4.8.1.1 Our solar system

Content

Within our solar system there is one star, the Sun, plus the eight planets and the dwarf planets that orbit around the Sun. Natural satellites, the moons that orbit planets, are also part of the solar system.

Our solar system is a small part of the Milky Way galaxy.

The Sun was formed from a cloud of dust and gas (nebula) pulled together by gravitational attraction.

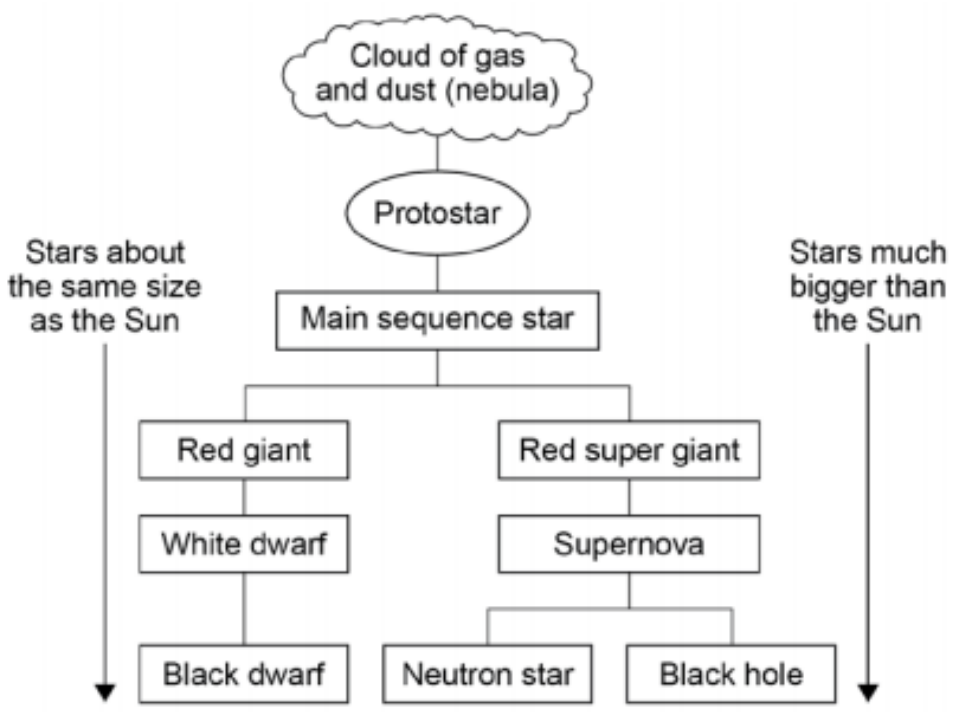
Students should be able to explain:

- how, at the start of a star's life cycle, the dust and gas drawn together by gravity causes fusion reactions
- that fusion reactions lead to an equilibrium between the gravitational collapse of a star and the expansion of a star due to fusion energy.

A star goes through a life cycle. The life cycle is determined by the size of the star.

Students should be able to describe the life cycle of a star:

- the size of the Sun
- much more massive than the Sun.



Fusion processes in stars produce all of the naturally occurring elements. Elements heavier than iron are produced in a supernova.

The explosion of a massive star (supernova) distributes the elements throughout the universe.

Students should be able to explain how fusion processes lead to the formation of new elements.

4.8.1.3 Orbital motion, natural and artificial satellites

Content

Gravity provides the force that allows planets and satellites (both natural and artificial) to maintain their circular orbits.

Students should be able to describe the similarities and distinctions between the planets, their moons, and artificial satellites.

(HT only) Students should be able to explain qualitatively how:

- (HT only) for circular orbits, the force of gravity can lead to changing velocity but unchanged speed
- (HT only) for a stable orbit, the radius must change if the speed changes.

4.8.2 Red-shift (physics only)

Content	Key opportunities for skills development
There is an observed increase in the wavelength of light from most distant galaxies. The further away the galaxies, the faster they are moving and the bigger the observed increase in wavelength. This effect is called red-shift.	
The observed red-shift provides evidence that space itself (the universe) is expanding and supports the Big Bang theory.	
The Big Bang theory suggests that the universe began from a very small region that was extremely hot and dense.	WS 1.2
Since 1998 onwards, observations of supernovae suggest that distant galaxies are receding ever faster.	
Students should be able to explain: • qualitatively the red-shift of light from galaxies that are receding • that the change of each galaxy's speed with distance is evidence of an expanding universe • how red-shift provides evidence for the Big Bang model • how scientists are able to use observations to arrive at theories such as the Big Bang theory	
• that there is still much about the universe that is not understood, for example dark mass and dark energy.	WS 1.1, 1.3

Space: Monday, 25 January 2021

DIN – Complete your carousel quiz

Solar system: stability of orbital motions; satellites (physics only)

- Our solar system
- The life cycle of a star
- Orbital motion, natural and artificial satellites

Red shift (physics only)

- Red shift
- Big bang theory

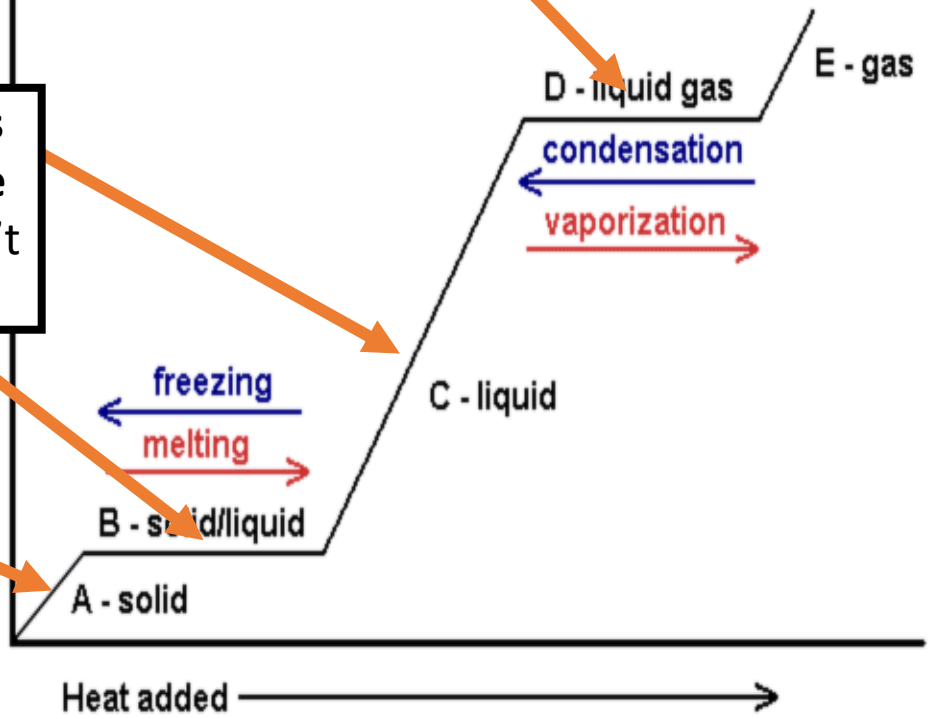
Based on the last quiz

3. Now all the ice has melted, the **internal energy of the particles begin to rise again**, increasing the temperature

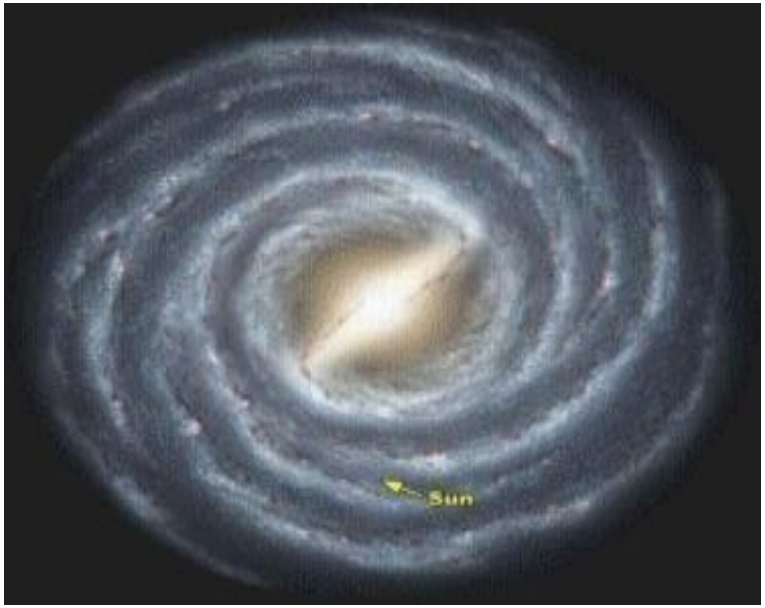
4. As the water turns to steam, even more energy is needed to break the intermolecular forces. The **internal energy doesn't increase**, so temperature doesn't increase

2. As the ice turns to water, all of the **energy is being used to weaken the forces**, **not increase the internal energy**, so the temperature doesn't rise.

1. Ice is given thermal energy, so the temperature of the particles start to rise. This **increases the internal energy**.



Our **solar system** is a small part of a **galaxy** called the **Milky Way**.



Our star (**The Sun**) is just one of approximately 300 000 000 000 stars in our galaxy. The whole **solar system** is too small to see on this picture of the Milky Way.

There is thought to be a massive **black hole** at the centre of the Milky Way.

The **Universe** is thought to have formed about **13.7 billion years** ago.
The **solar system** formed around **4.6 billion years** ago.

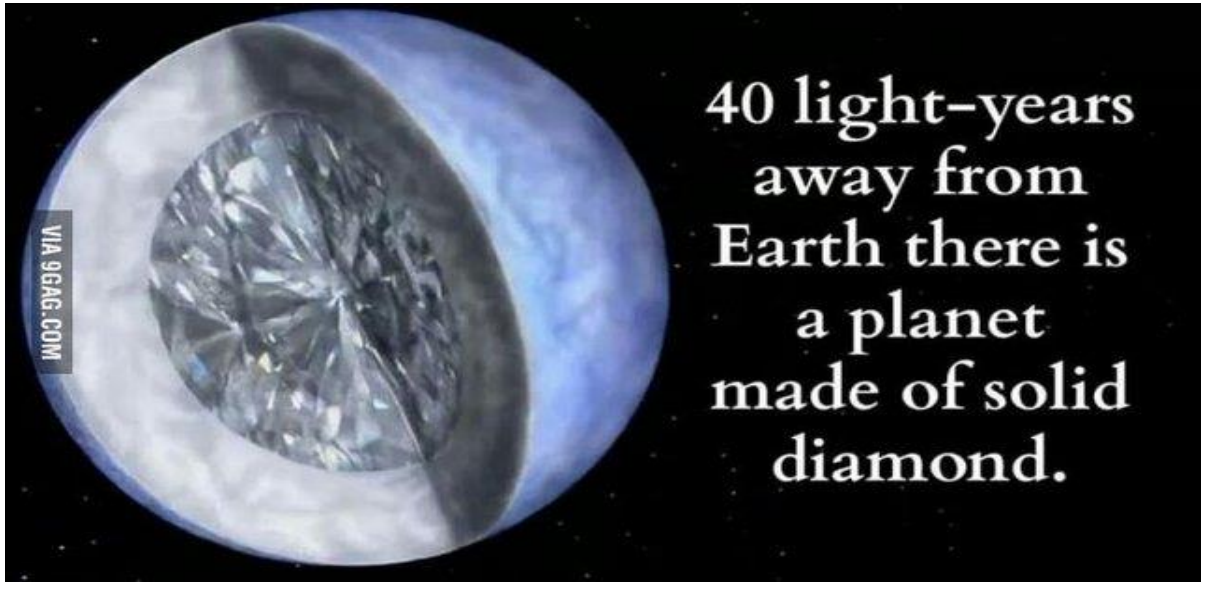
Space facts


Earth is the only planet not named after a god.


If Saturn were as close to the Earth as the Moon is, this is how it would look.


If an astronaut in Earth's orbit fired a bullet at the Sun at 1500ft/sec it would take roughly 10.4 years to hit its target!
thespacekiosk.com
@mention a friend who'd like this!


One million Earths could fit inside the Sun.


40 light-years away from Earth there is a planet made of solid diamond.
VIA 9GAG.COM

Scale of the universe.

https://www.youtube.com/watch?v=i93Z7zljQ7I

List the planets in our solar system in order of size.

How big is Jupiter ?

What is the largest star ? How big is that ?

What is the name of the galaxy we are in ? How big is it ?

How big is the universe ?

Give Jupiter's size in meters.

List the planets in our solar system in order of size.

Mercury, Mars, Venus, Uranus, Saturn, Neptune

How big is Jupiter ?

140,000 Km in diameter

What is the largest star ? How big is that ?

UY Scuti, 2,400,000,000 Km in diameter

What is the name of the galaxy we are in ? How big is it ?

The Milky Way, 100, 000 light years.

How big is the universe ?

150,000,000,000 light years.

1 light year is how far light can travel in 1 year.
Light takes 1.3 seconds to get from the Earth to the Moon,

It took the Apollo astronauts around 3 days.

Cartwheel

Milky Way

Starburst

Tadpole

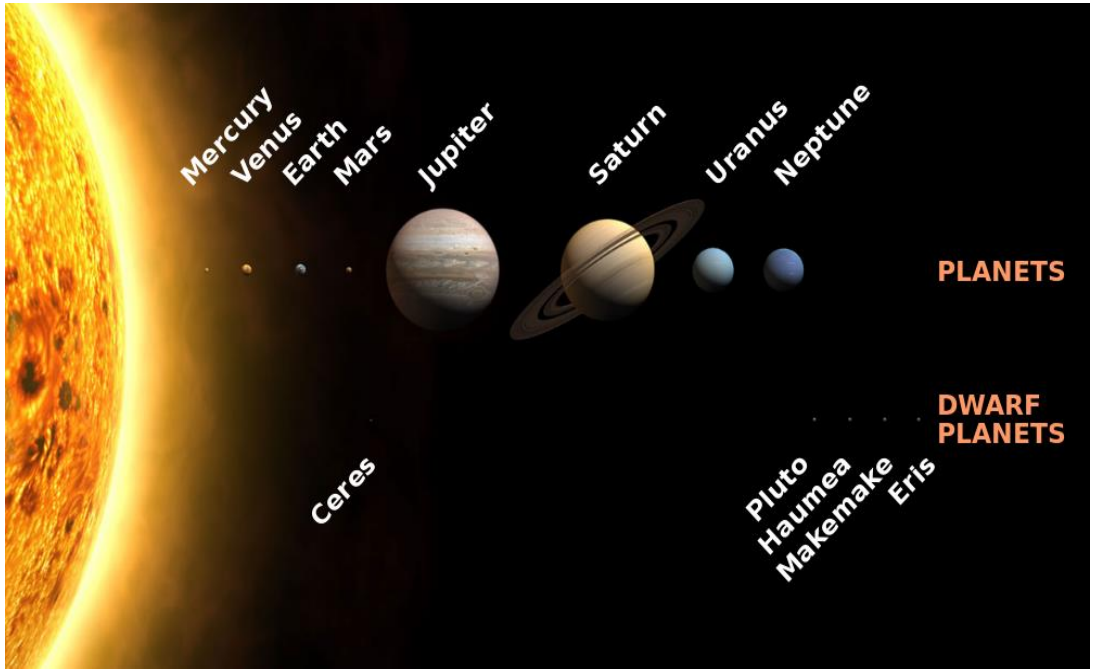
What do you think was the question to this ?

https://www.youtube.com/results?search_query=solar+system+jam+campus

How much information can you remember from this amazing video.

Space physics; orbital motions and satellites – Our solar system

The **solar system** is any object that is bound by **gravity** to a **Sun**. All objects in the solar system **orbit The Sun**.



Our solar system there is:

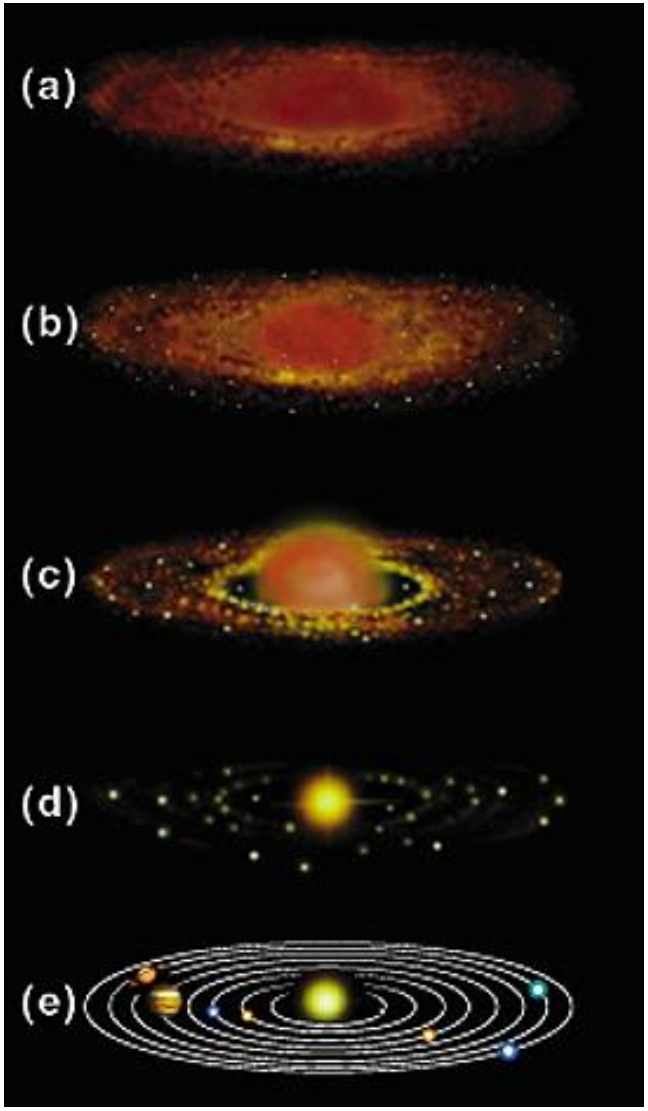
- **one star – the Sun**
- **eight planets**
- **dwarf planets**
- **natural satellites** called **moons** that orbit planets.

Other objects in
The solar system include:

- **Comets**
- **Asteroids**
- **Satellites**

Dust, ice and rocks make up the remaining mass.

Space physics; orbital motions and satellites – Formation of the sun and solar system



(a) The universe contains 'clumps' of **dust and gas** each called a **nebula**.

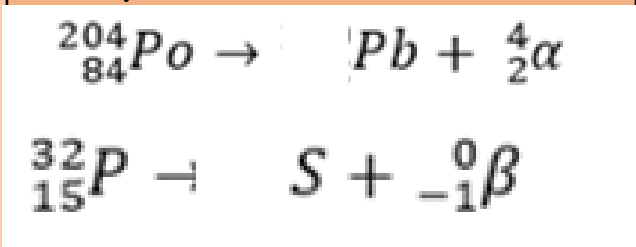
(b) Gravitational attraction pulls this dust and gas together.

(c) Forming the Sun (a star).

(d) Fusion reactions lead to an **equilibrium** between the **gravitational collapse** of the star and the **expansion** of a star due to fusion energy.

(e) The remaining parts of the solar system form from the remaining dust and gas.

4 TO START Do it now:

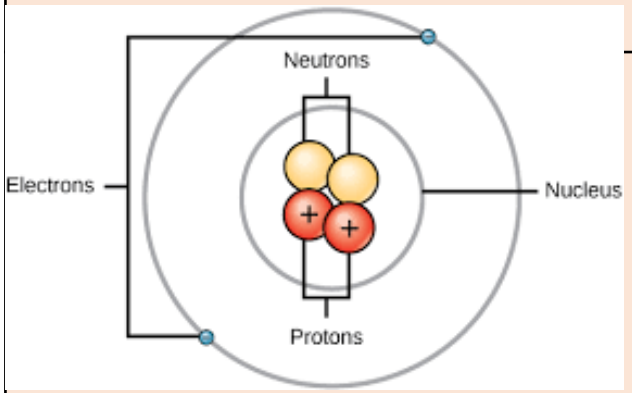
Write the equation that links energy, charge and voltage.	Why do atoms have no overall charge ?	A hairdryer transfers 200J of energy to 40J of sound, 90J of heat and 70J kinetic. What is the efficiency ?
Draw and label an atom.	Name 5 stores of energy.	Complete these 
State the masses and charges of protons neutrons and electrons.	Define current.	Compare the properties of alpha, beta and gamma radiation.

Challenge – Why does gamma not change the mass or charge of a nucleus ?

Energy (J) = charge (C) x voltage (V)

They have the same number of positive protons and negative electrons.

160J/ 200J = 0.8 X 100 = 80%



Kinetic, gravitational potential, thermal, chemical, elastic potential.

$$^{204}_{84}Po \rightarrow {}^{200}_{82}Pb + {}^{4}_{2}\alpha$$

$$^{32}_{15}P \rightarrow {}^{32}_{16}S + {}^{0}_{-1}\beta$$

Protons, mass 1, charge +1
Neutrons, mass 1, charge 0
Electrons, mass 0, charge -1

The rate of flow of charge.

Alpha least penetrating and least range in air but most ionising.

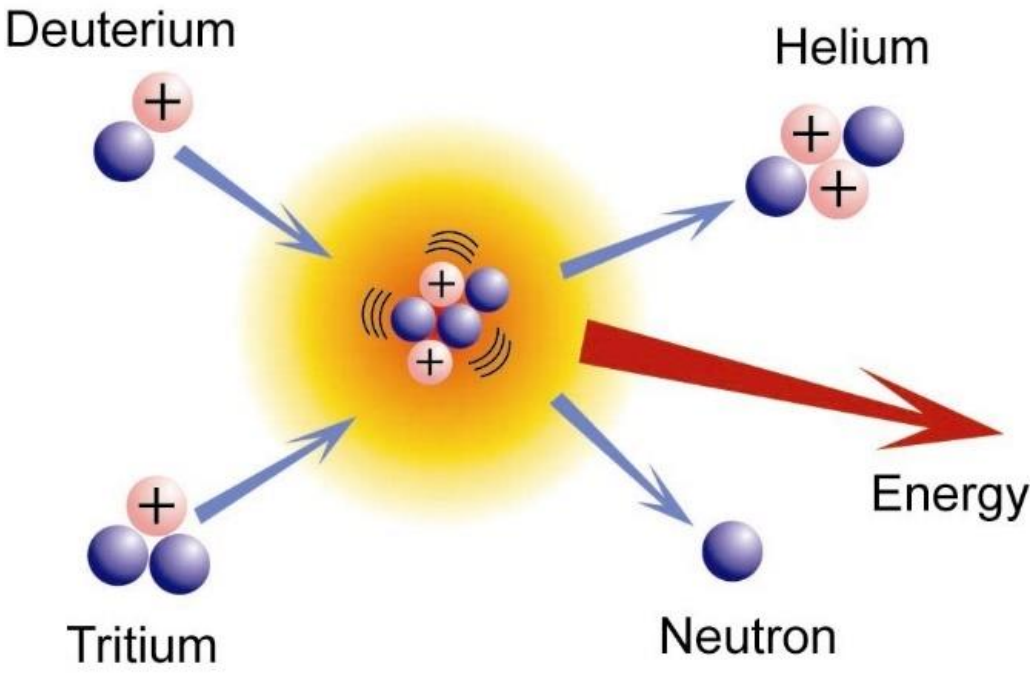
Gamma most penetrating and longest range in air but least ionising.

Charge is either electrons or ions (charged particles).

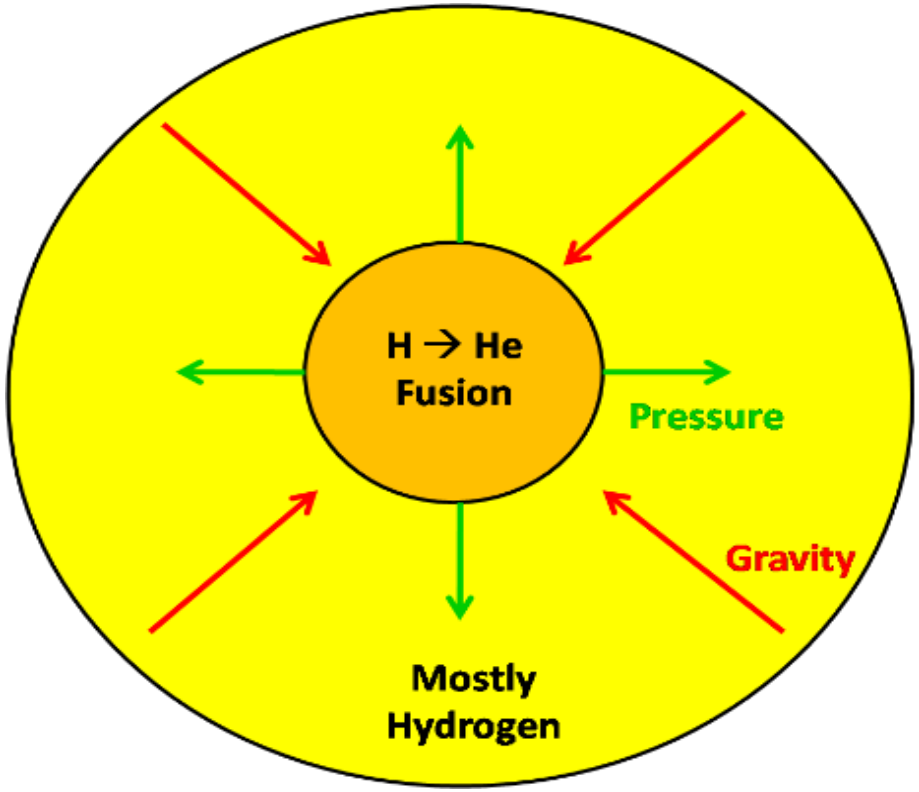
Challenge – Why does gamma not change the mass or charge of a nucleus ?

Gamma is an electromagnetic wave with no mass or charge.

The Sun, like all stars, releases energy through nuclear fusion reactions in the core.



What's happening here ?



What's happening here ?
What does it mean for the star ?

https://www.youtube.com/watch?v=PM9CQDlQI0A

Create a flow diagram from the following video.

Space lesson 3: Complete these questions.

1. How many planets in our solar system?

1. What is the difference between a moon and a dwarf planet?

1. What do we call the natural satellites in the solar system?

1. Name the galaxy our solar system is part of.

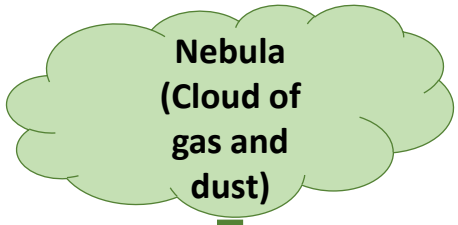
1. How was the sun formed, and what caused this to happen?

1. How many planets in our solar system?
   8
2. What is the difference between a moon and a dwarf planet?
   Dwarf planets orbit the sun; moons orbit planets.
3. What do we call the natural satellites in the solar system?
   Moons.
4. Name the galaxy our solar system is part of.
   The Milky Way.
5. How was the sun formed, and what caused this to happen?
   From a cloud of dust and gas (nebula); pulled together by gravitational attraction; causing fusion reactions.

Life cycle of a star.

Stars about the same size as the Sun

Stars much bigger than the Sun



Protostar

Main sequence star

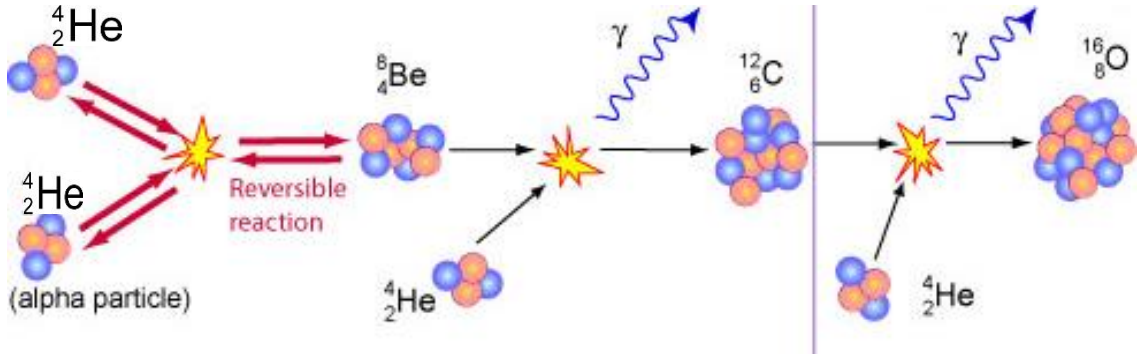
Red Giant

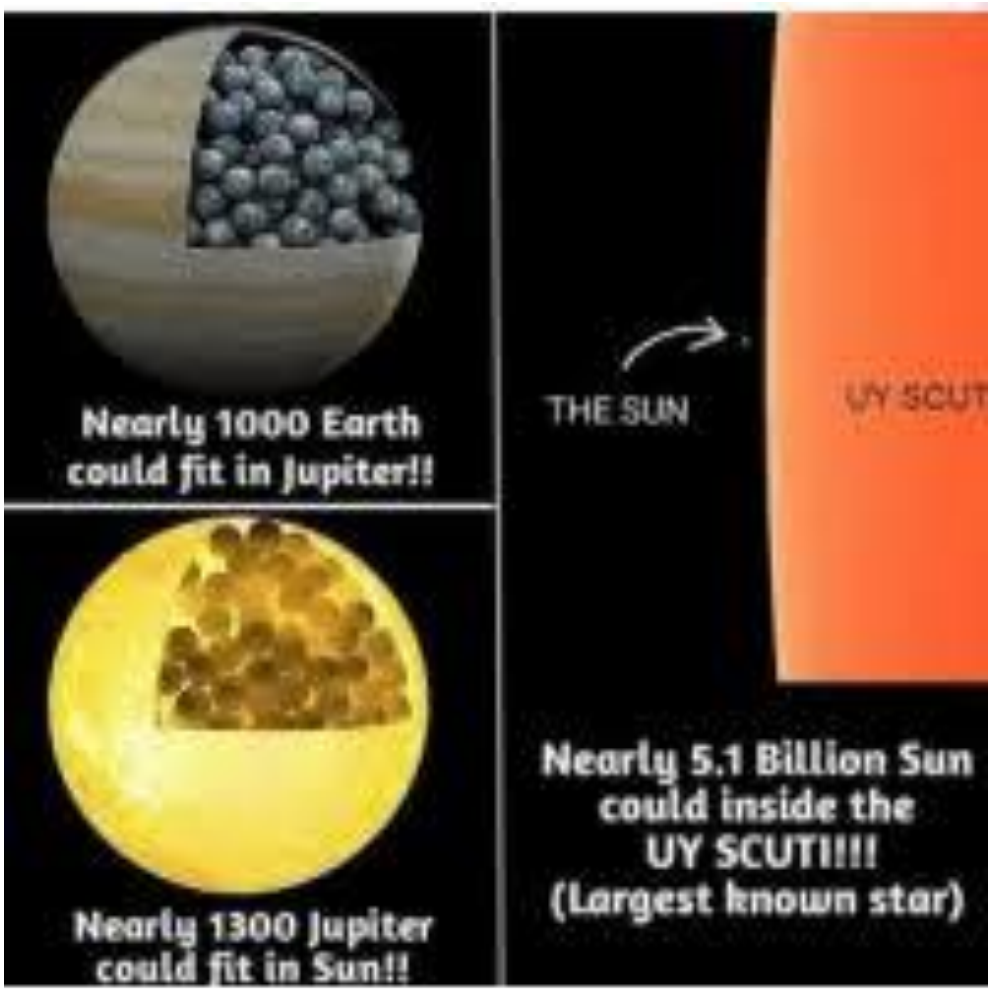
White dwarf

Black dwarf

Get this down, what is it like for a much larger star ?

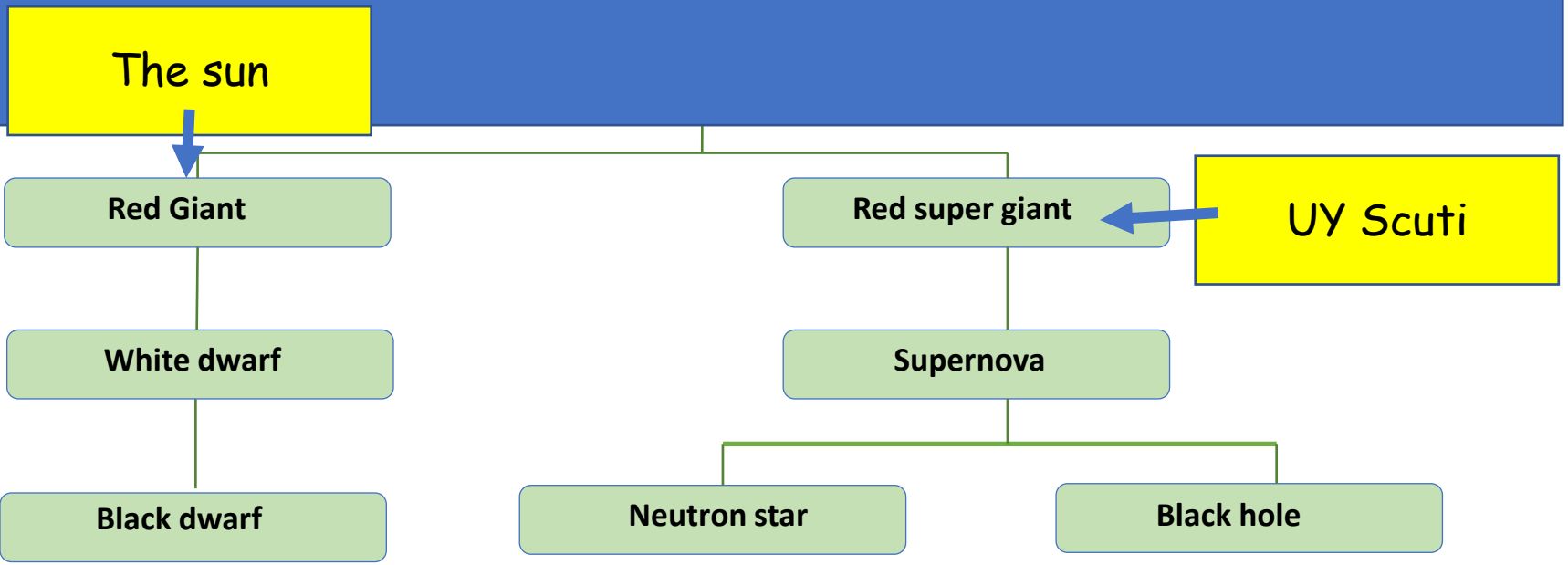
- **Fusion processes** in stars produce **all** of the naturally occurring elements.
- **Elements heavier** than iron are produced in a **supernova**.
- The **explosion of a massive star** (supernova) distributes the elements throughout the **universe**.

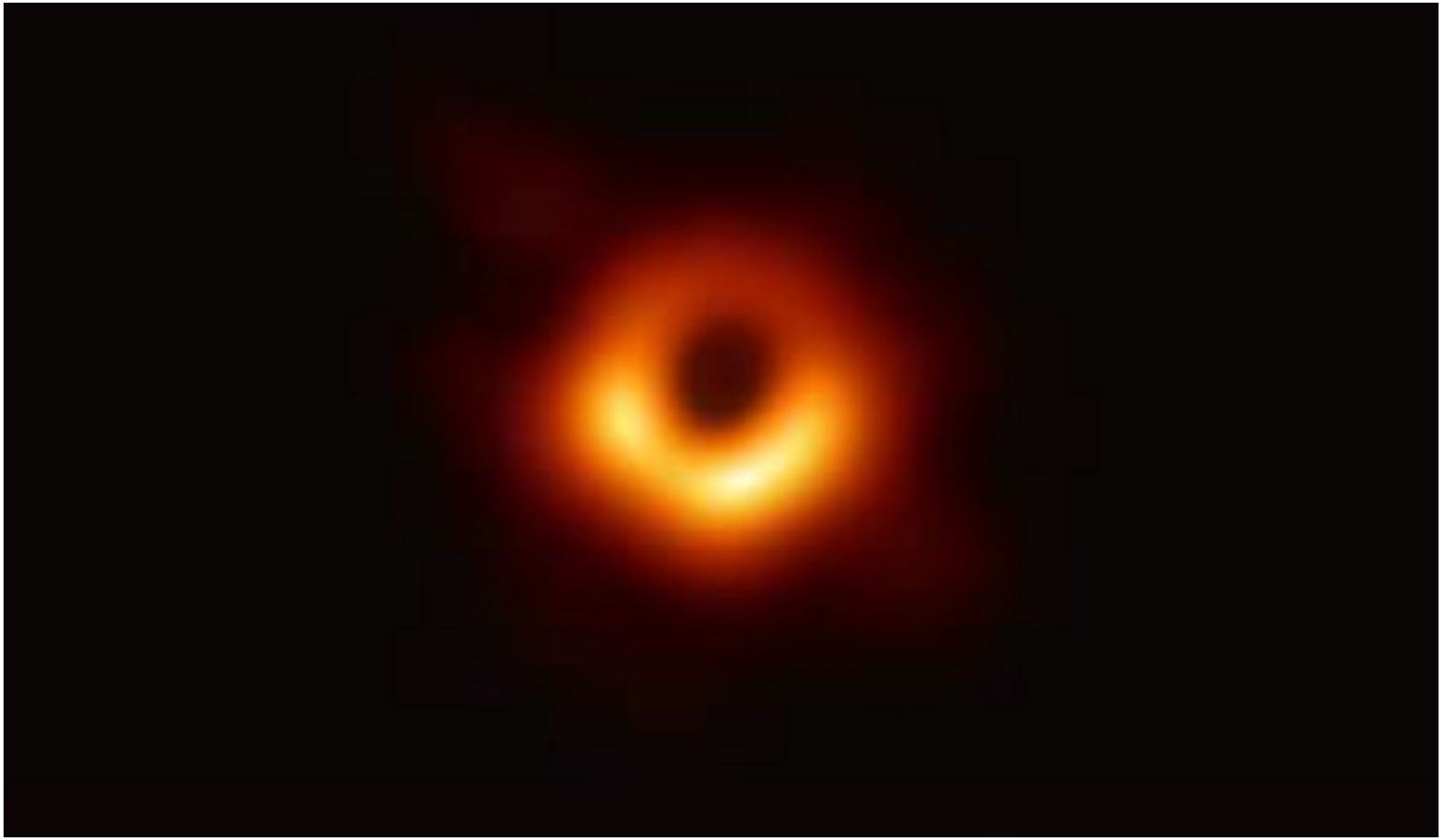




Compare the rest of the life cycles of the sun and UY Scuti (the largest known star).

https://www.youtube.com/watch?v=V0Y1JlVuin4


The sun
Red Giant
White dwarf
Black dwarf
Red super giant
Supernova
Neutron star
Black hole
UY Scuti



https://www.youtube.com/watch?v=kOEDG3j1bjs

Orbits and red shift: Complete these questions.

1. List the major bodies found in the solar system.

2. What is a nebula?

3. What determines the life cycle a star will take?

4. Describe the lifecycle of a star the size of the sun.

5. Describe the lifecycle of a star more massive than the sun.

6. What processes produce all of the naturally occurring elements?

7.Where are elements heavier than iron produced?

8.How are these elements distributed throughout the universe?

1. List the major bodies found in the solar system.
   Star, planets, dwarf planets, moons, asteroids, comets.
2. What is a nebula?
   Could of dust and gas.
3. What determines the life cycle a star will take?
   The size of the star.
4. Describe the lifecycle of a star the size of the sun.
   Cloud of gas and dust, protostar, main sequence star, red giant, white dwarf, black.
5. Describe the lifecycle of a star more massive than the sun.
   Cloud of gas and dust, protostar, main sequence star, red super giant, supernova, neutron star or black hole.
6. What processes produce all of the naturally occurring elements?
   Fusion.
7. Where are elements heavier than iron produced?
   Supernova.
8. How are these elements distributed throughout the universe?
   Explosion of massive star (supernova).

Link back – We looked at speed and velocity in Y10

1) Define speed and velocity.

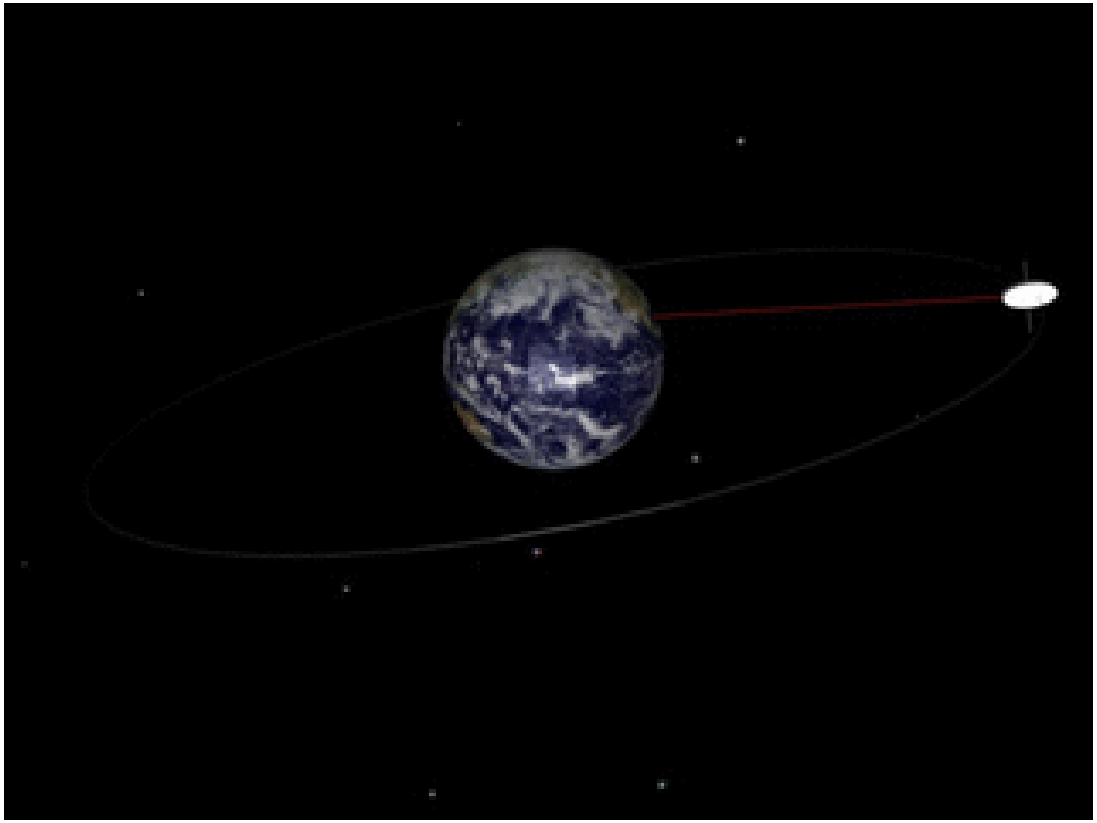
Speed is how much distance an object covers in a certain time.

Velocity is speed in a given direction.

2) Order them into scalar and vector quantities.

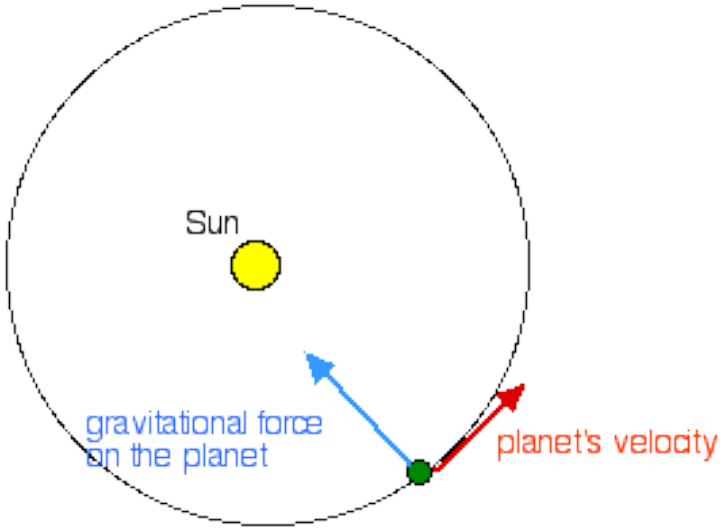
Speed is scalar.
Velocity is a vector.

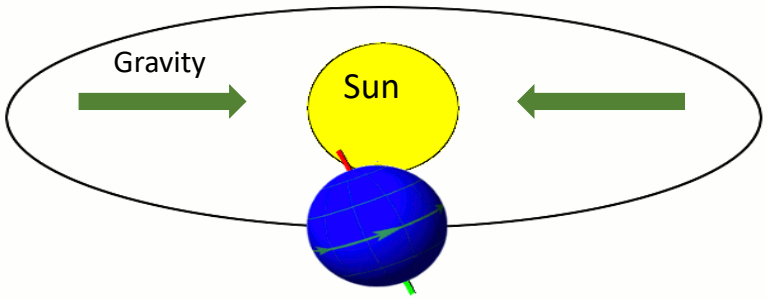
3) Acceleration is when an object changes it's velocity



Describe the motion of the satellite.

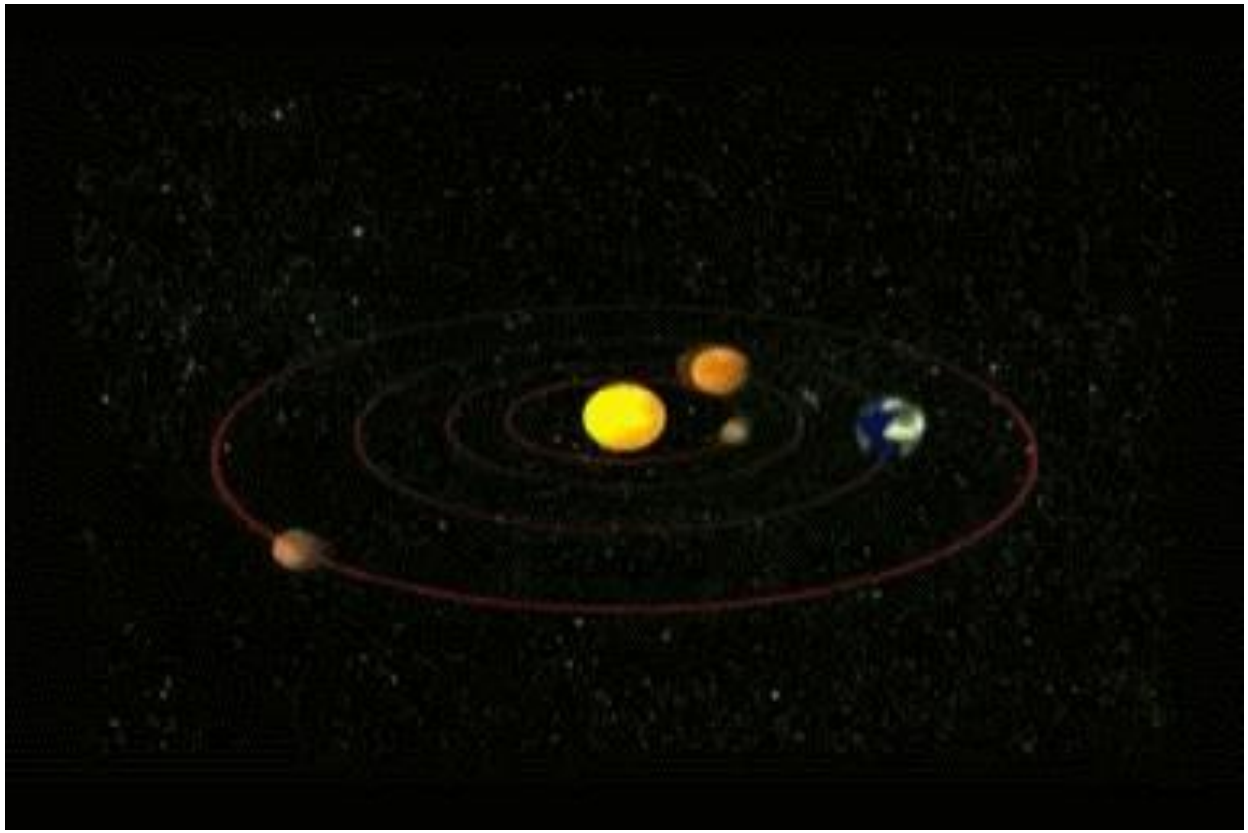
Gravity is constantly **changing** the **direction** of a body. As velocity depends on speed and direction, the **velocity** is constantly **changing** even though **speed** remains the **same**. It is accelerating.





Gravity pulls the Earth (and other planets) towards the sun. The planet is effectively "falling" towards the sun but is travelling fast enough so that it constantly misses falling into the sun.

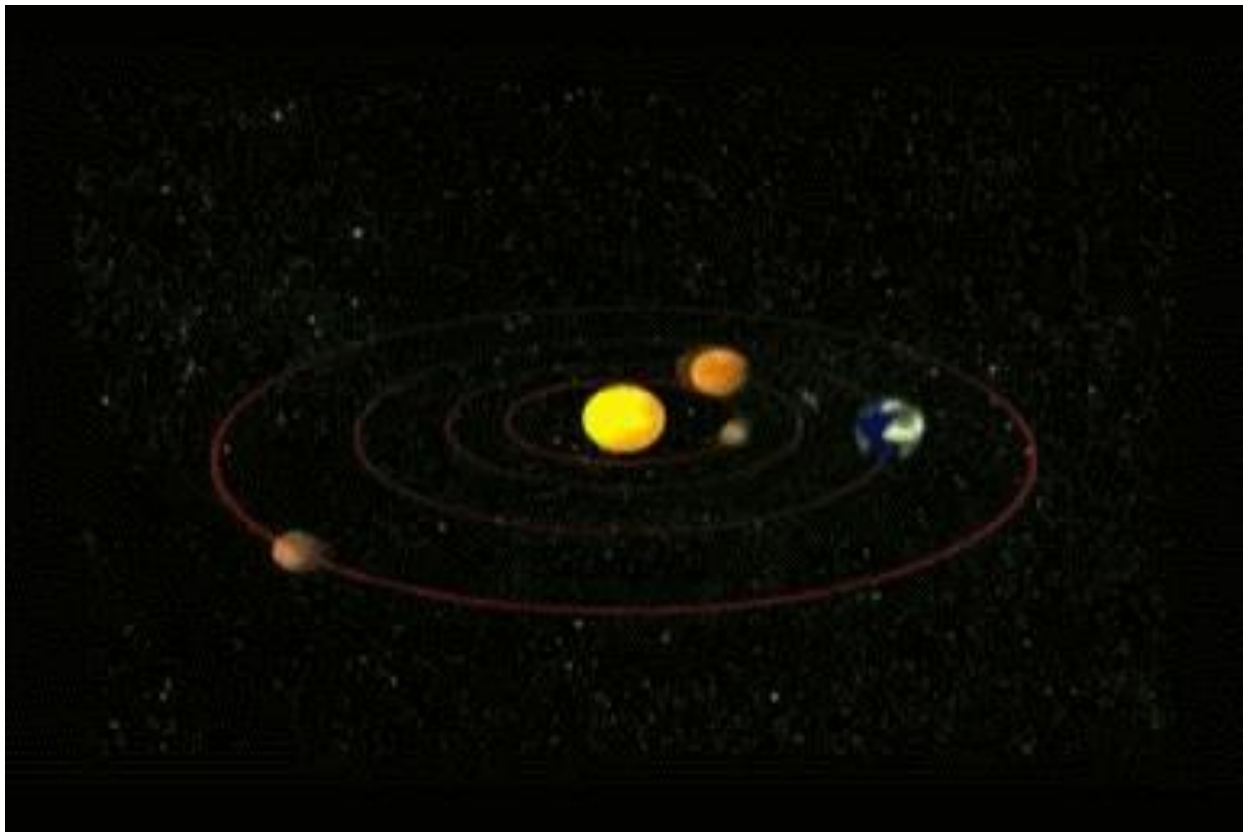
The Moon was a lot closer to the Earth 3 billion years ago.



Describe the motion of the satellite.

Planet	Radius of Orbit Relative to that of Earth's	[redacted]	Orbital Velocity Relative to That of Earth's
Mercury	0.387		1.607
Venus	0.723		1.174
Earth	1.0		1.000
Mars	1.524		0.802
Jupiter	5.203		0.434
Saturn	9.539		0.323
Uranus	19.18		0.228
Neptune	30.06		0.182

Describe the trend in this data.



The force of **gravity increases** the **closer an object** orbits. To avoid being pulled into the sun, a planet must be travelling faster, the closer it is to the sun.

This is why **Mercury's** orbit of the sun takes **3 Earth months** whereas it takes **Neptune 165 Earth years** to orbit the sun.

Link back – We looked at waves this year.

1) What is the speed of light ?

300,000,000 m/s

2) Write this in Km/s in standard form.

300,000 Km/s 3×10^5 Km/s

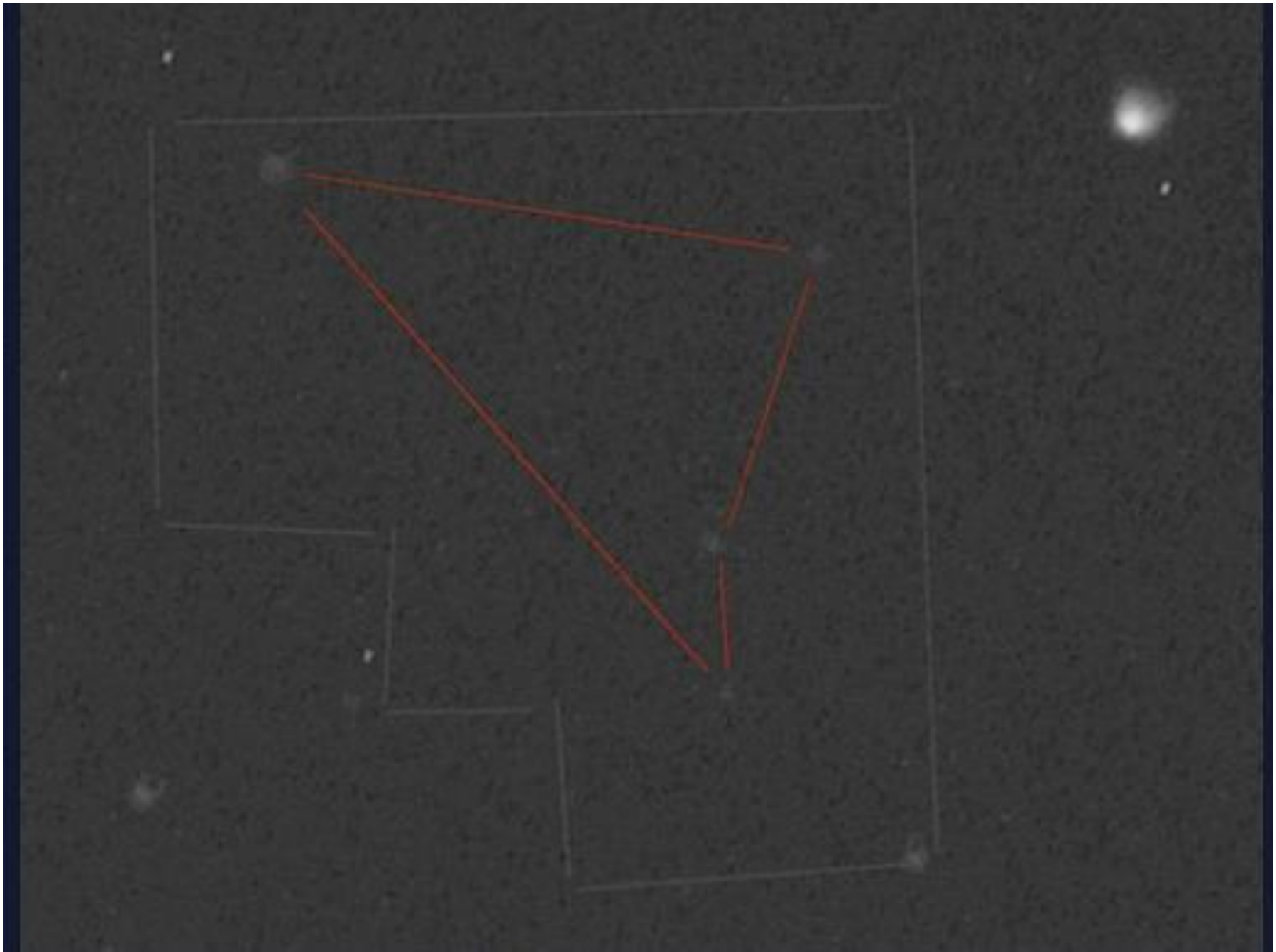
3) What colour of light has the longest wavelength ?

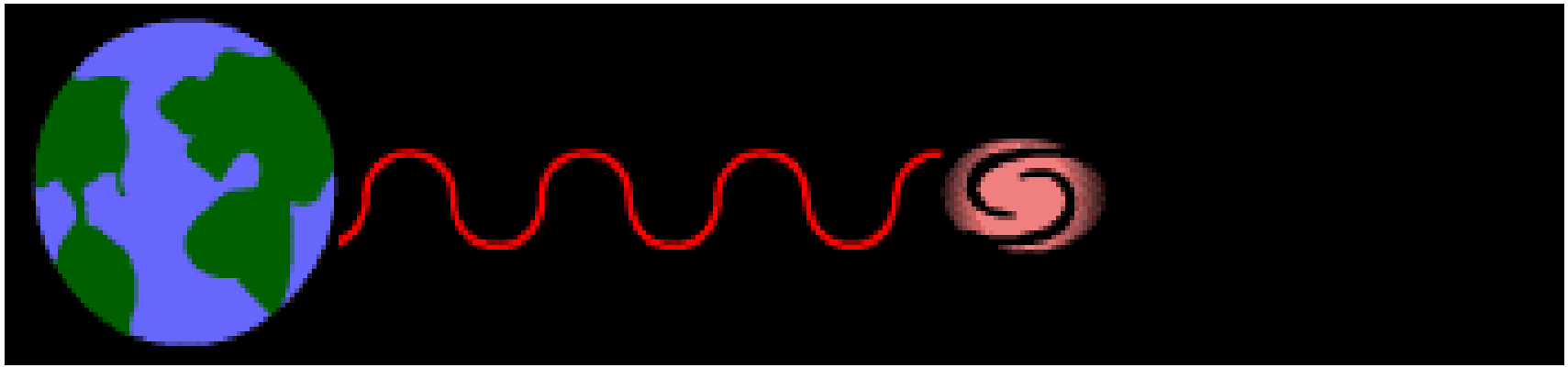
Red

4) Apart from their speed, what else do red and blue light have in common ?

Both transverse and both can travel trough a vaccum

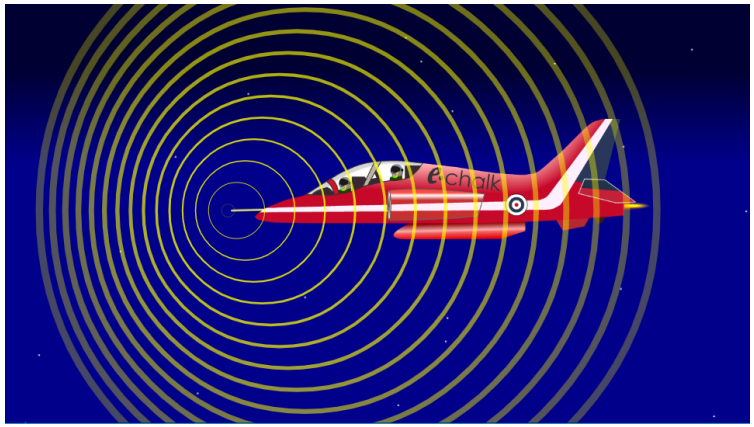
Hubble deep field

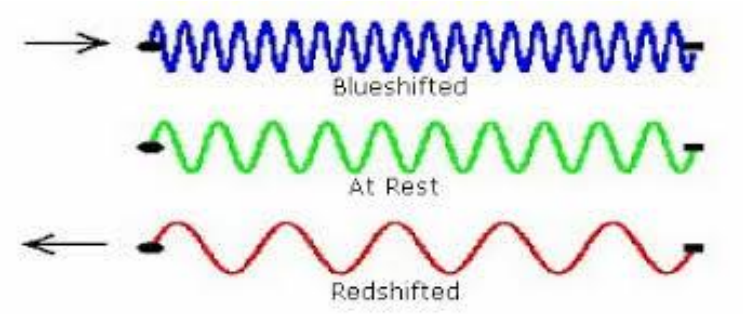


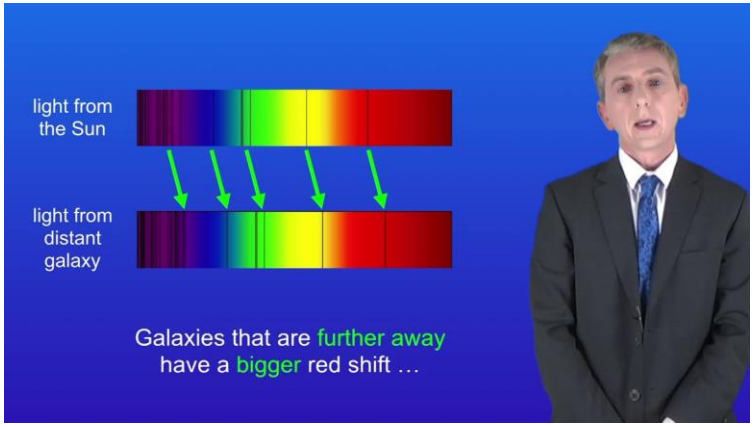


Light from a **nearby star** appears **white** as the wavelength of light emitted covers the **whole visible spectrum**.
The light we receive from a **distant galaxy** has had its **wavelength increased**. As longer wavelengths of light are the red end of the spectrum, the light appears redder than from the nearby star – this is called **RED SHIFT**.

Red shift happens because the galaxy is **moving away** from us at high speed, causing the wavelengths of light to be **stretched.**


e-chalk


Blueshifted
At Rest
Redshifted

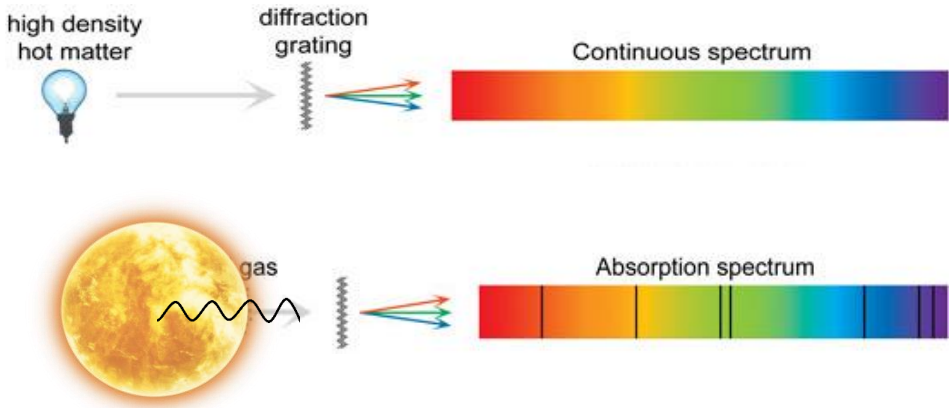

light from the Sun
light from distant galaxy
Galaxies that are further away have a bigger red shift …


RED !!

https://www.youtube.com/watch?v=-mQ41yA6LaA

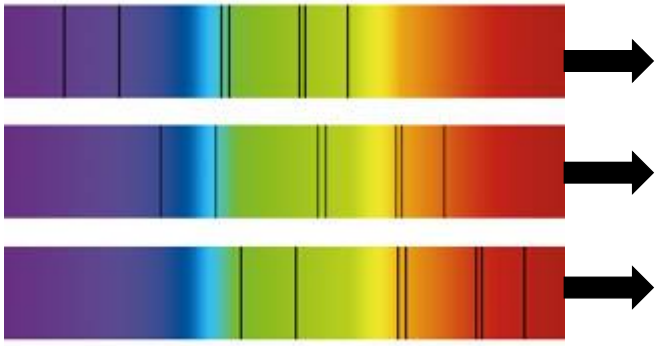
Red shift

Light emitted by a hot object produces a continuous spectrum. When light is emitted by a star, the light has to travel through the gases which make up the star. These gases absorb specific wavelengths of light, leaving black lines in the spectrum.



Absorption spectra from stars in every galaxy would look the same if all the galaxies were a fixed distance from the Earth. Galaxies have different amounts of red shift which means they are moving away from us at different speeds.

The faster a galaxy is moving, the further away it is.



Spectrum from a star in our galaxy – no red shift

Spectrum from a star in another galaxy – some red shift

Spectrum from a distant galaxy – a lot of red shift

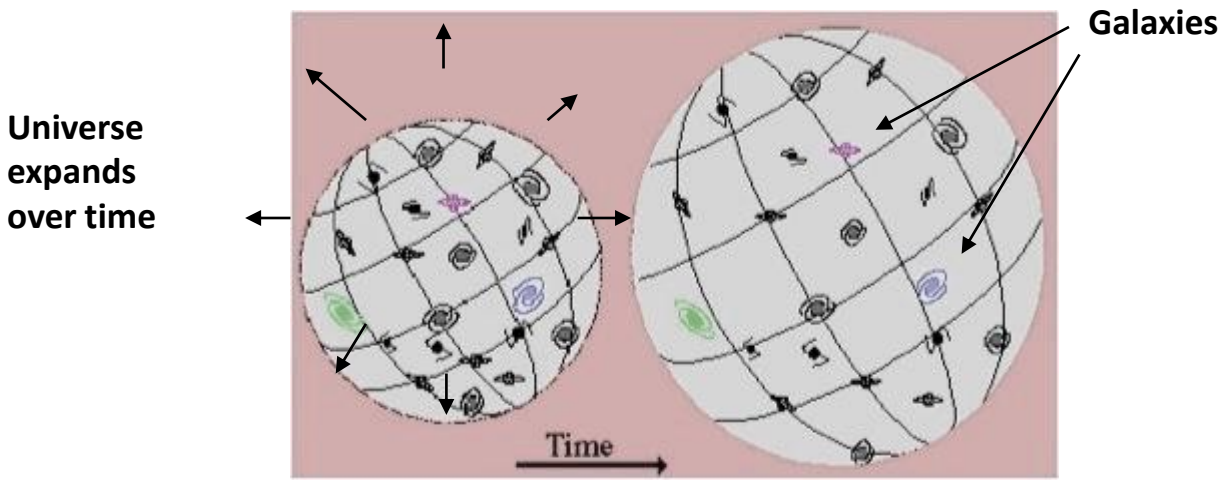
Red shift

Summary

- Red light has a **longer wavelength** than blue light.
- Most **distant galaxies** show an **increase in wavelength** of light.
- The **further away** the galaxies the **faster** they are moving and the **bigger the increase in wavelength**.
- This effect is called the **RED-SHIFT**.
- The observed red-shift provides **evidence** that the **universe is expanding** and supports the **Big Bang theory**.

Big Bang theory

Like a balloon expanding, all **galaxies** are **moving away from each other** and from a point of origin. Only the fastest moving galaxies would be on the surface of this model. Slower moving galaxies would be on the inside but still moving away from the centre. These observations have provided evidence of an **expanding Universe**.



Red shift measurements of many galaxies have given evidence that all galaxies are **moving away** from a **single point** of origin at **different speeds**. This has led to the **Big Bang theory** that the Universe expanded from a single point of matter around 13.7 billion years ago.

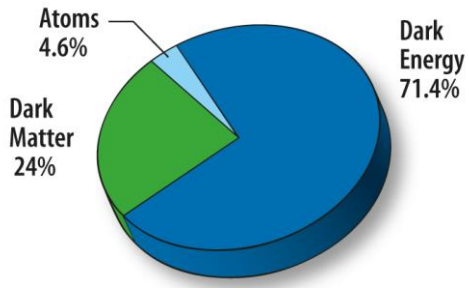
Understanding the Universe

Over the last century, much has been discovered about our Universe:

- The age of the Universe.
- The Universe is more than just our galaxy.
- The size of the Universe.
- There are probably billions of other planets beyond our Solar System.
- The Universe is expanding.
- Cosmic microwave background radiation supporting the Big Bang theory.

However, there is still much we do not yet understand about the Universe.

- **Dark matter** and **dark energy** – continued expansion and acceleration of the Universe suggests there must be a lot more matter and energy than we can see. This is described as dark matter/energy that we have yet to find.
- **Fate of the Universe**. Is the Universe going to continue forever or collapse back to a point and start again?
- Is our Universe just one of a series of **multiverses**?
- Does **life** exist anywhere else in the Universe?



QuestionIT!

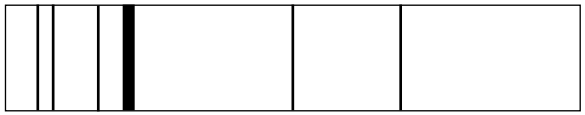
Red shift (physics only)

- Red shift
- Big bang theory

Red shift and Big Bang theory – QuestionIT

1. Which colour of light has the longest wavelength?

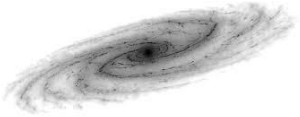
2. The diagram shows the spectrum of light from a star in our galaxy.

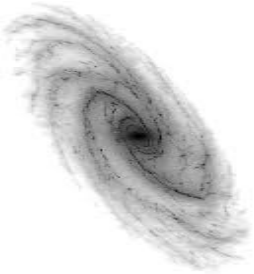


Copy the second box by adding the spectra you would expect from a star in a distant galaxy.

3. The light reaching Earth from distant galaxies exhibits red shift.
Explain why red shift occurs.

4.

Galaxy A 

Galaxy B 

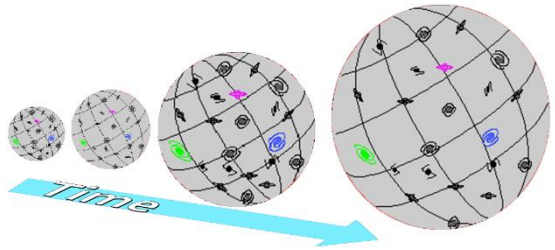
If galaxy A has a much bigger red shift than galaxy B, what does this tell you about galaxy A?

5. Which theory about the origin of the Universe does red shift of galaxies support?

6. Approximately how many years ago did the Universe begin? (Circle the correct answer)

14 million 14 billion 14 trillion

7. What does the diagram suggest is happening to the Universe over time?



8. Describe the current theory of how the Universe began.

9. Atoms are only thought to make up about 5% of the known Universe. What do scientists think the remaining 95% is made up of?

10. The most distant galaxies in the Universe are thought to be:
(tick the correct box)

The biggest galaxies	☐	Accelerating	☐
Slowing down	☐	The coldest	☐

AnswerIT!

Red shift (physics only)

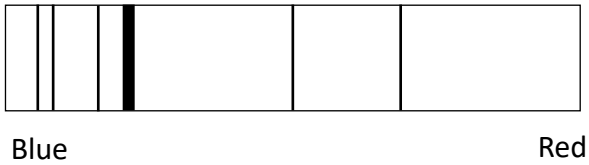
- Red shift
- Big bang theory

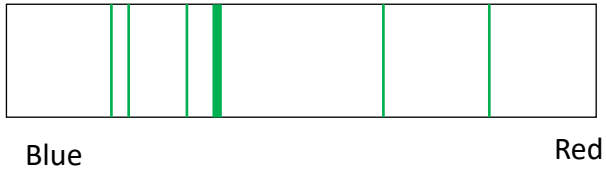
Red shift and Big Bang theory – AnswerIT

1. Which colour of light has the longest wavelength?

   Red

2. The diagram shows the spectrum of light from a star in our galaxy.





   Copy the second box by adding the spectra you would expect from a star in a distant galaxy.

3. The light reaching Earth from distant galaxies exhibits red shift.
   Explain why red shift occurs.

   Galaxy is moving away at high speed

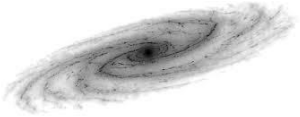
   Light waves from the galaxy are being stretched to longer wavelengths.

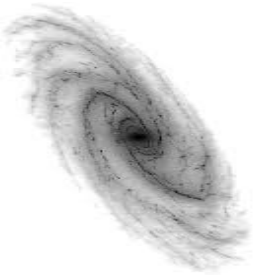
   Longer wavelengths of light are found at the red end of the spectrum.

   This shift of wavelength is called red shift.

Red shift and Big Bang theory – AnswerIT

4.

Galaxy A 

Galaxy B 

If galaxy A has a much bigger red shift than galaxy B, what does this tell you about galaxy A?

It is travelling away at a higher speed. It is further away.

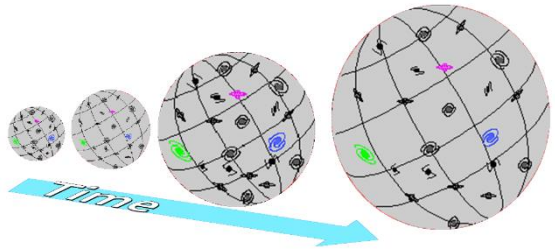
5. Which theory about the origin of the Universe does red shift of galaxies support?

Big Bang theory.

6. Approximately how many years ago did the Universe begin? (Circle the correct answer)

14 million 14 billion 14 trillion

7. What does the diagram suggest is happening to the Universe over time?



It is expanding.

8. Describe the current theory of how the Universe began.

Started as a small region that was very hot and dense.
Big Bang caused it to rapidly expand.

9. Atoms are only thought to make up about 5% of the known Universe. What do scientists think the remaining 95% is made up of?

Dark matter and dark energy.

10. The most distant galaxies in the Universe are thought to be:
(tick the correct box)

The biggest galaxies	☐	Accelerating	☑
Slowing down	☐	The coldest	☐

AnswerIT!

Changes of state and the particle model

- Density of materials
- Changes of state

Solar system: stability of orbital motions; satellites (physics only) – **QuestionIT**

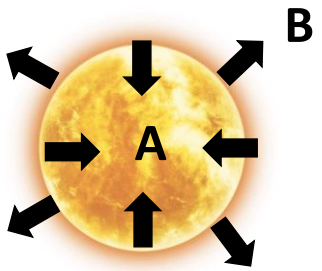
1. How many planets in our solar system?
   8
2. What is the difference between a moon and a dwarf planet?
   Dwarf planets orbit the sun; moons orbit planets.
3. What do we call the natural satellites in the solar system?
   Moons.
4. Name the galaxy our solar system is part of.
   The Milky Way.
5. How was the sun formed, and what caused this to happen?
   From a cloud of dust and gas (nebula); pulled together by gravitational attraction; causing fusion reactions.

7. List the major bodies found in the solar system.
   Star, planets, dwdwarfarf planets, moons, asteroids, comets.
8. What is a nebula?
   Could of dust and gas.
9. What determines the life cycle a star will take?
   The size of the star.
10. Describe the lifecycle of a star the size of the sun.
    Cloud of gas and dust, protostar, main sequence star, red giant, white dwarf, black.
11. Describe the lifecycle of a star more massive than the sun.
    Cloud of gas and dust, protostar, main sequence star, red super giant, supernova, neutron star or black hole.
12. What processes produce all of the naturally occurring elements?
    Fusion.
13. Where are elements heavier than iron produced?
    Supernova.
14. How are these elements distributed throughout the universe?
    Explosion of massive star (supernova).

Solar system: stability of orbital motions; satellites (physics only) – QuestionIT

12. What processes produce all of the naturally occurring elements?
    Fusion.
13. Where are elements heavier than iron produced?
    Supernova.
14. How are these elements distributed throughout the universe?
    Explosion of massive star (supernova).
15. What force enables planets and satellites to maintain their circular orbits?
    Gravity.

16. Main sequence stars are stable despite opposing forces acting on the star. Describe forces A and B.



A – gravitational attraction

B – thermal expansion

16. The international space station takes 92 mins to orbit the Earth. The Moon takes 27.3 days to orbit the Earth. Explain why these orbital times are different.

Moon orbits at a much greater distance than the ISS; it is much further away from the Earth.

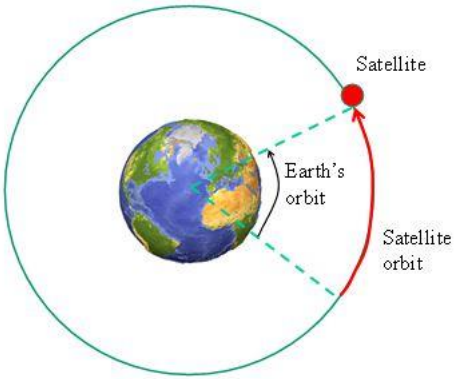
The further from the Earth the lower the gravitational attraction

So The Moon travels slower and it takes much longer to orbit the Earth.

The Moon was a lot closer to the Earth 3 billion years ago.

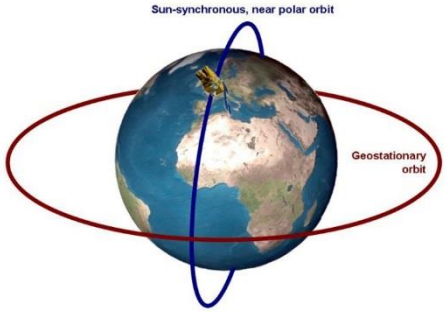
Solar system: stability of orbital motions; satellites physics only) (HT) – QuestionIT

18. The diagram shows a satellite orbiting the Earth.
Explain how the Earth's gravity can result in the satellites velocity changing but not its speed.



In a circular orbit the speed of the satellite remains constant. Velocity is a vector so has size AND direction.
As the direction is changing, the velocity must be changing.

19. Explain why satellites in a polar orbit must travel at much higher speeds than a satellite in a geostationary orbit.



Polar satellite are in a much lower orbit than geostationary satellites.
In a lower orbit, gravity has a much stronger influence so the polar satellite must travel much faster to avoid being pulled down to Earth.