Gravity - Facilitator Guide

Learning objectives

To describe qualitatively how things fall under the effect of gravity including:

- Objects that start at the same height, take the same amount of time to fall regardless of their mass
- Mass of object has some effect on what happens when they land
- Height from which object is released affects the way object lands

Science concepts

Gravity, mass, energy

Materials

Per group:

- 1 box filled approximately halfway with sand
- 1 steel ball bearing
- 1 aluminium ball bearing, approximately the same size as the steel ball bearings
- 1 hair clip
- 1 flashlight

Tip

The day BEFORE the activity: Open all the boxes to allow the sand to dry during night, otherwise observing the crater may not work.

Activity plan

ENGAGE the students:

1. Show pictures of the moon, mars, or other objects with craters in the solar system. Tell students, scientists need to understand gravity and how things fall on other planets/the moon, but first we have to understand how things fall on Earth
2. Begin by asking students about their observations about how things fall. Questions to ask include:
    a. Why do things fall?
    b. What falls faster, heavier things or light things?
    c. What would hurt more, falling out of your chair or falling off the roof of your school?

    d. Would you rather have a rubber playground ball or a bowling ball dropped on your head?
3. Tell students that they will nowo do some experiments to check their ideas.

Let the students EXPLORE:

1. Write the following questions on the board
    a. What falls faster, heavier or lighter objects?
    b. How does height affect how things fall (and the craters they make)?
    c. How does weight (mass) affect how things fall (and the craters they make)?
2. Students will be working in groups of 3-4 and should select *one* question to work on. (Once they complete one question, they can move onto the next one as time allows.)
    a. Discuss with students the importance of changing just one thing at a time.
3. Have students make a prediction before they start their experiment, based on their previous knowledge and the previous discussion.
    a. It does not matter if their prediction is “right” or “wrong” - it’s more important that they are able to
4. Bring students together in the front of the classroom to demonstrate how to do the experiment:
    a. Show students how to use the hair clip to drop a ball bearing in the sand and how to use the flashlight on the side of the box to observe the crater made in the sand.
    b. Throw the ball bearing at the sand, making a bigger crater. Show the students how this looks different than the one that you dropped with zero initial velocity.
5. Distribute the sand boxes, and ball bearings to the students
6. Have students repeat drops until they are confident that they have answered their question.
    a. Make sure that every student gets to take a turn dropping the ball bearings. This ensures that everyone is participating and will minimize systematic errors due to drop technique
    b. Make sure that students are only testing one variable at a time
        i. Example: “When I do experiments, sometimes it is hard to know exactly what is causing the result. So I try to only change one thing at a time”
    c. Make sure that the students are dropping (v_i=0) rather than throwing the marbles. This may take some practice.
        i. Example: “Remember when I threw the marble into the sand? It made a different crater than when I just let the marble fall. Since we are just trying to figure out what happens when things fall, maybe you should try gently letting it go.”
7. If a group finishes early, have them test another question

EXPLAIN the concepts

1. When students have finished their experiment, or when there are 15-20 minutes left in the class period, have each group briefly state the question(s) they tried to answer and their results
2. Write all of the findings on the board (correct or incorrect)
3. Discuss any discrepancies in the findings
    a. If one group got an incorrect result, have the class brainstorm what experimental errors could have produced the incorrect or contradictory results. For example:
        i. Throwing the marbles
        ii. Not releasing them at exactly the same time
        iii. Difficulties in seeing the size of the craters

EXTEND the activity

4. If time and classroom setup allow show the following videos:
    a. https://youtu.be/ZVfhztmK9zI (0:47), Apollo 15 Proves Galileo Correct (feather and hammer fall at the same rate on the moon because of zero air resistance.)
    b. https://youtu.be/E43-CfukEgs (4:41), Brian Cox visits the world's biggest vacuum chamber, compares effect of gravity on feather and bowling ball.

Acknowledgements

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