God is Truth Year 5
Gravity and Pendulums

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.

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?

Activities
a) Gravity
- Predict the ways in which the following things fall: a ball, a heavy weight, a light weight, rain.
- Study the work of Galileo Galilei (1564-1642) who performed a famous experiment, dropping two objects from the Tower of Pisa.
- Replicate his experiment. First predict whether a heavier or larger object, if dropped from a height, will fall to Earth faster than a lighter or smaller object. Use balls of different sizes, books, paper, cardboard etc. Do objects of different sizes and weights fall at the same rate of speed?
- Try comparing a sheet of paper with a ball of paper. Ask students to suggest why the sheet falls more slowly, (air resistance)
- Write a report explaining the results of the experiments and draw conclusions.
- Compare the difference in going uphill / upstairs with downhill / downstairs.

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 '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.

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.

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 machines.
- 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'.

Values education Year 5
God is Truth
Honesty

Honesty is…

- speaking the truth
- not cheating
- not stealing
- not exaggerating
- being trustworthy
- being yourself and not trying to be someone you are not.

Activities

1. Sometimes people think they are telling the truth by saying the right words, but the meaning of their words is not completely truthful. This is called a white lie. Here is an example:
   John is asked to clean his room. He goes to his room and pushes all the things on the floor under the bed. The room looks neat and tidy but really it isn't.
   Mum calls, "John, have you cleaned your room?"
   John answers, "Yes."
   Why would you say this is not telling the truth?

2. Why would you like your best friends to be honest?
3. Which of these are caused by dishonesty:
   a) shop-lifting (stealing)
   b) fighting
   c) swearing
   d) cheating in a test
   e) riding on a bus without a ticket

What does the Bible say about honesty?

Acts 5 Ananias and Sapphira
James 1:22 Be doers of the word and not hearers only.
Proverbs 8:7 My mouth shall speak truth.
Proverbs 12:17 When you tell the truth, justice is done.

Practical Science 1: Gravity and Pendulums

Balancing Act (Gravity)

http://www.madaboutscience.com.au/store/index.php?main_page=page&id=20

Balance a can on its bottom rim and amaze your friends. Suitable for kids aged 6+

What you will need:

- 2 empty 375ml cans
- 100mls of water approx

What to do:

1. Pour about 100mls of water secretly into one can.
2. Have someone try to balance the other empty can on its bottom rim. It is impossible.
3. Then amaze them, by easily balancing your 'magic' can on its bottom rim (they don't need to know it has water in it).

How does it work?

It works because the water adds weight to the bottom of the can, changing its centre of gravity and allowing it to balance in impossible ways.

Practical Science 2: Gravity and Pendulums

Raw or Boiled Egg? (Gravity)

http://www.sciencekids.co.nz/experiments/eggboiledraw.html

Two eggs look and feel the same but there is a big difference, one is raw and the other hard boiled, find out which is which with this fun experiment.

What you'll need:
Two eggs, one hard boiled and one raw. Make sure the hard boiled egg has been in the fridge long enough to be the same temperature as the raw egg.

Instructions:

1. Spin the eggs and watch what happens, one egg should spin while the other wobbles.
2. You can also lightly touch each of the eggs while they are spinning, one should stop quickly while the other keeps moving after you have touched it.

What's happening?
The raw egg's centre of gravity changes as the white and yolk move around inside the shell, causing the wobbling motion. Even after you touch the shell it continues moving. This is because of inertia, the same type of force you feel when you change direction or stop suddenly in a car, your body wants to move one way while the car wants to do something different. Inertia causes the raw egg to spin even after you have stopped it, this contrasts with the solid white and yolk of the hardboiled egg, it responds much quicker if you touch it.

Practical Science 3: Gravity and Pendulums

Gravity as a pump – Make a siphon

Did you know that you can use the earth's gravity to help you pump water? This is very helpful if you have a flood!

What you will need:

- Approx 350 cm (10 feet) of transparent flexible tubing (2-4 cm in diameter (half inch)
- Kitchen sink
- Large bucket
- Food colouring
- Ladder or stack of books
- Chair

What to do

1. Coil the flexible tube and put it in your kitchen sink.
2. Put the plug in the sink, then start to fill the sink with water.
3. Put one end of the hose to the tap and the other end in the sink. Run the tap to get all the air out of the hose.
4. Put your thumbs over both ends of the hose, put one end in the sink and bring one end to the bucket on the floor.
5. Take your thumbs off and see what happens.
6. Let the water drain out of the sink completely.
7. Now repeat the experiment, this time draining the water from the bucket back into the sink.
8. Now put the bucket on a chair. Will your pump still work?
9. Now put the bucket even higher. e.g. on a ladder or a stack of books. How high does it have to be before the water will drain back into the sink?

Why does it work?

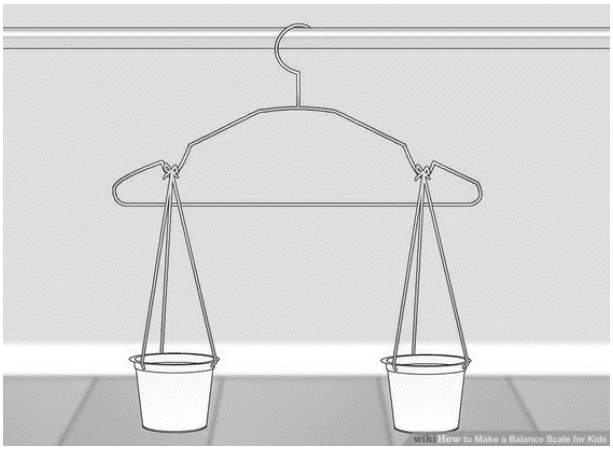
Why does the water drain out of the sink?

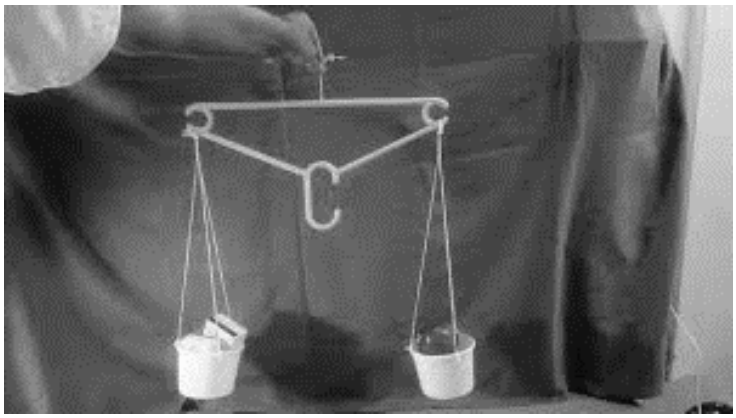
The water in the sink wants to come down seeing it is above ground level. This is due to the force of gravity.

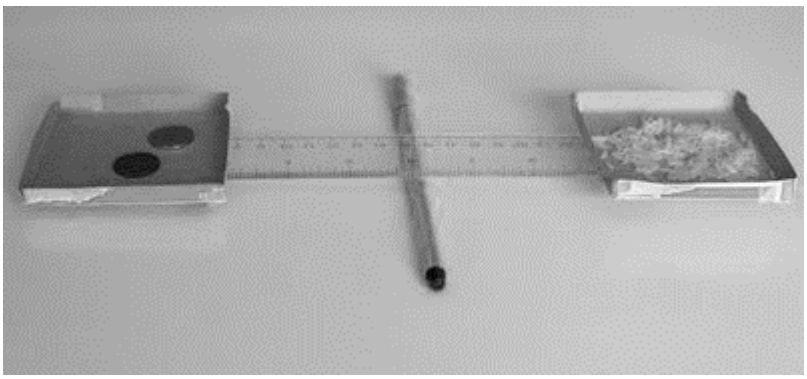
Practical Science 4: Gravity and pendulums

Build your own beam balance (balance scale)

*Live a life that **measures up** to the standard God set when He called you.*
Ephesians 4:1 (GNB) The Bible is our measure that we use to weigh up what we see and hear.







Practical Science 5: Pendulums

Build a pendulum

Follow these steps to build a pendulum:

1. Take a ball (the 'bob'), some string, a ruler, and strong sticky tape.
2. Place the ruler on a desk so that 10 cm (4 inches) of the ruler is on the desk and 20 cm (8 inches) extends over the side. Tape it to the desk.
3. Wrap one end of the string around the ball once. Wrap a piece of tape around the ball, covering the string. Put two pieces of tape where the string hangs off the ball.
4. Tie or tape the other end of the string around the ruler.

Now you are ready to do the experiment.

1. Set the pendulum in motion by pulling it up and letting it go.
2. Predict what will happen.
3. Observe how the pendulum swings back and forth (periods), and time how long it takes to stop. *(Note – one swing back and forth makes one period)*
4. Write your results.
5. Why you think it happened.
6. Now repeat the experiment using different lengths of string.
7. Record any differences in results.

	Prediction	**Results**	**Why do you think this happened?**
Pendulum 1			
Pendulum 2 (longer string)			
Pendulum 3 (shorter string)			

Practical Science 6: Pendulums

Bobs of different mass

1. Make a pendulum using the same length of string as the last one, but a bob of different mass. (The ball was the 'bob' in the first experiment.) e.g. You could use a marble, a bigger ball, a rock, a pebble
2. Predict what might happen.
3. Set the pendulum in motion and count the number of periods it completes until it stops. Write your results and why you think this happened.
4. Repeat the experiment using different bobs of different mass.

Type of bob	Prediction	Results	Why do you think this happened?

Practical Science 7: Pendulums

Pendulums can follow different paths

1. Take a pendulum that you have already made.
2. Release pendulum so that it follows a particular path, e.g. straight line, at a different angle or in a circular/oval path.
3. Count the number of periods the pendulum completes in 2 minutes.
4. Record your results.
5. Now repeat the experiment and set the pendulum swinging to follow a different path.
6. Examine your results to see whether the path followed affected the number of periods pendulum made in 2 minutes.
7. Explain why this happened.

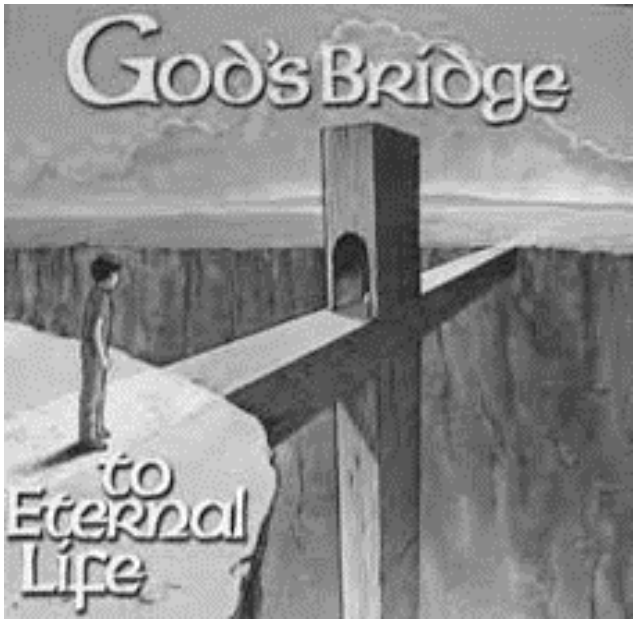
Type of path	Prediction	Results	Why do you think this happened?

Art Year 5

God is Truth

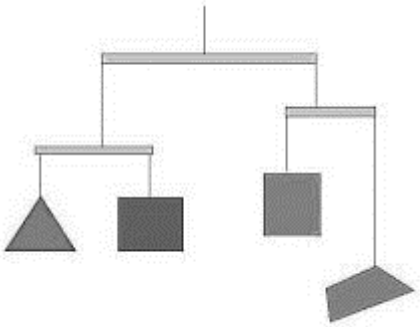
Pendulums and gravity

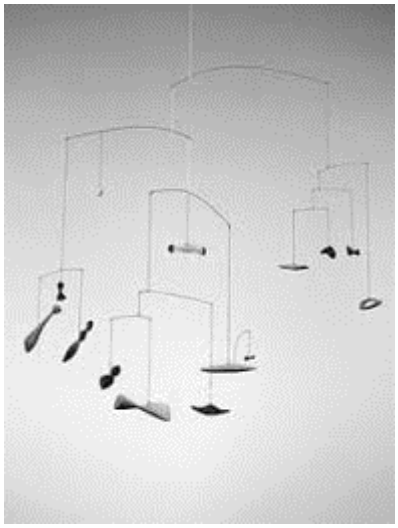
Biblical wall display: Jesus said, “I am the way, the truth and the life. No one comes to the Father except through me.”



Construction

Students can make 3D mobiles. They can find the centre of gravity of each piece to make the parts balance.





Galileo Galilei

Biography

Galileo Galilei lived in Italy from 1564 -1642. People in those days believed that the earth was the centre of the universe. They thought that the sun, moon and stars moved around the earth. Because the great teacher, Aristotle, had said that this was so, everyone believed it. Everyone, that is, except Galileo. He was one who wanted to find out truth for himself.

Galileo's brain couldn't rest. He had heard of a boy in Holland who had looked through a tube with spectacle glass in each end, and who found that distant objects looked much bigger. Galileo was determined to work out how this gadget worked.

He soon did. But Galileo's invention was far superior to the Dutch one. Through his telescope he could see Jupiter, which had four moons, Saturn with its rings, the spots on the sun and the milky way. Now that he had seen these things for himself, he was sure that the earth moved around the sun, and not the sun around the earth.

Galileo was very excited. He now understood that God's creation was greater than people had ever realised. Enthusiastically he started telling people of his discovery.
However, trouble lay ahead. Galileo was called before the Pope.
"How dare you defy the teachings of Aristotle!" shouted the Pope. "You must promise not to talk or write about your theory!"

Galileo kept quiet for seventeen years, but continued working silently. Then finally, he could keep quiet no longer. He published a book of his discoveries. He was brought before the Pope again.
"Deny your theory or you will be imprisoned!" the Pope demanded.

Now quite old, and unable to bear the thought of imprisonment or torture, Galileo decided to agree that he had made some mistakes. But in his heart he knew that he had discovered the truth. Galileo lived the rest of his life quietly, working until his death in 1642.

In due time, the world found out that his discoveries were true, for truth cannot be stopped by threats of imprisonment or torture. Soon others took up the teachings of Galileo, which opened people's eyes to the laws of the Creation and the glory of the stars.

Activities – Galileo searches for truth

1. Where did Galileo live?
2. Which great teacher did everyone believe in those days?
3. What did people believe about the earth?
4. Draw a picture of the earth in the centre and the planets, sun moon and stars orbiting around it.
5. How did Galileo prove that this was not so?
6. Now draw the solar system as it really is, with the sun at the centre.
7. How do you think Galileo would have felt when no one would believe him?
8. How does God feel when so many people do not believe the truth about Him?

Ignatius of Loyola

Biography

Ignatius was born in Loyola, Spain in 1491. When he was quite young he became a soldier for King Ferdinand. He was wounded in both legs by a cannon-ball. Gradually the wounds healed but one leg was shorter than the other. He was very vain about his appearance and couldn't bear the thought of walking with a limp so he insisted that the wound be reopened and part of the bone sawn off. There was no such thing as anesthetic and the operation was terribly painful but he bore it. Afterwards he became very ill and for a long time was very bored as you would expect in one who had been used to a life of action. He asked for books to read, 'A romance, a story; anything to pass away the time."

Among other books, they brought him book about the life of Jesus Christ containing stories from the Bible. The Bible itself was only available to trained Catholic Priests in those days and much to his surprise Ignatius found that this was the book he wanted to read again and again. Gradually Jesus and his life and death became so real and important to him that he decided he would study to be a priest. He had once been proud, vain, and noble and a soldier, but his decision to train for priesthood meant he had to begin at the beginning and sit beside schoolboys learning Latin. They teased him but he persevered and soon he was ready to go the University of Paris to finish his training.

Ignatius gathered a group of men round him who were prepared to make special promises to give away their money and possessions, stay poor, be very strict with themselves and offer themselves for special service wherever they were needed. They called themselves the 'Company' or 'Society of Jesus' (now known as Jesuits).

Some of them set themselves to give the very best education possible to the young so that they would know all about the Christian faith and help people to live in God's way. Some of the 'Company' became missionaries to far countries and to people who had never heard about Jesus Christ.

Although often sick, Ignatius continued his work until his death in 1556.

Gravity and pendulums 1

Student activities

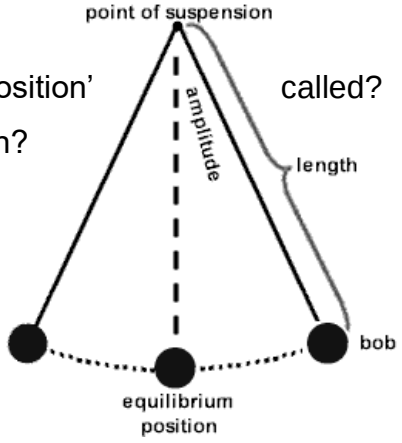
What is a pendulum?

A *pendulum* is a weight suspended on a string (or wire) so that it can swing freely. The weight is called a ‘bob’. When a pendulum is set into motion sideways from its resting position it will always go back to its resting position. The bob goes back to the resting position because of the force of gravity.

The resting position is called ‘the point is equilibrium’. To get back to its point of equilibrium the pendulum swings back and forth. This is called ‘oscillation’. We say that the swinging pendulum is ‘oscillating’. The distance the pendulum covers while oscillating is called ‘amplitude’.

The time for one complete cycle, (a left swing and a right swing), is called the *period*. The time for one complete period depends on the length of the string.

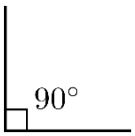
1. What is a ‘bob’?
2. What is the ‘resting position’ called?
3. What does ‘oscillating’ mean?
4. What is a period?



Gravity and pendulums 2

The earth's gravity and pendulums

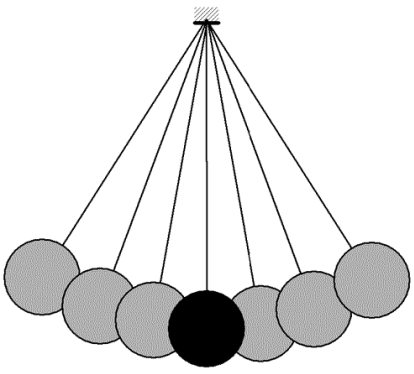
The Earth's gravity attracts the 'bob' of the pendulum. When the bob is hanging still, the string is hanging straight down at a 90-degree angle to the Earth. This is because gravity is pulling the string and the bob to the Earth. The pendulum will stay there at rest until a force causes it to move.



When the pendulum is set into motion, it keeps moving, unless there is a force that acts to make it stop.

Gravity works on the pendulum while it is moving. The force of the movement becomes less as the force of gravity acts on the pendulum. The pendulum slows down. Finally the bob returns to the starting point and the pendulum is still once again. The force of gravity pulls the pendulum down toward the Earth.

Why does a swinging pendulum finally stop?



Gravity and pendulums 3

What are pendulums used for?

Pendulums are used to regulate pendulum clocks, and are used in scientific instruments such as accelerometers, (which measure how fast things go), and seismometers, (which measure the strength of earthquakes). The word 'pendulum' comes from the Latin word *pendulus*, meaning 'hanging'. A swing is a pendulum. A Tarzan rope is a pendulum.

Task

Draw and label some things that work on the principle of the pendulum.

How do you make a pendulum?

A simple pendulum can be made with a string and a weight hung from a single point. Other material can be used for the string, such as a rod or wire.

Task

Draw a pendulum that you could make.

Gravity and pendulums 4

Do pendulums with different bobs swing at different rates?

The weight, (the bob), can be of any weight. It doesn't matter if the bob is heavy or light. Gravity will cause pendulums to swing at the same rate. However other forces such as wind or pushing can vary the rate. Think of a swing. If you lift the swing and let it go, and then walk away, it will act as a pendulum and gradually come to a stop. But if someone pushes the swing then it may go higher, depending on the strength of the push.

Task

Why do pendulums swing at the same rate?

What could vary the rate?

Gravity and pendulums 5

Who discovered the law of the pendulum?

The science of the way pendulums swing was discovered by Galileo Galilei in 1602. As a result of Galileo's discovery, pendulums were used for accurate timekeeping technology until the 1930s. Galileo Galilei was born in Pisa, Italy on February 15, 1564. He was the oldest of seven children. His father was a musician and wool trader. In those days parents often chose the occupation their children would follow. His father wanted him to become a doctor so that he could earn a lot of money, but Galileo wanted to become a monk. A monk was someone who dedicated their life to prayer and learning about God. He went to a school that was run by monks and here he developed a strong faith in God and marveled at the creation…especially the mathematical laws that held the universe together.

Although Galileo was not able to serve God by becoming a monk, he did serve God in another way. His keen interest in science and mathematics led him to make remarkable discoveries that changed the world, including the law of the pendulum.

Who discovered the law of the pendulum?

What were pendulums used for?

Gravity and pendulums 6

Galileo's discoveries: telescope and pendulums

One of Galileo's discoveries was the telescope, which he used to prove that the earth was not the centre of the universe. He discovered that the earth and other planets in our solar system travel around the sun. This was a new idea and different to what had been previously believed. Galileo also invented the thermometer and made some important discoveries about gravity.

At age twenty, Galileo noticed a lamp swinging overhead while he was in a cathedral. Curious to find out how long it took the lamp to swing back and forth, he used his pulse to time large and small swings. Galileo discovered something that no one else had ever realized: the period of each swing was exactly the same. (The period is the time in which a pendulum takes to return to the position it was in at the beginning.)

Galileo also noticed that the period of the pendulum is not dependent on the material from which it is made or on its weight. The pendulum's period is influenced by its length alone. The longer the pendulum string, the longer its period.

What did Galileo discover about the universe?

How did Galileo become interested in pendulums?

How did he find out that pendulums have a constant period?

Gravity and pendulums 7

Galileo’s famous discovery about gravity

At the time that Galileo arrived at the University, some debate had started up on a "law of nature”, that had been believed by an earlier scientist, Aristotle. The belief was that heavier objects fell faster than lighter objects. Aristotle's word had been accepted as gospel truth, and there had been few attempts to actually test Aristotle's conclusions by actually conducting an experiment!

According to legend, Galileo decided to try. He needed to be able to drop the objects from a great height. The perfect building was nearby: the Tower of Pisa, 54 meters high. Galileo climbed up to the top of the building carrying a variety of balls of varying size and weight, and dumped them off of the top. A huge crowd of students and professors stood at ground level, eager to see the result. They all landed at the base of the building at the same time. Galileo had proved that Aristotle was wrong!

Task

What is the connection between Galileo’s discovery on the Tower of Pisa and the principle that different weights of bobs swing at the same rate?

Gravity and pendulums 8

About truth

There were many times in Galileo's life when he had to stand up for the truth. People were not willing to change from their old ideas, that the earth was the centre of the universe. Galileo proved earlier scientists wrong with his new discoveries. Life was not easy for him and he was faced with much opposition.

Christians know the God of all truth, and we can look to His book, the Bible, for truth. We will not always be popular, but God wants us to be strong in standing for the truth.

Jesus said, "You shall know the truth and my truth will set you free." (John 8:32)

a. How do you think Galileo made such remarkable discoveries?
b. What is something that is true today, that many people do not believe?
c. How do we know the Bible is true?
d. If someone told you that you can get to heaven by following any religion you like, what would you say?
e. Read these Bible passages and write a short reflection for each one. What do these verses tell us about truth?

John 18:38; John 10:1-8; Matthew 7:13-14; John 14:5-7