Galileo Galilei

Historical Context 11

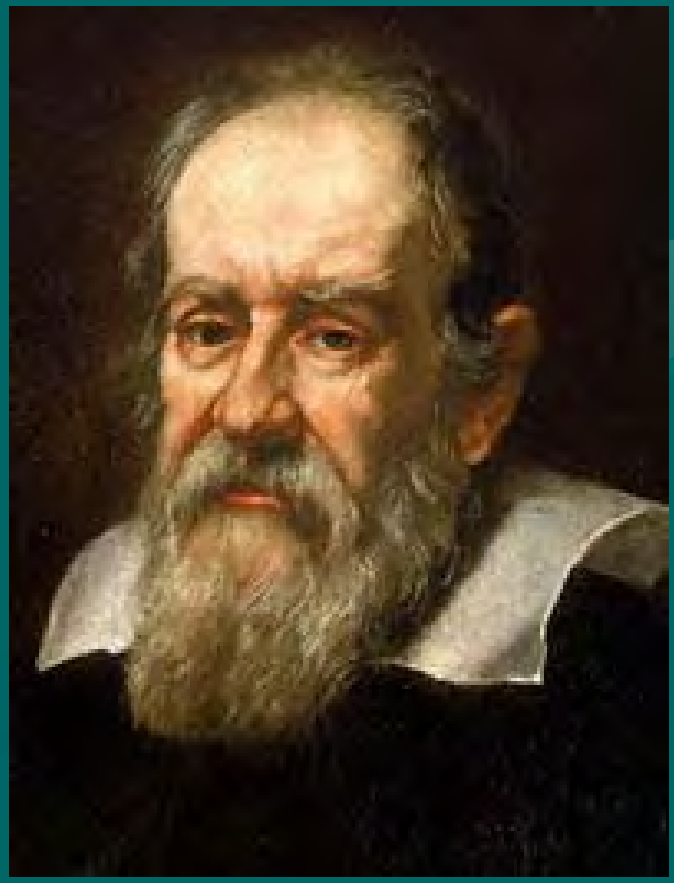
Caroline Gebel and Darren Alford

Life of Galileo

- Galileo was born on February 15 1564 in Pisa, Italy

Life of Galileo

- Originally went to school in Pisa for medicine but does not complete his degree
- Galileo finds an interest in mathematics and physics
- Begins teaching math at the University of Pisa in 1589
- Obtains Chair of Mathematics at the University of Padua



Life of Galileo

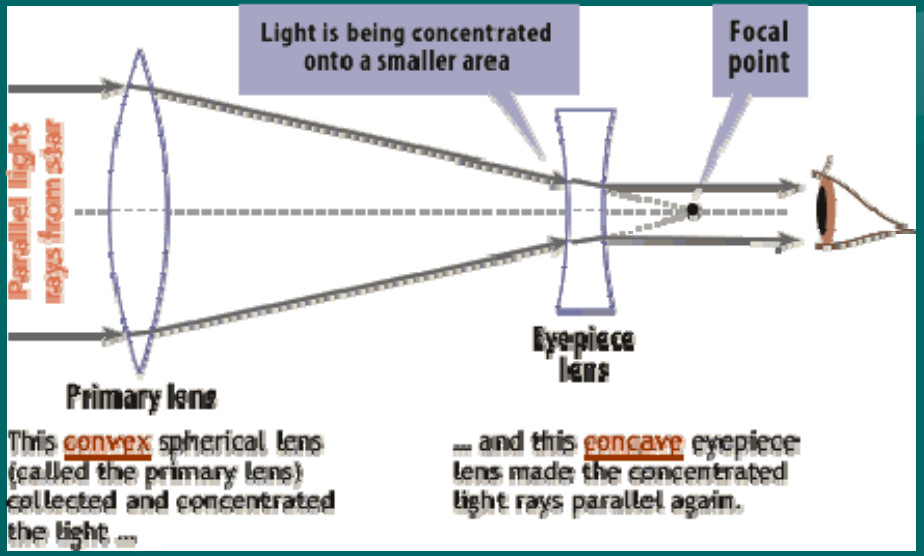
- In 1609 Galileo finds out about a spyglass invented by a Dutchman
- He created his own and improves upon it, and uses it to look at the sky
- In 1610 Galileo begins to write his book *The Starry Messenger*
- The publication stirs up controversy and Galileo is asked to not to advocate the Copernican theory of the universe
- Galileo continues to teach Copernican theory and publishes *Dialogue Concerning Two Chief World Systems* and later *Discouses Concerning Two New Sciences*

Life of Galileo

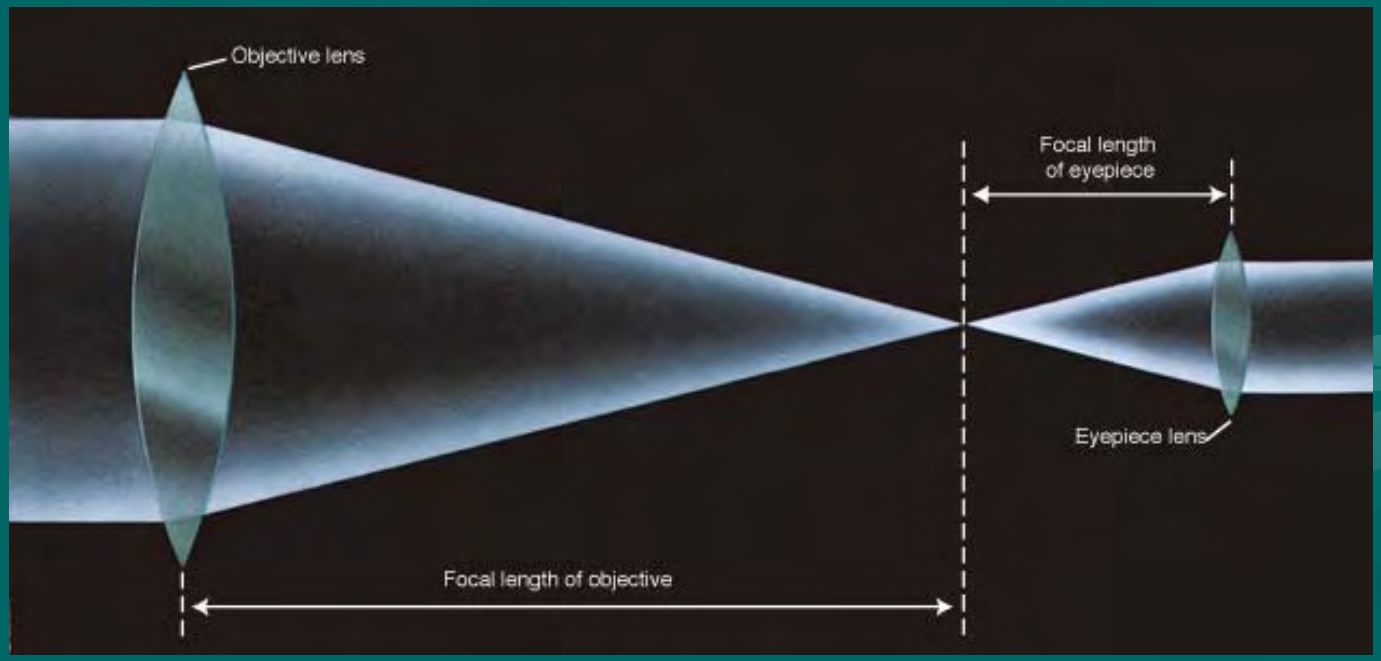
- In 1633 Galileo is found guilty of heresy and sentenced to house arrest
- Galileo remains in his home in Florence until his death in 1642

The Telescope

- Galileo's telescope was built using refracting lenses
- The first lens is a convex lens which focuses a larger amount of light than the eye would normally collect and focuses it onto the second lens
- The second being a concave lens then diverges the light so that it becomes easier to see



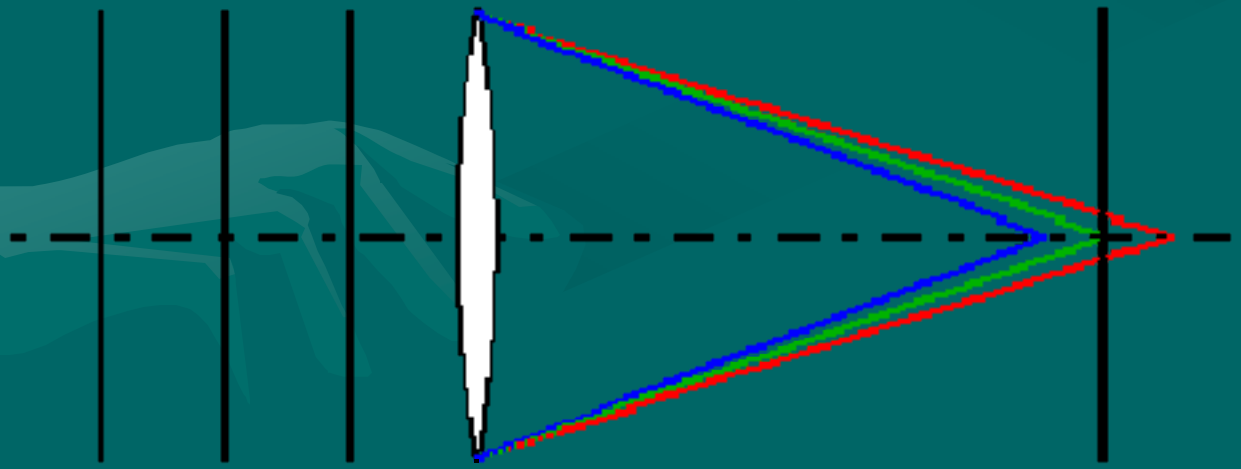
Magnification



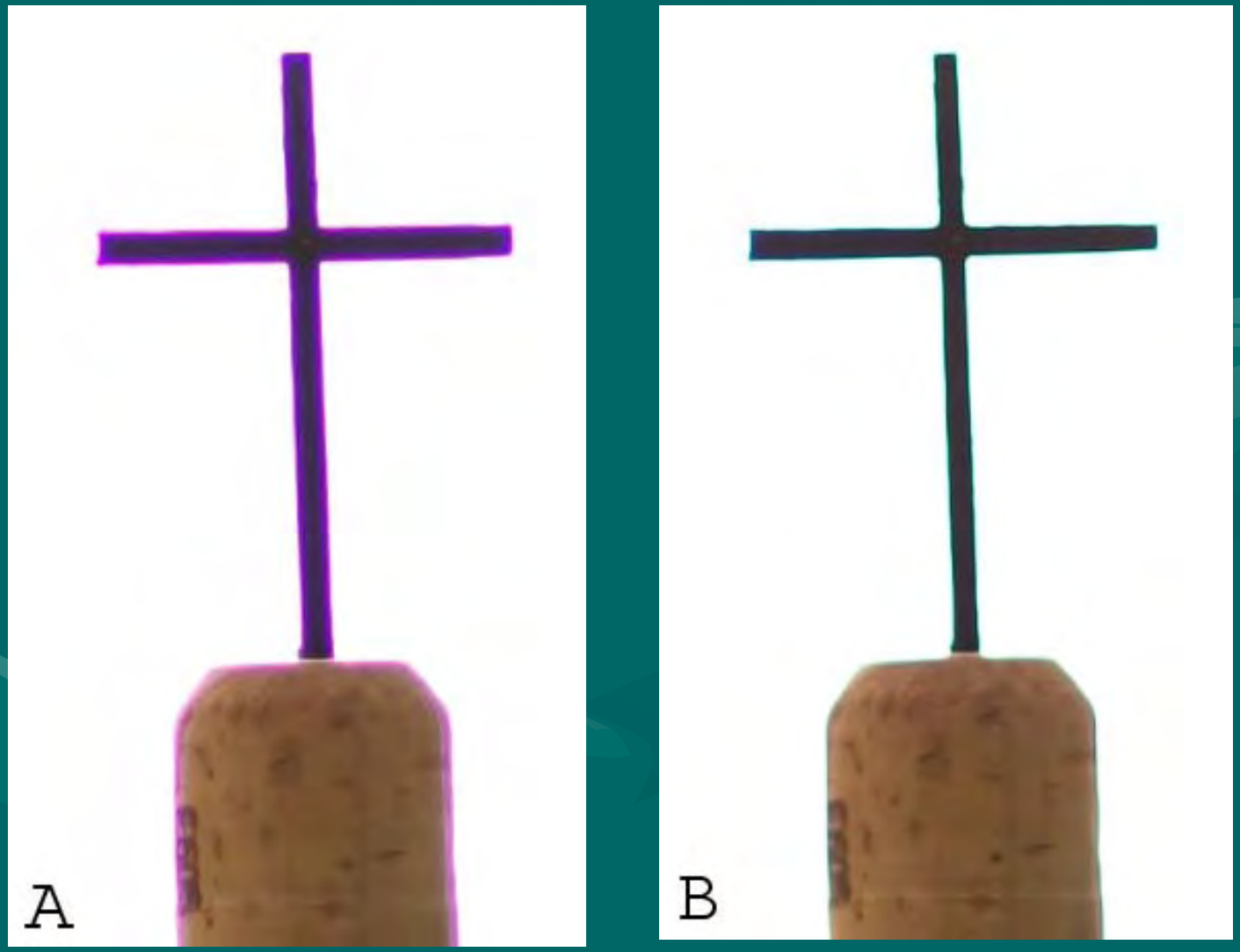
- The first spyglasses had a magnification factor of 2 or 3
- The magnification factor can be calculated by
  M = fe/fo
  where fe is the focal length of the eye piece and fo is the focal length of the objective lens
- Galileo's first telescope had a magnification factor of 8

Drawbacks

- Galileo's refracting telescope had limitations to how much it could magnify images
- Due to the nature of light, different frequencies refract at different angles resulting in a blurred image
- This is known as Chromatic Aberration



Chromatic Aberration

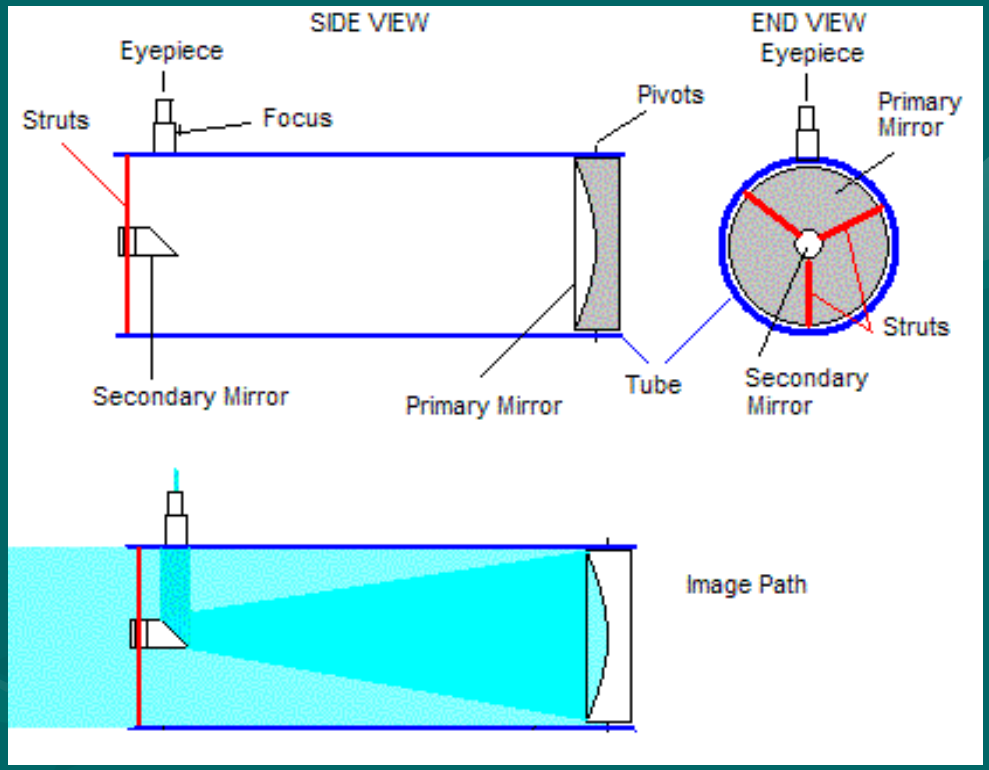


Other draw backs

- To focus a large amount of light, a large lens is needed
- As the lens size increases, the resolution becomes worse
- In large lenses air bubbles are common and blur the image
- Light is also absorbed by the lens reducing the quality of the image

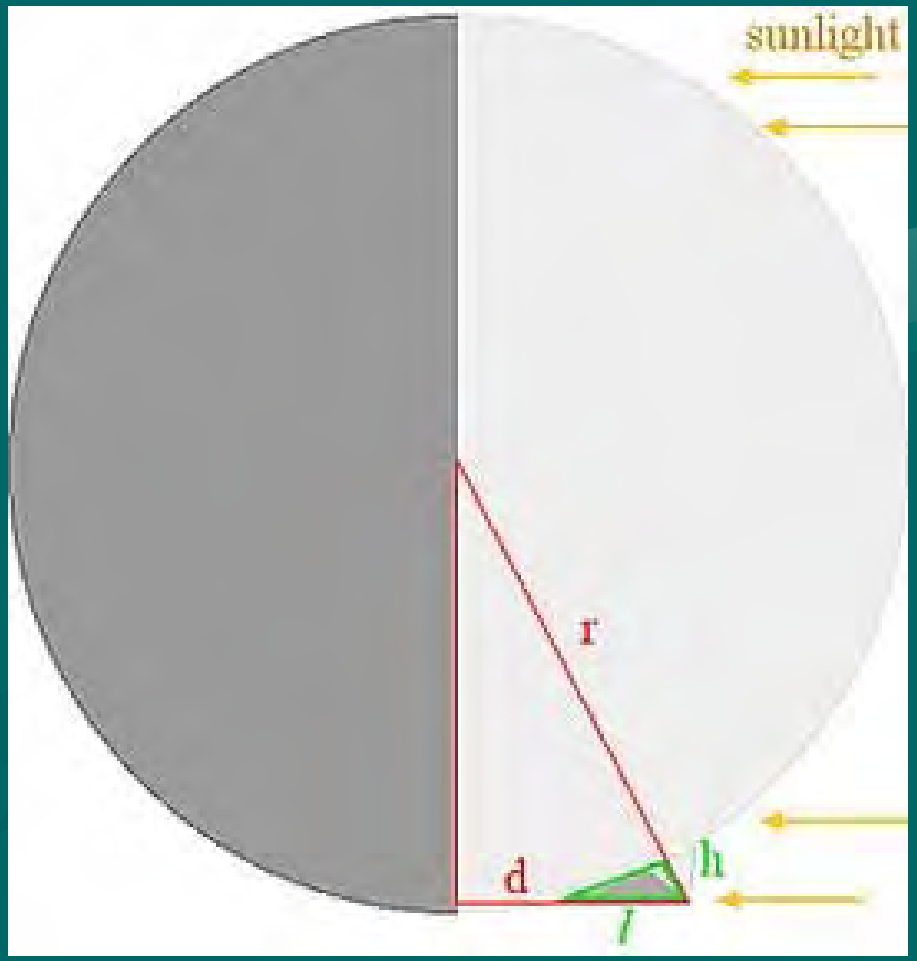
The Newtonian Telescope

- Newton's telescope (1672) uses a concave mirror rather than a lens as the objective
- This means less light is absorbed than by the lens
- The light is corrupted less by reflection than refraction

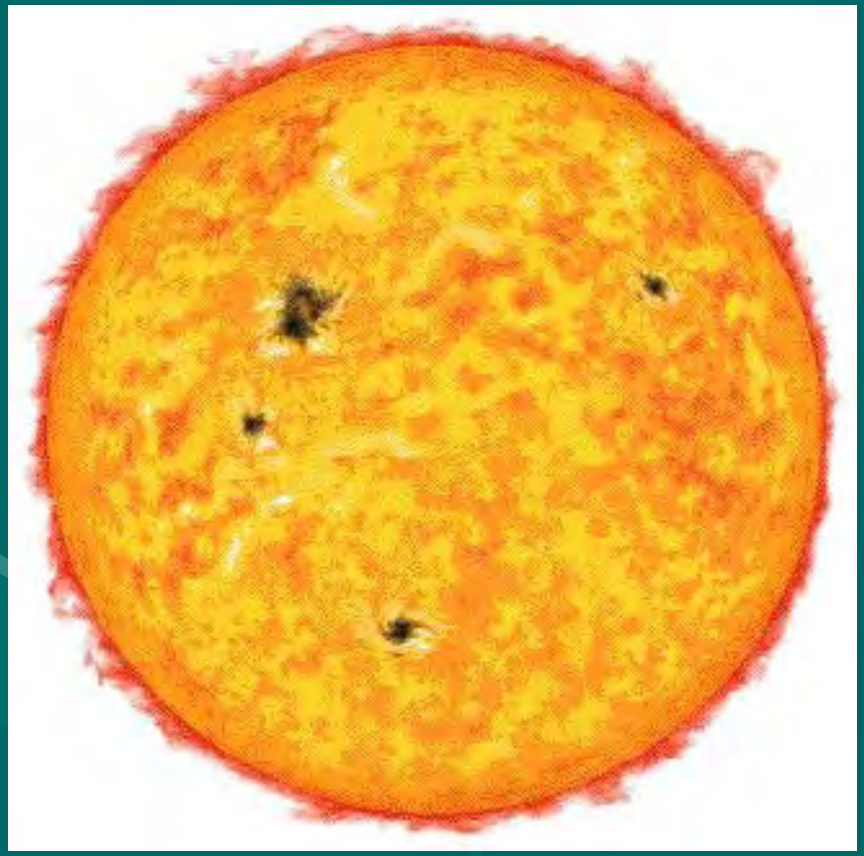


The Moon

- Galileo discovered that the moon had mountains and creators on it
- This was contradictory to belief that the “Heavens” were perfect
- He was even able to measure the height of the mountains by observing their shadows



Sun Spots



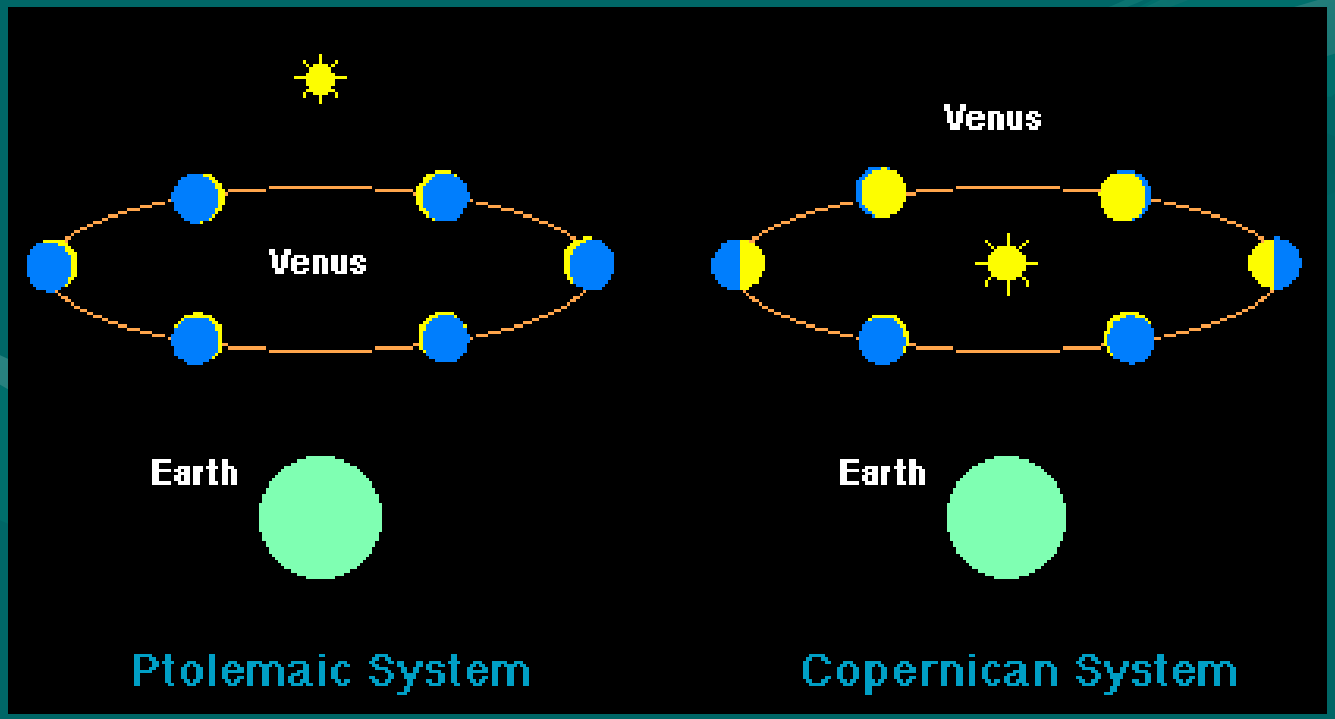
- With his telescope, Galileo also observed sun spots
- He discoed dark patches on the sun
- Through this observation he was able to conclude that the sun rotated on its axis
- This discovery that the sun rotated made it easier to believe that the earth might rotate as well, which contradicted the theory of a motionless earth

New Stars

- Galileo also observed “invisible” stars
- These stars were invisible to the naked eye, but could be clearly seen with the Galilean Telescope

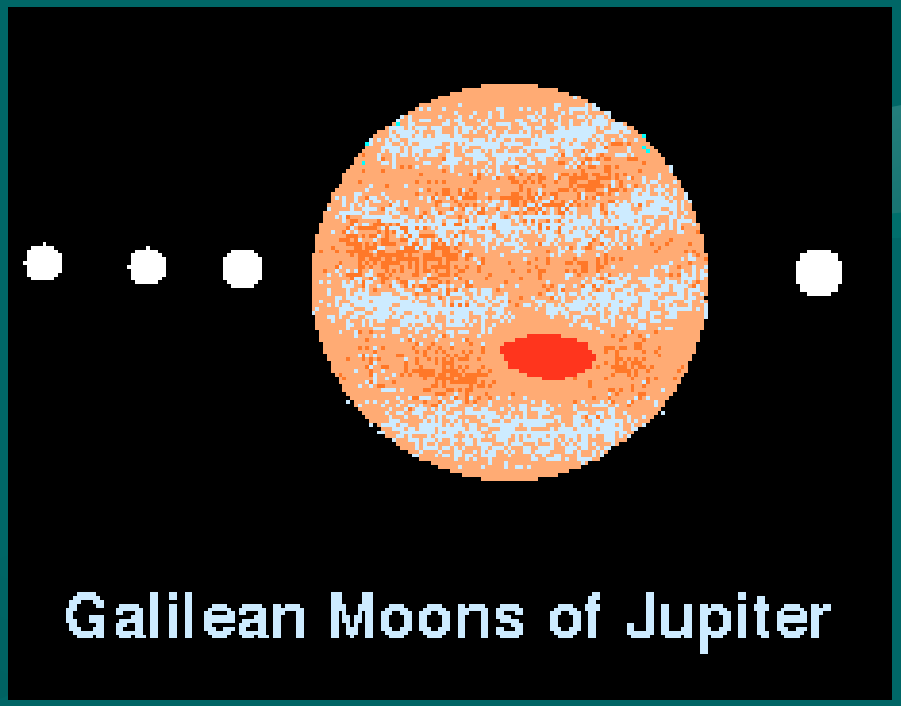
The phases of Venus

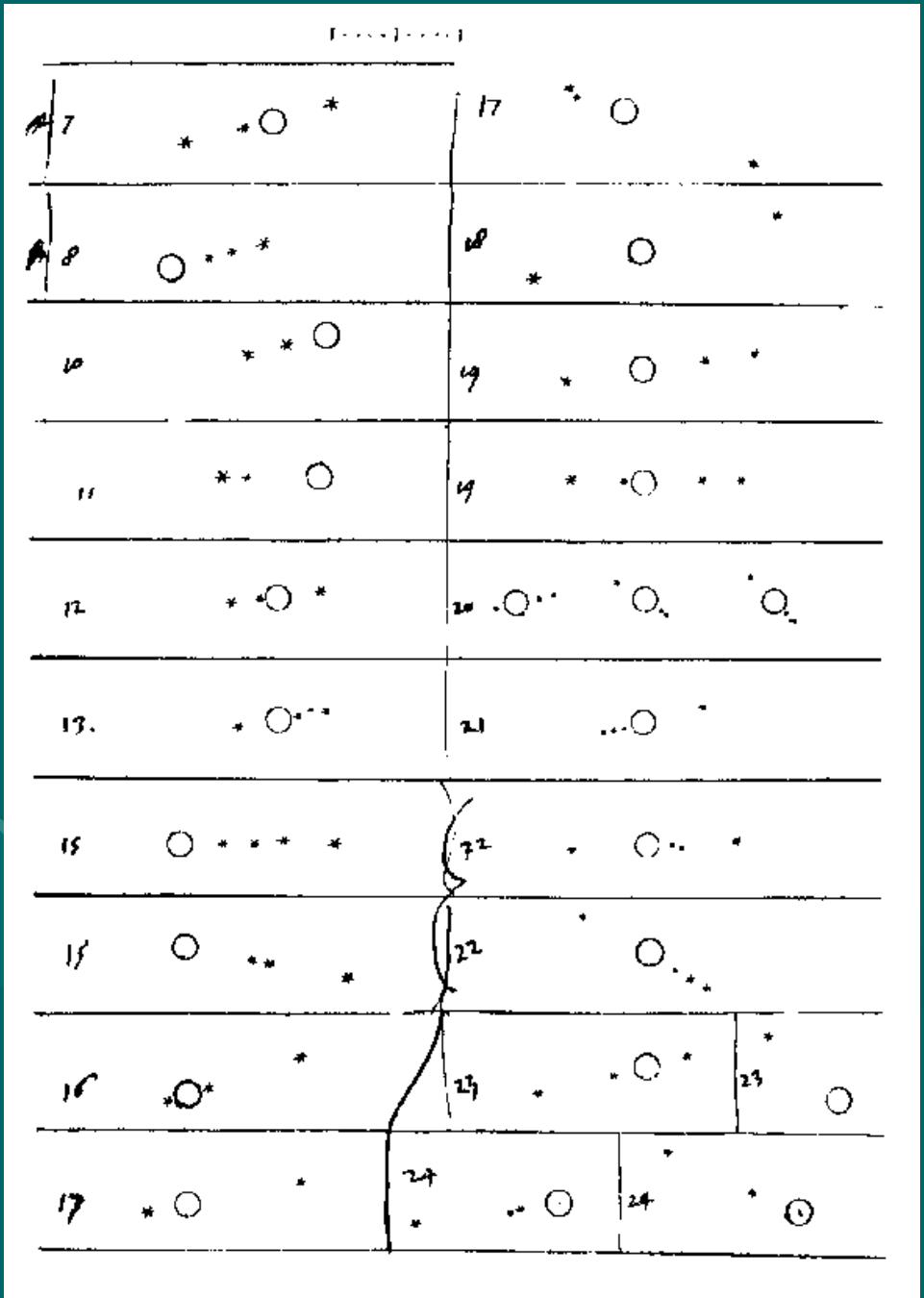
- Galileo was able to observe that Venus, like the moon, had phase
- From this observation he was able to conclude that Venus revolved around the sun and not around the earth



Jupiter's Stars

- Another discovery of Galileo's was the four "stars" of Jupiter
- When he first observed them, Galileo believed Jupiter's moons to be stars
- With further observation he discovered that they moved, which contradicted the belief of unmoving stars
- Shortly after he calculated that the "stars" revolved around Jupiter
- He had originally thought he had found another solar system





Jupiter's Stars

- He called these "stars" the "Medicean Stars" in honour of the Medici family who ruled Tuscany
- This discovery further contradicted the believe that earth was the center of the solar system and all things revolved around it

Galileo vs. the Church

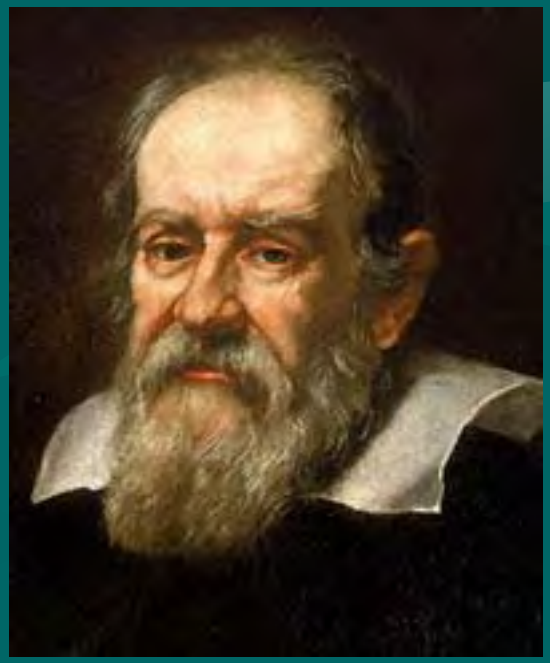
- The conflict with Galileo and the Church is a well known one
- It is important to note that the Church was not always in opposition to Galileo and sometimes even encouraged him

Galileo vs. the Church

- After Galileo discovered the “Medicean Stars”, the Church rallied to his support
- He even had an audience with pope Paul V
- His scrutiny came from jealous colleagues rather than the church
- Some such colleagues even refused to look through the telescope
- Around the world the elite Jesuit astronomers where confirming Galileo’s discoveries as well as improving on them
- (a satellite of Saturn was discovered along with the presence of its ring)

Galileo vs. the Church

- With this new support Galileo was getting, he decided not to only endorse the Copernican system , but went as far as denigrating anyone who opposed it as one “hardly deserving to be called human.”
- This was unreasonable since the discovery of Jupiter’s moons proved Ptolemy wrong, they did not prove Copernicus right



Galileo vs. the Church

- The Copernican model was hard for scientists of the time to accept
- It insinuated that the stars were at an unimaginable distance from earth due to their fixed positions
- This idea was simply too astonishing for them to believe

Galileo vs. the Church

- Galileo's enemies decide to try and engage Galileo in a conflict between science and scripture
- "Thus, Joshua, after defeating the Philistines, commanded the sun to stand still"
- This implied that the sun usually moves, which contradicts Copernicus
- Galileo replied by insisting that the Copernican system was right beyond doubt and that the church must re-interpret scriptural passages that contradict it
- These statements could not go unnoticed by the Church

Galileo vs. the Church

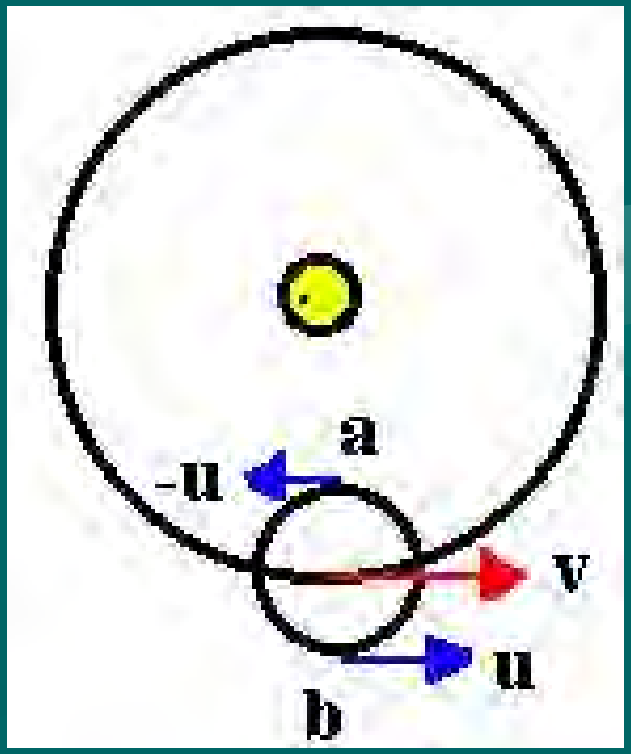
- Cardinal Bellarmine, the Superior General of the Jesuit Order replied:
- “I say that if there were a true demonstration that the sun was in the center of the universe and the earth was in the third sphere, and that the sun did not go around the earth but the earth went around the sun, then it would be necessary to use careful consideration in explaining the Scriptures that seemed contrary, and we should rather have to say that we do not understand them than to say that something is false which had been proven.”
- Bellarmine went on to say that to speak the Copernican system as an established truth “is a very dangerous attitude.”

Galileo vs. the Church

- Galileo fiercely argued the Copernican system was right and went to Rome to force a decision
- As a result, the Holy Office declared the Pythagorean doctrine of the motion of the earth to be “false and altogether opposed to Holy Scripture.”

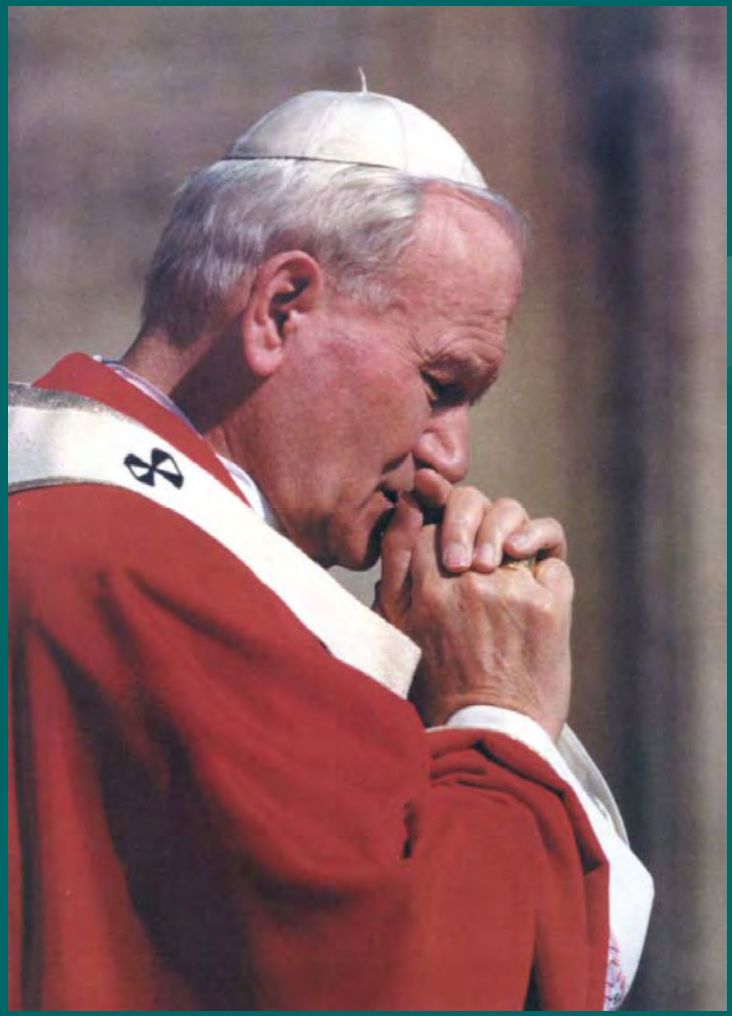
Galileo vs. the Church

- Galileo then published the Dialogue on the Two Great World Systems, in which he describes the tides as being proof of the motion of the earth
- In addition, he publicly insulted Pope Urban VIII, who had previously supported Galileo



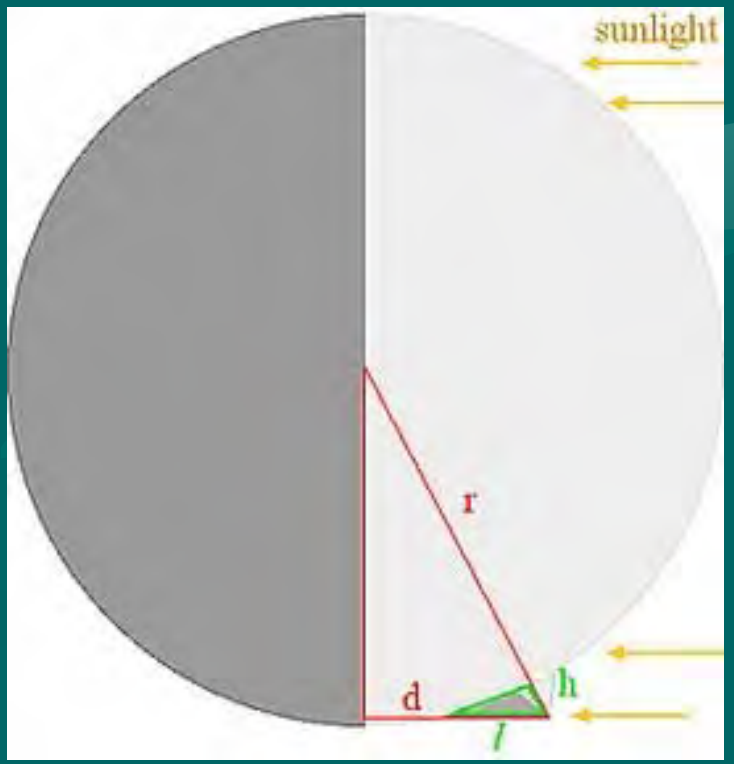
Galileo's Right

- On October 31, 1992 Pope John Paul II expressed regret for how the Galileo affair was handled and officially conceded that the earth was not stationary

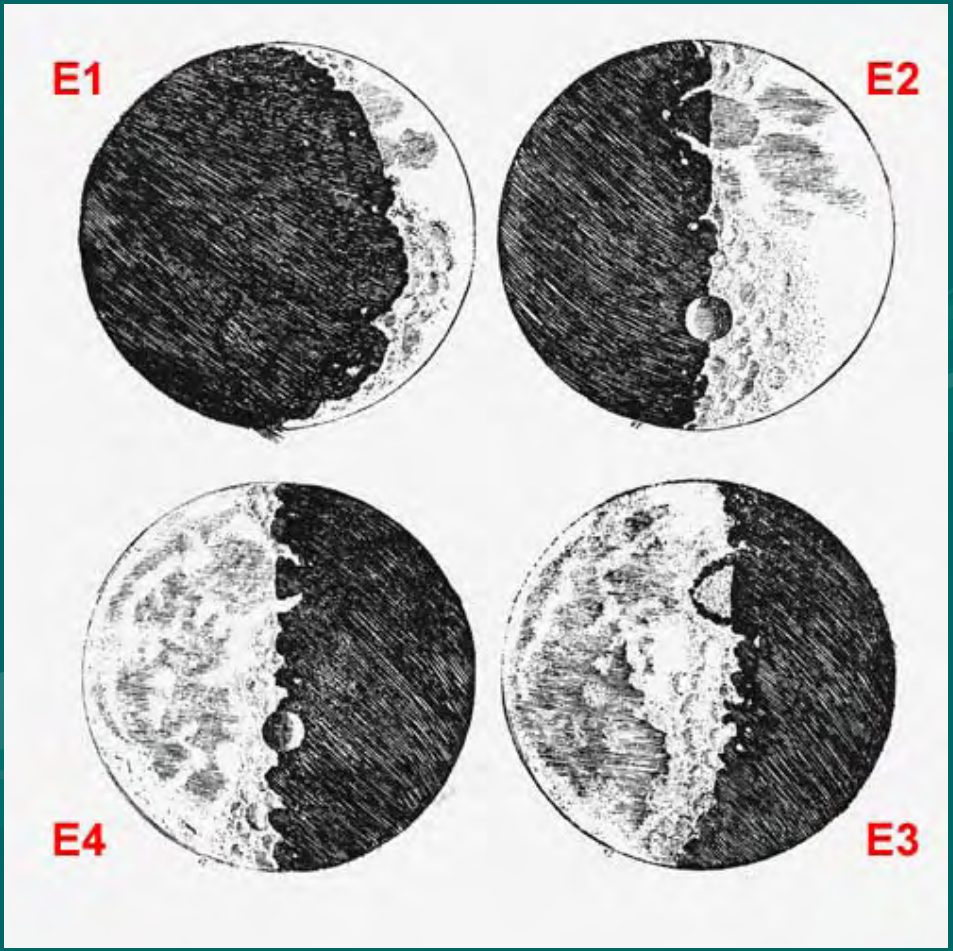


Problems

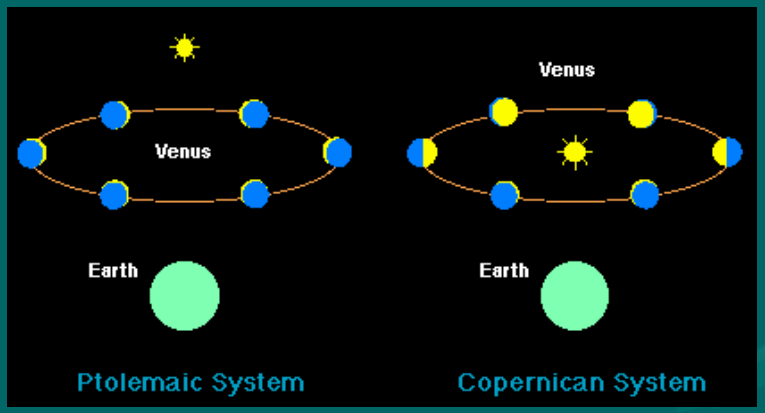
1. Using the diagram, calculate the height of the mountain h if r=1700 km, d=160.1 km and l=10 km?
2. Why did the observation that Venus had phases like the moon contradict Aristotelian philosophy?
3. Name and describe one telescope design other than the Galilean Telescope design.



End



Answers

1. 1 km
2. 

3. Cassegrain Reflecting telescope