

# Gravity and Pendulums

## God is Truth

### **Spiritual Awareness: Seek the truth; Discern the truth**

In order to understand truth, we need to weigh up and balance the things we hear and see. Through the creation we can see balance at work. This can be used as a symbol for balancing spiritual truth.

To be able to weigh up and measure truth correctly is an essential gift that God makes available to all Christians. This is the gift of discernment.

Throughout history there have been Christian scientists who relied on God for wisdom, and in doing so discovered scientific truth. This newly discovered truth was often unaccepted, and many scientists were persecuted for their beliefs. One such scientist was Galileo, who discovered the telescope and the laws relating to gravity and pendulums.

The persecution of Christians who stand for scientific truth continues today. The theory of evolution is no more plausible than earlier theories, such as the flat earth theory or the idea that earth was the centre of the universe. Columbus was one who demonstrated that the Earth was round. Copernicus, and Galileo, through the invention of the telescope, proved that the Earth was not the centre of the universe, but traveled around the sun.

Francis Bacon was another who restored the teachings of the Bible to science. Living in a time of superstition, where beliefs were dominated by astrology, Bacon was persecuted for bringing truth to science. He invented a new method of inductive reasoning known as the 'scientific method'. That is, argument based on the observation of many individual cases.

### **Our response to 'God is Truth'**

Because God is Truth I will...

- Speak the truth
- Be honest
- Never cheat
- Never steal
- Never lie or exaggerate
- Be trustworthy
- Be true to my word and keep promises.
- Be myself and not try to be someone I am not.
- Search for the truth
- Ask God to show me the truth.
- Ask the Holy Spirit to lead and guide me into all truth.
- Believe that God's word is the truth.
- Believe that Jesus is the Way, the Truth and the Life.

## **Supporting devotional resource**

*Themes for Christian Studies 5, (Truth): True or false? - includes the story of Galileo*

*Themes for Christian Studies 6, (Truth): Jesus, the way, the truth, the life*

*Themes for Christian Studies 7, (Truth): Those who seek the truth will find it.*

*Themes for Christian Studies 6, (Servant): Spreading the Good News*

## **Biblical References**

### **Bible stories and passages**

Matthew 16:13-20 Peter declared that Jesus was the Son of God, a truth given directly by the Father.

Acts 7:51-60 Stephen gives his life for believing the truth.

Luke 11:9-13 He that seeks finds.

Daniel ch 13 Shadrach, Meshach and Abednego stood up for the true God.

Daniel ch 6 Daniel also stood up for the true God.

Romans 1:20-25 The truth about God is evident in the Creation, but instead they worship idols. Verse 25 says, "They exchange the truth about God for a lie." (GNB)

Matthew 7:15-21 Wolves in sheep's clothing.

John 18:38 Everyone that is of the truth hears my voice.

John 10:1-8 The Good Shepherd. The sheep hear His voice.

Matthew 7:13-14 The broad and narrow way.

Exodus 20:3-4; Isaiah 42 verses 8 & 17 No other gods.

2 Peter ch 2 False teachers.

2 Corinthians 11:13-14 False apostles, and Satan as an angel of light.

1 Peter 5:8 Satan is a roaring lion.

Luke ch 4 Jesus knew how to deal with Satan

### **Memory verses**

Proverbs 3:5 Trust in the Lord with all your heart. Never rely on what you think you know. (GNB)

John 16:13 When the Spirit of truth comes, He will guide you into all truth.

Acts 14:7 God has always given evidence of His existence by the things He does. (GNB)

John 8:32 You shall know the truth and the truth shall set you free.

Proverbs 11:1 The Lord hates dishonest scales, but He is pleased with correct weights.

John 14:6-7 I am the way, the truth and the life.

### **Key Questions**

*about truth*

Who do we believe?

How do we know what is true?

How do we weigh and measure solid objects?

How do we weigh and measure the things we see and hear?

How does Satan try to make us turn away from God?

What did Jesus do when He was tempted by Satan?

*about science*

How do scientists find truth?

How can we use the Bible as a guide to truth about the universe?

What were some of the discoveries made by Galileo about the universe?

What is gravity?

What did he discover about gravity?

How does the earth's gravity differ to that of the moon and other planets?

Why did many people disbelieve the new discoveries of Christian scientists such as Galileo?

Why do we need truth and accuracy in science and not just guess work?

## **Outcomes**

Students will

*Knowledge*

- Study in detail the work of Galileo, and in particular, his discoveries concerning gravity and pendulums.
- Conduct experiments with pendulums
- Conduct experiments with gravity.
- Explain gravitational forces

*Skills*

- Experiment with pendulums and gravity
- Use different kinds of scales for weighing objects
- Use drawings to record experiments and graph results
- Predict
- Manipulate, measure and assemble pendulums

*Values*

- seek truth
- show curiosity to explore the physics of gravity and pendulums
- show patience in experimenting
- show keenness for accuracy in results
- be willing to co-operate
- relate discoveries on the physics of balance to Biblical teaching on balance and truth

## **Activities**

### **a) Gravity**

- Discuss the ways in which the following things fall: a ball, a heavy weight, a light weight, rain.
- Compare the difference in going uphill / upstairs with downhill / downstairs.
- Make your own weighing device from rubber bands. Measure weight by noting the extension of the bands supporting the object that is being pulled down by gravity.

### **Gravity lesson plan**

<http://www.discoveryeducation.com/teachers/free-lesson-plans/gravity-gets-you-down.cfm>

### *Objectives*

Students will understand the following:

1. Without air resistance, all objects would fall with the same acceleration, regardless of mass.
2. Gravity is the force that causes objects to fall.
3. Air resistance, a type of friction, works against gravity to decrease the acceleration of a falling object.

### *Materials*

An encyclopedia or a computer with Internet access should be available to students. The following materials should be provided for each group:

- A variety of object pairs, such as balls of different sizes and weights, or a book and a sheet of cardboard the same length and width as the book
- Objects, such as a feather or a sheet of paper, that encounter more air resistance when dropped than the other objects

### *Procedures*

1. Ask your students if they predict that a heavier or larger object, if dropped from a height, will fall to Earth faster than a lighter or smaller object. Tell them that Galileo Galilei (1564-1642) performed a famous experiment that they are going to replicate in order to confirm or refute their predictions.
2. Have students use the Internet or an encyclopedia to find out about Galileo's experiment in which he dropped objects from the Leaning Tower of Pisa in Italy.
3. Divide the class into groups, giving each group a variety of objects to experiment with.
4. Instruct groups to meet in order to design their own experiments. Remind them that a good experiment should have a control and introduce only one variable at a time. Each group's experimental design should include a chart on which to record the results of each test performed.
5. Have students experiment with the object pairs, dropping them, one at a time, while standing on a chair or desk. Other students in the group should observe closely to see whether one object reached the floor before another or both objects reached the floor at the same time. Students should carefully record their results on their charts. (Students should find that balls of different sizes and weights fall at the same rate of speed, as do a book and a sheet of cardboard the same length and width as the book.)
6. When students try dropping a feather or a sheet of paper from the same height from which they dropped the other objects, they will discover that the feather and the paper fall more slowly. Suggest that they bunch the sheet of paper up into a ball and drop it from the same height. They will find that the ball of paper reaches the floor in less time than the sheet of paper.

7. Have students meet in their groups to discuss possible reasons for these results. They should conclude that air resistance, a type of friction, is slowing down the feather and the sheet of paper.
8. Ask students what they think would happen if they performed the same experiment in a vacuum tube, which has no air in it. (The feather would fall at the same rate of speed as a ball or a brick.)
9. Each student should write a report explaining the results of the experiments and drawing conclusions regarding the effects of both gravity and air resistance on the acceleration of falling objects. Encourage students to accompany their paragraphs with labeled drawings and diagrams.

### **Activities for 'centre of gravity'**

- Discover centre of gravity by experimenting with:
  - mobiles
  - tower constructions
  - making model a see-saw
  - using a beam balance
- Use kitchen scales, bathroom scales and a beam balance.
- Set up see-saws, balancing objects on both ends.
- Move the fulcrum from the see-saw center to investigate how this influences results of above experiment.
- Experiment with cantilevers.
- Make miniature brick arches. Observe the function of the keystone in maintaining balance of forces.
- Examine photographs of ruins that show arches that have survived the centuries.
- Experiment with 'tug-of-war' games to examine balance of forces.
- Experiment with spinning tops.
- Play games with spinning tops. Try to knock opponent out of the circle.
- Play a balancing game, trying to balance on different body parts as directed, e.g. on one hand and one foot; on back or front with arms and legs off the ground.
- Balance bodies when blindfolded. Note effects of spinning, (dizziness).
- Walk while balancing a book on the head.
- Walk along a narrow beam.
- Relate the experience of walking along a narrow beam to the Biblical reference to the broad and narrow way.

### **b) Pendulums**

One of Galileo's key experiments involved observing pendulums. Using a variety of different lengths and weights, he carefully noted each pendulum's period (the amount of time it takes for a pendulum to make one complete swing). Galileo's observations allowed him to determine that the period of a pendulum's swing is affected by its length but not its weight—an observation that may run counter to what students expect.

To begin the following activities, lead a class discussion about the fact that scientists cannot rely on intuition alone, but must perform experiments to test their hypotheses. Ask your students to replicate Galileo's pendulum experiments using varying lengths of string with different numbers of washers attached to the ends. Students should measure each pendulum's length, weight, and period, making sure that they keep the amplitude, or angle to which the pendulum is raised, consistent. When their observations are complete ask them to record their data in a chart. (see *Beacon Media* 'student work books').

### **Activities**

- Free play with pendulums.
- Define a pendulum.
- Experiment using pendulums with the same mass bob but different lengths. Use the steps of the Scientific Method.
- Discuss applications of pendulums, e.g. clocks, demolition.
- Construct a giant pendulum several metres long. Students make predictions which can then be checked.
- Use pendulums of the same length, but attach a variety of different mass bobs. Use the same mass bob and the same length line, but vary angles of release. Does this affect the number of periods per unit time?
- Release pendulums from different heights and time the number of periods over 3 minutes. Does release height influence the number of periods?
- Release pendulum so that it follows different paths. Include a circular path. Does the path the bob follows influence the number of periods the pendulum swings through in 2 minutes?
- Graph results, infer from the graphs, test inferences.
- Set up a set of skittles and use the pendulum bob as the 'bowling ball'.
- Link pendulums together and explore the effect of releasing one pendulum on its partner.
- Discuss whether the evidence of design in the forces that control pendulums suggests the product of random forces, or God the designer.

### **Assessment**

Students are to write a report on their experiments:

1. Describe what they did.
2. Record the results.
3. Illustrate and label diagrams.
4. Write a conclusion.

You can evaluate your students by using the following three-point rubric:

*Excellent:* results accurately reported; illustrations or diagrams clearly labeled; conclusions explained logically in well-written, well-organized paragraphs

*Satisfactory:* results adequately reported; illustrations or diagrams included; paragraphs lacking in organization

*Not satisfactory:* reporting of results sketchy or inaccurate; no illustrations or diagrams; conclusions lacking in logic; paragraphs poorly organized.

**Assess spiritual development:**

What have the students learned from the study of pendulums and gravity...

- about God?
- about doing what God wants me to do?
- about the Bible?

**Learning Connections**

**English:** Discuss the story of Galileo, (*Themes for Christian Studies 5 (Truth)*). Outline his discoveries. Discuss the difficulties he faced in standing up for the truth.

**Mathematics:** graphs and calculations involved in Science experiments

**Art:** Make mobiles that balance, finding the centre of gravity for the elements of the mobile.

**Physical Education:** Conduct gymnastics and balancing activities which rely on finding the body's centre of gravity; Use a rope swing to make yourself into a giant pendulum.

**Additional Beacon Media resource**

Gravity and Pendulums – Student workbook