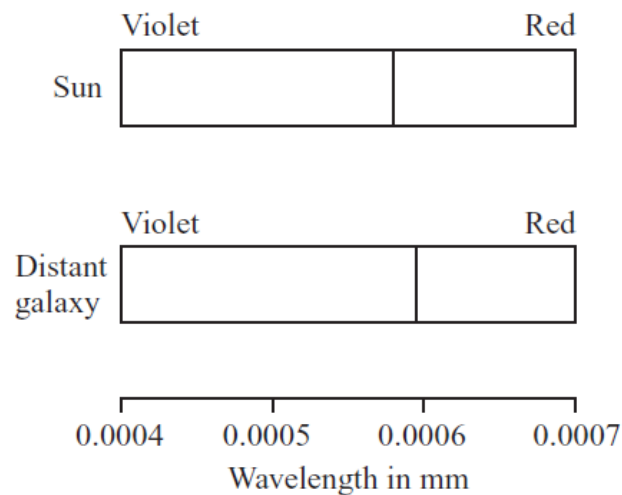


Astronomy - 1

1.

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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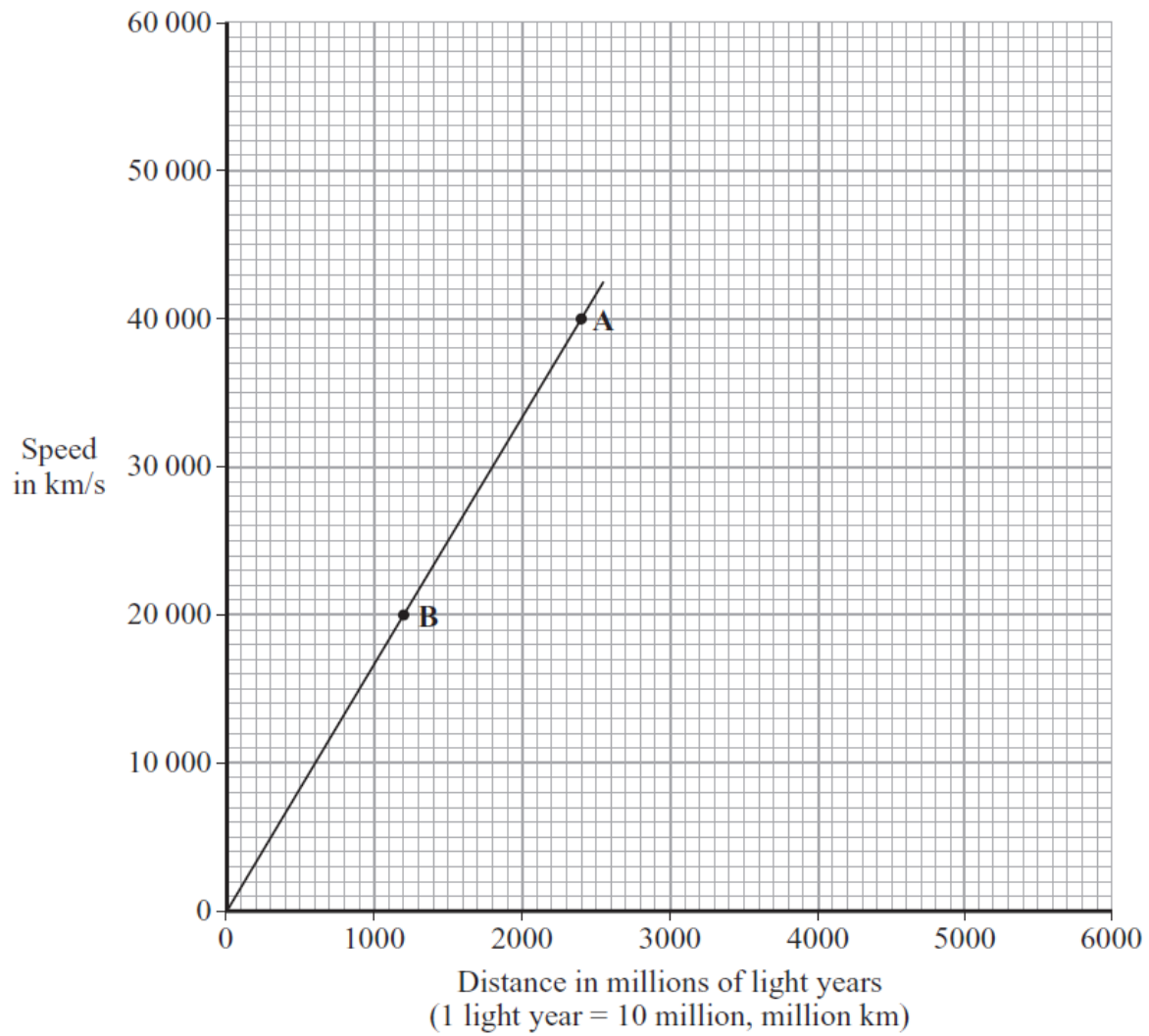
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(3 marks)

- (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**?

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(1 mark)

- (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.

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Distance between galaxy C and the Earth = million light years
(2 marks)

- (c) Astronomers use telescopes to observe distant galaxies. Since 1990 the Hubble optical telescope has been in orbit around the Earth.

Explain why an optical telescope in space allows astronomers to see further and more clearly than an optical telescope on Earth.

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(2 marks)

2.

- (a) A student listens to the sound waves produced by a car siren. When the car is stationary, the student hears a constant frequency sound.

Describe how the wavelength and frequency of the sound waves heard by the student change when the car is driven away from the student.

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(2 marks)

- (b) 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?

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(1 mark)

- (c) 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 mark)

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

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(1 mark)

- (d) Red-shift provides evidence for the ‘big bang’ theory.

- (i) Describe the ‘big bang’ theory.

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(2 marks)

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

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(1 mark)

3.

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 marks)

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

- (i) What is *red-shift*?

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(1 mark)

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

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(2 marks)

- (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 mark)

4.

The table gives data about two space telescopes. The Hubble telescope is already in space, but the James Webb telescope is still being built.

Name of telescope	Mirror diameter in metres	Launch Year	Orbit distance from the Earth in kilometres
Hubble	2.4	1990	575
James Webb	6.5	2013	1 500 000

- (a) Explain why the Hubble telescope produces clearer images than optical telescopes positioned on the Earth.

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(2 marks)

- (b) After the Hubble telescope was launched into space, scientists found that it was not able to focus properly. Astronauts sent into space were able to repair the fault.

The James Webb telescope is to be fully assembled and tested before it is launched into space. Suggest why.

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(2 marks)

- (c) To get the large mirror for the James Webb telescope into space, it will be folded in segments, launched into space and then opened out. This is a complicated process so a working scale model of the optical system has been built.

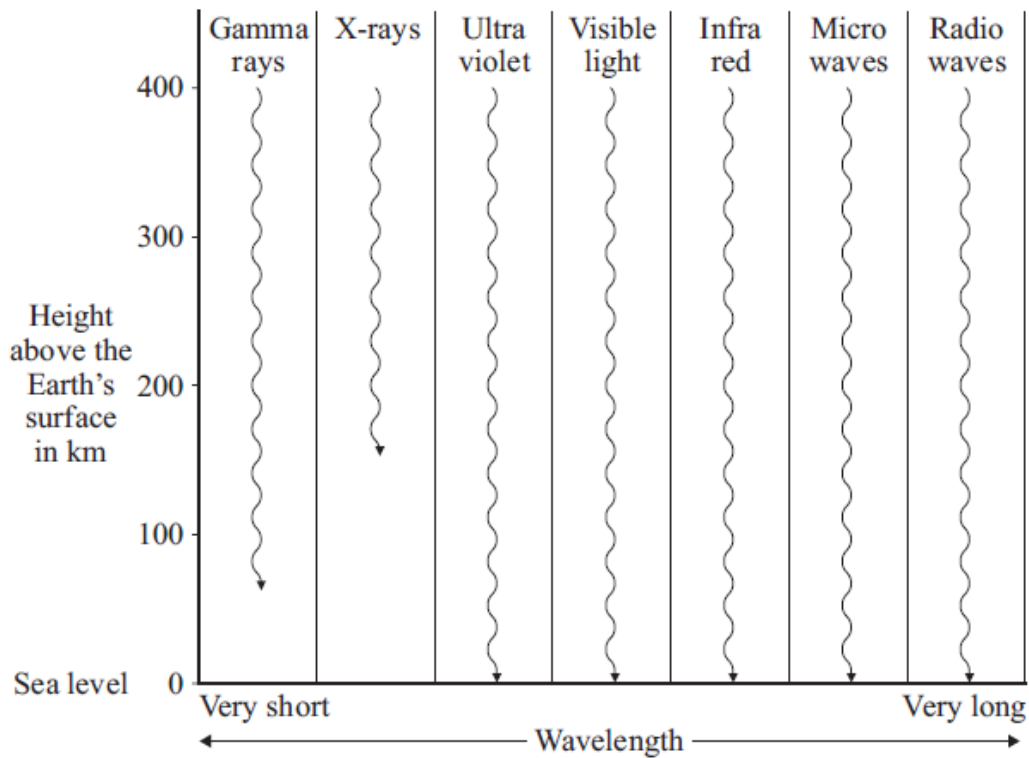
Suggest **one** reason why building a scale model is a good idea.

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(1 mark)

- (d) The diagram shows how far different types of electromagnetic wave can travel through the Earth's atmosphere before being absorbed.



Explain why an optical telescope can be positioned on the Earth but an X-ray telescope must be in space.

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(2 marks)

5.

- (a) The table lists the names of seven telescopes. Each one of the telescopes is designed to detect a different one of the seven types of electromagnetic wave. The table is incomplete.

Name of telescope	Type of wave detected
HESS	Gamma
XMM Newton	X-ray
FUSE	Ultraviolet
William Herschel	Visible light
Spitzer	
SPT	Microwave
Lovell	Radio

- (a) (i) Which **one** of the telescopes is designed to detect the type of wave with the shortest wavelength?

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(1 mark)

- (a) (ii) What type of wave is the Spitzer telescope designed to detect?

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(1 mark)

- (b) The William Herschel telescope is on the Earth's surface. Another telescope, the Hubble telescope, which also detects visible light, orbits the Earth.

How is the image produced by the Hubble telescope better than the image produced by the William Herschel telescope?

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Give a reason for your answer.

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(2 marks)

- (c) Some types of electromagnetic wave are absorbed by water.
The SPT telescope is located in the Antarctic, which is a dry environment.

Explain why it is better to have this type of telescope in a dry environment rather than in a wet, humid environment.

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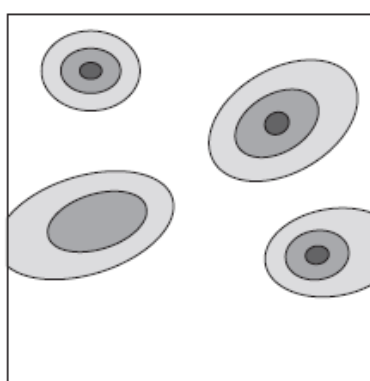
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(2 marks)

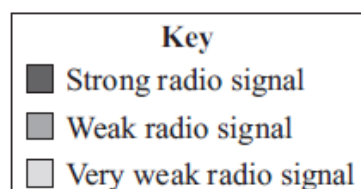
- (d) The pictures represent the images produced using a visible light telescope and a radio telescope. Both images are of the same part of the sky. The shading on the radio telescope image represents the strength of the radio signals.



Visible light image



Radio telescope image



Suggest what extra information can be gained from the radio telescope image compared with the visible light image.

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(1 mark)

6.

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 marks)

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

Explain how.

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(2 marks)

- (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 marks)