GOD IS TRUTH

Gravity and Pendulums

Term 4

Year 5

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.

Thinking Skills

Year 5 Truth

Gravity and pendulums 1 Invent a game that uses a beam balance. 	**Gravity and pendulums 2** To prove the theory of gravity, Galileo dropped a feather and a rock from the top of the tower of Pisa. What else could he have dropped to prove the theory?
Gravity and pendulums 3 Make an improvement to a playground swing so that it is not so dangerous. 	**Gravity and pendulums 4** Design a children's playground that is made up of equipment that relies on gravity.
Gravity and pendulums 5 Work out a sequence of 5 balancing exercises that do not use equipment. List the activities, e.g. balance on the left foot. 	**Gravity and pendulums 6** Invent a game that uses a pendulum to hit a target.

Gravity and pendulums 1

Student activities

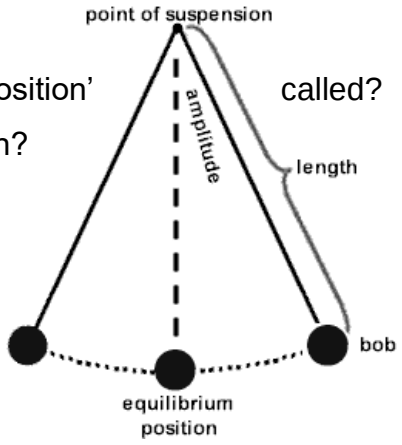
What is a pendulum?

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.

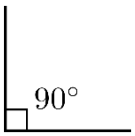
1. What is a ‘bob’?
2. What is the ‘resting position’ called?
3. What does ‘oscillating’ mean?
4. What is a period?



Gravity and pendulums 2

The earth’s gravity and pendulums

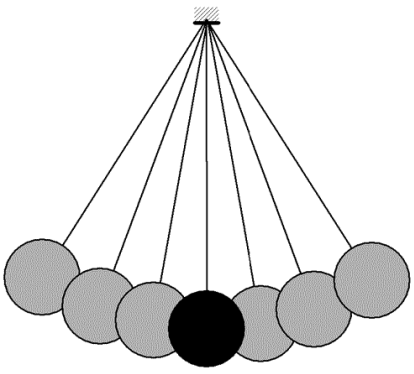
The Earth's gravity attracts the ‘bob’ of the pendulum. When the bob is hanging still, the string is hanging straight down at a 90-degree angle to the Earth. This is because gravity is pulling the string and the bob to the Earth. The pendulum will stay there at rest until a force causes it to move.



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?



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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?

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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?

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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?

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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?

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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