## Astronomy


"Actually they all look alike to me."

| Earth's Motions <br> (Verbal Quiz 1-7) | Rotation | Revolution |
| :---: | :--- | :--- |
| Definition |  |  |
| What is the <br> direction of <br> movement? |  |  |
| How long does it <br> take? <br> What is the rate? |  |  |
| Result of the <br> motion <br> How can you <br> move this <br> motion? |  | Two ways: |

## (Wilance for Roation|

1) Foucault Pendulum




Kirchhoff-Institut für Physik, Uni Heideiberg Thu.1 0.5.2007 07:04:1 2

## Wiliance for Roation|

## 1) Foucaulk Pendorlum 2) Coriolis Effect

## Earth's Revolution around the Sun

- Slightly eccentric elliptical orbit



## Earth's Revolution around the Sun

- Slightly eccentric elliptical orbit

Earth is moving around the Sun at about 67,000 miles per hour.

## Midiance for Realomion||

## 1) Changing Constellations

http://highered.mcgraw-hill.com/sites/dl/free/0072482621/59233/2.htm


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## 

# 1) Changining Constellations <br> 2) Doppler Shift 

OBJECT RECEDING: LONG RED WAVES

VNMN

## Earth's Motions

## How long is one rotation of Earth? 1 day ( 24 hours)

How long is one revolution of Earth? 1 year ( $\mathbf{3 6 5}$ days)

## 

Rising and setingof the sum:
Rising and setting ofthe mon:
The sexanss:
Changing Constallations:
Morementiof Starsthroughithe dy:

## Rotation

Rotation
Revolution

## Revolution

Rotation

## 

## One rotation $=360^{\circ}$

Time for one rotation = 24 hours

## $360^{\circ} / 24$ hours $=15^{\circ} /$ hour



Floix mandy degrees did the staks move
 diagram 2 ?


## It'ethe onit one that If aix cranaren itha 408药 Pol ENTE?



## Whatiotyhsphere  been sectigin, the North



## Diagram 2 - 11:00 p.m.



## WYat direcction must you be RFot?ing?



## inhat dinection

 do
## the staics applearCounter to Clockwise more?



## TMhat causes the stane apppeac to morye?

## EARTH'S ROTATION

## Satellites

## Satellite - Any object in space moving in orbit around another object

## Earth is a satellite of the sun

The moon is a satellite of earth. .

Why do the distances between the sun and earth change? $\qquad$

## Because Earth's orbit is elliptical (oval shaped)

https://video.yahoo.com/harry-caray-space-infinite-frontier-000000505.html -



## Nasis

## Formation of Earth's Moon

Have you heard of the face on the Moon



## Phases of the Moon

1) The apparent shape of the moon depends on the changing positions of the Sun. Earth and Moon.
2) How long does it take the moon to revolve around the Earth? 1 month
3) One complete orbit of the moon around the Earth takes about 27 1/3 days
4) A complete cyle the moon's phases takes $\mathbf{2 9} 1 / 2$ days
5) Explain why there is a $2 \frac{1}{2}$ day difference between the revolution of the moon and the amount of time it takes to complete all of its phases.

As the moon is taking $271 / 3$ days to revolve around Earth, Earth is also revolving around the sun. It takes an additional 2 days for the Earth, Sun and Moon to align and complete all of its phases.


## How long does

## one revolution of the moon take?

## 27.3 days

 How long does one rotation of the moon take?
## Solar System Data

| Object | Mean Distance <br> from Sun <br> (millions of km) | Period <br> of <br> Revolution | Period <br> of <br> Rotation | Eccentricity <br> of <br> Orbit | Equatorial <br> Diameter <br> $(\mathrm{km})$ | Mass <br> $($ Earth $=1)$ | Density <br> $\left(\mathrm{g} / \mathrm{cm}^{3}\right)$ | Number <br> of <br> Moons |
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| EARTH | 149.6 | 365.26 days | 23 hr <br> 56 min <br> 4 sec | 0.017 | 12,756 | 1.00 | 5.5 | 1 |
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| JUPITER | 778.3 | 11.86 years | 9 hr <br> 50 min <br> 30 sec | 0.048 | 142,800 | 317.896 | 1.3 | 16 |
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| PLUTO | 5,900 | 247.7 years | 6 days <br> 9 hr | 0.250 | 2,300 | 0.0025 | 2.0 | 1 |

# What phenomenon does this explain? 

 side of the moon,

## Phases

of the
Moon


## Important Vocabulary

New Moon: Occurs when the moon is between the earth and the sun. You can not see the moon.

* However you can see moon because moons orbit of earth is tilted 5 degrees compared to Earth's orbit.


## Important Vocabulary

Full Moon: Occurs when all the moons surface facing earth reflects light. You see all of the moon.


## Important Vocabulary

Waning: The decreasing of the visible amount of the moons surface, from full moon to new moon.

Waxing: The increasing of the visible amount of the moons surface, from new moon to full moon


## Important Vocabulary

Gibbous: A phase of the moon that is between full and quarter phase, you see more of the moon.

## Important Vocabulary

Crescent: A phase of the moon that is between a quarter moon and a new moon, you see less of the moon.

http://www.sumanasinc.com/webconte nt/anisamples/astronomy/moonphase.h tml




| New Moon | Full Moon |
| :---: | :---: |
| Waxing Crescent | WWaning Gibbous |
| First Quarter | Third Quarter |
| Waxing Gibbous | Waning Crescent |

## The phases of the mocnare whathye of crente

GJOHC

## Tides

High Tide

Tidal Range

FLOOD CURRENT
Low Tide




## Tides

- The rising and falling of the ocean surface. - Change in tide is the result of the changing positions of the Moon, and Sun relative to


## Earth.

- Close to 2 high tides and 2 low tides per day


## What Causes Tides

> Caused by the gravitational pull of the moon \& sun

## Based on the Diagram, which are larger?



## 



HIACMHII


Nean) Tos of ard Cumante


## Syylings <br> 

## Spring Tide:

- Occurs when the Moon and Earth are aligned in a straight line with the sun.
- Highest of the high tide and lowest of the low tide


## NeapTide:

- Occurs when the Moon and Earth are at right angles with the sun.
- Lowest of the high tide and highest of the low tide


## Eclipses



## What's the difference between solar and lunar eclipses?



Earth goes into moon's shadow.

## Moon goes into Earth's shadow

## SOLAR ECLIPSE

- Occurs when the moon is in the New Moon Phase
- Moons shadow moves over the Earth's surface, and you can't see the sun. (Sun, Moon, Earth,) (SME)
- Eclipse occurs where the point of the shadow hits Earth's surface


## Solar

 Eclipse
## What phase?

## New Moon

http://www.bbc.co.uk/science/space/solars ystem/sun/solareclipse.shtml

## Total Solar Eclipse



Sunlight

Path of total eclipse


## LUNAR ECLIPSE

- Occurs when the Moon is in the Full Moon phase
- The moon moves into Earth's shadow. (Sun, Earth, Moon) (SEM)
- Lasts until the moon moves out of Earth's shadow.


## Lunar Eclipse

## What phasef

http://www.classzone.com/books/earth_sci ence/terc/content/visualizations/es2504/es 2504page01.cfm?chapter_no=25

## Lunar Eclipse



Total Eclipse of the Moon

November 8-9, 2003

## Garth's Penumbra

In overet thave asdar eclipe, maxa phase must the mon bein?
In ordet thavere lunare eliphe, what phase must the moon bein?

## New Moon

## Full Moon



## The moons orbit around Earth is tilted

 about 5 degrees


Lunar Eclipse (SEM)



Solar<br>Eclipse (SME)

# Our <br> Solar <br> System 



## The Plangis



"Dwarf
Planets"


## Terrestrial vs. Jovian Planets

Terrestrial
-Closer to the sun

- Mostly Solid
- Smaller with
high densities

Jovian

- Far from sun
-Gaseous
- Larger with low densities

Terrestrial Planets "Rocky", small, more dense
examples Mercury, Venus, Earth, Mars

Jovian Planets 'Gaseous", large, less dense
examples Jupiter, Saturn, Uranus, Neptune
Asteroid belt - Located between Mars and Jupiter

- Composed of thousands of Asteroids

Reference Table Page 15

## Solar System Data

| Object | Mean Distance from Sun (millions of km) | Period of Revolution | $\begin{gathered} \text { Period } \\ \text { of } \\ \text { Rotation } \end{gathered}$ | Eccentricity of Orbit | Equatorial Diameter (km) | $\begin{gathered} \text { Mass } \\ (\text { Earth = 1) } \end{gathered}$ | $\begin{aligned} & \text { Density } \\ & \left(\mathrm{g} / \mathrm{cm}^{3}\right) \end{aligned}$ | $\left\|\begin{array}{c} \text { Number } \\ \text { of } \\ \text { Moons } \end{array}\right\|$ |
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| EARTH'S MOON | $\begin{gathered} 149.6 \\ \text { (0.386 from Earth) } \end{gathered}$ | 27.3 days | 27 days 8 hr | 0.055 | 3,476 | 0.0123 | 3.3 | - |

meteor A streak of light in the sky that occurs when a meteoroid enters Earth's atmosphere "shooting star"
meteorite A meteor that reaches Earth's surface

Conets - Huge dirty ice ball that revolves around the sun.

- When close enough to sun, exhibits a tail

Reference Table Page 15

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## Draw a line across the table between the terrestrial and jovian planets and label.

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## Which are more dense? Jovian or terrestrial

Solar System Data

| Object | Mean Distance <br> from Sun <br> $($ millions of km) | Period <br> of <br> Revolution | Period <br> of <br> Rotation | Eccentricity <br> of <br> Orbit | Equatorial <br> Diameter <br> $(\mathrm{km})$ | Mass <br> $($ (Earth $=1)$ | Density <br> $\left(\mathrm{g} / \mathrm{cm}^{3}\right)$ | Number <br> of <br> Moons |
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## Which have more moons ? Jovian or terrestrial

Solar System Data

| Object | Mean Distance <br> from Sun <br> (millions of km ) | Period <br> of <br> Revolution | Period <br> of <br> Rotation | Eccentricity <br> of <br> orbit | Equatorial <br> Diameter <br> $(\mathrm{km})$ | Mass <br> $($ Earth $=1)$ | Density <br> $\left(\mathrm{g} / \mathrm{cm}^{3}\right)$ | Number <br> of <br> Moons |
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## Which have longer periods of revolution? Jovian or terrestrial

Solar System Data

| Object | $\begin{aligned} & \text { Mean Distance } \\ & \text { from Sun } \\ & \text { (millions of } \mathrm{km} \text { ) } \end{aligned}$ | Period of Revolution | $\begin{gathered} \text { Period } \\ \text { of } \\ \text { Rotation } \end{gathered}$ | $\left\|\begin{array}{c} \text { Eccentricity } \\ \text { of } \\ \text { Orbit } \end{array}\right\|$ | Equatorial Diameter (km) | $\begin{gathered} \text { Mass } \\ (\text { Earth = 1) } \end{gathered}$ | $\begin{aligned} & \text { Density } \\ & \left(\mathrm{g} / \mathrm{cm}^{3}\right) \end{aligned}$ |  |
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Complete the rest yourself

## Models of the Solar System

## Geocentric - Earth- Centered



## Geocentric Model: Earth Centered

Explained the following:

- Earth was stationary with the sun Moons and planets revolving around it
- Night and Day
- Revolution of the moon

Did not easily explain the following:

- Movement of the inner
 and outer planets


## Heliocentric

## - Sun- Centered



## Heliocentric Model: Sun Centered

Explained the following:

- Puts sun in the center of our solar system
- Day and Night
- Seasons
- Motions of Celestial Objects


Heliocentric Model

Copernicus, Brahe, Kepler, Galileo and other scientists in the $16^{\text {th }}$ and $17^{\text {th }}$ centuries supported this model. This is the model we use today.

## Shape of Orbit

## The planets move in ollipsess with the Sun at one focus

# Shape of Earth's orbit: Slightly elliptical with the sun at one foci 

Eccentricity How "oval" an orbit is

## Eccentricity = Distance between foci Length of major axis

## Calculate the eccentricity of the ellipse below: <br> length of major axis



Formula: eccentricity = distance between foc

Determine the eccentricity of the ellipse to the right:


1) A circle has an eccentricity of
0 , and is least eccentric.
2) The more oval an ellipse is the more eccentric it is.

# What keeps the planets in their orbit? 

 ${ }^{*}$ GRAVITY
## The Force of Gravity

1) Graxity An invisible force of attraction
2) Gravity depends on two things: Mass and _Distance
3) The larger the mass, the Greater the gravitational attraction.
4) The closer objects are together, the Greater the attraction.

## Fact(s) to memorize:22-26 Planet Velocities

The line joining the Sun and a planet sweeps out equal areas in equal intervals of time

1. Between which two letters is the orbital speed the slowest? $\qquad$
2. Between which two letters is the orbital
 speed the fastest?
3. The area's covered by the Earth as it travels from $A$ to $B$ and from $C$ to $D$ are
4. The speed of a planet depends upon its distance from the $\qquad$ .

## Distance of planets with respect to the Sun

Perihelion $\qquad$
Aphelion $\qquad$
The square of the time ( $\mathrm{T}^{2}$ ) of revolution of a planet divided by the cube of its mean distance ( $\mathrm{R}^{3}$ ) from the Sun gives a number that is the same for all the planets

Base your answers to questions 1 and 2 on the diagram of the ellipse below.
$\begin{array}{ll}F_{1} & F_{2} \\ + & +\end{array}$

1. Calculate the eccentricity of the ellipse to the nearest thousandth.
2. State how the eccentricity of the given ellipse compares to the eccentricity of the orbit of Mars.

## Star formation:

Stars start out is a nebula which is a massive cloud of dust, hydrogen, and plasma.

Due to gravitational attraction the cloud collapses and temperature increases, nuclear fusion is taking place where hydrogen is becoming helium.

A protostar forms. From there, stars can become a main sequence star or a massive star.


## Whataie the supergiants

## main classilicaidions

- of staris?


## Main sequence <br> White Dwarfs

ESRTs p15

## Stars <br> \section*{Reference table page 15}

## Luminosity and Temperature of Stars

(Name in italics refers to star shown by a $\oplus$ )


Luminosity is the brightness of stars compared to the brightness of our Sun as seen from the same distance from the observer.

## Sun

Jupiter



Earth is invisible at this scale


What two characteristics are used to classify stars?

## Luminosity

## Temperature

Luminosity and Temperature of Stars
(Name in italics refers to star shown by a $\oplus$ )


Luminosity is the brightness of stars compared to the brightness of our Sun as seen from the same distance from the observer.

Luminosity and Temperature of Stars
(Name in italics refers to star shown by a $\Theta$ )


What type of star is our Sun classified as?
Main Sequence
Circle where it is on the chart above.

Shade the chart where all of the stars are hotter than our sun.
Draw a line on the chart which separates those stars brighter than our sun and those less bright.

The star Betelgenses is located in the constellation Orion. What colori it it? Red The star Rigel is ocated in the constellation Orion. What color isit? White

How do stars generate their energ:? Nuclear Fusion

## Earth in the Universe

## ©.




## Galaxy

Galaxy • collection of billions of stars, planets and various amounts of gas and dust
held together by gravity.

What is the name of our galaxy? Milky Way
What kind of a galaxy do we live in? Spiral Galaxy
Where is our solar system located within the galaxy In one of the Spiral arms


## The Universe

## The Universe Includes everything that exists from the smallest object to the largest galaxies.

## Big Bang Theory About 14 billion yrs ago a massive

 explosion took place and started the formation of the universe.
# evidence - The universe is expanding in every direction. 

- Doppler Effect $\rightarrow$ Red Shift
- Cosmic background radiation

The diagram below illustrates three stages of a current theory of the formation of the universe.


Stage 1
A ball of hydrogen
exploded.


Stage 2
A huge hydrogen cloud moved outward with cloud parts condensing to form galaxies.


Stage 3 (present)
The galaxies continue to move outward.

## - The separation of different colors based on wavelength

Violet

Standard Spectrum (a normal pattern)



Table of Contents
Visual Stimulus

# red shift: <br> - Objects moving away cause by explosion of space 

Violet



BLUESHIFTED


## UNSHIFTED



REDSHIFTED
http://www.ww norton.com/co llege/geo/ege o/flash/1_2.sw

Red Shift = away Blue Shiff: foward
http://www.color ado.edu/physic s/2000/applets/ doppler2.html

## Long Wavelength Low Frequency <br> Small Wavelength High Frequency



The Doppler Effect for a Moving Sound Source

