Fettuccini Physics

Name ________________________ Hour ______

Lab Partners ____

Background

An object is in equilibrium when the net force acting on it is zero. Examine the forces acting. The weight of the object held is a force that acts downward. It is balanced by the normal force exerted on the object held by the structure. The normal force is a force that acts upward. As long as the weight (downward force) is balanced by the normal force (upward force), the net force acting on the object is zero and the object is in equilibrium. When an object is in equilibrium, there is no change in motion, so it is at rest (as in this case) or moves at constant velocity.

According to Newton's third law, the normal force exerted by the structure on the object is equal in magnitude, but opposite in direction, to the weight of the object. In other words, the normal force that the structure exerts on the object is equal to the weight of the object until the structure fails.

According to Newton's second law, a net force causes an object to accelerate. In this case, the sum of the normal force and the weight is zero represents the net force acting on the object. There is no acceleration and the object remains in equilibrium.

When the object falls, breaking the structure, the normal force exerted by the structure was insufficient to offset the weight of the object. The net force is no longer zero. The weight of the object is greater than the normal force. Now, the object accelerates downward (in the direction of the greater weight) until it strikes a surface whose normal force will balance the object's weight.

Objectives

- To design a structure capable of holding a textbook using the materials supplied.
- To demonstrate that the weight of a textbook is offset by the normal force exerted on the book by the structure.
- To estimate the normal force exerted by the structure on the textbook the instant before structural failure.

Materials

- 20 pieces of dry fettuccini
- one meter of masking tape
- meter stick
- piece of paper, light weight book, medium weight book
- Physics textbook(s)

Design Requirements

1. The height of the structure shall be at least 5 cm, supporting the book 5 cm above the table. All parts of the book should be supported at least 5 cm above the table. It should be at least 10 cm wide and 10 cm long.
2. The structure shall use all or part of the 20 pieces of fettuccini and all or part of the 1 m of masking tape. No additional tape or pasta may be used.
3. Tape must be used to secure the support structure. The structure must be one unit that can be picked up and placed on the testing area. Overlapping, non-taped pieces of fettuccini are not allowed. Any or all versions of a "column" of fettuccini pieces circled by tape are not allowed. A "log cabin" type structure or circular fences consisting of overlapping, taped pieces of fettuccini is not allowed.
4. The structure must have a minimum of three points of support.

Procedure

1. Design and build a support structure according to the design requirements
2. Measure and record the mass of the structure. Measure and record the masses of the paper, the lightweight book, the medium weight book, and one Physics textbook.
3. Measure and record the dimensions of the structure. Note minimum height.
4. The students will test the integrity of the pasta structure by placing the piece of paper on the structure first. The paper is removed, and the lightweight book is placed on the structure. The lightweight book is removed, and the medium weight book is placed on the structure. Last, the medium weight book is removed and the Physics book is placed on the structure. To be successful, the structure must hold the item for <u>ten seconds</u>.
5. Students who successfully hold the Physics book for the required amount of time will be allowed to compete in the contest.
6. Continue loading the structure with Physics books until structural failure occurs.

Questions

1. Calculate the weight of the object (or objects) held just prior to structural failure.
2. Calculate the normal force exerted by the structure just prior to ` structural failure.
3. Calculate the efficiency (as a %) of your structure by comparing the maximum mass held by the structure to the structure's mass. (hint it should hopefully be more than 100%)
4. What happens to the structure when the normal force is less than the object's weight?
5. Which part of your structure broke or collapsed first? Why do you feel the structure broke or collapsed at this point? What would you do to make your structure stronger at this point?