Period 5 Activity Sheet: Gravity, Mass and Weight

5.1 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.

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.

d) Balance a meter stick on two fingers. Start with one finger under each end of the meter stick. Slowly slide your fingers together while balancing the meter stick on them. Explain what happens to your fingers in terms of the downward force of the stick on your finger, the friction between the stick and your finger, and the center of mass of the meter stick.
5.2 The Gravitational Force and the Acceleration of Gravity

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

1) Drop a piece of paper and this textbook at the same time from the same distance above the floor. Do they hit the floor at the same time? ____________

2) Find a way to make the book and the paper fall at the same rate. Describe what you did and why it worked.

3) When the paper and book fall at the same rate, is the amount of acceleration of the paper the same as the amount of acceleration of the book?

4) Is the amount of gravitational force acting on the paper the same as the amount of gravitational force acting on the book? (Hint: Think of Newton’s Second Law, $F = Ma$) Explain your answer.

5) Neglecting the effect of air resistance, which do you think would reach the ground traveling at a faster velocity: a bowling ball dropped from a fourth story window or a soccer ball dropped from an eighth story window? ____________ Explain your reasoning.
b) Newton’s Law of Gravitational Force can be written as

\[ F = \frac{G M_1 M_2}{D^2} \]

The gravitational force acting on an object near the Earth’s surface can be written as

\[ F = M g \]

1) Explain the relationship between \( G \) and \( g \) in these equations.

2) Which value is constant throughout the universe - \( G \) or \( g \)?

3) What is the value of \( g \) near the surface of the Earth?

4) Calculate the value of \( g \) on the surface of the Moon.

   The mass of the Moon = \( 7.36 \times 10^{22} \) kg

   The radius of the Moon = \( 1.74 \times 10^6 \) m

   

c) 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?

5.3 What is the Difference between Mass and Weight?

a) Hang a brass mass from a spring scale. (Note that the values on the masses are in grams, and 1 gram = 0.001 kilograms.)

1) What is the mass in kilograms?

2) What is its weight in newtons?

3) What force does it exert on the scale?

4) Explain how mass, weight, and force are related.
b) 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 mass of an 80 kg person on the surface of the Moon? ________

3) Find the weight (in newtons) of the same person on the surface of the Earth. __________

4) Calculate the gravitational force acting on this person when standing on the surface of the Earth.
   The mass of the Earth = 5.98 x 10^{24} kg
   The radius of the Earth = 6.37 x 10^{6} m

5) How does a person’s weight compare to the attractive force of gravity pulling their body toward the center of the Earth?

6) Explain the difference between mass and weight.

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

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Measure of Mass?</th>
<th>Measure of Weight?</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kilograms</td>
<td></td>
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<tr>
<td>10 pounds</td>
<td></td>
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<tr>
<td>10 newtons</td>
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<tr>
<td>10 milligrams</td>
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