One of the most important parts of physics is being able to understand forces. A force is something that changes an object’s shape or movement, like a push or pull. One of the most important forces that directly impact our lives is GRAVITY. Gravity is a force that pulls objects towards each other. It is the force that makes objects fall to Earth.

Mars Pathfinder Landing

The mission to land a robotic rover on Mars in 1997 is a great example of exploring the physics of forces, free fall, and gravity. This piece of astronomical research equipment had to be dropped to the surface of the planet in order to conduct its missions. The impact on the rover caused by the gravitational force exerted on the object had to be overcome in some way to reduce or eliminate the possibility of damage to the equipment.

From NASA: “Diving directly into the thin atmosphere at about 26,460 kilometers per hour (16,600 miles per hour), Pathfinder will release its parachute, then jettison the heat shield that protected it from the heat of entry. A tether will be deployed to lower the spacecraft from its backshell; airbags will then inflate about eight seconds before landing. Deceleration rocket engines will fire to nearly halt the craft for an instant in mid-air just before impact. Once the rockets have been fired, Pathfinder will free-fall up to 30 meters (100 feet) before hitting the ground at a speed of up to 90 kilometers per hour (55 miles per hour). The lander could hit the ground in almost any orientation as a result of the rocket burn and bridle cut. At impact, the spacecraft, now looking like a huge (5-meter-diameter (15-foot)) beach ball, will bounce many times, possibly as high as a 10-story building, until all impact energy dissipates. The interval between initial impact and complete halt may take as long as several minutes. The airbags completely enclose the lander, so subsequent bounces should not result in high deceleration. Each face of the spacecraft's tetrahedron has a single six-lobed airbag, and energy is dissipated through vents in between the lobes.”

The Challenge

Through the application of these principles of physics, students will design a vehicle for an egg using various materials to protect the egg while demonstrating the concepts of free fall and forces. As an egg falls towards the floor, it begins to travel faster and faster. When it slams into the floor, the egg is stopped almost immediately. If the force of the floor against the eggshell is too large, it breaks. In an example, a pillow is soft and is a way to cushion the fall of the egg, unlike the hard floor. The pillow would allow the egg to stop slowly, decreasing the force against the egg so it doesn’t break.
OFFICIAL RULES

1. The object of the challenge is to design a device that will protect a raw large egg from breaking when it is dropped from a height of 10-50 feet. Teams will compete to design a vehicle with the lightest mass, the fewest number of parts, and the most successful landing on the target without breaking the egg.

2. All scores will be determined using the Awesome Egg Drop Equation of Physics (AEDEP).

3. Raw eggs will be provided on the day of the challenge to each team and are the only eggs allowed for use.

4. A representative from each team will drop their own vehicle.

5. A representative from each team will remove the egg from the vehicle after the drop for inspection by the Professor. No repairs will be allowed between drops.

6. Each vehicle will be weighed with the egg prior to drop.

7. The target will be comprised of an X marking the center of a spot. Distance of landing site from the center of the X will be measured.

8. Each team member must submit a completed worksheet to validate results.

AWESOME EGG DROP EQUATION OF PHYSICS (AEDEP)

The formula is:

\[ AEDEP = [100M + 100N + 10T] - [10(H_1)(EIF)] - [10(H_2)(EIF)] - [10(H_3)(EIF)] \]

Where:

- \( M \) = Mass of the device in grams
- \( N \) = Number of parts
- \( T \) = Distance from target in centimeters
- \( H_{1,2,3} \) = Height of drop in meters
- \( EIF \) = Egg Integrity Factor (1 if not cracked, 0 if cracked or broken)

MATERIALS

The following is a list of materials that each team may use in the construction of the egg vehicle. No other materials will be permitted.

1. Cardboard
2. Plastic grocery bag
3. Toothpicks
4. Newspaper
5. Masking tape
6. Rubber bands