

Name _____ Section _____

Period 4 Activity Sheet: Gravity, Mass and Weight

4.1 Where Does the Force of Gravity Appear to Act on An Object?

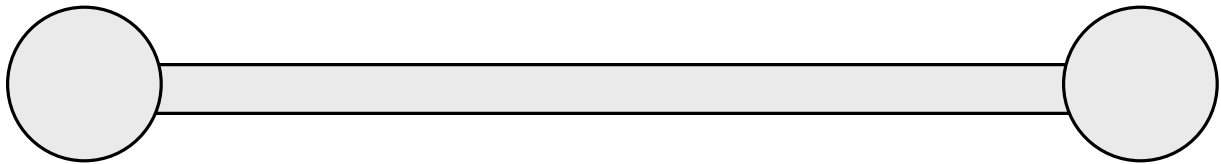
a) **Distributed forces:** Your instructor will show you how to lift a heavy metal rod using strips of paper.

- 1) Is it possible to lift the rod with a single strip of paper? _____
- 2) If 4 strips of paper are distributed along the rod so that each exerts an upward force of 5 lbs, what is the combined force of the strips? _____

Explain why can you lift the rod using several strips at the same time.

b) **Center of mass and center of gravity:**

- 1) If you were to lift the rod with 4 paper strips placed at one point along the rod, where must you place the strips? _____
- 2) Draw an "X" on the diagram to show the center of mass of the rod. Draw an arrow to show the apparent position of the force of gravity acting on the rod.



4.2 How Can You Find the Center of Mass of an Object?

a) Stack one wooden block on top of a second block. Slide the top block so that it is not directly over the bottom block.

- 1) How far can the top block overhang the bottom block before it falls?
- 2) How does the distance the top block can overhang relate to its center of mass?

b) Use the gravity set to find the center of mass of the irregularly shaped brown board. Before you begin, attach a piece of paper to the board with tape. Draw a diagram showing the center of mass and how you found it.

c) Adapt the method you used in part b) to find the center of mass of a C clamp. (Hint: pieces of string are useful.) Explain what you did. Draw a diagram showing the center of mass of the C clamp.

4.3 What Is the Acceleration of Gravity?

Your instructor will discuss the gravitational force and the acceleration of gravity.

- a) Drop two balls from the same height at the same time. The larger, heavier ball is golf ball size and the smaller, lighter ball is marble size. Predict which ball will reach the floor first. Then drop the balls to check your prediction.

Prediction: _____ **Answer:** _____

- b) Watch the video of a feather and a penny falling in a vacuum jar. Do the objects accelerate as they fall? _____ If so, what causes them to accelerate?

- c) A penny and a feather fall for 4 seconds inside of a very tall vacuum tube. Calculate the penny's velocity after it has fallen for 4 seconds.

- d) What is the feather's velocity after it has fallen for 4 seconds? _____

- e) If we neglect the slowing effect of air resistance, we can determine what the velocity of falling objects depends upon.

- 1) Does the rate of an object's fall depend upon its size (volume)? _____
- 2) Does it depend upon how much matter the object contains (its mass)? _____
- 3) Does it depend upon the shape of the object? _____
- 4) Does it depend upon how long it falls? _____

- f) Suppose that a soccer ball and a bowling ball are dropped from a 4th story window at the same time.

- 1) Neglecting the effect of air resistance, which ball will reach the ground first?

- 2) How does the acceleration of the bowling ball compare to the acceleration of the soccer ball? _____
- 3) Is the amount of gravitational force acting on the soccer ball the same as the amount of gravitational force acting on the bowling ball? _____
(Hint: consider $F = M a$) Explain your answer.

- g) Now the bowling ball is dropped from a 4th story window, but the soccer ball is dropped from an 8th story window.

- 1) How does the acceleration of the bowling ball compare to the acceleration of the soccer ball? _____
- 2) Which ball reaches the ground traveling at a faster velocity? _____
Why?

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4.4 What Is the Acceleration of Gravity (g)?

- a) To denote the acceleration of falling objects, we use the more specific symbol g instead of the more general symbol a for acceleration.

The value of g is different for each planet or moon. Near the Earth, $g = 9.8 \text{ m/s}^2$ or 32 ft/s^2 .

Write the equation for the gravitational force acting on a rock falling toward the Earth. (Hint: this is a form of Newton's second law.)

- b) We can also express the gravitational force acting on the falling rock as

$$F = \frac{G M_{\text{rock}} M_{\text{Earth}}}{D^2}$$

where D is the radius of the Earth, M_{Earth} is the mass of the Earth, and G is the universal gravitational constant = $6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$

Set these two equations equal to each other and solve for g .

- c) Using your result from part b), explain why the rate at which an object falls is independent of its mass.
- d) Using your equation from part b), calculate the value of g on the surface of the Earth. The mass of the Earth = $5.98 \times 10^{24} \text{ kg}$ and the radius of the Earth = $6.37 \times 10^6 \text{ m}$

4.5 What is the Difference between Mass and Weight?

- a) Hang a 1 kg mass from a ring stand. Calculate the amount of gravitational force acting down on the mass.

- b) Since the mass is not falling, what amount of force must be exerted up on the mass by the ring stand to hold it up?

c) In the metric system, weight is measured in units of newtons (N). Hang the 1 kg mass from the blue spring scale. What is the weight of the 1 kg mass as measured by the scale? _____

d) Explain how force, weight, and mass are related.

e) Indicate with a check mark in the table whether the quantities are measures of mass or of weight.

Quantity	Measure of Mass?	Measure of Weight?
10 kilograms		
10 pounds		
10 newtons		
10 milligrams		

f) Calculations with mass and weight.

1) What is the mass of an 80 kg person on the surface of the Earth? _____

2) What is the weight of an 80 kg person on the surface of the Earth?

3) What is the mass of an 80 kg person on the surface of the Moon? _____

4) What is the value of **g** on the Moon? The mass of the Moon = 7.36×10^{22} kg and the radius of the Moon = 1.74×10^6 m

5) What is the weight of an 80 kg person on the surface of the Moon?

g) Group Discussion Question: Which requires more force to lift off – a rocket traveling from the Earth to the Moon or a rocket traveling from the Moon to the Earth? Why?