LAWS OF MOTION

Learning Cycle

INTRODUCTION

Even before Newton's time it was thought that if an object was moving there must be some force acting on it and if you couldn't see the force then it must be inside the body being acted upon. Newton clarified this with his first law known as the Law of Inertia, which states that if the forces acting on a body are balanced then the object will be in equilibrium and not accelerate. Conversely, Newton's second law states that if the forces acting on an object are not balanced the net force will cause the object to accelerate at a rate dependent on the mass of the body and the force acting on it. So, in terms of the alternative conception stated above; Newton showed that forces do not cause motion; forces cause accelerations, but all objects have force acting on them at all times.

STUDENT LEARNING OBJECTIVES

1. Students will be able to apply Newton's Laws of Motion to satellites, planets, and asteroids

MATERIALS

Teaching Aids

Handouts for each student

- Laws of Motion: Scenarios and Tutorials
- Laws of Motion: Satellites, Planets, and Asteroids

Student Materials

For Each Group:

Book, plastic car, tennis ball, cardboard building, drawing of road on sheet of paper, 2 plastic figurines, and a feather.

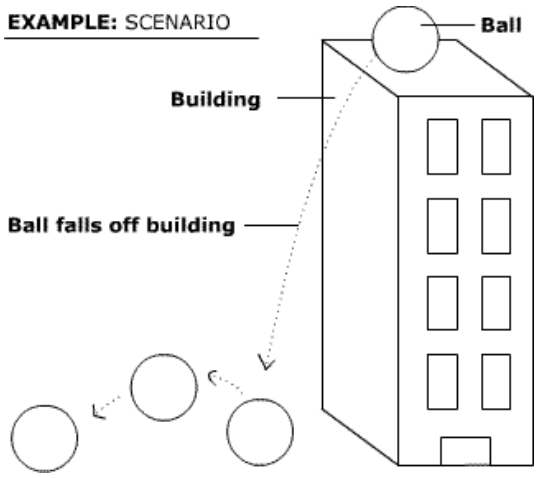
For Each Student Pair

Laptop with internet access

PROCEDURES

Exploration (15 minutes)**:**

1) Students form groups and explore the objects on the table
2) Each student needs to develop two physic-related scenarios using only those objects on the table. Students should illustrate and label their scenarios in the spaces provided on the handout "Laws of Motion: Scenarios and Tutorials." An example scenario might be to put the ball on top of the cardboard building and push it off (see illustration). Each scenario must involve at least two objects.



Concept Introduction (35 minutes)**:**

Call on a few students to demonstrate their scenarios (~5 min)

Develop Vocabulary – Refer to student scenarios to add clarity (~5 min)

i. Newton's first law - All about inertia (Ball rolling)
ii. Newton's second law - All about acceleration (Push the car)
iii. Gravity, inertia, acceleration
iv. Balanced forces vs. Unbalanced forces (car at rest vs. car in motion)

Online Activity (~25 min)

1) Students form pairs around a laptop and load the following website: http://www.physicsclassroom.com/mmedia/newtlaws/newtlawsTOC.html
2) Students explore the following physics tutorials:
   i. The Car and the Wall
   ii. The Motorcyclist
   iii. The Truck and Ladder
   iv. The Elephant and The Feather - Free Fall - OR - The Elephant and The Feather - with Air Resistance
   v. Skydiving
3) Each pair chooses two of the tutorials and uses the information online to complete the following questions listed on the handout "Laws of Motion: Scenarios and Tutorials."
   i. When the object(s) are at rest, what are the balanced forces?
      - For the "Car and Wall" example: The car is balanced between the upward force of the road and the downward force of gravity.
   ii. What started the acceleration of the object(s), i.e., what unbalanced the forces?
      - For the "Car and Wall" example: The driver pressed the gas pedal, which started the fuel burning that provided enough energy to counter the force of gravity.
   iii. What forces keep the object(s) from staying in motion indefinitely?
      - For the "Car and Wall" example: Friction between the car and road slowed the car and the wall stopped the car.
4) Students reform their groups

Concept Application (20 minutes)**:**

<u>Group Activity</u> - Handout "Laws of Motion: Satellites, Planets, and Asteroids"

1) Discuss how we managed to get satellites to stay in orbit around the earth:
    a. Are the forces acting on the satellites balanced or unbalanced? - Forces are balanced forces between acceleration of satellite and pull of gravity.
    b. What are the forces acting on the satellites? - Gravity and acceleration.

2) Discuss planet rotation around the sun:
    a. Are the forces acting on the planets balanced or unbalanced? - Mostly Balanced, but other objects may contribute forces. What other object in our galaxy might be able to exert forces on the planets.
    b. What are the forces acting on the planets? - Gravity and acceleration set into motion after the Big Bang
    c. Why don't all planets have the same orbit around the sun? - Difference in mass and acceleration.

3) Discuss how we could we stop an asteroid from slamming into our lovely planet Earth:
    - We would have to divert the force! Like in Star Wars! We would need to have a larger object in space with a greater force of gravity than earth to counter Earth's gravitational pull and alter the asteroids trajectory in a direction away from earth.
    - Another idea proposed in the move Deep Impact is to blow up the asteroid with lots of nuclear weapons. Why isn't this a good idea? – We'd turn one big falling rock into hundreds of falling rocks, not to mention the nuclear waste products that might also fall down to earth.
    - Or we could put something behind the asteroid like a rocket that would increase the acceleration so that it's greater than the force of Earth gravity.

ASSESSMENT

Students will observe two online physics tutorials and answer three questions about the forces controlling the objects in those tutorials. In addition, students will form groups to discuss and answer questions about the forces controlling satellites, planets, and asteroids.

REFERENCES

Study Works! Online – The Physics Classroom Website
http://www.physicsclassroom.com/mmedia/newtlaws/newtlawsTOC.html
European Space Agency News Website:
http://www.esa.int/esaCP/SEM8SUB1S6F_index_0.html