

Unit Three SECTION J: Religion and Science

**PART TWO: The Relationship between Religion and Science**

<b>Syllabus Aim</b>	<ul style="list-style-type: none"> <li>- To develop an awareness of the changing nature and methods of the scientific and theological enterprises</li> <li>- To examine some key moments in the history of the relationship between religion and science</li> <li>- To examine some of the issues and debates concerning the contemporary relationship between religion and science</li> <li>- To explore the ethical implications of scientific progress</li> </ul>
<b>Syllabus Objectives</b>	<p><i>Knowledge</i></p> <ul style="list-style-type: none"> <li>- be familiar with key moments in the relationship between science and theology from the Renaissance to the present day</li> <li>- be able to identify possible future points of conflict and communication for science and theology</li> </ul> <p><i>Understanding</i></p> <ul style="list-style-type: none"> <li>- be aware of the lack of understanding of these connections in the past and the consequent tensions between science and theology</li> <li>- have an awareness of the limits and possibilities of the dialogue between religion and science</li> </ul> <p><i>Skills</i></p> <ul style="list-style-type: none"> <li>- engage critically in current debates between religion and science</li> <li>- identify ethical implications of scientific progress</li> </ul> <p><i>Attitudes</i></p> <ul style="list-style-type: none"> <li>- appreciation of the limitations of scientific and religious fundamentalism</li> <li>- openness to the insights of science and religion in current debates</li> </ul>

**Topic 2.1 Science and religion go their separate ways**

**Procedure**

*Introduction Galileo and his context; the beginnings of modern science*

The combination of Greek Philosophy and Christian doctrine provided the overall vision of the medieval world that Galileo inherited.

*Research Assignment:* THE MEDIEVAL WORLD-VIEW & THE BEGINNINGS OF MODERN SCIENCE  
 SOURCES: Religion and Science – F. McCarthy & J. McCann etc.

- Assignment: Pick two key words associated with the medieval understanding of the universe and write a paragraph describing the world-view that each reflects.
- Or
- Draw a diagram describing the medieval understanding of the universe.
  - Draw a diagram describing Copernicus’ understanding of the universe.

*Galileo and his context - the methods and theories of Galileo*

*Read Student Work:* GALILEO’S METHODS AND THEORIES

Discuss: In what ways did the methods and ideas of Galileo contribute to the rise of modern science? Take feedback and conclude explaining how Galileo pioneered the scientific method, which brought together observation, and experimentation with mathematical theory giving rise to what he called ‘thought experiments’. This led to conflict between new theories based on observation and the old theories based on appeals to authority and tradition e.g. Copernicus versus Aristotle

## **Galileo and his context - the reaction from the secular and religious world**

*Read Student Work:* GALILEO

Discuss: What reaction did Sagredo expect from the religious world to Galileo's discoveries?  
What reaction did Galileo expect from the religious world to his discoveries?

*View Video:* Galileo's Daughter- Channel4. com /History

*Or Read Student Work:* Galileo – Video Note

*Or Read extracts from Galileo's Daughter- Dava Sobel 1999 Fourth Estate Ltd (ISBN 1-85702-712-4)*

Discuss: Did Galileo consider his scientific ideas to be in conflict with his religion? Why? Why not?

Take feedback and conclude explaining how Galileo spoke of two Books: the Book of the Scripture and the Book of Nature. The Bible teaches how one goes to heaven, not how the heavens go.

*Research Assignment:* GALILEO - THE REACTION FROM THE SECULAR AND RELIGIOUS WORLD  
SOURCES: Religion and Science – F. McCarthy & J. McCann etc.

Assignment: Re-enact Galileo's trial in class with role cards for the main characters.

## **Assessment Questions**

'Science is never done in a vacuum. It is always influenced by the world around it.'  
Briefly describe the world from which Galileo's ideas were born.

*Or*

Briefly describe the main theories of Galileo.

Outcomes: As a result of studying this section, students should be able to -

- present a portrait of the world from which Galileo's ideas emerged
- describe the methods Galileo used
- present an summary of Galileo's main findings and ideas
- explain the various sources of modern science
- show the various reactions of religions to the rise of science.

### *Student Work: GALILEO'S METHODS AND THEORIES*

Medieval thought was based on the deductive method of Aristotle - it deduced what should happen from universal first principles. Starting from the most general principles, moving to the more particular and concrete, from the top down. In contrast Galileo's inductive method meant arriving at a theory from observation. Beginning with concrete data, moving to more general patterns and hypotheses to explain the data, from the bottom up. Galileo struggled against a background of religious authority that gave Greek notions of perfection priority over observation and experimental evidence. Galileo's telescope was the instrument that punctured the deductive vision of the world and showed it to be flawed. Looking through the telescope he saw that the moon was pockmarked with mountains and valleys like the earth. Hence the earth was not unique, but a moving planet like the others. Jupiter had four satellites orbiting it; no longer could one hold that heavenly bodies revolve exclusively around the earth. He observed phases in Venus the only explanation for which was that Venus moves around the sun and not the earth. He was overwhelmed by the vast quantity of stars in the Milky Way which could not be enlarged by a telescope and so must be vast distances away beyond the planets. His results, published in 1610 in *The Starry Messenger*, revolutionised astronomy and laid the foundations of the modern science of motion. For Galileo the structure of the physical world cannot be deduced from first principles; observation, measurement and experimentation can only discover how it works. Appeal to authorities, was no substitute for the hands-on investigation of the physical world.

Galileo was very religious and wished no quarrel with his Catholic faith; he was anxious to relate his discoveries about the world to his Christian understanding. So he tried hard to resolve the apparent contradiction between Copernican astronomy and the Bible. For Galileo, the key question was: how should the Bible be read and how should that reading affect or be affected by science? Galileo maintained that Christianity had taken for granted the Aristotelian view and both had become confused. An attack on Aristotle should not be seen as an attack on the Bible. In a letter to Grand Duchess Christina 1615 Galileo tried to show the compatibility between the Bible and the Copernican view by reference to Francis Bacon's "two books" metaphor - God reveals himself in the Book of Scripture and the Book of Nature. Galileo made an important contribution to the "two book" metaphor and to biblical interpretation by questioning the frequently held assumption that they were written in the same language. He argued that the Book of Nature was written in the language of mathematics, whereas the Book of Scripture included poetry and other forms of symbolism. Caution was thus needed about trying to read science, such as astronomy out of Scripture texts - something which prompted his famous quote from Cardinal Baronius that the Bible is intended to teach "not how the heavens go but how one goes to heaven".

Galileo's combined mathematical reasoning with empirical observation and experiment giving rise to what he called "thought experiments" i.e. constant interaction between mathematical abstractions and the concrete world of our experience, between theoretical ideas and experimental data. This application of mathematical methods to the physical world was the most significant change to the ancient world-view in the seventeenth century. For Galileo the physical world was not mystical, but particles of matter in motion, and mathematics were the key to understanding it. Galileo's understanding of motion undermined Aristotle's physics of "common sense". Aristotle's physics of "common sense" appeared reasonable in the Middle Ages: it is "obvious" to the observer that the sun moves from east to west and the earth is still; commonsense suggests that the earth does not spin on its axis. Aristotle answered the question why a stone falls to earth in terms of purpose or goal; everything is pulled into the centre of the universe by a mystical impulse, it returns to its "natural" place of rest as a heavy element.

Galileo asked not why objects fall (telos or goal), but how they fall. This was a crucial move away from explanations in terms of mystical purposes in matter to mechanical causes; there are forces and masses at work rather than a hierarchy of purposes. He endeavoured to discover the laws governing motion and these could only be detected by reasoning and not by our senses. Galileo's formulation of the law of falling bodies began a progressive and increasingly successful description of the world using the tool of mathematics. He was able to demonstrate that an object follows the path of a parabola with two independent motions: a uniform, forward horizontal motion and an accelerated, downward or vertical motion. In 1971, the Apollo 15 astronauts dropped a hammer and a feather in the near vacuum of the Moon. The two objects plummeted to the lunar surface, untroubled by air resistance, and landed at precisely the same moment, proving Galileo correct 328 years after his death.

*(Adapted from Channel 4 Website & Religion and Science – F. McCarthy & J. McCann)*

## Student Work: GALILEO



- The time is 10TH JANUARY 1610
- The place is Galileo's Workroom in Padua
- The setting is Galileo and Sagredo, wrapped in thick cloaks, stand at the telescope pointed towards the night sky

*Sagredo:* The edge of the crescent is quite uneven, jagged and irregular. In the dark half, near the luminous edge are luminous spots. They appear one after the other. From these spots the light streams over ever-widening areas until it merges into the greater, luminous part.

*Galileo:* How do you explain those luminous spots?

*Sagredo:* It cannot be.

*Galileo:* But it is. They are mountains.

*Sagredo:* On a star?

*Galileo:* Giant mountains. Whose summits are gilded by the rising sun, whilst all around night still covers their slopes. You see the light descending from the topmost peaks into the valleys.

*Sagredo:* But that contradicts all astronomy for the last two thousand years.

*Galileo:* Yet that's how it is. What you see has never been seen by any man besides myself. You are the second.

*Sagredo:* The moon cannot be an earth with mountains and valleys, any more than the earth can be a star.

*Galileo:* The moon can be an earth with mountains and valleys, and the earth can be a star. An ordinary heavenly body – one among thousands. Look again. Do you see the darkened part of the moon quite dark ?

*Sagredo:* No. Now when I look closely I can see a pale, ashen light upon it.

*Galileo:* What sort of light could that be?

*Sagredo:* ?

*Galileo:* It's light from the earth.

*Sagredo:* What's nonsense. How can the earth shine - a dead body, with its mountains and forests and seas?

*Galileo:* In the same way as the moon shines. Both stars are illuminated by the sun - that is why they shine. What the moon is to us, we are to the moon. Sometimes it sees us as a crescent, and sometimes full, and sometimes not at all.

*Sagredo:* So there would be no difference between the moon and the earth?

*Galileo:* Evidently not.

*Sagredo:* Not ten years ago a man was burnt in Rome. His name was Giordano Bruno and he alleged just that.

*Galileo:* He did. And now we can see it. Keep your eye at the telescope Sagredo. What you see means that there is no difference between Heaven and Earth. Today is the tenth of January, sixteen hundred and ten. Mankind will write in its journal: Heaven abolished.

*Sagredo:* That is appalling

*Galileo:* I have discovered yet another fact. Perhaps even more astonishing. I am now going to show you one of the Shining, milk white clouds of the Galaxy. Tell me what it is composed of.

*Sagredo:* Those are stars. Countless stars.

*Galileo:* In the constellations of Orion alone there are five hundred fixed stars. Those are the many worlds, the numberless others, the further stars of which Giordano spoke. He did not see them; he predicted them.

*Sagredo:* But even if the earth is a star, that's still a long way from the assertions of Copernicus that it revolves round the sun. There is no star in Heaven round which another one revolves. Except' that the moon revolves round the earth.

*Galileo:* Sagredo I have been wondering. Since the day before yesterday I have been wondering. There is Jupiter. He focuses on it. There are four smaller stars close by it, which you only see through the telescope. I saw them on Monday, but took no particular notice of their position. Yesterday I looked again. I could have sworn that all four had changed their position. I made a note of it. Now their position is different again. What's this? I saw four. Excitedly: Look! Look!

*Sagredo:* I see three.

*Galileo:* Where is the fourth? Here are the tables. We must calculate what movement they could have made.

*They set to work excitedly*

- Galileo:* It is proved. The fourth can only have gone behind Jupiter, where it cannot be seen. There you have a star round which another revolves.
- Sagredo:* But the crystal sphere to which Jupiter is attached?
- Galileo:* Yes, Where is it now? How can Jupiter be attached to anything when other stars circle round it? There is no framework in Heaven, there is no fixity in the universe. There is another sun!
- Sagredo:* Calm yourself. You think too quickly.
- Galileo:* Quickly! Rouse yourself, man! What you have seen, no one has seen before. - They were right.
- Sagredo:* Who? The Copernicans?
- Galileo:* And the others! The whole world was against them, and they were right.
- Sagredo:* Galileo calm yourself !
- Galileo:* Sagredo, exite yourself !
- Sagredo:* Will you stop roaring around like a lunatic?
- Galileo:* And will you stop standing there like a fool – when the truth has been discovered.
- Sagredo:* I am not standing like a fool, but I tremble lest it may in fact be truth.
- Galileo:* What?
- Sagredo:* Have you entirely lost your senses? Do you really no longer know what you are involved in, if what you see there is true? And you go shouting about for all the world to hear: that the earth is a star and not the centre of the universe.
- Galileo:* Yes! And that the whole, vast universe with all its stars does not revolve round our tiny earth - as must be obvious to everyone.
- Sagredo:* So that there are only stars there! - And where then is God?
- Galileo:* What do you mean?
- Sagredo:* God! Where is God?
- Galileo:* Not there! Any more than he could be found on earth, if there were beings up there and they were to seek him here!
- Sagredo:* Then where is God?
- Galileo:* Am I a theologian? I'm a mathematician.
- Sagredo:* First and foremost, you are a man. And I ask you, where is God in your universe?
- Galileo:* In us or nowhere.
- Sagredo:* As the heretic Giordano said?
- Galileo:* As the heretic Giordano said.
- Sagredo:* That was why he was burnt! Not ten years ago!
- Galileo:* Because he could prove nothing. Because he only stated it.
- Sagredo:* Galileo, I have always regarded you as a shrewd man. For seventeen years in Padua and for three years in Pisa you patiently instructed hundreds of pupils in the Ptolemaic system, which the Church supports, and the Scriptures, on which the Church is founded, confirm. You thought it untrue, like Copernicus; but you taught it.
- Galileo:* Because I could prove nothing.
- Sagredo:* And you believe that makes a difference?
- Galileo:* All the difference in the world! Look here, Sagredo. I believe in mankind, and that means I believe in its common sense. Without that belief I should not have the strength to get up from my bed in the morning.
- Sagredo:* Then I will tell you something. I do not believe in it. Forty years among men has consistently taught me that they are not amenable to commonsense. Show them the red tail of a comet, fill them with black terror, and they will all come running out of their homes and break their legs. But tell them one sensible proposition, and support it with seven reasons, and they will simply laugh in your face.
- Galileo:* That is untrue - and a slander. I cannot understand how you, believing such a thing, can yet love science. Only the dead are no longer moved by reason.
- Sagredo:* How can you confuse their miserable cunning with reason?
- Galileo:* I am not speaking of their cunning. I know they call a donkey a horse when they want to sell, and a horse a donkey when they want to buy. That is their cunning. The old woman who, on the eve of a journey, gives her mule an extra bundle of hay with her hand; the mariner who, when laying in stores thinks of storms and calms ahead; the child who pulls on his hat when it is proved to him that it may rain - they are my hope - they all listen to reason. Yes, I believe in the gentle power of reason, of commonsense, over people. They cannot resist it in the long run. Nobody can watch for long and see how I - *Galileo lets fall a stone from his hand to the floor* - drop a stone, and then say: 'It does not fall.' Nobody is capable of that. The temptation offered by such a proof is too great. Most succumb to it, and in the long run - all. Thinking is one of the greatest pleasures of the human race.

(Adapted from *The Life of Galileo* by Bertolt Brecht London Methuen & Co Ltd pages 35 to 42  
& Picture from *Galileo's Daughter* by Dava Sobel)

*Student Work: GALILEO - VIDEO NOTE on Galileo's Daughter*

Galileo Galilei (1564–1642) was the foremost scientist of his day, whose inventions and discoveries were heralded around the world. His telescopes allowed him to reveal a new reality in the heavens and to propound publicly the astounding argument that the Earth actually moves around the Sun. For this belief, he was brought before the Inquisition, tried for heresy and threatened with torture.

Galileo's illegitimate daughter Virginia became a nun. She was 13 when Galileo placed her in a convent near him in Florence, where she took the name of Suor Maria Celeste. He later described her as 'a woman of exquisite mind, singular goodness, and most tenderly attached to me.' Dava Sobel was inspired by her long fascination with Galileo and by the remarkable surviving letters of his daughter, which she translated into English for the first time, to write *Galileo's Daughter*. In this edited extract, she reveals the impact that this relationship with Suor Maria Celeste – as seen through her letters – had on this great man.

***Most Illustrious Lord Father***

*We are terribly saddened by the death of your cherished sister, our dear aunt; but our sorrow at losing her is as nothing compared to our concern for your sake, because your suffering will be all the greater, Sire, as truly you have no one else left in your world, now that she, who could not have been more precious to you, has departed, and therefore we can only imagine how you sustain the severity of such a sudden and completely unexpected blow. And while I tell you that we share deeply in your grief, you would do well to draw even greater comfort from contemplating the general state of human misery, since we are all of us here on Earth like strangers and wayfarers, who soon will be bound for our true homeland in Heaven, where there is perfect happiness, and where we must hope that your sister's blessed soul has already gone. Thus, for the love of God, we pray you, Sire, to be consoled and to put yourself in His hands, for, as you know so well, that is what He wants of you; to do otherwise would be to injure yourself and hurt us, too, because we lament grievously when we hear that you are burdened and troubled, as we have no other source of goodness in this world but you.*

*I will say no more, except that with all our hearts we fervently pray the Lord to comfort you and be with you always, and we greet you dearly with our ardent love.*

*From San Matteo, the 10th day of May 1623.*

*Most affectionate daughter,  
S Maria Celeste*

The day after his sister Virginia's funeral, the already world-renowned scientist Galileo Galilei received this, the first of 124 surviving letters from the once-voluminous correspondence he carried on with his elder daughter. She alone of Galileo's three children mirrored his own brilliance, industry and sensibility, and by virtue of these qualities became his confidante. Galileo's daughter, born of his long illicit liaison with the beautiful Marina Gamba of Venice, entered the world on 13 August 1600 – the same year the Dominican friar Giordano Bruno was burned at the stake in Rome for insisting, among his many other heresies and blasphemies, that the Earth travelled around the Sun instead of remaining motionless at the centre of the universe. In a world that did not yet know its place, Galileo would engage this same cosmic conflict with the Church, treading a dangerous path between the Heaven he revered as a good Catholic and the heavens he revealed through his telescope. Galileo christened his daughter Virginia, in honour of his 'cherished sister'. But because he never married Virginia's mother, he deemed the girl herself unmarriageable. Soon after her 13th birthday, he placed her at the Convent of San Matteo in Arcetri, where she lived out her life in poverty and seclusion. Virginia adopted the name Maria Celeste when she became a nun, in a gesture that acknowledged her father's fascination with the stars. Even after she professed a life of prayer and penance, she remained devoted to Galileo as though to a patron saint. The doting concern evident in her letter was only to intensify as her father grew old, fell more frequently ill, pursued his singular research nevertheless, and published a book that brought him to trial by the Holy Office of the Inquisition.

Galileo, now 59, stood boldly alone in his world view, as Suor Maria Celeste knew from reading the books he wrote and the letters he shared with her from colleagues and critics all over Italy, as well as from the continent beyond the Alps. Although her father had started his career as a professor of mathematics, teaching first at Pisa and then at Padua, every philosopher in Europe tied Galileo's name to the most startling series of astronomical discoveries ever claimed by a single individual.

All his observations lent credence to the unpopular Sun-centred universe of Nicolaus Copernicus, which had been introduced over half a century previously but foundered on lack of evidence. Galileo's efforts provided the beginning of a proof. And his flamboyant style of promulgating his ideas – sometimes in writings, sometimes loudly at dinner parties and staged debates – transported the new astronomy from the Latin quarters of the universities into the public arena. In 1616, a pope and a cardinal inquisitor reprimanded Galileo, warning him to

curtail his forays into the realms of a higher world. Galileo obeyed their orders, silencing himself on the subject. For seven cautious years, he turned his efforts to less perilous pursuits.

Shortly after his sister's death in May of 1623, however, Galileo found reason to return to the Sun-centred universe like a moth to a flame. That summer a new pope ascended the throne of St. Peter in Rome. The supreme pontiff Urban VIII brought to the Holy See an intellectualism and an interest in scientific investigation not shared by his immediate predecessors. Urban had admired Galileo so long and well that he had even written a poem for him, mentioning the sights revealed by 'Galileo's glass'. The presence of a poet pope encouraged Galileo to proceed with a long-planned popular dissertation on the two rival theories of cosmology: the Sun-centred and the Earth-centred, or, in his words, the 'two chief systems of the world'.

It might have been difficult for Suor Maria Celeste to condone this course – to reconcile her role as a bride of Christ with her father's position as potentially the greatest enemy of the Catholic Church since Martin Luther. But instead she approved of his endeavours because she knew the depth of his faith. She accepted Galileo's conviction that God had dictated the Holy Scriptures to guide men's spirits but proffered the unravelling of the universe as a challenge to their intelligence. Understanding her father's prodigious capacity in this pursuit, she prayed for his health, for his longevity, for the fulfilment of his 'every just desire'. Her letters, animated by her belief in Galileo's innocence of any heretical depravity, carried him through the ordeal of his ultimate confrontation with Urban and the Inquisition in 1633.

Most of Suor Maria Celeste's letters travelled in the pocket of a messenger, or in a basket laden with laundry, sweetmeats or herbal medicines, across the short distance from the Convent of San Matteo, on a hillside just south of Florence, to Galileo in the city or at his suburban home. Following the angry papal summons to Rome in 1632, however, the letters rode on horseback some 200 miles and were frequently delayed by quarantines imposed as the Black Plague spread death and dread across Italy. Gaps of months' duration disrupt the continuity of the reportage in places, but every page is redolent of daily life, down to the pain of toothache and the smell of vinegar.

Galileo held on to his daughter's letters. Similarly, Suor Maria Celeste saved all of Galileo's letters, as rereading them, she often reminded him, gave her great pleasure. By the time she received the last rites [in March 1634], the letters she had gathered over her lifetime in the convent constituted the bulk of her earthly possessions. On first learning of Suor Maria Celeste's letters, people generally assume that Galileo's replies must lie concealed somewhere in the recesses of the Vatican Library. But the archives have been combed, several times, by religious authorities and authorised researchers all desperate to hear Galileo's voice – to no avail. It seems likely that the mother abbess, who would have discovered Galileo's letters while emptying Suor Maria Celeste's cell, burned them out of fear. After a celebrated trial at Rome, a convent dared not harbour the writings of a 'vehemently suspected' heretic.

Although numerous commentaries, plays, poems, early lectures and manuscripts of Galileo's have also disappeared (known only by specific mentions in more than 2,000 preserved letters from his contemporary correspondents), his enormous legacy includes his five most important books, two of his original handmade telescopes, various portraits and busts he sat for during his lifetime, even parts of his body preserved after his death. (The index finger of his right hand can be seen, encased in a gilded glass egg atop an inscribed marble pedestal, at the Museum of the History of Science in Florence.)

Of Suor Maria Celeste, however, only her letters remain. Bound into a single volume with cardboard and leather covers, the frayed, deckle-edged pages now reside among the rare manuscripts at Florence's Central National Library. The letters, which have never been published in translation, recast Galileo's story. They recolour the personality and conflict of a mythic figure, whose 17th-century clash with Catholic doctrine continues to define the schism between science and religion. For although science has soared beyond his quaint instruments. It is still burdened by an impression of Galileo as a renegade who scoffed at the Bible and drew fire from a Church blind to reason. This divisive power of the name of Galileo is what Pope John Paul II tried to tame in 1992 by recalling his torment as 'a tragic mutual incomprehension' that 'has been interpreted as the reflection of a fundamental opposition between science and faith.' Yet the Galileo of Suor Maria Celeste's letters recognised no such division during his lifetime. He remained a good Catholic who believed in the power of prayer and endeavoured always to conform his duty as a scientist with the destiny of his soul.

*All 124 of Suor Maria Celeste's letters – translated into English by Dava Sobel – are available on the [Galileo Project](#) website.*

*(Adapted from Channel 4 website - History Heads / Galileo's Daughter)*