**Lab: Identifying the Centre of Gravity**

**Part A**

**Materials:**

* Ruler
* Cardboard
* Scissors
* Pencil

**Method:**

1. *Balance* a ruler with one finger and record where your finger is placed along the length of the ruler.

Finger balances ruler at \_\_\_\_\_\_\_\_\_ cm.

1. Place your finger towards one end of the ruler and observe what happens.

Finger placed at \_\_\_\_\_\_\_\_\_\_\_\_ cm and I observed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Results:**

Answer the following questions:

1. Where along the length of the ruler did you place your finger to ***balance*** the ruler?
2. What force was pulling on the ends of the ruler?
3. Your finger, pushing on the ruler, counteracted the pull of ***gravity*** only when the force of gravity was ***divided equally*** on either side of the ruler.

*Complete the two force diagrams* below (see info at bottom of page).

The arrows illustrate the forces when the ruler was balanced and when it was not. Indicate **where your finger would be**, and which diagram is **balanced**, and which is **unbalanced**.

**Force Diagrams**

**Force Diagram Background Information:**

* The direction and strength of a force is represented by arrows called ***vectors***. A **longer arrow** **represents a stronger force**. The point of the arrow shows the direction in which the force is being applied.
* Pairs of forces are usually included in force diagrams and it is possible to **predict the effects** **of forces by comparing their relative size**.

1. The balancing point you found with the ruler is called the ***centre of gravity***, the object’s most stable point.

Complete the following steps to investigate what happens to the center of gravity when the shape of the object is ***not*** *a rectangle*?

1. Draw a 10 cm circle on a piece of cardboard and cut it out.
2. Predict and then test to determine where the centre of gravity is located so that you can balance the circle on your fingertip.
3. Record your observations in the chart below.
4. Create a variety of shapes, predict and then try to find the balancing point for each.

|  |  |  |
| --- | --- | --- |
| **Shape and dimensions** | **Predicted centre of gravity** | **Actual centre of gravity** |
| Circle, 10 cm diameter |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Part B:**

**Materials:**

* **Belt**
* **Washer**
* **String**
* **Pencil**

**Method:**

1. In pairs, connect one end of a string to the buckle of a belt that one partner is wearing. Connect the other end of the string to a large washer which should hang at knee level on the person wearing the belt.
2. The partner wearing the belt will be asked to stand straight in four positions:

• with feet together

• with feet slightly apart

• with feet shoulder-width apart, and knees bent

• on one foot

1. Record predictions of where the washer will be located in each stance/position BEFORE doing the activity.

|  |  |
| --- | --- |
| **Position** | **Prediction washer location when balance lost** |
| Feet together |  |
| Feet slightly apart |  |
| Feet shoulder width apart, knees bent |  |
| On one foot |  |

1. Have the belted partners assume each of the four positions and attempt to reach for something in front of them without moving their feet.
2. Observe and record the position of the washer at the point at which balance is lost or almost lost.

|  |  |
| --- | --- |
| **Position** | **Observed washer location when balance lost** |
| Feet together |  |
| Feet slightly apart |  |
| Feet shoulder width apart, knees bent |  |
| On one foot |  |

**Results:**

After completing part B, answer the following:

1. What was the position of the washer in relation to the student’s feet and hips when he or she lost balance?
2. The **centre of gravity of a person is located in the mid-abdomen region**, over the hips. Where must the centre of gravity be in relation to your feet for you to remain balanced while standing?
3. a) Of the four demonstrated stances/positions, which one provided the most stability? Why?

b) Test your previous answer by having your partner take the same set of positions again, but this time try to push him or her over with one hand.

c) Was your prediction correct? If not, which position was found to be the most stable? Explain why.

d) How is this knowledge of stability, balance, and centre of gravity used in sports?

**Two Stations:**

1. **Tower-Building Contest**

This is a contest to build the tallest free-standing structure with blocks or dominoes (not

interlocking) in a given period of time.

Your group must follow these guidelines:

* Prior to building, **create a plan** for your tower.
* Decide, as a class, the time limit allowed for construction, taking into consideration time allowed for “stability checks.”
* During construction, you **may not modify the structure once the blocks are in place**. However, you may modify your plans for subsequent layers.
* The structure **must be stable for a 10-second count**, so you may wish to conduct stability checks as you build. You should **record the height you achieved** at each stability check.
* **Draw your final structure** and **record the height on the board**.

After all groups have completed the tower construction, compare diagrams and heights and have students answer the following questions:

1. What similarities in structure were found among the shortest towers?
2. What was the common characteristic of the taller towers?
3. Using the terms *stability* and *centre of gravity,* describe what is needed to ensure that a tall tower is stable.
4. **Balance, Force, and Centre of Gravity Investigation**

Working in pairs, take turns sitting on a chair and then standing up without using hands.

Have one partner sit in a chair while the other partner stands in front of the chair, placing his or her outstretched hand on the seated partner’s forehead. Ask the seated partner to attempt to stand up.

The standing partner should not move or bend his or her arm as the seated partner attempts to stand up from the chair. The standing partner should not use undue force in preventing the seated partner from standing, but should keep the seated partner from passing a certain plane. Have students change roles and repeat the experiment.

After completing the above steps, answer the following questions, using the terms *balance, force,* and *centre of gravity*:

Why is it difficult to stand up from the seated position with a person’s hand on your forehead?