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Physics Class Project

Part 1: Star Identification:

Deneb

Traditional name: Alpha Cygni but known as "the Tail"

Distance in light years from Earth: 3,200 light years away

How it compares to the sun:

Luminosity is about 60,000 greater than the sun

Mass is 25 times greater than the sun

Diameter is 200 times greater than the sun

Type of star: Blue Supergiant

Delta Cygni

Traditional name: Rukh but known as "The Rider"

Distance in light year from Earth: 170 light years away

How it compares to the sun:

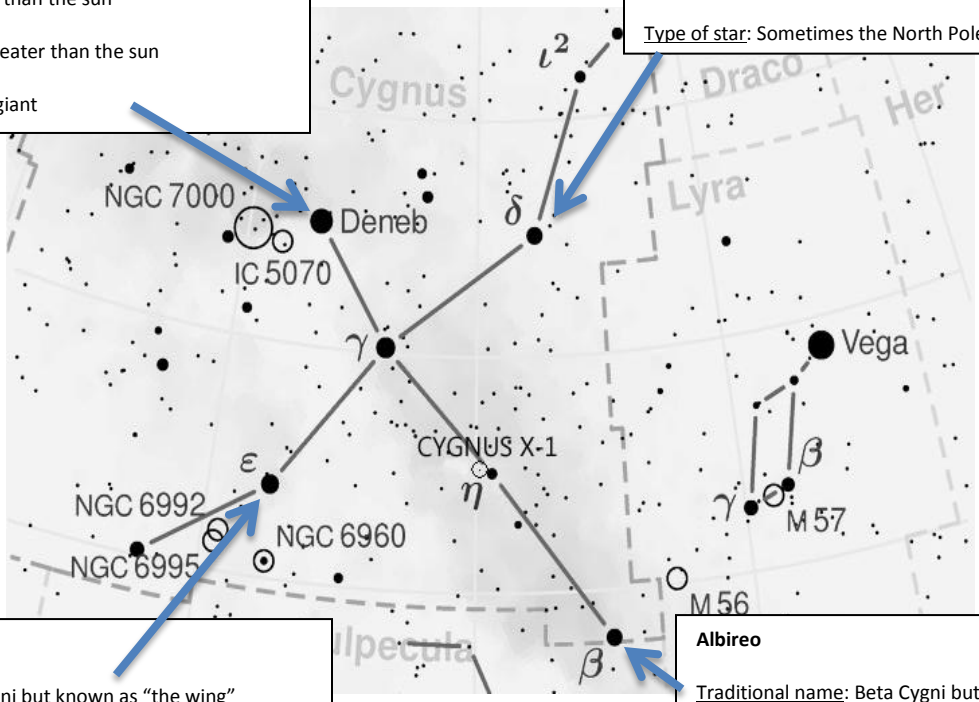
Luminosity is about 6 times greater than the sun

Its mass is about 1.5 times bigger than the sun

It spins 60 times faster than the sun

Orbit: about 828 years

Type of star: Sometimes the North Pole star



Gienah

Traditional name: Epsilon Cygni but known as "the wing"

Distance in light years from Earth: about 73 light years away

How it compares to the sun:

Luminosity is about 62 times greater than the sun

It is about 4-5 times larger in diameter than the sun

Type of star: Orange Giant

Albireo

Traditional name: Beta Cygni but known as the "beak star"

Distance in light years from Earth: 380 years away

How it compares to the sun:

Luminosity is about 100 times greater than the sun

It is about 20 times larger in radius than the sun

Orbit: about 600 years

Type of star: Actually a double star called binary double

Part 2: Equation Analysis

$E=mc^2$

1) E is a variable and it stands for the Amount of Energy
   M is a variable and it stands for Mass
   C^2 is a constant and it stands for the speed of light squared
   Energy= Mass times Speed of light squared

2) C^2 is the speed of light squared and the maximum speed that elements can travel. Speed of light travels at about 300,000 kilometers per second or at exactly 299,792,458 meters per second. (Wikipedia, 2012)

3) Yes, the amount of energy (E) is directly related to the amount of mass (M). They are linked together because all energy has mass and all mass has energy. Energy is used to create mass and if energy disappears than so does the mass. In the equation $E=mc^2$, c^2 is a constant so if energy increases so does mass and if mass increases than so does energy.

4) Yes, a little bit of mass can produce a lot of energy because you are multiplying the mass by the large constant of speed of light squared. In the equation, c is equivalent to about 300,000 kilometers per second squared and it is a constant and so it is always multiplied by the mass which equals a very large amount of energy.

$d=gt^2/2$

5) I agree that all objects fall at the same speed (with no air resistance) and weight doesn't matter. Weight is not a factor of the distance, acceleration, or time that an object falls. Mass doesn't factor into the equation $d=gt^2/2$ at all. The reason that heavier objects may fall faster in a natural environment is because of the air resistance on the object, not because of its weight. In a vacuum environment a heavy object and a light object will fall from rest the same distance at the same speed and hit the ground at the same time. Both objects cover the same distance at the same time.
   Suppose a 3lb. ball and a 5lb. ball were dropped from rest for 5 seconds
   The distance of the 3 lb. ball would be $D= 9.8(5^2)/2=122.5$
   The distance of the 5 lb. ball would be $D= 9.8(5^2)/2=122.5$

$V= gt$

6) I agree that all objects fall at the same speed (with no air resistance) and weight doesn't matter. Velocity is the speed and direction of an object. Both objects, regardless of weight, would be falling in the same direction (down) at the same speed (with no air resistance). In this equation velocity is equal to the objects acceleration and the time falling, which would be the same for both objects. Weight isn't a factor.

7) Aristotle, who was an amazing scientist, came to the conclusion that heavier objects will strive harder to get to the ground when falling, therefore they would fall faster. The speeds of objects falling have a direct relationship to their size. People believed his conclusion. If they tried to demonstrate his conclusion in a natural environment, it would appear that the heavier object would fall faster, but this was because of air resistance. Without a vacuum chamber or a zero gravity environment it was hard to see that all objects would fall at the same speed. Aristotle's conclusion wasn't questioned until Galileo dropped objects of various sizes off the Leaning Tower of Pisa and noticed that all objects (neglecting air resistance) fell together and landed together. Even with the results of Galileo's experiment, most people continued to agree with Aristotle's conclusion because that's what they had been taught. Change of thinking can be difficult.

8) Because an object is heavier it exerts more force and has more force exerted upon it. The size of the object's mass determines how effected it is by the Earth's gravity and the speed that it falls.

$E=1-T_{cold}/T_{hot}$

9) In theory, if you lowered the temperature of the environment to absolute zero then it would be possible to achieve 100% efficiency. The greater the temperature difference between hot and cold reservoirs will give us the greatest efficiency.

   Ex: $\frac{300K-0K}{300K} = \frac{300}{300} = 1$ e=1 is 100% efficiency

10) In practice, it is impossible to achieve 100% efficiency by lowering the temperature of the environment. Since it is impossible to lower the temperature of the environment to absolute zero, it is impossible to reach 100% efficiency. In practice, no heat engine is capable of converting all the heat into energy. Only some of the heat can be converted into work. This reduces the efficiency of the heat engine.

11) In theory, it is impossible to achieve 100% efficiency by raising the internal operating temperature of the heat engine. Raising the internal operating temperature of the heat engine does increase the engine's efficiency. Extreme temperatures will allow the heat engine to achieve close to 100% efficiency but even at extreme temperatures it won't quiet reach an efficiency level of 100%.

    Ex: $\frac{300K- 100K}{300K} = \frac{2oo}{300}$ = 66.67% efficiency

    If we raise the internal operating temperature of the engine to extremely high temperatures the efficiency increases but never reaches 100% efficiency.

Ex: $\frac{3{,}000K-100K}{3{,}000K} = \frac{2{,}900}{3{,}000} = 96.67\%$ efficiency

12) In practice, it is not possible to achieve 100% efficiency by raising the internal operating temperature of the heat engine. Even at extreme temperatures the heat engine won't reach an efficiency of 100%. If we tried to increase the efficiency of the heat engine by raising it to extreme temperatures, the parts of the heat engine would melt. Also, the Second Law of Thermodynamics tells us that it is impossible for a heat engine to convert all of the heat into energy .Some of the heat is transformed into work but the rest is wasted.

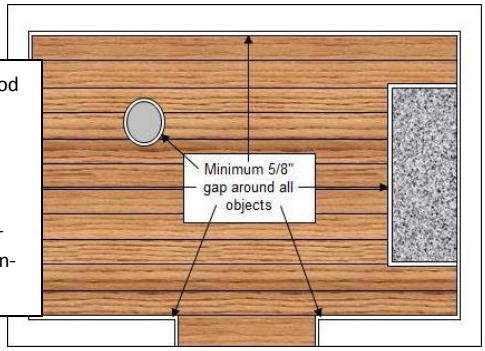
13) No, it is not possible to a build a car, using any kind of burning fuel, which is 100% efficient. It is impossible, no matter what kind of burning fuel used, to achieve 100% efficiency. No fuel can be burned at high enough temperatures to even come close to 100% efficiency. There is always some fuel that is expelled as waste. No heat engine can convert all the heat into mechanical energy.

Part 3: Learning the Law of Physics

Principle of Thermal Expansion

1) Thermal expansion is when the dimensions of an object increase due to an increase in temperature and when the dimensions of an object contract due to a decrease in temperature. When the temperature of an object increases, its molecules move faster and farther apart which causes the object to expand. In colder temperatures the molecules tend to become sluggish and closer together which causes the object to contract.

2) One real world example of thermal expansion I noticed is in the installation of hard wood floors. We installed hard wood floors last week, shortly after completing the thermal expansion section in our textbook. I knew that we needed to put small gaps around the outside of the flooring but I had no idea why. Thermal Expansion taught me that the wood will expand in the summer months and creating a gap will keep the wood from buckling. In the winter the wood is contracted leaving just a small gap in the wood underneath the baseboards. The change in dimensions is only slight but without gaps the expansion could be quiet damaging.



Expansion gaps in a hard wood floor.

Picture taken from: http://www.renovation-headquarters.com/installing-hardwood-flooring-expansion-gap.html

Another real world example of thermal expansion is when my wedding ring is easier to get off in the summer and harder to get off in the winter. In the summer time my ring has slightly

expanded due to the increase in temperature, therefore making it easier to slip off. In the winter the decrease in temperature causes the ring to contract making it more difficult to remove.

A third example of Thermal Expansion in the real world is when a guitar's strings expand or contract to differences in the temperature. In hotter temperatures a guitar's strings expand and it changes the sound of the guitar to a lower pitch. When the temperature is cold a guitar's strings will contract. These changes in temperature cause the guitar to need to be tuned regularly.

Part 4: Explanation of Fermi's Paradox and possible resolution

1) Fermi's paradox is about the lack of any signs of alien life in the universe. The question asked by Fermi's paradox is that, if aliens are out there then why haven't we seen them yet? According to this paradox the size and the age of the universe would allow for aliens to exist on other planets (Fermi Paradox, 2007). However, there has been no scientific evidence to support his possibility. Fermi's paradox implies that we are not a special planet and that there are potentially many other planets in the galaxy that are just like Earth. They would have very similar characteristics and a similar ability to support life. So if there are other planets supporting life then Fermi's paradox wonders why other planets have not made themselves evident to us. Why have they not done space exploration to our planet or left signs that they are out there somewhere. It seems as though we should have seen some evidence or traces that extraterrestrial life exists. Without any signs of alien life, it is impossible to know if extraterrestrial life truly exists.

   Fermi's paradox is considered a paradox because it seems to contradict itself. It describes that the size and the age of the universe should allow for extraterrestrial life but it also says that if there was extraterrestrial life that we should have seen signs and evidence of their existence. It contradicts itself when it discusses the high likeliness that other planets are capable of supporting life but that there is a high probability that if there was alien life we would have seen some proof or sign of this.

2) One possible solution to Fermi's paradox is that we are the first civilization. The Earth and it civilizations could have been created under unique circumstances. We are then either the only civilization or the first and therefore the oldest civilization in the universe. There are either no other civilizations or there are too new of civilizations to have any technological advances for us to have seen any signs of life. We are then the only intelligent civilization in the universe. The problem with this solution is that there are older planets in the universe and it is very unlikely that our planet is unique. With the older galaxies it would be very unlikely for us to be the oldest or most evolved civilization.

   The second possible solution to Fermi' paradox is that there are other civilizations on other planets but they are simply too far away for us to see any evidence of them. Even with their

probable technological advances, we may still be too far for them to travel to us and to send us a sign that they are out there. It is possible that we are so far away that they don't know we exist either. Then they wouldn't know to send us any signs that they are out there. The problem with this solution is that is other galaxies that that are considerable older and would probably be highly evolved, aware of us, and have already discovered a way to send messages to us.
A third possible solution to Fermi's paradox is that there are civilizations on other planets but that they have no interest in communicating with us, either because they are so technologically evolved that we are insignificant or that we may be considered a danger to them. They may even be observing us in what is called a "zoo paradox,' which is that there are other civilizations on other planets but they are only interesting in observing our species and seeing what happens (Fermi Paradox, 2007). They are keeping us isolated and aren't interested in interacting with us. Another possibility of this solution is that aliens are out there and are trying to communicate with us but we don't have the abilities to detect or understand the communications. The problems with this solution are that it seems like there would be some interest in a foreign species. Some civilization would be curious enough to try to contact us. Even if we were so low on the evolution and technological charts that they may figure were not worth bothering with, it would still seem life there would be some interference for them. We would still see some signs of alien life.

A fourth possible solution to Fermi's paradox is a popular but unscientific resolution which is that aliens exist and are around us. Aliens have been here which are why there have been UFO sightings. There are aliens present here on Earth and either the government has them locked away in some deep dark secret cover-up or the aliens are able to blend in and observe our species without us detecting them. They are only interested in observing and interacting with us without us knowing that they exist. Most scientists heavily discredit this possible solution. If aliens were truly landing on our planet or flying over it then there would be some scientific proof. Eye witness accounts of UFO sightings can be explained by things from our universe like satellites. Also, it is very unlikely that the government is capturing aliens and hiding proof of their existence. If alien civilizations are so technologically advanced that they can arrive on our planet then our technology would probably be a very little match to be able to contain them.

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