Q1. (a) Satellites fitted with various telescopes orbit the Earth. These telescopes detect different types of electromagnetic radiation.

Why are telescopes that detect different types of electromagnetic waves used to observe the Universe?

.....

.....

(1)

(b) In 2005 a space telescope detected a star that exploded 13 billion years ago. The light from the star shows the biggest *red-shift* ever measured.

(i) What is *red-shift*?

.....

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(1)

(ii) What does the measurement of its red-shift tell scientists about this star?

.....

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(1)

(c) Red-shift provides evidence for the 'big bang' theory.

(i) Describe the 'big bang' theory.

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(2)

(ii) Suggest what scientists should do if new evidence were found that did not support the 'big bang' theory.

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(1)

(Total 6 marks)

Q2. (a) The light spectrum from a distant galaxy shows a red shift.

What is meant by *red shift* and what does it tell us about distant galaxies?

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(2)

(b) What name is given to the theory that the Universe started with a massive explosion?

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(1)

(Total 3 marks)

Q3. (a) In 1929, the astronomer Edwin Hubble observed that the light from galaxies that are moving away from the Earth showed a *red-shift*.

What is *red-shift* ?

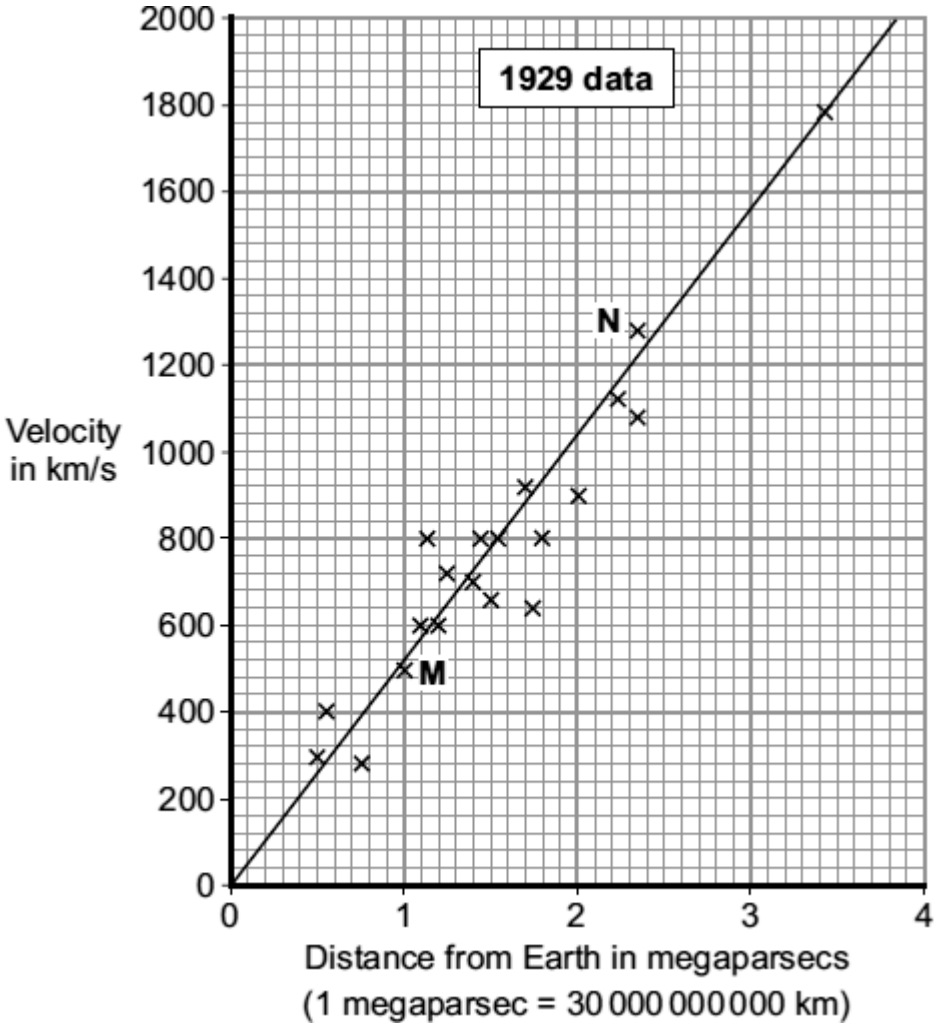
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(1)

(b) By measuring the *red-shift*, Hubble was able to calculate the speed at which the galaxies are moving away from the Earth. He was also able to calculate the distance of these galaxies from the Earth.

The graph shows some of the data calculated by Hubble.



(i) The data from two galaxies, **M** and **N**, has been included in the graph. The light from galaxy **M** has a smaller *red-shift* than the light from galaxy **N**.

What does the difference in *red-shift* tell scientists about the two galaxies, **M**

and **N**?

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(2)

(ii) The gradient of the line drawn on the graph gives a number known as the Hubble constant. The Hubble constant can be used to estimate when the universe began.

Use the graph to calculate the value of the Hubble constant.

Show clearly how you obtained your answer.

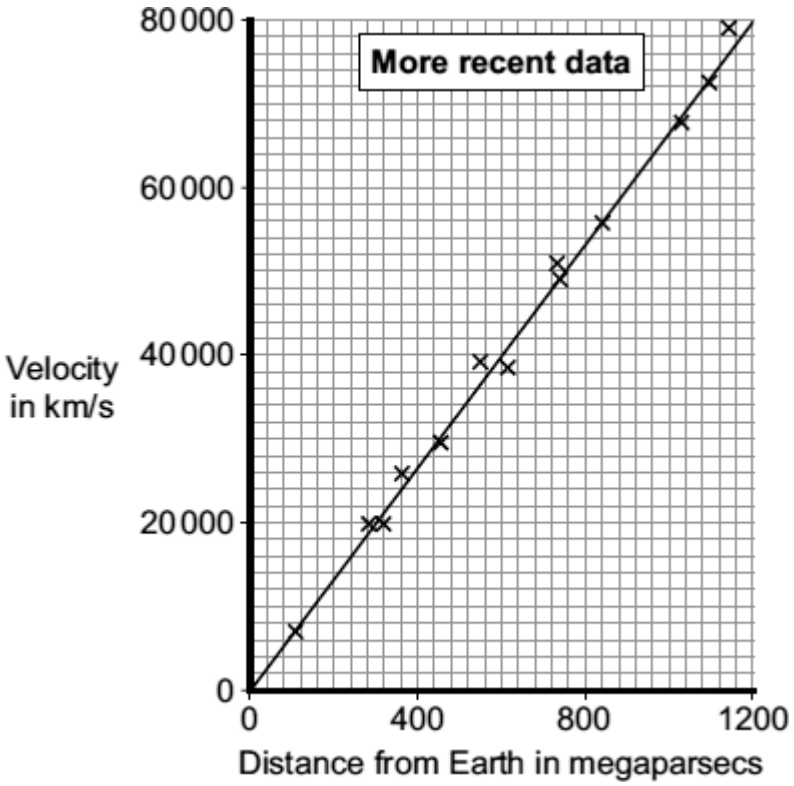
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Hubble constant = ... km/s per megaparsec

(2)

(iii) More recently, data has been obtained from more distant galaxies.



The results from the more recent data give a totally different value for the Hubble constant to the one calculated from the 1929 data.

Which set of data, the 1929 or the more recent, is most likely to give the value closest to the true value for the Hubble constant?

Draw a ring around your answer.

1929 **more recent**

Give a reason for your answer.

.....

.....

(1)

(c) The Andromeda galaxy is not moving away from the Earth. It is actually moving towards the Earth. This means that the light from Andromeda shows a blue-shift.

How do the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth?

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(2)
(Total 8 marks)

Q4. Read the passage.

> In the SolarSystem, the inner planets, such as the Earth, contain elements which are eavierthan the elements hydrogen and helium.
>
> Our star,the Sun, is a medium sized star. If a star is much more massive than the Sunit will eventually swell into a red giant, start to contract, continue tocontract and finally explode.

(a) What is the explosion called?

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(1)

(b) Explain why scientists believe that the Solar System was formed from the material produced when earlier stars exploded.

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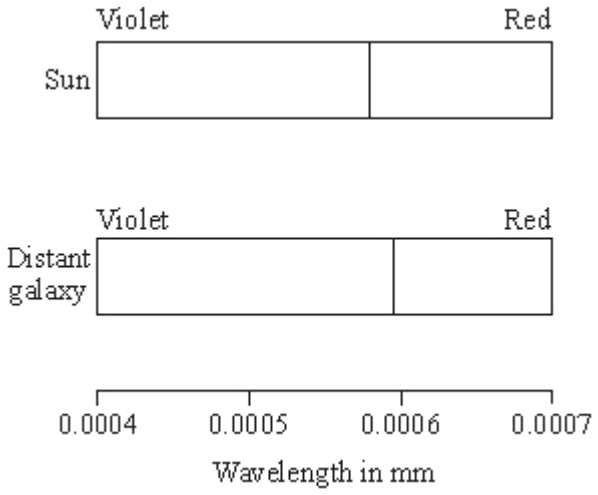
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(3)
(Total 4 marks)

Q5. The visible part of the electromagnetic spectrum from a star includes a dark line. This line is at a specific wavelength. The diagram shows the position of the dark line in the spectrum from the Sun and in the spectrum from a distant galaxy.



(a) Explain how the spectrum 'shift' of the dark line supports the theory that the Universe began from a very small point.

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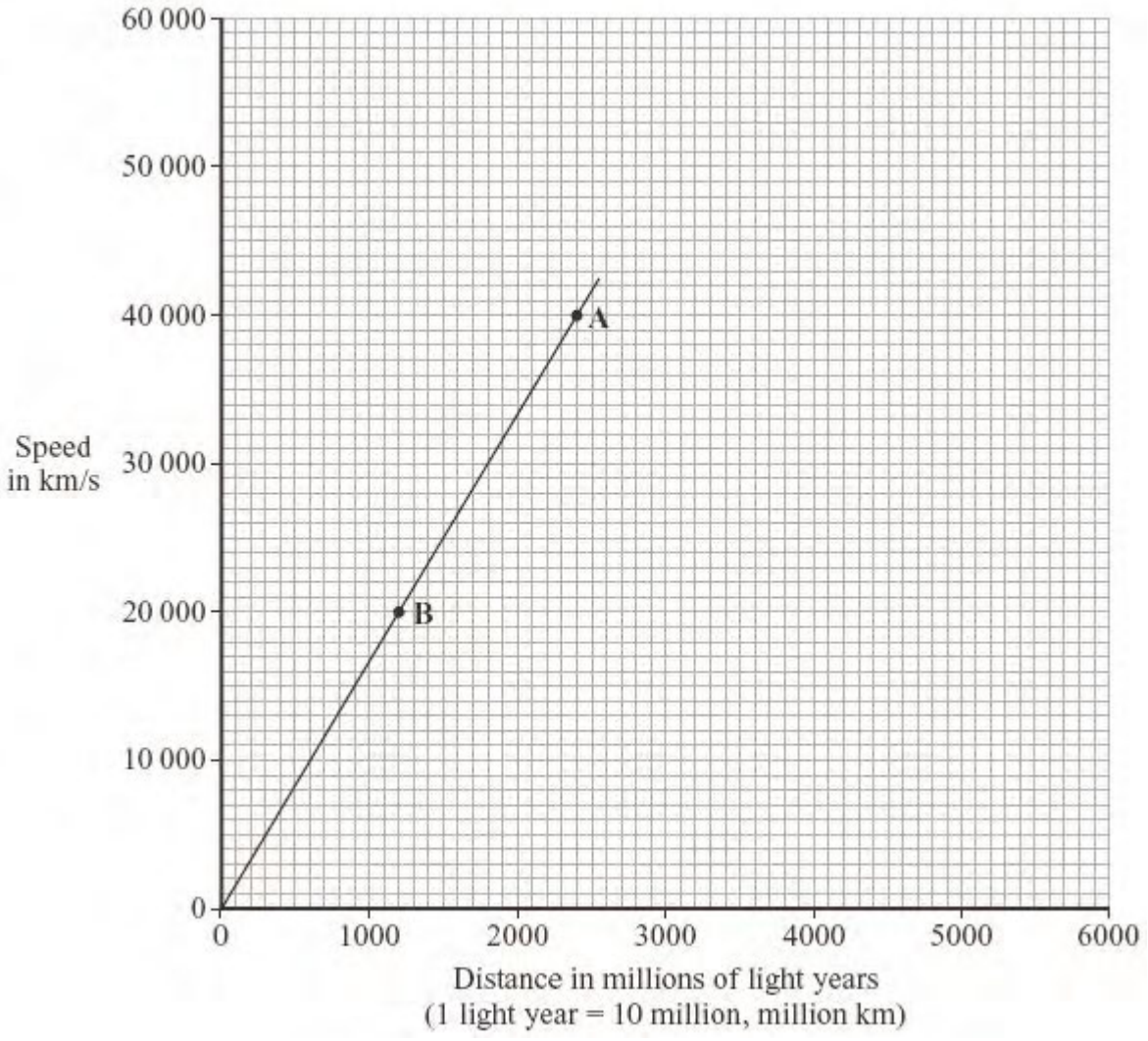
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(3)

(b) From data collected, a graph can be drawn that links the speed of a galaxy with the distance of the galaxy from the Earth.



(i) How does the visible light spectrum from galaxy **A** look different from the visible light spectrum from galaxy **B**?

.....

.....

(1)

(ii) A third galaxy, **C**, seems to be travelling away from the Earth at about 60 000 km/s.

Estimate how far galaxy **C** might be from the Earth, showing how you use the graph to do this.

.....

.....

Distance between galaxy **C** and the Earth = …… million light years

(2)

(Total 6 marks)

Q6. The ‘steady state’ theory was once a popular alternative to the ‘big bang’ theory.

The ‘steady state’ theory suggested that the universe, although expanding, had no origin and it has always existed. As the universe expands, a small amount of matter is created to keep the universe looking exactly the same all of the time.

(a) When considering the origin of the universe, what is the difference between the ‘big bang’ theory and the ‘steady state’ theory?

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(2)

(b) The light from distant galaxies shows a *red-shift*.

(i) What is *red-shift*?

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(1)

(ii) Why does red-shift provide evidence to support both the ‘big-bang’ theory and the ‘steady state’ theory?

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(2)

(c) The ‘steady state’ theory was important in encouraging new research into the universe.

Suggest a reason why scientists were keen to carry out new research.

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(1)

(d) Scientists can answer many questions about the universe, but not the question:

'Why was the universe created?'

Suggest a reason why this question cannot be answered by scientists.

.....

.....

(1)

(Total 7 marks)

Q7. Optical telescopes may be used to observe galaxies. Some optical telescopes are on the Earth and some are on satellites in space.

Scientists have observed that the wavelengths of the light from galaxies moving away from the Earth are longer than expected. This observation is called red-shift.

(i) What does the size of the red-shift tell the scientists about the distance a galaxy is from the Earth?

.....

.....

(1)

(ii) Complete the following passage.

Red-shift provides evidence to support the 'big bang' theory. The 'big bang' theory is one of the ways of explaining the ..... of the Universe.

(1)

(Total 2 marks)

Q8. The ‘Big Bang’ theory is one theory of the origin of the Universe.

(a) (i) Explain what is meant by the ‘Big Bang’ theory.

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(2)

(ii) The light arriving from distant galaxies provides scientists with evidence to support the ‘Big Bang’ theory.

Explain how.

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.....

(2)

(b) At a meeting held in 2005, a group of scientists claimed that new data had been collected that showed the ‘Big Bang’ theory to be wrong. Other scientists said that there was no reason to doubt the ‘Big Bang’ theory.

What should scientists do when a theory does **not** appear to be supported by new data?

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.....

(2)

(c) Scientists can answer many questions about the Universe, but not the question:

Why was the Universe created?

Suggest a reason why this question **cannot** be answered by scientists.

.....

.....

(1)
(Total 7 marks)

Q9. (a) The 'Big Bang' theory uses red-shift as evidence to explain the beginning of the Universe.

How does the red-shift from distant galaxies provide evidence for the beginning of the Universe?

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(3)

(b) Cosmic microwave background radiation (CMBR) is a type of electromagnetic radiation. CMBR fills the Universe. It was first discovered in 1965 by two astronomers called Penzias and Wilson.

(i) What do scientists believe is the origin of CMBR?

.....

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(1)

(ii) Why was the discovery of CMBR so important to the scientists believing the 'Big Bang' theory to be correct?

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(1)

(iii) How is the wavelength of CMBR likely to change, if at all, over the next billion years?

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Give a reason for your answer.

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(2)
(Total 7 marks)

Q10. Galaxies emit all types of electromagnetic wave.

(a) (i) Which type of electromagnetic wave has the shortest wavelength?

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(1)

(ii) State **one** difference between an ultraviolet wave and a visible light wave.

.....

.....

(1)

(b) Electromagnetic waves travel through space at a speed of 3.0×10^8 m/s.

The radio waves emitted from a distant galaxy have a wavelength of 25 metres.

Calculate the frequency of the radio waves emitted from the galaxy and give the unit.

.....

.....

.....

Frequency = ...

(3)

(c) Scientists use a radio telescope to measure the wavelength of the radio waves emitted from the galaxy in part (b) as the waves reach the Earth. The scientists measure the wavelength as 25.2 metres. The effect causing this observed increase in wavelength is called red-shift.

(i) The waves emitted from most galaxies show red-shift.

What does red-shift tell scientists about the direction most galaxies are moving?

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(1)

(ii) The size of the red-shift is **not** the same for all galaxies.

What information can scientists find out about a galaxy when they measure the size of the red-shift the galaxy produces?

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(2)

(iii) What does the observation of red-shift suggest is happening to the Universe?

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(1)
(Total 9 marks)