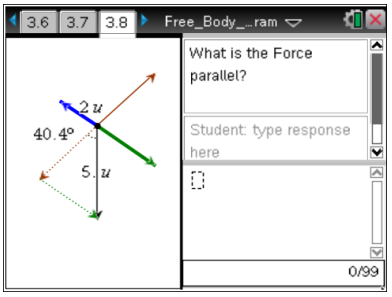
Q15. The net force causing acceleration down the ramp is equal to _____.

Answer: F_p-F_f

Q16. If the friction force is 1.0 N and the weight of the object is 3.0 N, at what angle will the block slide?

Answer: greater than 20°

Q17. What is the magnitude of the parallel force for the data shown?



Answer: (5 N)sin(40.4°) = 3.24 N

Q18. What is the magnitude of the normal force for the data shown?

Answer: (5 N) cos(40.4°) = 3.81 N

Move to pages 3.10–311.

The **sliding force** is equal to the sum of all forces. When the block slides down a ramp, it has overcome the friction force and begins to accelerate down the ramp.

Q19. What is the magnitude of the sliding force for the data shown?

Answer: 3.24 N – 2.00 N = 1.24 N

Wrap Up

When students are finished with the activity, collect the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.