Ace in the Hole

Newton's First Law of Motion

Grade Level	6th – 8th Grade	**Time Frame**	90 minutes
Subject	Science	**Duration**	1-2 class period(s)

Essential Question

How do forces change a projectile's trajectory?

Summary

Students explore projectile motion using Newton's first law of motion.

Snapshot

Engage

Students watch the commercial "Second Chance" and use the I Think/We Think strategy to describe how it relates to inertia and projectile motion.

Explore

Students are given the task of dropping a ball on a target while in motion. Students describe the motion of the ball and sketch a line that describes the motion of the ball.

Explain

Students work together to explain how inertia relates to projectile motion and how gravity and inertia work together to form the projectile's trajectory.

Extend

Students read an article about bombing during World War I and World War II and relate it to projectile motion.

Evaluate

Students reflect on the lesson by answering three overarching questions.

Standards

Next Generation Science Standards (Grades 6, 7, 8)

MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Oklahoma Academic Standards (7th Grade)

7.ESS3.3 : Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.*

Materials

- World War II Technology that Changed Warfare (linked)

- Butcher paper
- Tape
- Marker
- Tennis balls
- Optional: Inertia activity (linked; see Explore)

Engage

Show "Second Chance," a seat belt safety commercial that shows the consequence of not wearing a seat belt.

Embedded video

https://youtube.com/watch?v=L62ueMB0E5E

Use the I Think/We Think strategy by instructing students to write down their thoughts on how the video demonstrates Newton's first law and inertia. After 2-3 minutes, instruct students to pair up and share their ideas to formulate one "we think" statement about the video and Newton's law.

Call on pairs to share their "we think" statements with the class. Address misconceptions and be sure that students know the key term in Newton's first law and can define inertia. Students should also know that this first law can be called Newton's law of inertia.

- Newton's first law: An object remains in motion or remains at rest until an unbalanced force is applied to the object, causing it to change its motion or state of rest.
- Inertia: an object's tendency to resist changing its motion or its state of rest.

Teacher's Note: Addressing Misconceptions

Students must understand that the seat belt opposes the inertia of the passenger, while the inertia of the unrestrained driver is not opposed in any way. He continues moving while the car is stopping. Students must not have the misconception that both occupants were at rest in the car. They were moving the same speed as the car. Use the Explore section to take this idea a step further with a falling object that has an initial velocity.

Show the video a second time, and instruct students to sketch the motion of the man. Students will refer to this sketch later and use it as comparison to another projectile's motion.

Explore

Students must be in groups of four or five.

Students will explore the concept of inertia further by observing a falling ball from a moving person. Students will run toward a target that is placed on the floor. The goal is to hit the bull's eye of the target while other group members watch from the side to determine how the ball falls. Before they begin, have the groups brainstorm and record their ideas about the challenges of hitting the target. Students take turns so everyone has a chance. Students may even record the ball drop and watch in slow replay. When they are finished, have them draw a sketch of the ball's motion and write a conclusion that states how Newton's first law and inertia apply.

If you feel that your students need to follow an exact procedure, you may consider using this "Inertia" activity from Sonoma State University. It gives an excellent, detailed procedure for this activity. If you want your students to own the entire inquiry process, just give them the goal (to run toward a target and hit the bull's eye) and let them devise their own procedure. This is also a good place to mention the key term: trajectory.

- Trajectory: the path taken by a flying projectile or an object moving based on the action of a given force.

Teacher's Note: Expected Outcome

The ball, while it appears to be stationary, is moving the same speed as the person. Students should find it difficult to hit the target and may have to make adjustments to their drop. The ball will travel in a parabolic motion and must be dropped slightly before the target is reached. Because of the ball's inertia, it resists changing its horizontal motion; therefore, it will not fall straight down, although it may appear to do so.

Explain

Ask or post the following questions:

- *How is the inertia of the occupants inside the car related to the inertia of the ball in your hand?*
- *How does your sketch of the man's motion compare to the motion of the falling ball?*
- *Are both the man and the ball considered projectiles?*
- *What effect does gravity, paired with inertia, have on the motion of the man and falling ball?*

Answers:

1. Both the occupants and ball are moving with an initial velocity and resist changing their motion.
2. Both should show a curved path. This curved path shows parabolic motion.
3. Yes, according to the definition of a projectile (see note).
4. Gravity pulls down while the projectile still continues in the horizontal motion causing it to curve rather than fall straight down.

Teacher's Note: Defining Projectile

Students may not have a formal definition of a projectile. It might not be so easy to put into words for them. Informally, a projectile is any object that is cast, fired, flung, heaved, hurled, pitched, tossed, or thrown and is influenced by its own inertia and downward pull of gravity.

Use the Gallery Walk strategy to have students create a visual presentation that shows both sketches and answers all four questions. Give each group enough Post-its to leave feedback on each poster.

Teacher's Note: Content Feedback

Instruct students to focus their feedback on the content of the poster, not so much about how the poster looks. Challenge them to look for misconceptions and errors in their peers' thinking and offer constructive questions and critiques.

Extend

Ask the question: *Beyond the classroom, where might you encounter or see a projectile that has similar motion to the man in the car and falling ball?* Allow for open, informal discussion. Call on volunteers to answer.

Sample Student Responses

Things students might say: dropping bombs, dropping aid packages, skydiving.

The article, "World War II Technology that Changed Warfare," is an excellent extension of this lesson. Instruct students (still in groups of four or five) to employ the Jigsaw strategy.

Teacher's Note: Preparation

Print one article per group and then allow students to split up the sections. If there is internet access, students can access the article themselves. The article is long, so be sure students start at the section heading "Bombsights."

When the groups are finished, allow time for them to regroup and write one summary (with each giving input) that reflects the article. Allow time to regroup as a whole class, discuss the article, and share their summaries.

Evaluate

Separate the groups so students can be evaluated without peer input.

Post or ask the following questions. Give students thinking time, and instruct students to answer the questions on a separate sheet of paper.

- *How are the man, the ball, and the bombs from WWI and WWII all related?* Instruct students to use key terms from the lesson.
- *Before bomb sight technology and radar, what factors would have to be considered to get the falling projectile (the bomb) to hit its exact target?*
- *In what situations is a projectile launched but the effect of gravity on the path is not easily observed, only its own inertia?*

Answers:

1. They are all projectiles with their own inertia, subjected to gravity's pull, displaying a parabolic curve.
2. Some answers may include: time to fall, distance from target, altitude, initial velocity of the plane/bomb.
3. The distance is only minimal. Examples might include throwing a dart at a dart board or shooting a gun at a close-range target.

Resources

- Foley, S. (2011). World War II technology that changed warfare - radar and bombsights. Academic Symposium of Undergraduate Scholarship. Paper 8. http://scholarsarchive.jwu.edu/cgi/viewcontent.cgi?article=1011&context=ac_symposium
- Granger, K., & Whitlock, L. (n.d.). Activity #2: Inertia – a body in motion. Newton's 1st Law. http://swift.sonoma.edu/education/newton/newton_1/html/newton1.html
- K20 Center. (n.d.). Gallery walk / carousel. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f505a54d
- K20 Center. (n.d.). I think / we think. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5065bfd
- K20 Center. (n.d.). Jigsaw. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f507c1b8
- USDOTNHTSA. (2015, May 8). Second chance [Video]. YouTube. https://www.youtube.com/watch?v=L62ueMB0E5E

FOR MORE INFORMATION ON THIS TOPIC:

- http://www.physicsclassroom.com/mmedia/vectors/pap.cfm
- http://epo.sonoma.edu/