

Stars & The Universe

Question Paper

Course	CIE IGCSE Physics
Section	6. Space Physics
Topic	Stars & The Universe
Difficulty	Hard

Time Allowed	70
Score	/51
Percentage	/100

Question 1a**Extended tier only**

Edwin Hubble was an American scientist who studied galactic recession.

Define the Hubble constant, H_0 .

[1 mark]

Question 1b**Extended tier only**

State the current value of the Hubble constant.

[2 marks]

Question 1c**Extended tier only**

The Andromeda galaxy is the Milky Way's largest galactic neighbour. The Andromeda galaxy is approximately 2.5 million light years from Earth.

Calculate the speed with which the Andromeda galaxy is receding from Earth. You should give your answer in km/s.

..... km/s
[4 marks]

Question 2a**Extended tier only**

State and explain the two pieces of evidence which support the Big Bang Theory of the origin of the Universe.

[4 marks]**Question 2b****Extended tier only**

Calculate the distance of 50 light-years in metres.

Speed of light = 3.0×10^8 m/s.

[4 marks]

Question 2c**Extended tier only**

Redshift measurements show that a galaxy is receding from Earth at a speed of 32 000 km/s.

Use Hubble's Law to calculate how many light-years the galaxy is distant from the Solar System.

Take the Hubble constant to be 2.2×10^{-18} per second.

[5 marks]**Question 3a****Extended tier only**

Explain what type of radiation the CMBR will eventually change into over the next billion years.

[2 marks]

Question 3b**Extended tier only**

Scientists measure the wavelength of the radio waves from galaxy A travelling at 260 km/hr away from Earth to be 63.2 m. Sometime later, the wavelength is measured to be 63.4 m.

The wavelength of the radio waves from galaxy B is initially measured to be 63.4 m and at the same time later, measured to be 63.8 m.

Calculate the velocity of galaxy B.

velocity of galaxy B = m/s
[4 marks]

Question 3c

Extended tier only

By measuring the redshift of galaxies, Hubble was able to calculate the speed at which they move away from the Earth. Hubble was also able to calculate the distance of these galaxies from the Earth.

The graph in Fig 1.1 shows some of the data calculated by Hubble.

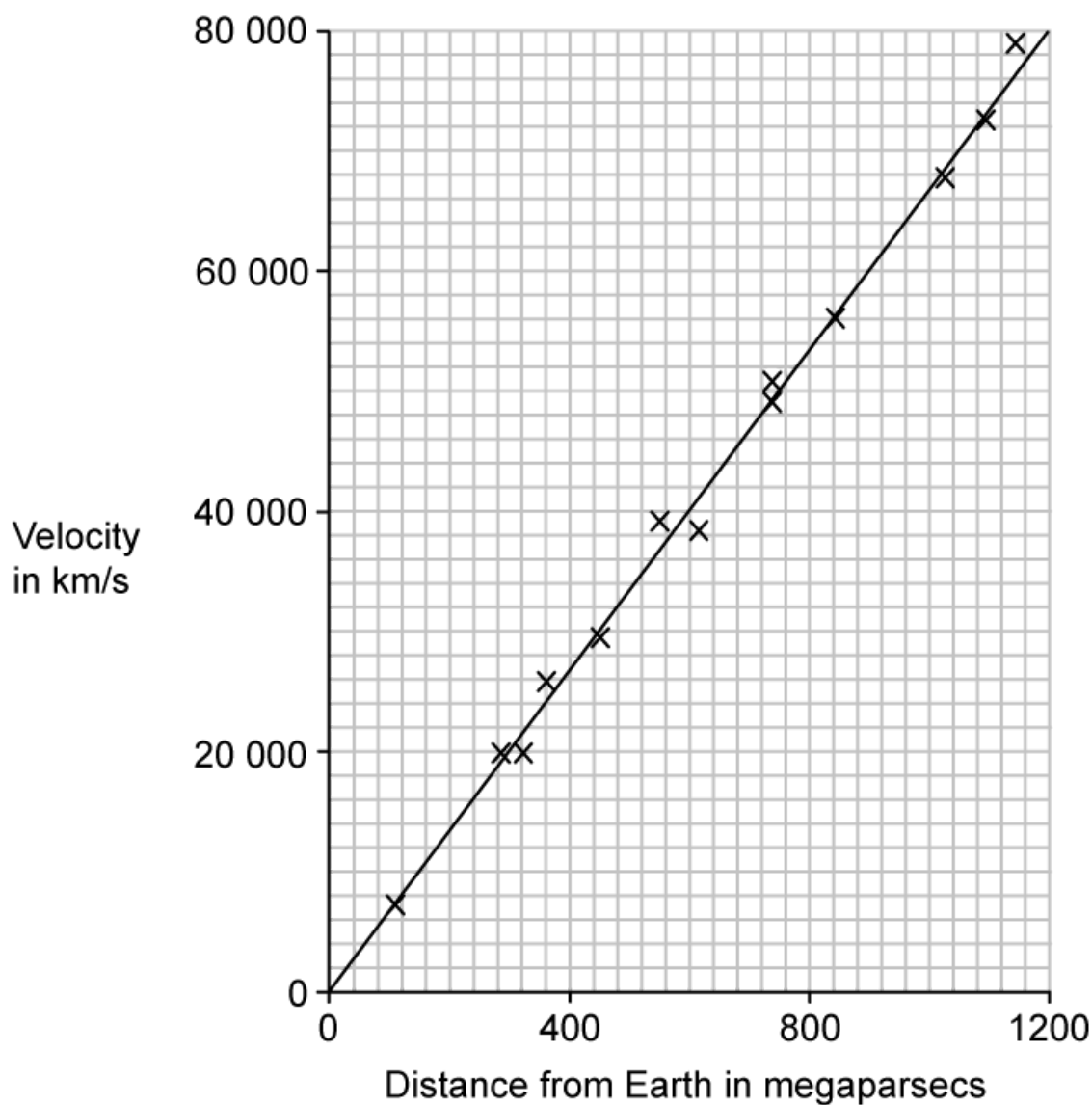


Fig 1.1

The graph in Fig 1.1 was used to calculate the most up-to-date value of the Hubble constant, H_0 .

Megaparsecs are a unit for large distances commonly used in Astronomy and Cosmology. 1 megaparsec = 3.1×10^{22} m.

Calculate H_0 in km/s megaparsec.

[3 marks]

Question 3d

Extended tier only

Show that H_0 is roughly equal to 2.0×10^{-18} per second.

[3 marks]

Question 4a

The 'big bang' theory is one theory explaining the origin of the Universe.

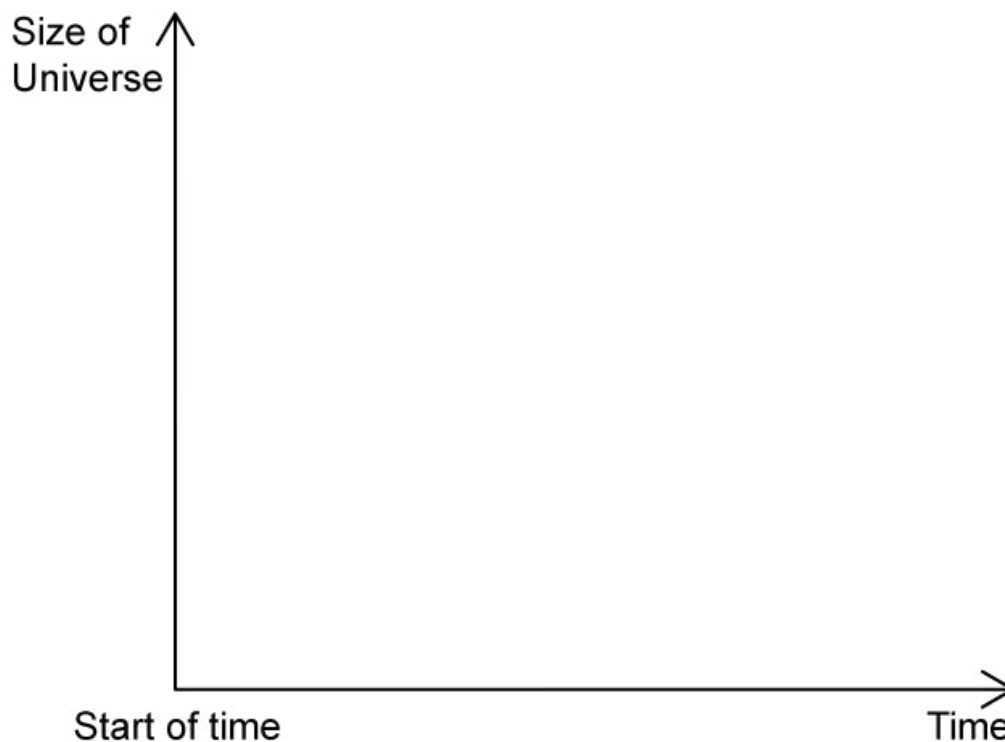


Fig 1.1

- (i) Sketch the graph of the size of the Universe with time on Fig 1.1.

[2]

- (ii) Explain how your graph in part (i) supports the Big Bang Theory.

[2]

[4 marks]

Question 4b**Extended tier only**

- (i) Describe and explain the main properties of CMBR.
- (ii) Explain how CMBR provides evidence for the evolution of the Universe.

[2]

[3]

[5 marks]**Question 4c****Extended tier only**

Suggest why our understanding of the very earliest moments of the Universe is unreliable.

[2 marks]

Question 5a**Extended tier only**

Nuclear fusion reactions in the Sun fuse hydrogen to make helium.

In the Solar System, the inner planets, such as the Earth, contain elements which are heavier than the elements hydrogen and helium.

Explain how this can be the case.

[2 marks]

Question 5b

Extended tier only

From the data collected, a graph can be drawn that links the speed of a galaxy with the distance of the galaxy from the Earth. This graph is shown in Fig. 1.1.

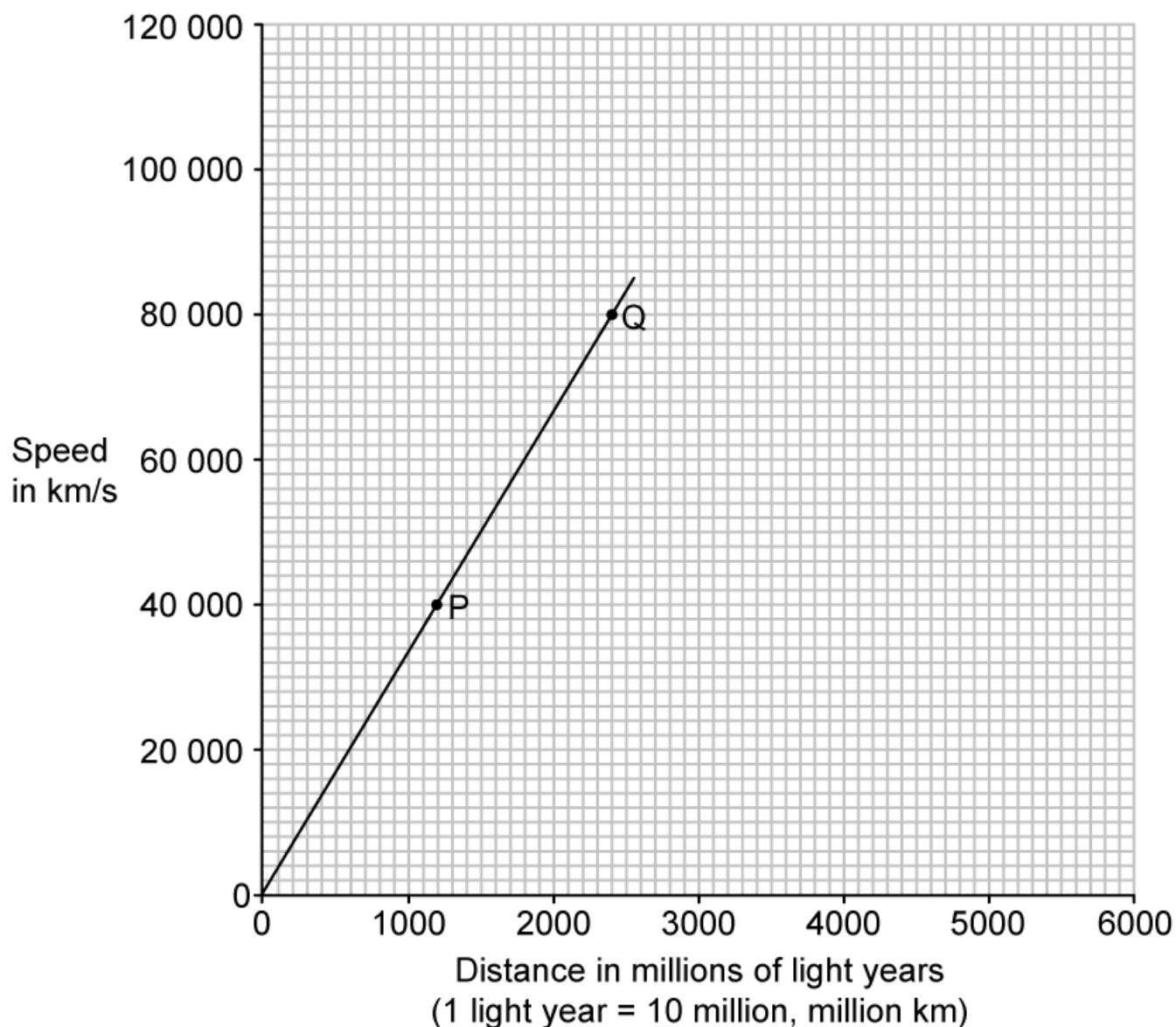


Fig 1.1

Describe how the visible light spectrum from galaxy Q looks different from the visible light spectrum from galaxy P.

[3 marks]**Question 5c****Extended tier only**

A third galaxy, R, seems to be travelling away from the Earth at about 110 000 km/s.

Estimate how far galaxy R might be from the Earth, showing how you use the graph in Fig. 1.1 to do this.

[3 marks]