

Lift the Weight

SUMMARY INFORMATION

Keywords

Force, pressure, friction

Topics Covered

Physics

Target Grade(s)

7, 8

Estimated Time Required

2 – 2.5 hours

LESSON

Goals and Pre Requisites

Goals

- To derive creative solutions from students that would help overcome practical difficulties in lifting heavy objects.
- To introduce students to the concept of design thinking.

Instructional Objectives

Students would develop:

- Engineering design skills
- Critical Thinking
- Analytical Thinking

Instructional Resources

Problem Statement

As we age, we have difficulty in doing even the simplest things, such as tying shoe laces or buttoning the shirt. How can we provide solutions for this issue? Let's develop solutions for the elderly that would help them lift heavy objects.

Background

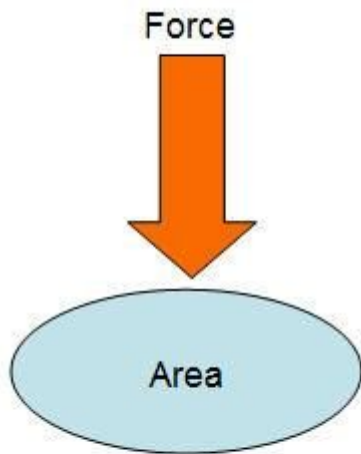
Force

In physics, a **force** is any interaction that, when unopposed, will change the motion of an object. In other words, a force can cause an object with mass to change its velocity (which includes to begin moving from a state of rest), i.e., to accelerate. Force can also be described by intuitive concepts such as a push or a pull. A force has both magnitude and direction, making it a vector quantity. It is measured in the SI unit of Newton and represented by the symbol **F**.

Related concepts to force include: thrust, which increases the velocity of an object; drag, which decreases the velocity of an object; and torque, which produces changes in rotational speed of an object. In an extended body, each part usually applies forces on the adjacent parts; the distribution of such forces through the body is the so-called mechanical stress. Pressure is a simple type of stress. Stress usually causes deformation of solid materials, or flow in fluids.

Pressure

Pressure is the force applied perpendicular to the surface of an object per unit area over which that force is distributed. Gauge pressure is the pressure relative to the ambient pressure.

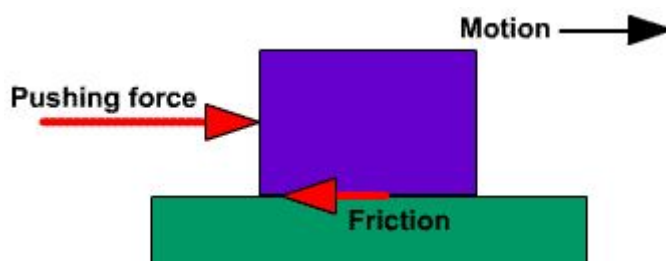


$$\text{Pressure} = \text{Force} \div \text{Area}$$

Friction

Friction is the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other. There are several types of friction:

- Dry friction resists relative lateral motion of two solid surfaces in contact. Dry friction is subdivided into *static friction* ("stiction") between non-moving surfaces, and *kinetic friction* between moving surfaces.
- Fluid friction describes the friction between layers of a viscous fluid that are moving relative to each other.^{[2][3]}
- Lubricated friction is a case of fluid friction where a lubricant fluid separates two solid surfaces.^{[4][5][6]}
- Skin friction is a component of drag, the force resisting the motion of a fluid across the surface of a body.
- Internal friction is the force resisting motion between the elements making up a solid material while it undergoes deformation.^[3]



When surfaces in contact move relative to each other, the friction between the two surfaces converts kinetic energy into thermal energy (that is, it converts work to heat). This property can have dramatic consequences, as illustrated by the use of friction created by rubbing pieces of wood together to start a fire. Kinetic energy is converted to thermal energy whenever motion with friction occurs, for example when a viscous fluid is stirred. Another important consequence of many types of friction can be wear, which may lead to performance degradation and/or damage to components. Friction is a component of the science of tribology.

Friction is not itself a fundamental force. Dry friction arises from a combination of inter-surface adhesion, surface roughness, surface deformation, and surface contamination. The complexity of these interactions makes the calculation of friction from first principles impractical and necessitates the use of empirical methods for analysis and the development of theory.

Friction is a non-conservative force - work done against friction is path dependent. In the presence of friction, some energy is always lost in the form of heat. Thus mechanical energy is not conserved.

Procedure

1. Introduce the **Problem Statement** to students.

2. Form students into groups of four.
3. Allow them to brainstorm with their groups, on the given **Problem Statement**.
4. Each group must come up with their unique solution(s) to the given problem.
5. Each group can compare their solutions with fellow groups and with their teacher to check on the feasibility of their solution.
 - In order to check on feasibility, instruct students to discuss with their team mates and have a rough sketch of their plan before constructing it. Students must be able to provide justification for their choice of materials.
6. Ask students to build a timeline (within the estimated amount of time provided under summary information) and ensure that all members of each group are involved in planning the project in terms of availability and cost of materials.
7. Students must make sure that the design incorporated in their process would address the existing problem.
8. Each group can present their solution and evaluate feasibility with peer groups and the teacher.

Sample Methodology

Note: The following is an example of how the given **Problem Statement** might be addressed. **For Teacher Reference only.**

Students can come up with designs that would help lift heavy objects with available materials such as wooden planks, woollen threads, metal clips and rods, plastic straws, rubber bands, hollow pieces of wood etc.

Procedure

1. Students can assemble their choice of materials and experiment methods to lift a heavy object (e.g. hardbound textbook, water bottle filled with water etc.)
2. The heavy object must be lifted atleast 2-3 cm from the ground and moved to another spot.
3. The design of the heavy object lifter may be variable of length, size, thickness and materials involved.
4. Example, a simple robot arm can be constructed which people with muscular dystrophy can use to help them lift and move objects. For step by step instructions, see the link -
<http://pbskids.org/designsquad/build/robo-arm/>



Extension

- The best working model can be given to a suitable agency for prototyping.

Assessment and Rubric

Define the need or problem – Did students identify the need to resolve this problem? Were they able to relate the problem to their own environment?

Come up with ideas - Did students weigh various possibilities brainstorm on various ideas before arriving at a solution? Did each group collaborate effectively to (1) work within the time given (2) give equal opportunity for participation (3) consolidate relevant information (4) provide rationale for their decisions and choices.

Select the most promising idea or design - Were students able to evaluate the feasibility of their solution to the given problem statement? On what basis was the feasibility of the solution determined?

Communicate and plan the project – Were groups able to provide justification for their choice of materials? Were students able to see completion of the activity within the estimated time?

Create/Build and test a design –Were all members of the team participative during the course of the activity?

Evaluate and revise the design – Were student groups able to present their solutions in a clear and distinct manner with other groups? Were they keen on improving their model further?

Credits

- <http://hyperphysics.phy-astr.gsu.edu/hbase/force.html>
- <http://www.merriam-webster.com/dictionary/friction>
- https://en.wikipedia.org/wiki/Ferdinand_Beer
- <http://ruina.tam.cornell.edu/Book/RuinaPratapNoProblems.pdf>

- <http://cbseadda.blogspot.in/2011/03/8th-force-and-pressure.html>
- <http://study.com/academy/lesson/static-friction-definition-formula-examples.html>
- <http://pbskids.org/designsquad/build/robo-arm/>