Activity 2B: Gravity in Pixel-Land

Students develop and conduct procedures for calculating the acceleration due to gravity in a video game. Students share their results and discuss how game play is affected by realistic and unrealistic treatments of gravity.

Understandings

- Techniques for measuring *g* (acceleration due to gravity) in the real world can be adapted to calculate *g* in the imaginary worlds of video games.

Materials

- **Handout 8: How Should Gravity Work?**
- **Handout 9: Calculating Acceleration Due to Gravity**
- Students' completed copies of Handouts 4, 5, 6, and 7
- List of browser-based games for gravity calculations (one for each team) (see *Advance Preparation*)
- Stopwatch (one for each team)
- Calculator (one for each team)
- For paper analysis:
  - Computer with access to a printer (one computer for each team)
  - Ruler (one for each team)
  - Optional: Scissors (one for each team)
- For onscreen analysis:
  - Computer with drawing software (one for each team)
- **Handout 10: Mechanics Review**

1. Discuss gravity in video game worlds.
Distribute **Handout 8: How Should Gravity Work?**, which presents three situations (a character jumping, a character throwing a ball, and objects falling) that are represented in many video games. Allow a few minutes for students who have played games that include these situations to discuss the games, the physics in the games, and what makes them fun to play.

Have students work in pairs to answer the questions on the handout. Discuss their responses as a class, and clear up any misconceptions students may have.

Teacher's Notes: Misconceptions About Gravity

Many students, even those in high school, have misconceptions about gravity. Probably the most common misconception is that heavy objects fall faster than light objects. In the absence of air resistance, heavy and light objects fall at the same speed. However, in students' day-to-day experiences with gravity, they don't have an opportunity to observe objects falling in a vacuum.

Another common misconception is that there is no gravity in space. This may be a result of seeing images of astronauts floating "weightless" in a space shuttle. This phenomenon is not due to an absence of gravity but rather to the fact that the astronaut and the space shuttle are both falling at the same speed. People may experience a similar feeling of weightlessness when skydiving, or even, very briefly, on a roller coaster or a rapidly descending elevator.

2. Introduce the gravity calculation activity.
Distribute **Handout 9: Calculating Acceleration Due to Gravity** and the list of games you prepared. Explain that each team will choose a video game from the list and develop a method for calculating *g*, the acceleration due to gravity, in the game world.

Explain to students that to develop this method, they should draw on two things:

- What they learned in Activity 1B about estimating distances in video games
- What they learned in Activity 2A about ways to measure *g*

Divide the class into teams. Ideally, the team members will not all have completed the same gravity investigation in the previous session; having team members who are each familiar with a different one of those investigations will help the team figure out what method to use in the video game.

3. Have teams develop a method for calculating *g*.
Because the method for calculating *g* will depend on the type of motion undergone by the characters or objects, teams should first choose a game to analyze. Check in with teams as they work on developing their methods. You might wish to have each team share its method and discuss the methods as a class, or you might choose to examine each team's procedure individually. If necessary, refresh students' memories about the various procedures that were used in Activity 2A.

Note: The simplest way to calculate the value of g in a game is to follow the procedure used in **Handout 4: High Flying**:

1. Time how long it takes for a dropped object to fall. (If the object is falling quickly, you may get a better result by recording a video clip of the game and analyzing the video.)
2. Take a screenshot on which you'll be able to measure the distance from the initial location to the final location of the falling object. Estimate the distance fallen by using a method analogous to the one used in Activity 1B. For example, if the falling object is a person, assume that the person is 1.7 m tall, and see how many person-heights the person has fallen.
3. Use the formula $g = 2d/t^2$ to calculate g.

4. Have teams implement the methods they developed.
Give each team a stopwatch and a calculator so they can take measurements and perform the calculations.

5. Discuss students' results.
After students have completed their calculations, have some teams demonstrate their games and share their results. Ask:

- How does the acceleration due to gravity in the video games compare to the acceleration due to gravity on Earth?

If g is different in the video games, ask:

- How would the game play be different if acceleration due to gravity was the same as it is on Earth?

If g is the same in the video games as it is on Earth, ask:

- What might the game be like if acceleration due to gravity were different from how it is on Earth?

Note: Handout 9 provides a good opportunity for formative assessment.

6. Assign students to create mechanics review sheets.
Distribute **Handout 10: Mechanics Review**. Assign each student or team of students a topic, and tell them when the review sheets are due.

Tell students that this assignment does not require extensive research. They should base their review sheets primarily on your classroom content, such as textbooks, class notes, and handouts. Provide students with the Web addresses of just a couple of recommended sites, and explain that they can refer to these sites to see their topic expressed in a slightly different way.

Note: Mechanics reviews provide a good opportunity for formative assessment of students' understanding of forces, motion, and energy. You can assign the mechanics review for homework or as an in-class exercise.

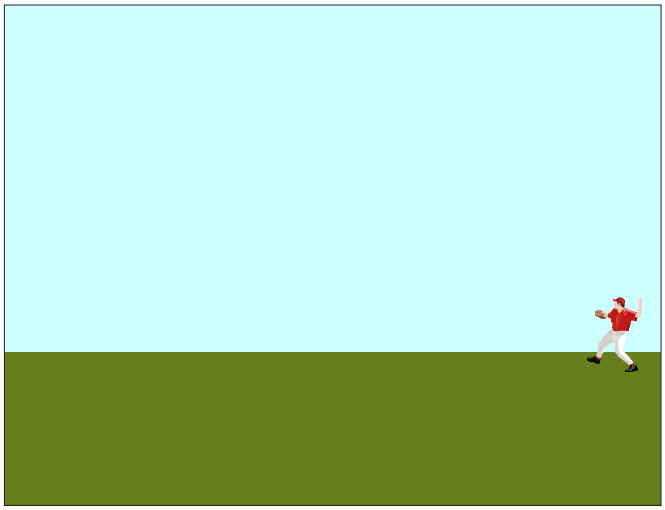
Handout 8:
How Should Gravity Work?

Look at the images below. On each image, draw your prediction for what would happen in the real world.

1. Mario jumps as high as he can (Mario is a "real" person, not a cartoon superhero).

Screenshot from *New Super Mario Bros. Wii* by Nintendo

2. The player throws the ball.



3. An anvil and a feather are dropped at the same time.

Handout 9:
Calculating Acceleration Due to Gravity

In this investigation, your team has three tasks:

- Develop a procedure for calculating the acceleration due to gravity (*g*) in a video game
- Collect data from the game
- Calculate *g*

Materials

- Computer with Internet access
- List of browser-based games that include falling objects or characters
- Stopwatch
- Calculator
- For paper analysis:
  - Ruler
  - Computer with access to a printer
  - Optional: Scissors
- For onscreen analysis:
  - Computer with drawing software

Procedure

1. Explore the video games that are available and find one in which you could calculate the acceleration due to gravity. You could calculate *g* based on measurements of following:

   - Falling objects (such as bombs)
   - Thrown objects (such as balls or grenades)
   - Characters jumping from a high platform to a lower platform
   - Characters jumping up and down

   You may need to "die" or lose the game in order to make your observations. For example, you might

   - Allow a bomb to hit rather than shooting it out of the sky.
   - Have a character make a jump you know it can't survive.
2. With your team, develop a procedure for calculating acceleration due to gravity in your video game.

   Hint: Think about the ways you calculated the acceleration due to gravity on Earth in the previous activity.

3. Share your procedure with your teacher.
4. Use your teacher's feedback to refine your procedure.
5. Carry out your procedure and collect your data. Repeat the procedure and calculations at least two more times.

Analysis

1. Calculate *g*.
2. How do your results compare with *g* in the real world?

Handout 10:
Mechanics Review

Your class is going to create a Mechanics Review Handbook made up of review sheets on important mechanics terms and concepts. Each student will contribute one review sheet.

1. Note the term or concept you have been assigned:

_____

2. Do your research.

Start by looking at your physics textbook and any notes you've taken in class. Your teacher will direct you to one or more Web sites that you can consult for additional information. As you develop your review sheet, be sure to keep track of the sources you use.

3. Write your review sheet.

Your review sheet should include the following:

- A short definition of the concept or term you've been assigned
- An illustration of that concept
- Any equations associated with the concept, and an explanation of what the variables are and what information the equation yields
- Some examples of this concept at work in the real world
- A list of the sources you consulted