Answers The Universe

Year 10 Science Chapter 6

p133

1 The **universe** is considered to be the whole of all matter, energy, planets, solar systems, galaxies, and space. Many definitions of the universe also include time.

2 We belong to the Milky Way galaxy.

3 Light travels 300 000 000 m in one second. 1 light year is the distance light travels in a year.
In a light year, light travels = 300 000 000 m × 60 × 60 × 24 × 365.25 {min/hour/day/year}
$= 9.47 \times 10^{15}$ m

4 4.24 light years = $4.24 \times 9.47 \times 10^{15}$ m = 4.02×10^{16} m = 4.02×10^{13} km

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1 The massive mass of the Sun attracts the Earth with a huge gravitational force. The Sun's huge force of attraction prevents the Earth from speeding off into space.

2 The Earth spins towards the east. The stars appear to move to the west as we move to the east.

3 The Earth spins on an axis which is tilted at 23.5°. The 23.5° tilt causes the seasons. The tilt of the Earth causes some parts of Earth to have longer days than nights, summer, while other parts have shorter days than night, winter.

4 One Earth orbit of the Sun takes 365.25 days and the Earth completes a spin each day. Thus the Earth spins 365.25 times in one orbit of the Sun.

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1 Our Sun, through its powerful gravitational pull, keeps the solar system objects in orbit around the Sun.

2 The Asteroid Belt separates the inner planets from the outer planets.

3 Neptune, our outermost planet, is 4.4×10^9 km from Earth. How long would it take to get from Earth to Neptune travelling at?

a) 100 km/h. Time = distance/speed = 4.4×10^9 km / 100 km/h = 4.4×10^7 h

b) 60 000 km/h (Speed of Voyager probe).
Time = distance/speed = 4.4×10^9 km / 60 000 km/h = 73000 h or 7.3×10^4 h

p137

1 The massive gravity on the Sun provides the heat and pressure to stimulate nuclear reactions in the Sun. The nuclear fusion of hydrogen to helium produces massive amounts of energy.

2 **Stars**, such as our Sun, are formed when spinning clouds of interstellar dust and gas collapse under gravitational attraction.

3 Stars begin to collapse when the hydrogen at the core is depleted. The collapse produces an even hotter core and pushes the outer layers out. The expanding and cooler star is described as a **red giant**.

4 Our Sun will then become a white dwarf. Average size stars, such as our Sun, keep expanding until the very hot dense core can be seen and is then described as a **white dwarf**.

5 The main component of interstellar gas is hydrogen.

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1 A **galaxy** is a collection of stars, gas, dust, and dark matter. A galaxy is held together by gravitational attraction.

2 The Milky Way.

3 All points on a circle are the same distance from the centre.

The sum of the distances from any point on an ellipse to two points inside the ellipse (called the foci) are the same.

4 Spiral galaxies are a rotating spin wheel of stars. Elliptical galaxies have an elliptical shape.

5 Black holes are formed when large stars collapse. The density and gravitational pull of a black hole is so large that even light can't escape. It is believed that there is a supermassive black hole at the centre of every massive elliptical galaxy.

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1 The big bang theory proposes that the universe began as a single astoundingly hot, dense point about 13.8 billion years ago and massively expanded. The universe expanded faster than the speed of light within the first few tiny fractions of a second and has continued to expand.

2 **Phase 1** The inflation phase of a very early universe where extremely intense energy expands space-time.
Phase 2 The cooling of the early universe forms a wide variety of common particles resulting in gravitational forces and electromagnetic energy including microwave radiation.
Phase 3 Following a short dark age, the earliest stars and galaxies are formed. The universe evolves as stars are born and die, and the universe expands.
Phase 4 The universe darkens, as more stars die than are born, and the universe continues to cool. A number of different theories about the fate of the universe conclude that the universe will end (in a very long time from the present) (Image courtesy, NASA, Wikimedia Commons).

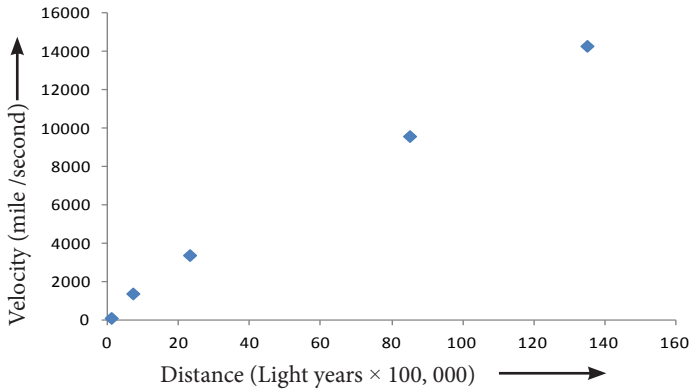
3 The approximate age of the universe, according to the big bang theory, is about 13.8 billion years.

4 A rough estimate of the radius of the universe (assuming an expansion at the speed of light)
$= 13.8 \text{ billion years} \times 3\times10^8 \text{ m/s} \times 60 \times 60 \times 24 \times 365.25$ {min/hour/day/year}
$= 1.38\times10^{10} \text{ years} \times 3\times10^8 \text{ m/s} \times 3.1\times10^7 \text{ secs per year}$
$= 1.3\times10^{26}$ m or approximately 1 300 000 000 000 000 000 000 000 km
(The diameter would be twice this.)

5 It was initially thought that the universe would be slowing its expansion because gravitational attraction would be pulling the masses back together. The evidence indicating that the universe is actually expanding at an increasing rate leads to a conclusion that something must be pushing the universe apart. The something has been given the name **dark energy**.

p143

1 A plot of velocity (miles per second) against distance (light years) using the above Hubble's data:



2 The plot supports the statement that 'The furthest galaxies are moving the fastest'.

3 A megaparsec (Mpc) is 3.26 million light years.

p145	**1**	The big bang theory for the origin of the universe predicts that, early in the expansion of the universe, microwaves would have been emitted. These microwaves are described as cosmic microwave background.
	2	The discovery of the cosmic microwave background gave strong extra support to the big bang theory. No other theory for the origin of the universe, to date, has been able to provide an explanation for the cosmic microwave background.
	3	The age of the universe must be as old as, or older, than the oldest objects in the universe. Ages of stars can be estimated by knowing their position within the life cycle of stars. The age of the universe can also be estimated by determining the rate of expansion of the universe and working backwards.
	4	It is generally agreed that the age of the universe is 13.798 billion years ±37 million years.
	5	It is thought that the larger the star, the more pressure on the central core, the faster the star burns the hydrogen.
p146	**1**	**Asteroids** are objects that orbit the Sun and are smaller than planets. There are millions of asteroids orbiting our Sun with the greater majority in the asteroid belt between Mars and Jupiter.
	2	**Asteroids** consist of rocky materials and metals. **Comets** have a fuzzy outline and sometimes a tail as they pass close to the Sun. **Meteoroids** are small rocks less than 10 m in diameter. **Meteors** burn up as they enter Earth's atmosphere. **Meteorites** are meteoroids that reach the Earth's surface.
	3	Given that millions of asteroids orbit our Sun and the many examples of previous Earth hits, it is a certainty that Earth will be hit with an asteroid sometime in the future.
	4	Near Earth objects are comets and asteroids that have had their orbits altered by the gravitational attraction of nearby planets into orbits that come close to Earth.
p147	**1**	A cluster of galaxies contains a large number of galaxies.
	2	In 1929, Hubble proved that the universe is expanding at an increasing rate. It is theorised that a **dark energy** is causing the universe to increase its expansion.
	3	**Dark matter** is the name given to hypothetical matter that would explain the difference between calculated gravitational attraction and the larger actual gravitational attraction. The extra gravitational attraction suggests that 27% of the universe consists of dark matter.
	4	It is thought that the amount of dark energy is increasing to support the increasing volume of the universe as the universe continues to expand.

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1 The **universe** is considered to be the whole of all matter, energy, planets, solar systems, galaxies, and space. Many definitions of the universe also include time.

2 We belong to the Milky Way galaxy.

3 **Cosmology** is the study of the origin , the growth, the evolution, and the eventual fate of the universe.

4 **Astronomy** is the study of nebulae, galaxies, stars, planets, moons, comets, and asteroids.

5 **Astrophysics** is the study of the physical laws and theories as they apply to nebulae, galaxies, stars, planets, moons, comets, asteroids, and space matter.

6 Light travels 300 000 000 m in one second. 1 light year is the distance light travels in a year.
In a light year, light travels = 300 000 000 m × 60 × 60 × 24 × 365.25 {min/hour/day/year}
$= 9.47\times10^{15}$ m

7 6.2 billion light years = $6.2\times10^{9} \times 9.47\times10^{15}$ m = 5.9×10^{25} m = 5.9×10^{23} km

8 13.1 billion light years = $13.1\times10^{9} \times 9.47\times10^{15}$ m = 1.2×10^{26} m = 1.2×10^{24} km

9 4.24 light years = $4.24 \times 9.47\times10^{15}$ m = 4.02×10^{16} m = 4.02×10^{13} km

p151

1 Our Sun, through its powerful gravitational pull, keeps the solar system objects in orbit around the Sun.

2 The Earth spins towards the east. The stars appear to move to the west as we move to the east.

3 **Stars**, such as our Sun, are formed when spinning clouds of interstellar dust and gas collapse under gravitational attraction.

4 The approximate age of the universe, according to the big bang theory, is about 13.8 billion years.

5 Mars is 2.3×10^{8} km from Earth. How long would it take to get from Earth to Mars travelling at?

a) 100 km/h. Time = distance/speed = 2.3×10^{8} km / 100 km/h = 2.3×10^{6} h

b) 60 000 km/h (Speed of Voyager probe).
Time = distance/speed = 2.3×10^{8} km / 60 000 km/h = 3800 h or 3.8×10^{3} h

6 The massive gravity on the Sun provides the heat and pressure to stimulate nuclear reactions in the Sun. The nuclear fusion of hydrogen to helium produces massive amounts of energy.

7 **Stars**, such as our Sun, are formed when spinning clouds of interstellar dust and gas collapse under gravitational attraction.

8 Stars begin to collapse when the hydrogen at the core is depleted. The collapse produces an even hotter core and pushes the outer layers out. The expanding and cooler star is described as a **red giant**.

9 Our Sun will then become a white dwarf. Average size stars, such as our Sun, keep expanding until the very hot dense core can be seen and is then described as a **white dwarf**.

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1 A **galaxy** is a collection of stars, gas, dust, and dark matter. A galaxy is held together by gravitational attraction.

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5 **Phase 1** The inflation phase of a very early universe where extremely intense energy expands space-time.
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p153

1 The 'hand rule' does work. There are a number of other methods such as 'dead end filling'.

2 The first arrow is straight.

3 Assume three slices of bread, each with sides: A1, A2, B1, B2, C1, C2

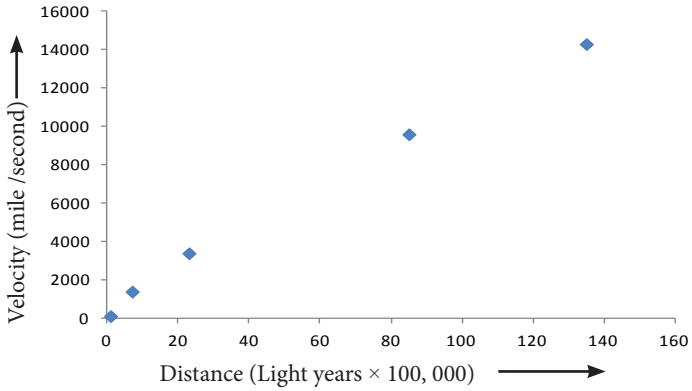
To toast the three slices in three minutes: A1 & B1 then B2 &C1 then A2 & B2

p154

1 Hubble provided evidence that:
- Galaxies are moving away from each other.
- The furthest galaxies are moving the fastest.

This evidence supports the theory of the big bang.

2 A plot of velocity (miles per second) against distance (light years) using the above Hubble's data:



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7 It is generally agreed that the age of the universe is 13.798 billion years ±37 million years.

8 It is thought that the larger the star, the more pressure on the central core, the faster the star burns the hydrogen.

p155	**1** d) **2** a) **3** a) **4** a)
p156	**1** The star marked D (0.77) is Alpha Crux. **2** 89 light years = $89 \times 3\times10^{8}$ m $\times 60 \times 60 \times 24 \times 365.25$ {min/hour/day/year} $= 8.4\times10^{17}$ m $= 8.4\times10^{15}$ km **3** The Sun, 4.6 billion years old and 5 billion years from becoming a red giant, is about half way to becoming a red giant. This means that the Sun has burned about 25% of its hydrogen for the first half, and will burn 75% of its hydrogen for the second half. This means that the Sun will increase its rate of burning hydrogen and will produce greater heat. **4** d) **5** Our Sun is the hotter star. **6** Betelgeuse would have an absolute magnitude of about -5 **7** Canopus would actually be the brighter star.