UNIT 5

Space Exploration

Part 2

- SCIENCE 9 -

How do we know so much about what we cannot actually see???

telescope

satellites

ISS

shuttle

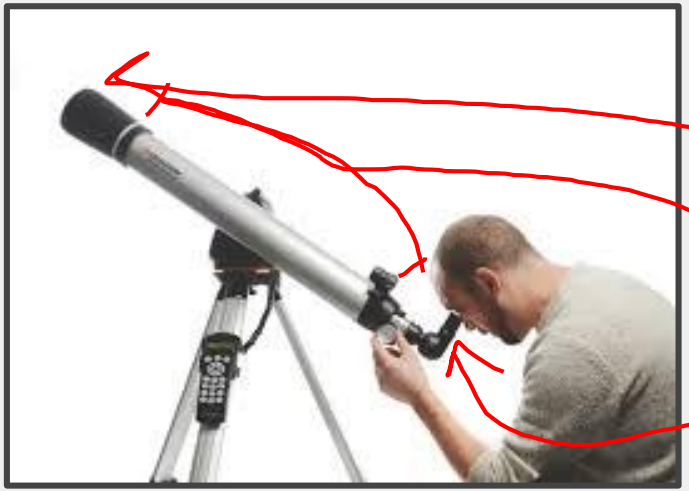
rocket

PART 2: SPACE EXPLORATION TECHNOLOGIES

I Can...

- Investigate the contributions of technological advances, including optical telescopes, to our understanding of space
- Investigate technologies, materials and processes used for space exploration
- Identify the use of space technologies in our everyday lives

Telescopes



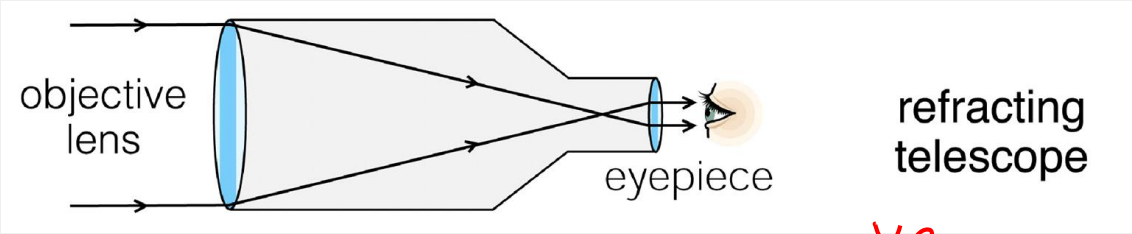
A telescope is a device that magnifies objects at great distances

A simple telescope has 3 parts

- ***Objective Lens***: Where light ***enters*** the telescope
- ***Focal Length***: Distance from the lens to the place where the light beams converge (focus).
- ***Ocular Lens or Eyepiece***: Where light ***leaves*** the telescope to enter the eye.

Types of Telescopes

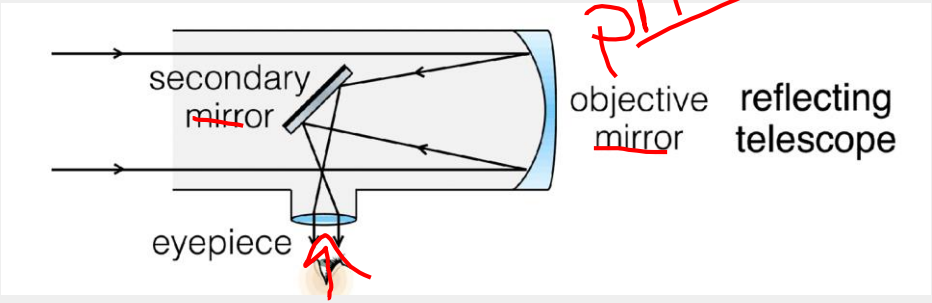
1. REFRACTING TELESCOPE



- First kind of telescope invented
- **Uses lenses to magnify objects in view**

Types of Telescopes

2. REFLECTING TELESCOPE



- **Uses mirrors to magnify objects in view**
- **Better resolution than refracting telescopes**

Hubble Space Telescope

- Refracting or reflecting?
- **orbits Earth**
- **advantages: not affected by night, bad weather, or air pollution**

Hubble Space Telescope

Where can I see pictures taken by the Hubble?

http://hubblesite.org/

Interferometry

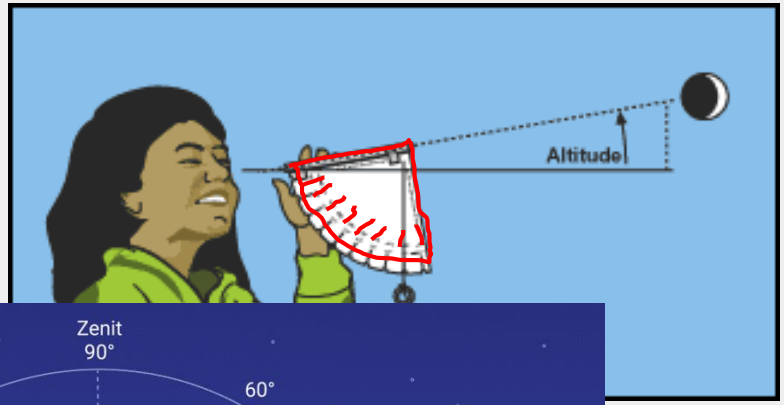
Combining the observations of two or more telescopes to produce higher quality images

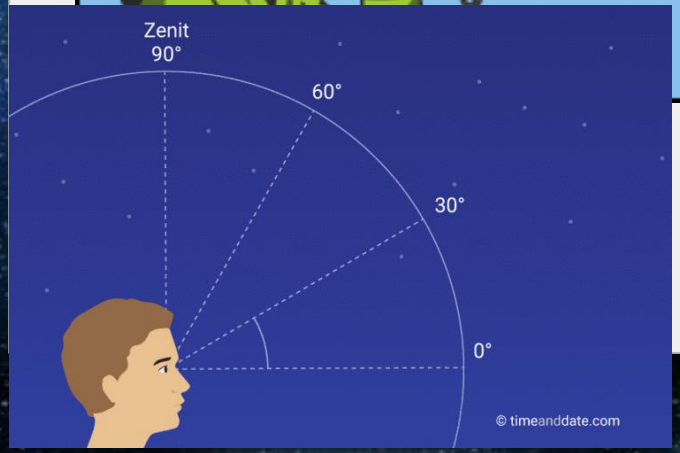
Sky Coordinates

To determine the location of celestial bodies in the sky, you must ask two questions:

1. how high in the sky is it?
2. in which direction is it?

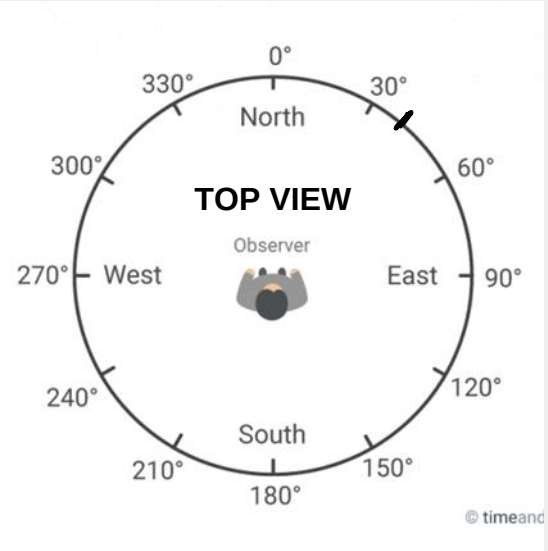
Sky Coordinates - ALTITUDE





- **The altitude of a celestial body is the measure of its angle above the horizon**
- **measured with an astrolabe** (basically a fancy protractor)

Sky Coordinates - AZIMUTH



- **The azimuth of a celestial body is the measure of its angle clockwise from north**
- measured with a compass

0° = North

90 ° = East

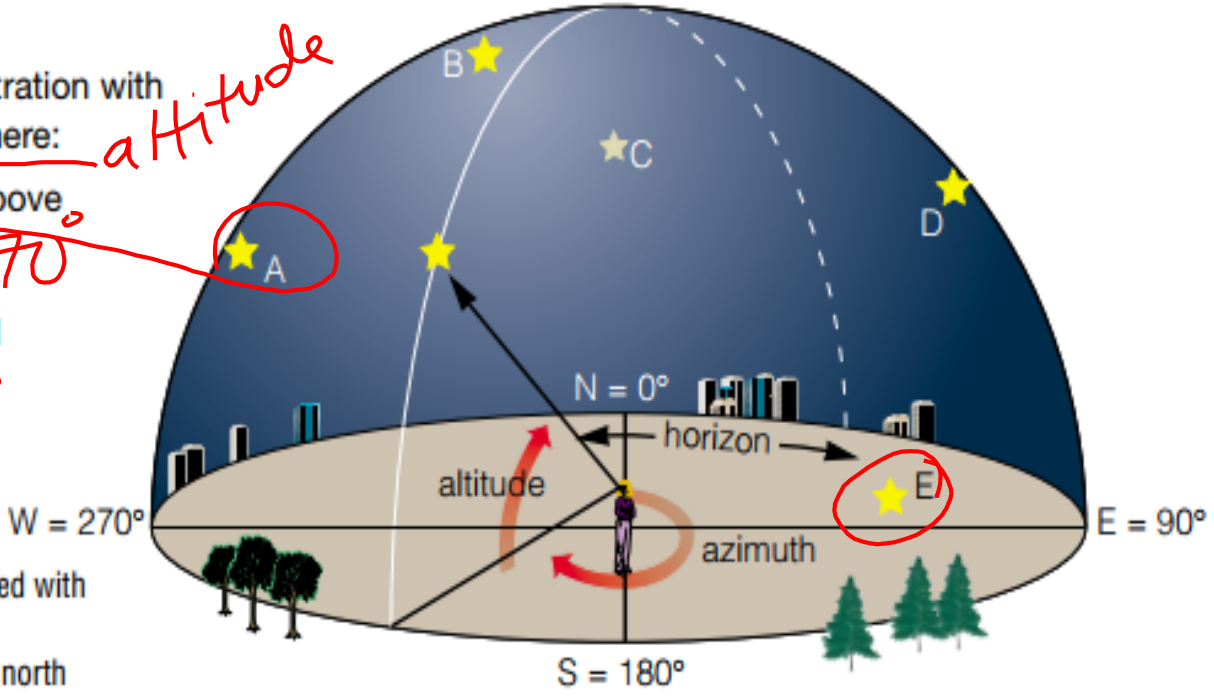
180 ° = South

270 ° = West

Practice Problems

Identify the stars in the illustration with the co-ordinates indicated here:

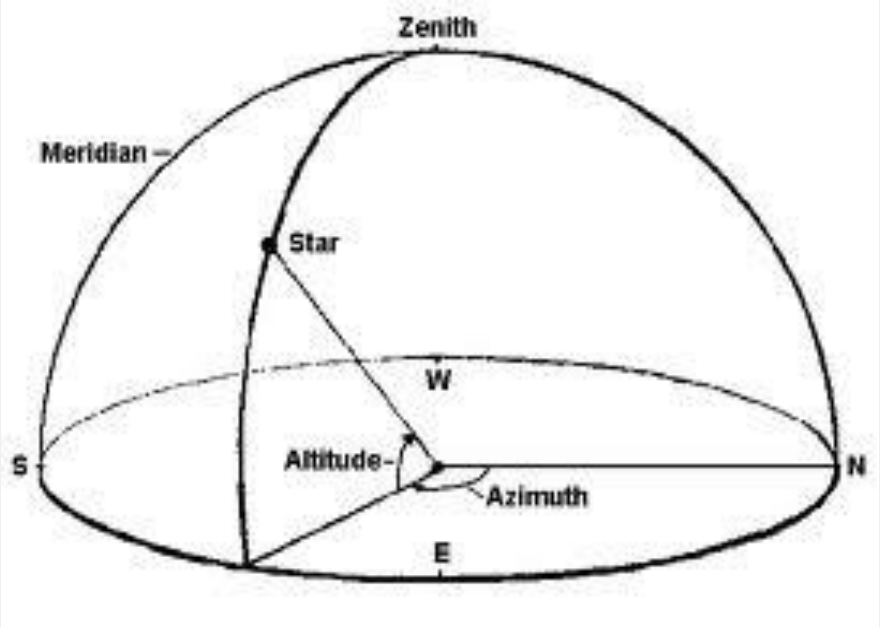
1. It's due west and 40° above the horizon.
2. It's in the southeast and 10° above the horizon.
3. It's due north and 53° above the horizon.



Celestial positions can be measured with altitude-azimuth co-ordinates:
Azimuth — angle clockwise from north
Altitude — angle above the horizon

What is the azimuth for the star in each question?

Sky Coordinates



The zenith is the highest point, directly overhead

✓ Check Your Understanding

True and False Statements About Refracting Telescopes

Statement 1	Refracting telescopes use mirrors.
Statement 2	Refracting telescopes were the first type to be designed.
Statement 3	The image from a refracting telescope is not distorted by atmospheric interference.
Statement 4	A refracting telescope has an eyepiece and an objective lens.

Which of the statements above are **true**?

A. Statements 1 and 3
B. Statements 1 and 4
C. Statements 2 and 3
D. Statements 2 and 4

✓ Check Your Understanding

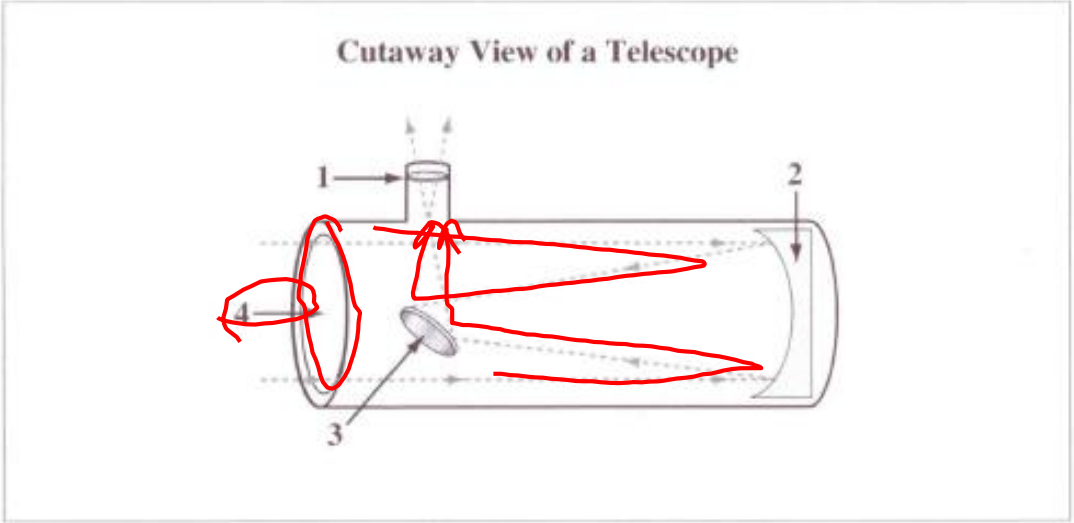
altitude

A celestial object that is located 10° above the horizon in the northeast part of the sky has an

45°

A. azimuth of 45° and an altitude of 10°
B. azimuth of 10° and an altitude of 45°
C. azimuth of 315° and an altitude of 10°
D. azimuth of 10° and an altitude of 315°

✓ Check Your Understanding



Hint: use the process of elimination to determine the aperture

Numerical Response

1. Match each part of the telescope numbered above with its name, as given below.

Part:	3	1	4	2
Name:	Secondary mirror	Eyepiece	Aperture	Main mirror

primary

✓ Check Your Understanding

When Jupiter is viewed with a telescope that is orbiting Earth, its image appears clearer than it does when viewed with a telescope positioned on Earth's surface.

The reason that the image of Jupiter appears clearer through the orbiting telescope is that in space,

A. the telescope is closer to its subject
B. more light is available for the telescope
C. there is little gravity to distort the image
D. there is little atmosphere to distort the image

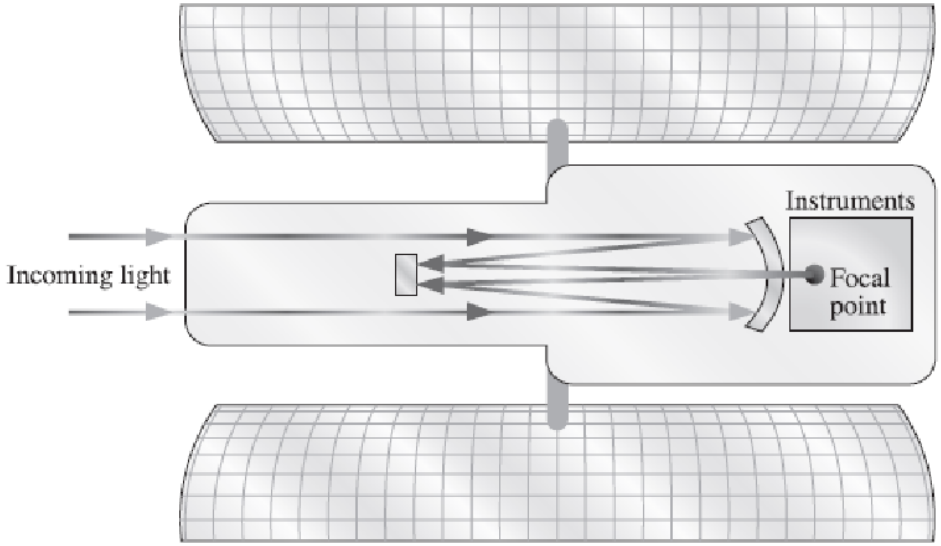
✓ Check Your Understanding

What is the student in the illustration above **most likely** trying to determine?

A. The altitude of the sphere
B. The azimuth of the sphere
C. The distance to the sphere
D. The diameter of the sphere

✓ Check Your Understanding

How Light Travels Through the Body of the Hubble Space Telescope



The Hubble Space Telescope uses _i_ to _ii_ the light into the focal point

The statement above is completed by the information in row

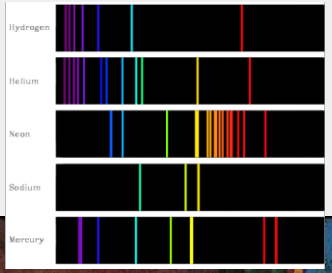
Row	*i*	*ii*
A.	lenses	reflect
B.	lenses	refract
C.	mirrors	reflect
D.	mirrors	refract

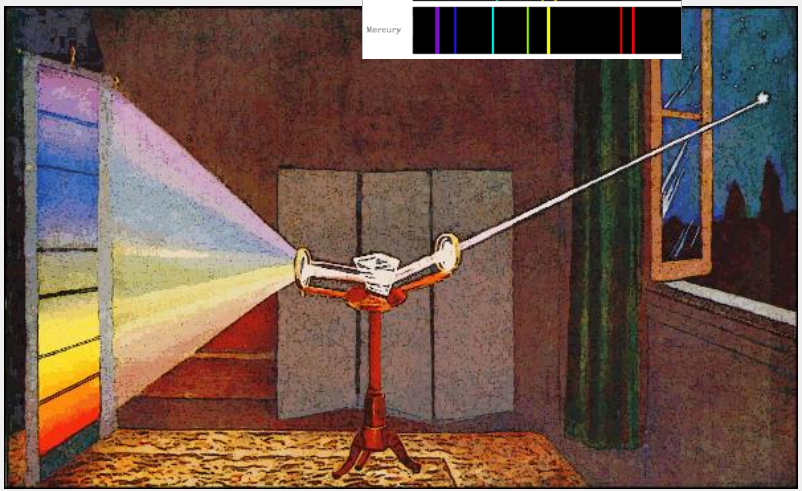

BREAK

The Spectroscope

Celestial bodies emit different types of light depending on their chemical composition.

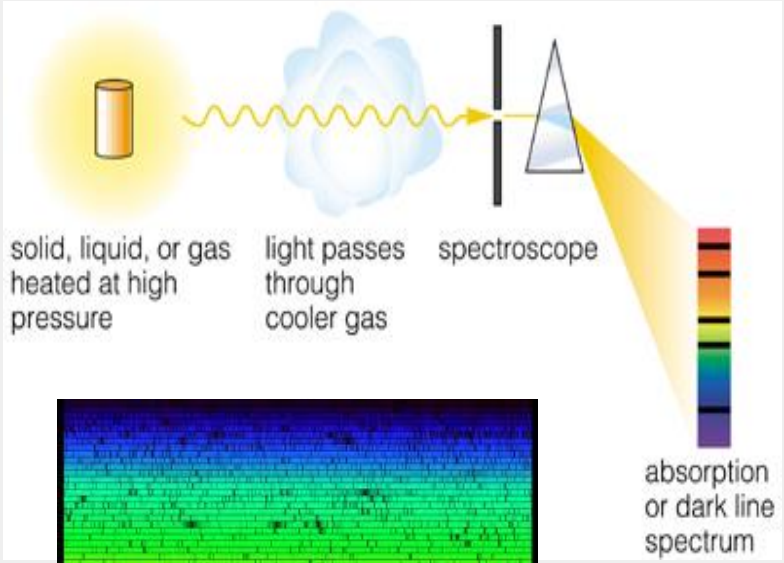
A *spectroscope* is a device used to determine the composition of a celestial body based on the light spectrum it emits.



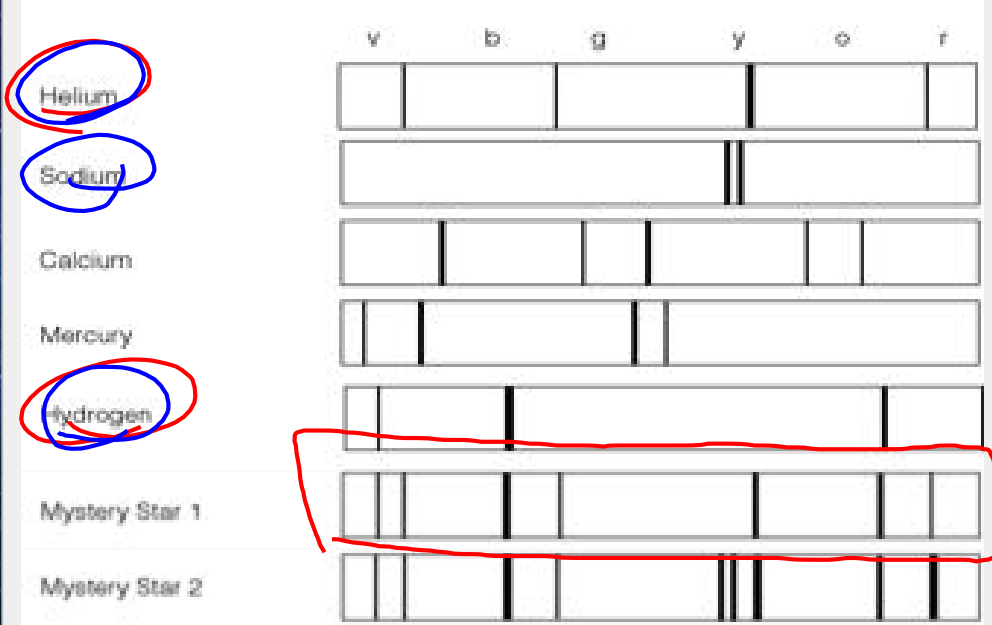


The Spectroscope

- When we look at the sun's light through a spectroscope, we actually see that there are many small lines of missing light
- These lines are called *spectral lines.*
- What does this tell us about the light from the sun?



Spectral Analysis

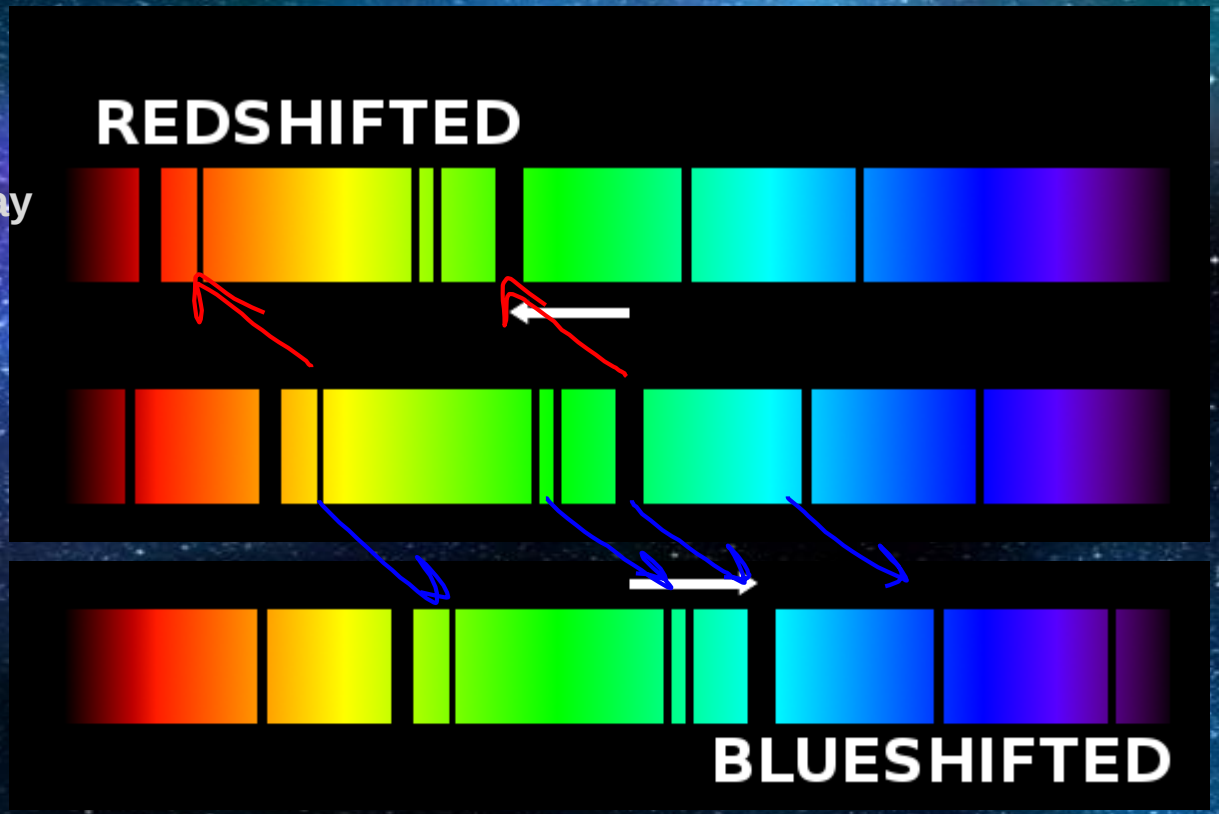


- Spectral analysis allows us to determine what a star is made of

- Which elements are present in Mystery Star 1?
  Hydrogen, helium
- Which elements are present in Mystery Star 2?
  H, He, Na

What happens to the spectral line pattern if the object is moving?

Object is moving away from us



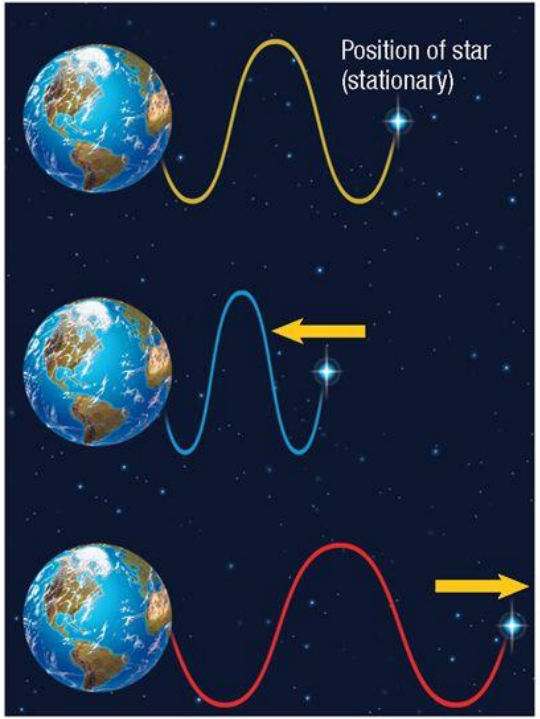
Object is moving towards us

Wavelengths & the Doppler Effect

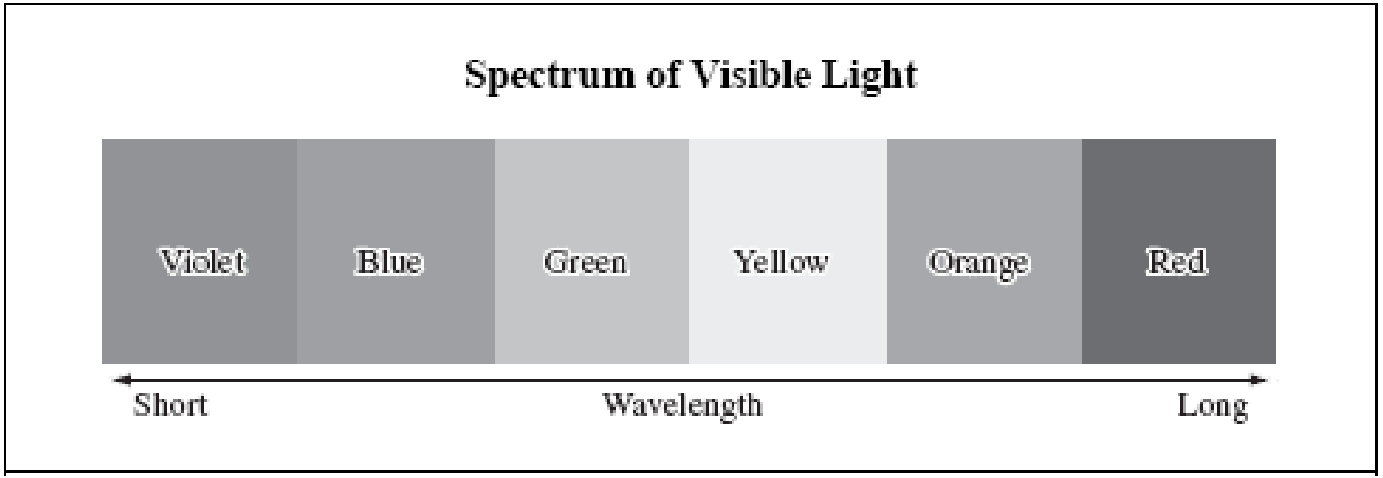
- Spectroscopes not only tell us what a star is made of, but also tell us how fast a star is moving towards or away from us
- Red wavelengths indicate moving away; blue wavelengths indicate moving towards
- This is comparable to the Doppler Effect; when an object is moving away from us, its sound waves are getting longer (like red wavelengths). When an object is getting closer, its sound waves are getting smaller (like blue wavelengths)

Red shift vs Blue shift

- When an object is approaching us, the shift is toward shorter wavelengths at the spectrum's blue end and is called *blue shift*
- Hubble found that most galaxies have red shifts and galaxies that are farther away have even greater red shifts
- He explained the red shift is occurring because galaxies are moving away from each other and the universe is expanding



✓ Check Your Understanding



Which of the following descriptions identifies a red-shifted star?

A. A star that is larger than Earth
B. A star that is smaller than Earth
C. A star that is moving toward Earth
D. A star that is moving away from Earth

moving away from us

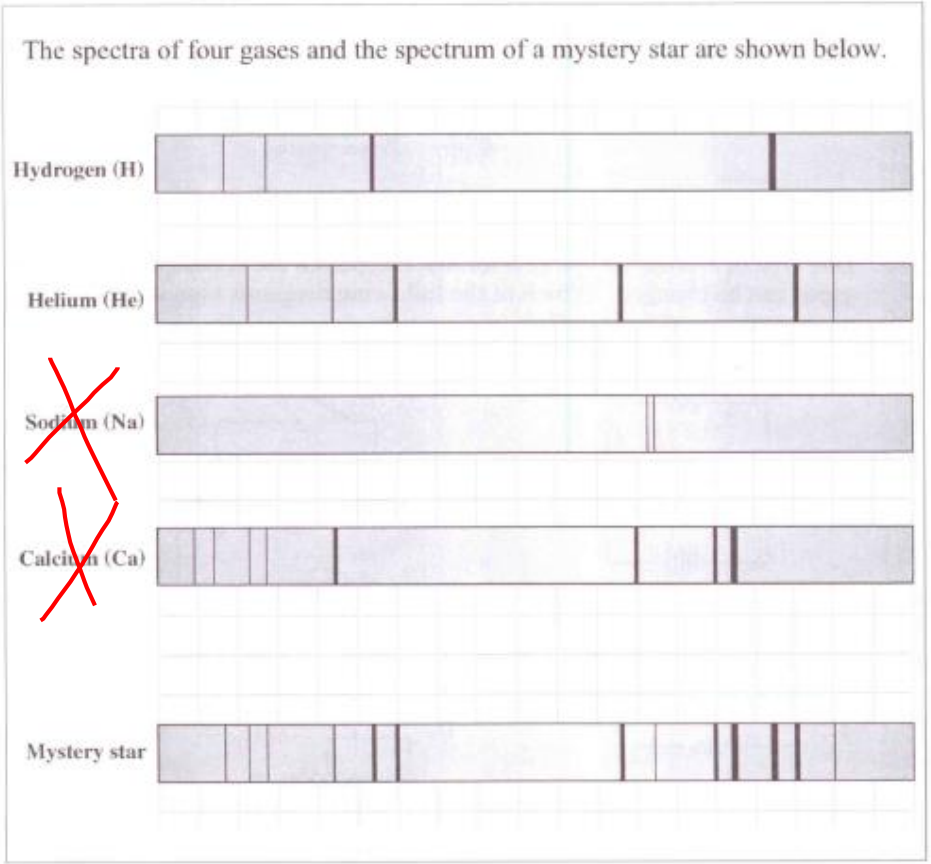
✓ Check Your Understanding

Researchers study the spectrum of a star to determine the star's

A. total mass
B. temperature
C. composition
D. gravitational force

C — what it's made of

✓ Check Your Understanding



Given the spectra of the four gases, what are two of the gases that are present in the mystery star?

A. hydrogen and helium
B. hydrogen and calcium
C. helium and sodium
D. sodium and calcium

✓ Check Your Understanding

Astronomers can use a spectroscope to

A. determine the composition of stars
B. map the location of celestial bodies in the sky
C. observe celestial bodies that were previously invisible
D. see images in space that are not distorted by Earth's atmosphere

Measuring Distance – Light Years

The distance between objects in space is too large to measure in units of meters or kilometers. Instead, distance is typically measured in ***light years*****, which describes the distance that light travels in one year (light years is NOT a measure of time!)**

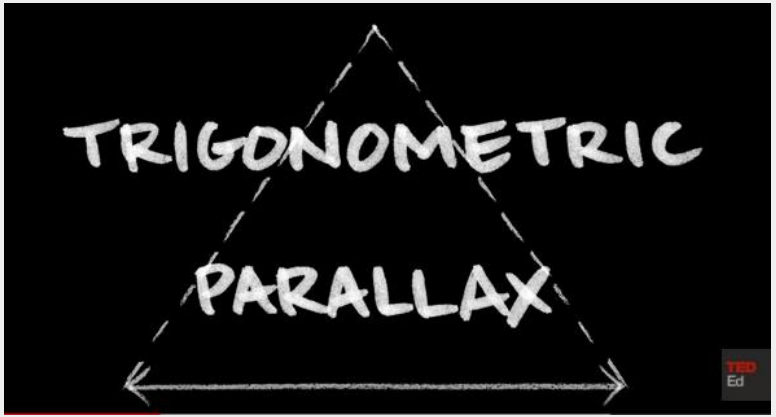
- Example: Proxima Centauri, the next closest star to us, is 4.28 light years away.
- *How do we know this if there's no ruler that long?!?!*

Parallax

Parallax is the apparent shift in an object's position when viewed from different angles.

Parallax

- **We can use parallax to measure the distance to a celestial object using trigonometry (triangle math)**



Parallax

Astronomers determine the distance to the star by viewing it from two angles: Earth's summer position and Earth's winter position

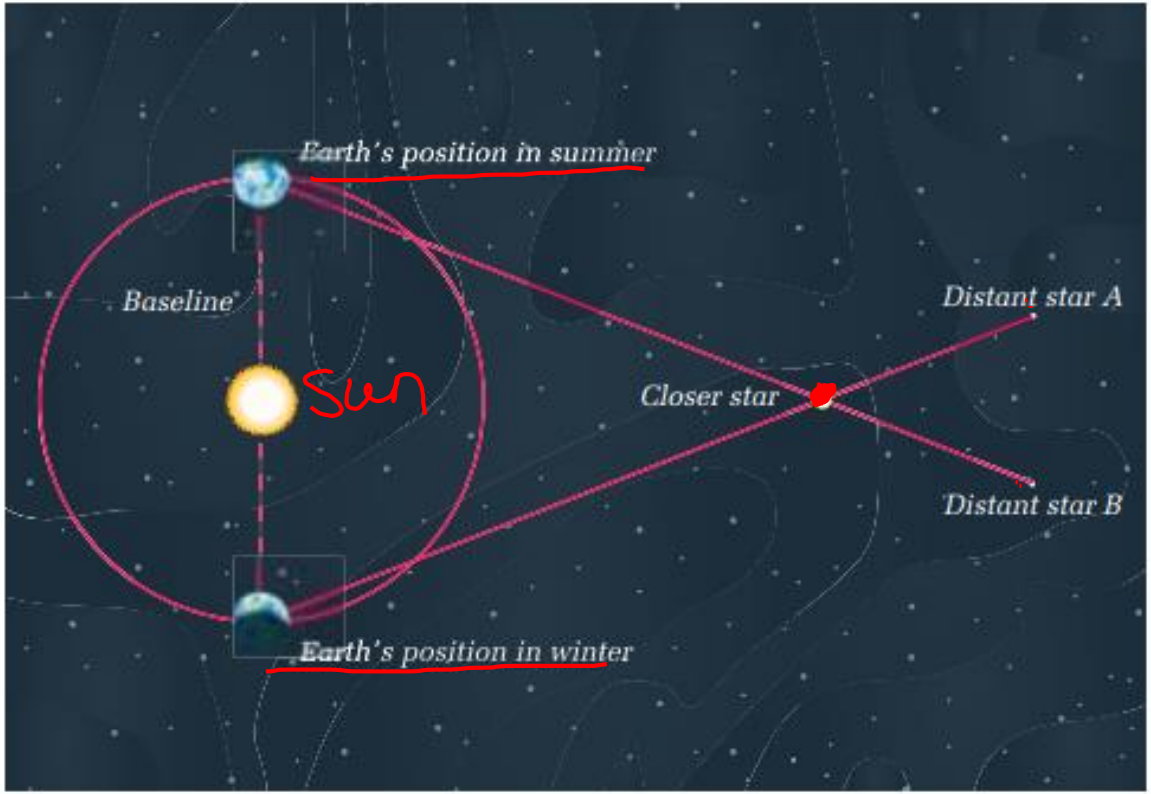
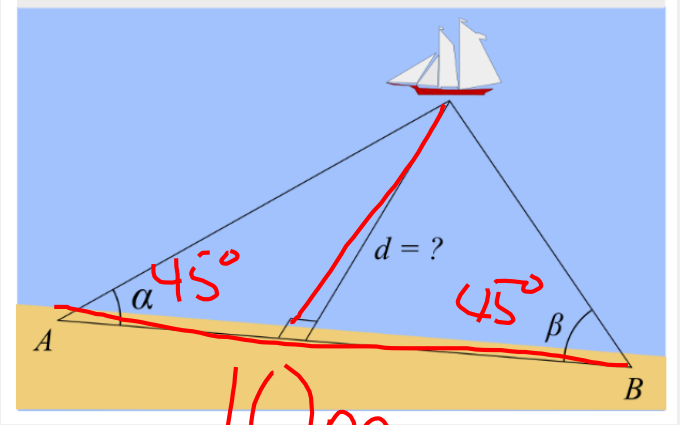


Figure 3.22 When viewed from Earth at different times of the year, a nearby star will appear to shift its position relative to different distant stars in the background. The angles between each end of Earth's baseline (the extreme ends of its orbit, six months apart) and the target star provide angles for triangulation.

Triangulation

SOH CAH TOA

- **Triangulation is the process of determining the distance to an object using trigonometry**
- To use the triangulation method, you need to know the length of one side of the triangle (the baseline) and the measure of the angles created when imaginary lines are drawn from either end of the baseline to the same point on the distant object.
- What math would we use?

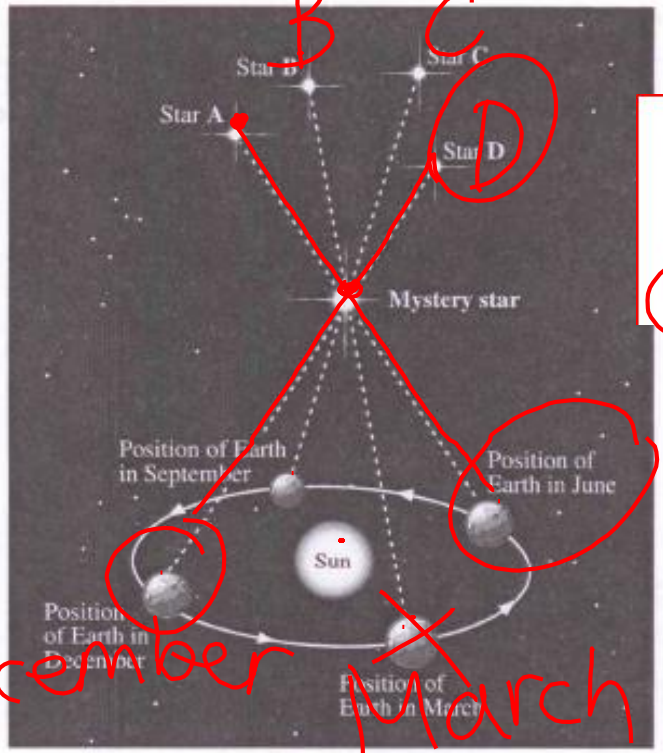


✓ Check Your Understanding

Triangulation is the measurement process that astronomers use to estimate the

A. size of a celestial body
B. orbit of a celestial body
C. distance to a celestial body from Earth
D. angle between a celestial body and Earth

The star map below shows the distance from Earth to a "mystery star."

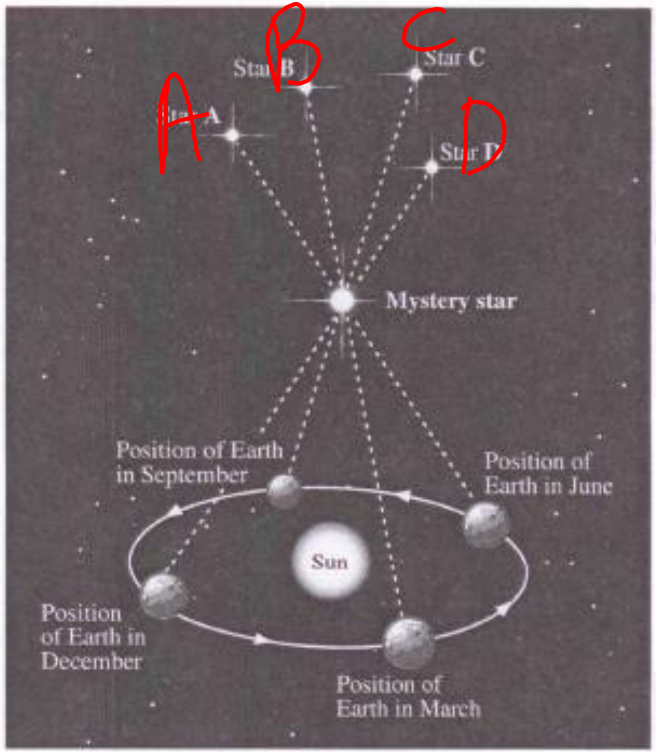


Relative to the position of Earth in June, the "mystery star" appears to line up with star A. In order to calculate the distance from the mystery star to Earth, a person must use this line and one other line.

In order to perform this calculation, the best line for the person to use is the line that is formed between the position of Earth in

A. June and star B
B. June and star D
C. March and star C
D. December and star D

The star map below shows the distance from Earth to a "mystery star."



Relative to the position of Earth in June, the "mystery star" appears to line up with star A. In order to calculate the distance from the mystery star to Earth, a person must use this line and one other line.

In relation to stars A, B, C, and D, the "mystery star" appears to shift its position as Earth moves around the sun. This apparent shift in position is called

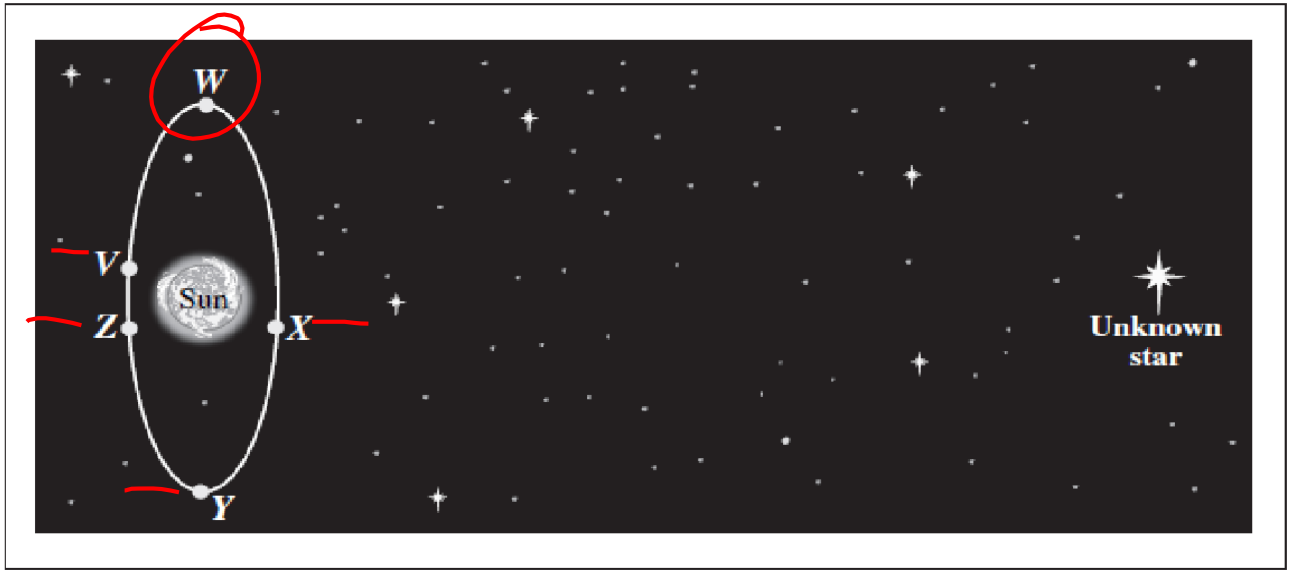
A. tracking
B. a parallax
C. an equinox
D. triangulation

✓ Check Your Understanding

Parallax and triangulation can be used to determine the

A. distance between a star and a planet
B. magnitude of a star's brightness
C. speed a planet is orbiting a star
D. composition of a star or planet

✓ Check Your Understanding



The **best** baseline for triangulation to determine the distance between the unknown star and the sun shown above will be established when Earth is in positions W and

A. V
B. X
C. Y
D. Z

LET'S PLAY

QUIZ – QUIZ – TRADE!!

GEOCENTRIC MODEL
HELIOCENTRIC MODEL
ELLIPSES
TERRESTRIAL PLANETS
GASEOUS PLANETS
STAR
NEBULA
GALAXY
CONSTELLATION
TELESCOPE
REFRACTING TELESCOPE
REFLECTING TELESCOPE
HUBBLE TELESCOPE

ALTITUDE
ASTROLABE
AZIMUTH
ZENITH
SPECTROSCOPE
SPECTRAL ANALYSIS
RED SHIFT
BLUE SHIFT
LIGHT YEAR
PARALLAX
TRIANGULATION