Unit 1 - The Universe and The Solar System

Key concept - **Systems** - How do different systems interact on Earth, in the solar system and in the universe?

Related concepts - **Models and environment** - How can we use scientific models to explain events and predict future events?

Global concept - **Orientations in time and space** - Why is the position of Earth in the solar system essential for our survival?

Unit 1 KEYWORDS

- Big Bang
- Geocentric
- Heliocentric
- Universe
- AU
- Light-year
- Galaxy
- Nebulae
- Star
- The Solar Sytem
- Planets
- Asteroid belt
- Dwarf planet
- Revolution
- Rotation
- Axis

Task guide

The tasks and questions on the website will be coloured to represent the different style of questions that you will find in your exams. The task should be completed in your "Natural Sciences" GoogleDrive document.

Green - Explaining scientific knowledge
Orange - Applying scientific knowledge and understanding
Red - Analysing and evaluating information

There will also be "**extension**" tasks for students who finish tasks quickly! Also look out for *links* to interactive resources and videos.

Where did it all start?

In your "Natural Sciences" Word document copy and paste the sentence below (in green) and then complete the task:

Task 1a: Write down as many things as you can about how the universe was created.

What is the Big Bang theory?

Looking out into space, we can see that all stars and galaxies are actually moving away from each other.

This suggests that the Universe must be expanding.

If we were to reverse time then we would see everything moving together until . . .

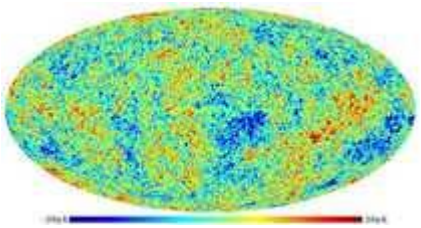
. . . at some point everything must have been found in a single point.

This suggests that there must have been some kind of explosion which created the universe from a single point. We call this **The Big Bang**. *Click on the photo above* to see a video showing the futhest stars that we can see. They are 13 billion light years away!

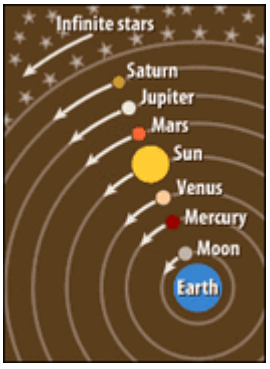
Task 1b:

1. **Add 2 more things** you now know about the Big Bang.
2. **State** how old the universe is?
3. **Explain** why are the words "big" and "bang" strange to use for this theory?

Extension: **Explain** what cosmic background radiation is and how it supports the Big Bang theory?



(Hossenfelder, 2006)



(Amazing-space.stsci.edu, 2015)

Theories of the Universe

THEORY 1 - The first well known theory of the universe was described by Aristotle in 384 B.C. and then developed by Claudius Ptolemy in 100 A.D.

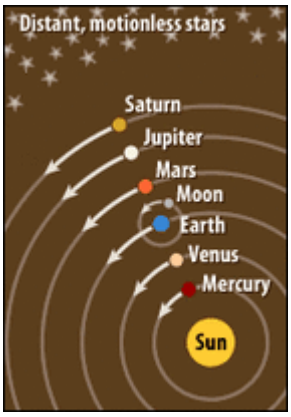
This theory states that The Earth was the centre of the universe and all the planets, The Sun and the stars rotate around it. This is called the **geocentric theory** because the prefix "geo" is to do with The Earth.

How many words can you think of beginning with "geo"?

THEORY 2 - Over 1000 years later, Nicolas Copernicus developed the**heliocentric theory**. This states that the Sun is at the centre of the universe with the planets rotating around it. At the other stars are around the outside but not moving.

Galileo Galilei and Johannes Kepler verified it with other observations. (*You do not need to know the names of the scientists*)

How could "helio" be related to the sun?
Does this match perfectly with what we know now?



(Amazing-space.stsci.edu, 2015)

What can we find in our Universe?

Task 1b: Use the internet to find a **definition** of the following things:

- **Galaxy**
- **Nebulae**
- **Star cluster**
- **Milky Way**

This image is of a nubula called the "Horsehead Nebula" because it looks like a horse!!!

(Nasa.gov, 2015)

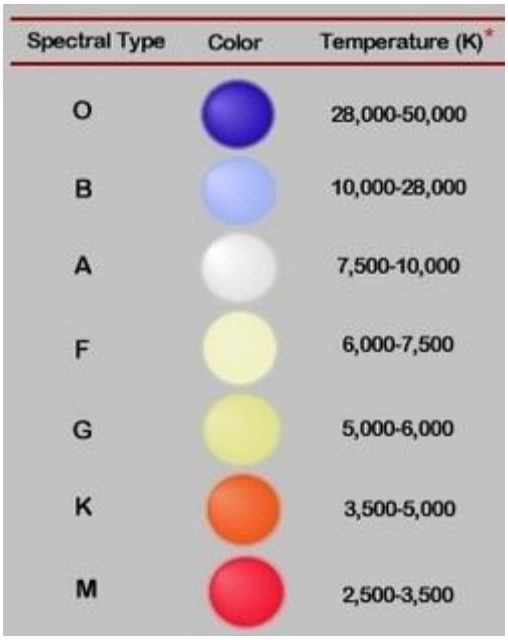
What is a star?

Stars are large balls of gas - mainly hydrogen and helium - that are releasing lots of heat and light energy due to chemical processes.

You may have noticed that in some of the images above, the stars are different colours. The colour are shown to the right and they depend mostly on the temperature of the star.

The star in our solar system is called the **Sun**.

The temperature on the outside of the Sun is about 5500 ºC but in the middle it is 15,000,000 ºC.!



Spectral Type	Color	Temperature (K)*
O		28,000-50,000
B		10,000-28,000
A		7,500-10,000
F		6,000-7,500
G		5,000-6,000
K		3,500-5,000
M		2,500-3,500

How big is the universe?

The furthest that our telescopes allow us to see is about 13.8 billion light-years. We call this the **observable** universe because this is the maximum that we can see. However, because we know the univers is expanding, the actual universe must be bigger than this.
What units of distance do we use in space? It would be ridiculous to use normal units of distance such as metr and kilometres as the numbers would be so big.

For example, the distance between Earth and Mars in metres would be 4,700,000,000,000.

To avoid these large numbers we use **astronomical units** (AU) and **light-years** (ly).

- 1 **AU** = 150,000,000 km (*approximately the distance between the Earth and the Sun*)
- 1 **ly** = This is the distance that light can travel in 1 year. Approximately 9,460,800,000,000 km!!!

Example distances:
Sun --> Jupiter 5.19 AU
Diameter of The Milky Way 100,000 ly
DIstance to furthest known star 13,800,000,000 ly

Task 1c:

1. **State** which units would be best for measuring the distances between galaxies? Why?
2. **State** which units would be best for measuring distances in our solar system?
3. **Calculate** which the longest distance is - 1 light-year or 100,000 astronomical units?
4. The distance between the Earth and the Sun can also be described as 8 light-minutes. Write a **definition** for a light-minute.

(Barrio Gómez de Agüero, 2011)

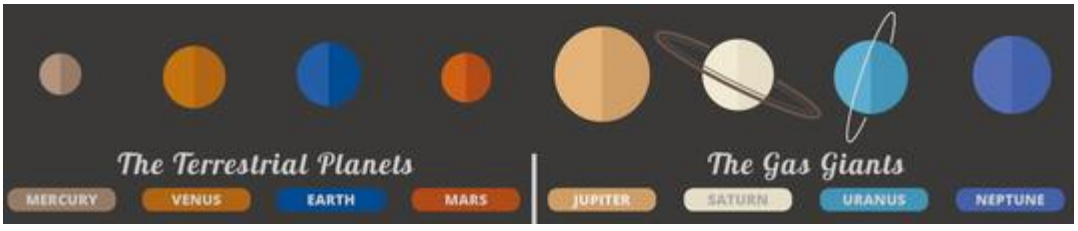
The Solar System

Definition - The solar system is the group of planets, dwarf planets, satellites, asteroids and comets which regularly orbit the Sun

As you saw in primary, our solar system is made up of several different different things.

You will need to be able to describe its composition and explain various facts about them. You will NOT need to remember all the individual facts about the planets!

Example question: Describe 3 differences between the terrestrial planets and the gas giants.



Task 1d: Complete the pratice exam questions below:

1. There used to be 9 planets in our Solar System, now there are only 8. **Explain** what happened to the 9th planet?
2. **Explain** why do the inner planets have higher average temperatures than the outer planets?
3. **Explain** which planet would take the longest to revolve around the Sun?
4. **Explain** why do the bigger planets usually have more moons that the smaller ones.
5. **Explain** why is Jupiter useful for the safety of the Earth?
6. Which other planet would be most suitable for humans to live on? **Explain** your answer.
7. Venus has an atmosphere made of 97 % carbon dioxide compared to 0.1 % on Earth. **Explain** why this makes Venus a much hotter planet?
8. If we look at the stars and galaxies around us, we notice that they are all moving away from each. **Explain** how this helps us to work out that the Universe started at a single point?

Task 1e: Criterion C practice: Use the information below to create a scatter graph about the distances of each planet from the Sun and the surface temperatures that they have.
Making a graph hints:

- Use **Microsoft Excel**
- Make a **scatter graph** (***dispersión***) NOT a line graph (*línea*)
- Add a **line of best fit** (**línea de tendencia**) that most accurately fits your data.
- Add a **title** - Graph to show...
- **Label** the axes with units.
- When it has been **checked by your teacher**, copy the graph and paste it into your NSD.

Planet	Average Distance from Sun (millions of km)	Average Surface Temperature (°C)
Mercury	58	167
Venus	108	457
Earth	150	14
Mars	228	–55
Jupiter	778	–153
Saturn	1427	–185
Uranus	2869	–214
Neptune	4496	–225

(Syvum.com, 2015)

Under the graph write a **conclusion** using the following questions to help you:

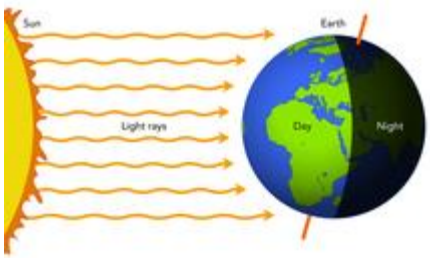
1. What does the line of best fit show about the distance compared to the surface temperature? Why is this?
2. Are there any planets that do not fit the trend? Why is this?
3. Why is Earth´s distance from the Sun important for life?
4. Which other planet might be able to support life? Explain why?

Homework: Choose one of the 8 planets and imagine that you are on holiday there! Write a postcard back to your family in Seville describing the holiday. Include interesting facts and possible activities that you have be doing.

The movements of the Earth

We will consider the 2 main movements of Earth:

1. **Rotation** - This is the movement of Earth around its own axis. The Earth makes a complete rotation once every 24 hours and this is responsible for day and night. The Earth´s axis is tilted at an angle of 23.5 º and this affects the length of days and nights, depending on location.



When a location is in the path of the Sun´s rays then it experiences daytime. When it is on the opposite side of Earth then it will be in night. The tilt of the Earth means that the length of day and night can vary.

2. **Revolution** - The Earth also moves in an elliptical orbit around the Sun. This movement, with the tilted axis of Earth, is responsible for the **seasons** we experience.

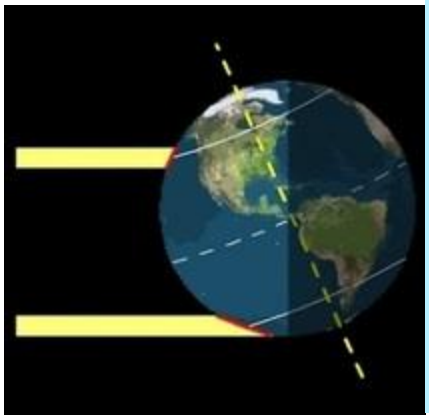
In the nothern hemisphere...

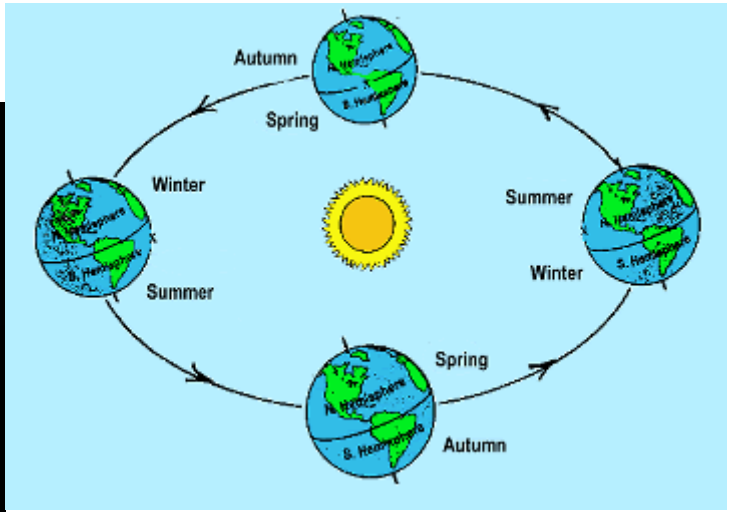
When the Earth is tilted towards the Sun (*as in the diagram to the right*), the same number of Sun´s rays are falling on a smaller area of the Earth´s surface. this can be seen in the length of the red lines in the diagram.

This means that more heat and light energy is received in the northern hemisphere and therefore we have **summer**.

In the southern hemisphere...

As the Sun´s rays are more spread out on the Earth´s surface they receive less heat and light energy. This is called **winter**.





As the Earth revolves around the Sun, the northern hemisphere will gradually end up pointing away from the Sun. This reverses the seasons.

The points in between summer and winter are when the tilt of Earth is not pointing to or away from the Sun.

Summer --> Autumn --> Winter --> Spring

NOTE: The seasons are **not** caused by the distance from the Sun!!!

Task 1f: Research challenge!!! Find a photo (and name of) of the following:

1. The most northern city on Earth (*also write the name*).
2. The driest place on Earth.
3. Showing a picture of the Sun at midnight.
4. An animal that lives near the South Pole.

Extension questions: Use the map to **state** which of these countries lie on the **equator**: Venezuela, Gabon, Tanzania, Indonesia and Hawaii.

How does the orientation of the Moon affect us on Earth?

Can you **state** any phenomena on Earth that are caused by the Moon?

A **satellite** is an object that has an orbit around something else. For example, the Earth is a satellite of the Sun. The Earth also has its own satellite that we call **The Moon**.

The moon was created by a collision between 2 planets that caused one large piece of debris that became the Moon. The rest of the debris reformed the planet we now call Earth.

(Anthony, 2015)

Task 1g:

1. Which force pulled the debris back together to form The Earth?
2. **Make** a pie chart about the chemical compostition of Earth and then make one for the Moon using the data to the left.

3. **Explain** how this helps scientists work out that the Moon and Earth were formed from a collision.

Extension: Which gases in the Earth´s atmosphere are most important for life? Why? Do any other planets have these gases in their atmospheres?

The Moon **revolves** around the Earth once every 28 days. It also **rotates** around its own axis once every 28 days.

Interactive simulation - The movements of the Moon

As the Moon does not produce any light, we can only see the part of it is reflecting the Sun´s light. This means that we see a variety of shapes as it **revolves** around Earth.

Table 2.1: Composition of the Earth & Moon

Element	Earth	Moon
Iron	34.6%	3.5%
Oxygen	29.5%	60.0%
Silicon	15.2%	16.5%
Magnesium	12.7%	3.5%
Titanium	0.05%	1.0%

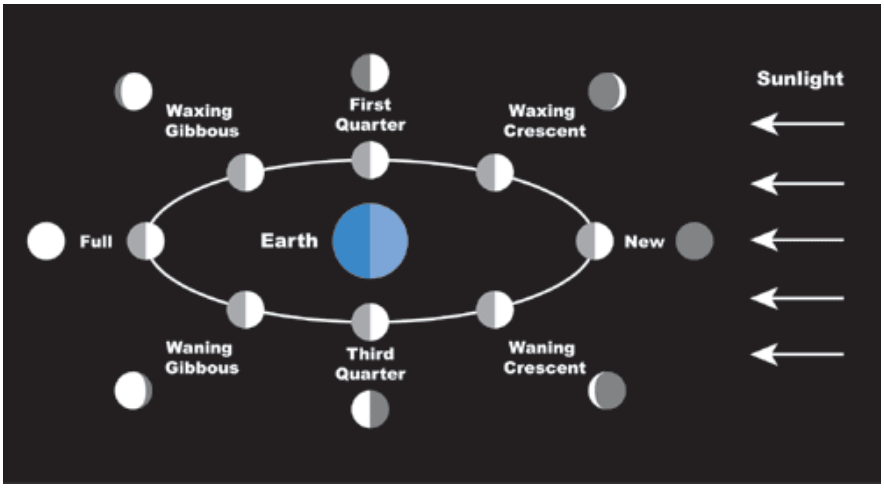
(Astronomy.nmsu.edu, 2015)

Extension: Which gases in the Earth´s atmosphere are most important for life? Why? Do any other planets have these gases in their atmospheres?

The Moon **revolves** around the Earth once every 28 days. It also **rotates** around its own axis once every 28 days.

Interactive simulation - The movements of the Moon

As the Moon does not produce any light, we can only see the part of it is reflecting the Sun´s light. This means that we see a variety of shapes as it **revolves** around Earth.



(Schimmrich & profile, 2011)

Task 1h:

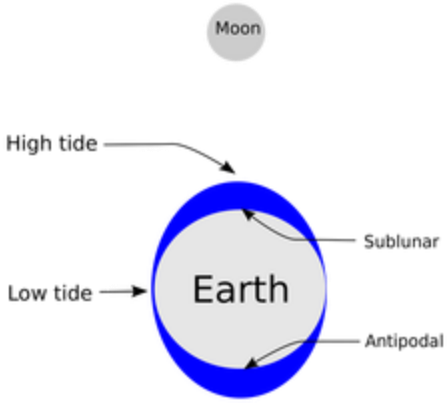
1. Which phase of the Moon reflects the most light towards Earth? Which phase the least?
2. Mr King has said that the use of paper is "**waning**" in our school. What does he mean by this and why? Use the word "**waxing**" in a sentence.
3. The position of the Moon in its **revolution** has no effect on the part of the Moon that faces the Earth. Why not? (*This photo shows the only side of the Moon we see -->*)
4. What causes the large craters that you can see?

(NTNews, 2015)

(Spittalschool.org.uk, 2015)

Extension: How did the Moon cause this boat to become stranded?

Tides



The gravity of the Earth keeps the Moon in a permanent orbit. The gravity of the moon, however, also has an effect on the Earth. As it revolves around the Earth, its gravity causes the oceans to bulge

towards itself. This causes a high tide (*marea alta*). For the places that are at the side of the Earth they have a low tide.

Why does the water "bulge" the opposite side of the Earth as well?

The gravity from the Sun can also make tides bigger or smaller. It the Moon and Sun are aligned then we get even higher tides. If they are not aligned then the tides are smaller.

When a changing tide is particularly strong it can actually form a wave that travels UP a river. This is called a **tidal bore**

Eclipses

How is this photo related to eclipses?

(Dickinson & Dickinson, 2011)

As the Moon **revolves** around the Earth, it sometimes blocks our view of the Sun and sometimes is hidden in Earth´s shadow. When this happens we see an eclipse.

There are 2 types of eclipse depending on where the Moon is: A **lunar eclipse** or a **solar eclipse**.

Solar eclipse

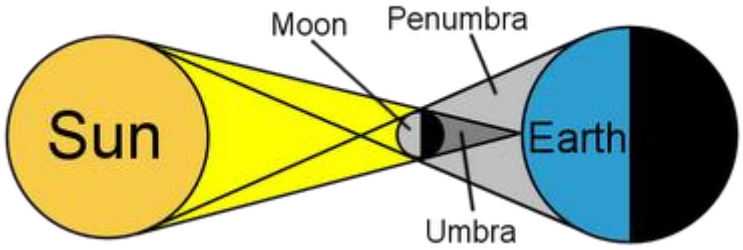
A **solar eclipse** is caused when the Moon is positioned between the Sun and the Earth.

This means that in a small area on Earth´s surface, the Sun is completely blocked from view. This is a **total eclipse.** Other parts of the Earth´s surface will experience a **partial eclipse** if the Sun is only partially blocked. Some places may not experience any eclipse.

(Patrickelwoodeclipse.wikispaces.com, 2015)

Remember that most diagrams you see are not to scale! The table and drawing below show a more realistic scale:

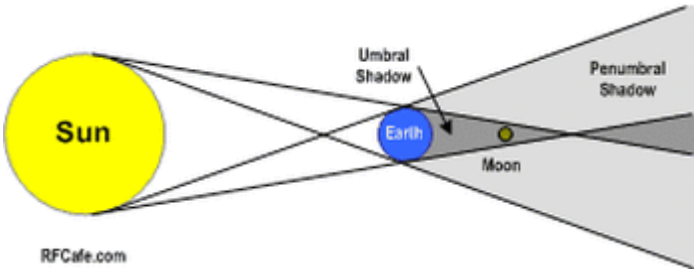
From Earth to...	Distance (km)
Moon	400,000
Sun	150,000,000
Neptune	4,700,000,000



(Gallery4share.com, 2015)

Lunar eclipse

Normally when the Moon is the opposite side of the Earth, we see a full moon as we see the reflection of the Sun´s light off the full half of the Moon. Sometimes, however, it passes through the Earth´s shadow. In this case, the Moon will not reflect any light and so looks as if it is disappearing (*as in the photo on the right*).



(Gallery4share.com, 2015)

(Space.com, 2015)

Task 1g: Click on this link and **complete** questions 1-4, in your NSD, from the "Exercises" tab.

Extension: **Complete** questions 5-9.

References:

ReferencesAmazing-space.stsci.edu,. (2015). *Figure: Views of the universe: Ptolemy vs. Copernicus*. Retrieved 25 June 2015, from http://amazing-space.stsci.edu/resources/explorations/groundup/lesson/basics/g37/

Anthony, S. (2015). *The Moon's real age, and creation from the collision of Earth and Theia, finally confirmed (Updated) | ExtremeTech*. *ExtremeTech*. Retrieved 26 June 2015, from http://www.extremetech.com/extreme/179768-the-moons-real-age-is-finally-revealed-but-the-mystery-of-earths-tardy-development-lives-on

Astronomy.nmsu.edu,. (2015). *The Moon*. Retrieved 26 June 2015, from http://astronomy.nmsu.edu/tharriso/ast105/Ast105week06.html

Barrio Gómez de Agüero, J. (2011). *Natural sciences, ESO 1*. [San Fernando de Henares, Madrid]: Oxford Educación.

Blog.visualmotive.com,. (2009). *Ten Examples of the Subway Map Metaphor - Chris Mueller – Visualmotive*. Retrieved 30 June 2015, from http://blog.visualmotive.com/2009/ten-examples-of-the-subway-map-metaphor/

Boyle, A. (2014). *Hubble Team. NBC News*. Retrieved 25 June 2015, from http://www.nbcnews.com/science/space/hubble-team-unveils-telescopes-most-colorful-cosmic-view-n121556

Demotix,. (2015). *Water pollution in the Buriganga River of Bangladesh*. Retrieved 24 June 2015, from http://www.demotix.com/news/4253788/water-pollution-buriganga-river-bangladesh

Dickinson, D., & Dickinson, D. (2011). *12 Famous Eclipses in History - Listosaur | Hungry for Knowledge*. *Listosaur | Hungry for Knowledge*. Retrieved 29 June 2015, from

http://listosaur.com/history/12-famous-eclipses-in-history/

Ezizka.net,. (2015). *Introductory Astronomy on the Internet, Topic 1 in Lesson 8*. Retrieved 25 June 2015, from http://www.ezizka.net/astronomy/lessons/topicslesson08/topic01lesson08.htm

Frontpagemag.com,. (2015). *Global Warming*. Retrieved 24 June 2015, from http://www.frontpagemag.com/2015/christopher-s-carson/science-journal-massages-data-to-show-no-pause-in-global-warming/

Gallery4share.com,. (2015). *Total Lunar Eclipse Diagram*. Retrieved 29 June 2015, from http://gallery4share.com/t/total-lunar-eclipse-diagram.html

Global Research,. (2015). *Global Warming, God, and American Complacency*. Retrieved 24 June 2015, from http://www.globalresearch.ca/global-warming-god-and-american-complacency/5431171

Google.es,. (2015). *hubble deep field - Buscar con Google*. Retrieved 25 June 2015, from https://www.google.es/search?q=hubble+deep+field&espv=2&biw=1366&bih=643&source=lnms&tbm=isch&sa=X&ei=W86LVZ6AGYGuUNiYgZAK&ved=0CAYQ_AUoAQ#imgrc=v1Rwtwk9GavedM%253A%3BAXDTCX9OHrCyhM%3Bhttps%253A%252F%252Fi.ytimg.com%252Fvi%252FpeqCfW8hSzQ%252Fmaxresdefault.jpg%3Bhttp%253A%252F%252Fwww.nbcnews.com%252Fscience%252Fspace%252Fhubble-team-unveils-telescopes-most-colorful-cosmic-view-n121556%3B1920%3B1080

Hamilton, C. (2015). *Earth Introduction*. *Solarviews.com*. Retrieved 25 June 2015, from http://solarviews.com/eng/earth.htm

Hossenfelder, S. (2006). *Backreaction: Anomalous Alignments in the Cosmic Microwave Background.Backreaction.blogspot.com.es*. Retrieved 26 June 2015, from http://backreaction.blogspot.com.es/2006/12/anomalous-alignments-in-cosmic.html

Hossenfelder, S. (2006). *Backreaction: Anomalous Alignments in the Cosmic Microwave Background.Backreaction.blogspot.com.es*. Retrieved 26 June 2015, from http://backreaction.blogspot.com.es/2006/12/anomalous-alignments-in-cosmic.html

Nasa.gov,. (2015). *NASA - Horsehead Nebula*. Retrieved 25 June 2015, from http://www.nasa.gov/multimedia/imagegallery/image_feature_89.html

NTNews,. (2015). *Tide catches fishos by surprise*. Retrieved 26 June 2015, from http://www.ntnews.com.au/news/northern-territory/tide-catches-fishos-by-surprise/story-fnk0b1zt-1226794761241

Patrickelwoodeclipse.wikispaces.com,. (2015). *PatrickElwoodEclipse - How is a solar eclipse different from a lunar eclipse?*. Retrieved 29 June 2015, from http://patrickelwoodeclipse.wikispaces.com/How+is+a+solar+eclipse+different+from+a+lunar+eclipse%3F

Scaleofuniverse.com,. (2015). *Scale of Universe - Interactive Scale of the Universe Tool*. Retrieved 25 June 2015, from http://scaleofuniverse.com/

Scharf, C. (2015). *Return To The Pale Blue Dot*. *Blogs.scientificamerican.com*. Retrieved 30 June 2015, from http://blogs.scientificamerican.com/life-unbounded/return-to-the-pale-blue-dot/

Schimmrich, S., & profile, V. (2011). *Movements of the Moon - Part III ~ Hudson Valley Geologist.Hudsonvalleygeologist.blogspot.com.es*. Retrieved 26 June 2015, from http://hudsonvalleygeologist.blogspot.com.es/2011/07/movements-of-moon-part-iii.html

Solar, M. (2015). *Mi Sistema Solar*. *PhET*. Retrieved 26 June 2015, from https://phet.colorado.edu/es/simulation/legacy/my-solar-system

Space.com,. (2015). *Photos: Total Lunar Eclipse of December 2011*. Retrieved 29 June 2015, from http://www.space.com/13894-photos-total-lunar-eclipse-december-2011.html

Spittalschool.org.uk,. (2015). *The Moon*. Retrieved 26 June 2015, from http://www.spittalschool.org.uk/Pages/Astronomy3.html

Syvum.com,. (2015). *Earth Science - New York Regents January 2009 Exam - Questions 63 - 65 (Part B-2)*. Retrieved 26 June 2015, from http://www.syvum.com/cgi/online/fillin.cgi/exam/regents/earth_science/regents_earth_jan_2009.tdf?11

YouTube,. (2015). *Star Size Comparison HD*. Retrieved 26 June 2015, from https://www.youtube.com/watch?v=HEheh1BH34Q

YouTube,. (2015). *The Solar System -- our home in space*. Retrieved 25 June 2015, from https://www.youtube.com/watch?v=KsF_hdjWJjo