# WATER-WISE FARMS: GRAVITY IN ACTION

Student Guide

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# Challenge Rationale

Farmers need water to grow crops, but sloped land makes delivering water evenly a challenge. Gravity pulls water downhill, sometimes creating overly saturated spots and dry patches. According to the Food and Agriculture Organization (FAO), about 70% of all freshwater withdrawals worldwide are used for agriculture (FAO, *World Agriculture: Towards 2015/2030*). By learning how gravity affects water flow, you can help design irrigation systems that use water wisely.

# Establishing The Challenge

## Challenge Question

How does gravitational force affect water flow on sloped farmland, and how can farmers use this understanding to design better irrigation systems?

### THIS SOLUTION MUST ADDRESS THE FOLLOWING NEEDS:

- Create a simulation or prototype where you can manipulate mass and distance to see how gravitational force changes.
- Record and analyze data from multiple trials to identify patterns.
- Use graphs, tables, or other visuals to clearly show relationships between variables.
- Apply your findings to a real farmland scenario and explain how your design could help farmers conserve water and grow crops more effectively.

### SUCCESS WILL BE DETERMINED BY:

- Accurate, evidence-based data showing how gravitational force changes with different mass and distance values.
- Clear visual representations (graphs, charts) of the relationships you observe.
- A thoughtful explanation of how your findings relate to improving irrigation systems on farms.

# STEP ONE

# 1 | IDENTIFY

## Purpose of Step

Define the problem—how gravity affects water flow on sloped farmland—and understand its broader impacts. Research how others have addressed this challenge and note the constraints you'll face (time, resources, etc.).

### Student Prompts and Guiding Questions:

- What is gravitational force?
- How do mass and distance affect gravity?
- How might water move on a slope?
- Why does this matter for farmers? What do you know about irrigation systems?

## Signs of Step Completion

- You can describe gravitational force and its impact on water flow in your own words.
- You've connected gravity to irrigation challenges on sloped land.
- You have a set of questions or topics you want to investigate next.

### Important discoveries during this step:

- Define the problem as it relates to you locally
- Plans for the next step
  (e.g., knowledge to gain, questions to answer, preparations to make, etc.)

# STEP ONE: REFLECTION

## 1 | IDENTIFY

### Important Discoveries During this Step:

### Define the Problem as it Relates to You Locally:

### Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):

# STEP TWO

# 2 | IMAGINE

## Purpose of Step

Brainstorm solutions to the challenge. List all of your ideas – don't hold back! Discuss and select the best possible solutions.

### Student Prompts and Guiding Questions:

- How could you model gravity's effects using simulations like PhET?
- How could you build a physical slope model?
- What materials could represent mass or distance?
- What kind of data would you need to collect?

## Signs of Step Completion

- A sketch or description of at least one proposed model or simulation.
- A clear sense of the data you want to collect.

# STEP TWO: REFLECTION

## 2 | IMAGINE

**Important Discoveries During this Step:**

**List Your Possible Solutions:**

**Identify the Solution that You Think will be Achievable:**

**Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):**

# STEP THREE

# 3 | DESIGN

## Purpose of Step

Plan your investigation. Decide which variables you'll change (mass, distance), how you'll control them, and how you'll record data.

### Student Prompts and Guiding Questions:

- What specific variables will you test?
- How will you record results—tables, graphs, spreadsheets?
- How will you make your experiment repeatable?
- How does this fit into a farm context?

## Signs of Step Completion

- A clear written plan or blueprint.
- A prepared data table or chart outline.
- Defined variables and controls.

# STEP THREE: REFLECTION

## 3 | DESIGN

**Important Discoveries During this Step:**

**Justify Your Model Design and the Materials You will Need:**

**Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):**

# STEP FOUR
# 4 | CREATE

## Purpose of Step

Build your model or run the simulation and begin collecting data.

## Student Prompts and Guiding Questions:

- What happens when you change mass or distance?
- How does gravity affect water on your model?
- Does it mirror real farming situations like erosion or dry spots?
- What practical insight could a farmer gain from your model?

## Signs of Step Completion

- A functioning model or simulation.
- Initial observations and data recorded.

# STEP FOUR: REFLECTION

## 4 | CREATE

**Important Discoveries During this Step:**

**Describe any Barriers You Overcame in Creating Your Model:**

**Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):**

# STEP FIVE

# 5 | TEST & IMPROVE

## Purpose of Step

Analyze your data, compare with expectations, and refine your model.

## Student Prompts and Guiding Questions:

- Are the results consistent? Any surprises?
- How can you improve accuracy or design?
- How do these findings help solve irrigation problems like pooling or dryness?
- Would your model work differently with different slopes or soil types?

## Signs of Step Completion

- Refined data set with improved model or method.
- Visual data (graphs, charts) showing clear patterns.
- Strong connections between data and real-world implications.

# STEP FIVE: REFLECTION

## 5 | TEST & IMPROVE

**Important Discoveries During this Step:**

**Impacts to the Global, National, and Local Community:**

**Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):**

# STEP SIX
# 6 | SHARE

## Purpose of Step

Present your findings clearly—with visuals, explanations, and evidence.

### Student Prompts and Guiding Questions:

- What patterns did you discover?
- Did the results match your expectations? Why or why not?
- How could farmers use this knowledge to improve irrigation?
- What are your recommendations for real-world systems?

## Signs of Step Completion

- A report, poster, presentation, or video including your process, data, and conclusions.
- A clear connection between your findings and responsible agricultural practices.

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