



GCSE Physics

Red Shift

Question Paper

Time available: 45 minutes

Marks available: 38 marks

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1.

In 1929, the astronomer Edwin Hubble observed that the light from galaxies moving away from the Earth had longer wavelengths than expected.

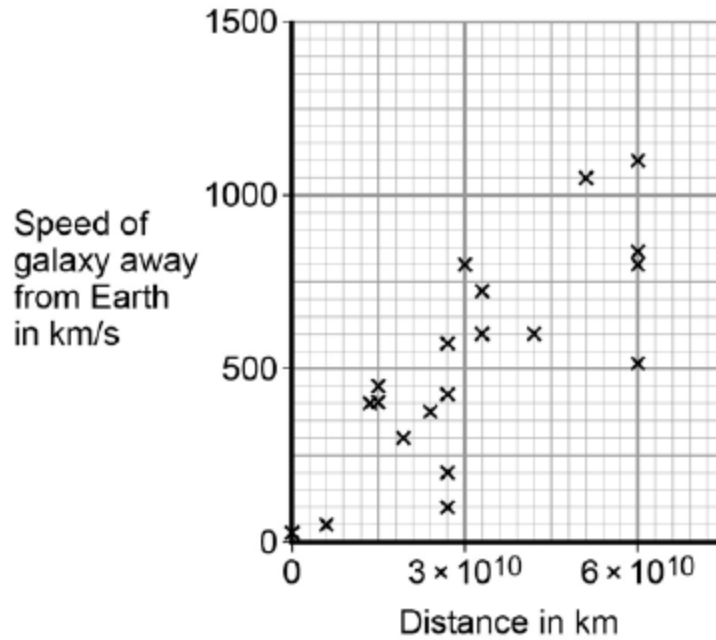
(a) What name is given to this effect?

(1)

(b) From his observations, Hubble was able to calculate the speed of a galaxy and the distance of the galaxy from the Earth.

Figure 1 shows the results of Hubble's calculations.

Figure 1



What relationship between the speed of a galaxy and the distance is suggested by Hubble's results?

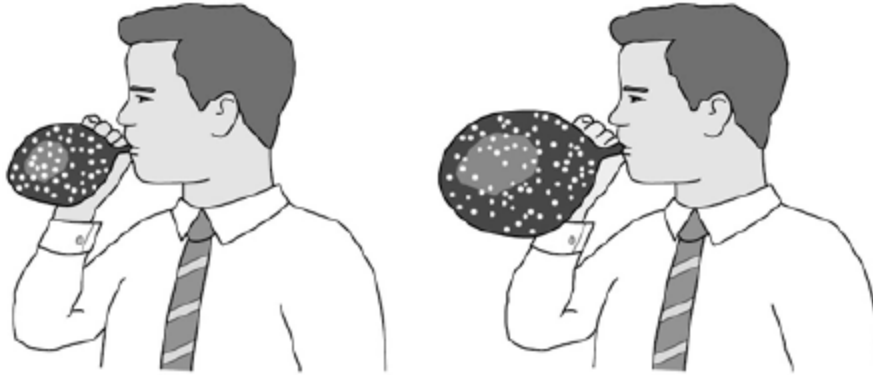
(1)

The observations made by Hubble support the idea that the Universe is expanding. This means that galaxies are continually moving away from each other and from the Earth.

Figure 2 shows a student using a balloon to model the idea of an expanding Universe.

Some dots, which represent galaxies, were marked on the balloon. The balloon was then inflated.

Figure 2



- (c) Give **one** strength and **one** weakness of this model in representing the idea of an expanding Universe.

Strength _____

Weakness _____

(2)

In the 1950s there were two main theories to explain how the Universe began.

Theory 1

The Universe has always existed, it is continually expanding. New galaxies are formed as older galaxies die out.

Theory 2

The Universe began from a very small region that was extremely hot and dense. The Universe has been expanding ever since.

- (d) In what way do the observations made by Hubble support both Theory 1 and Theory 2?

(1)

- (e) Most scientists now believe that Theory 2 is correct.
Suggest what is likely to have caused scientists to start thinking Theory 1 is wrong.

(1)

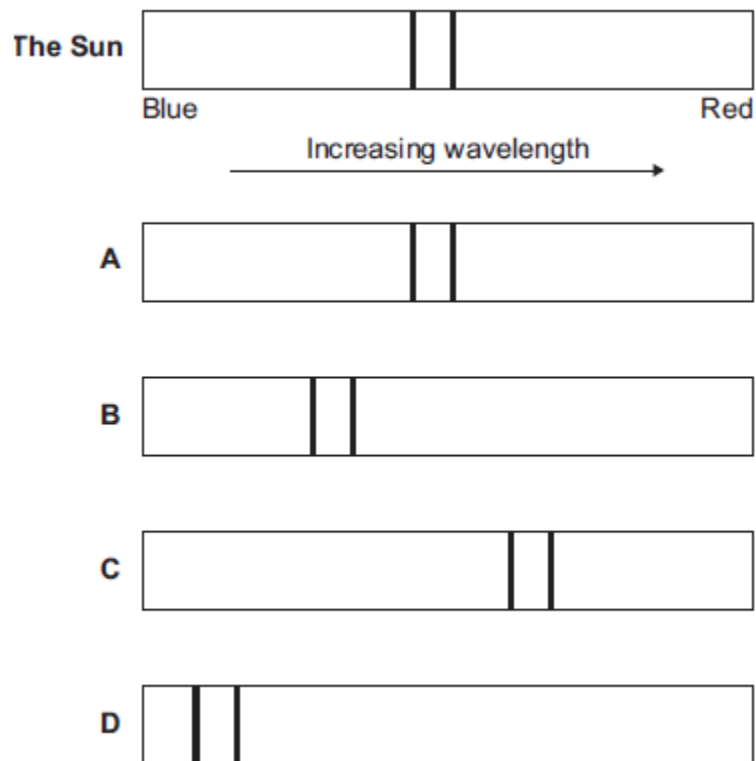
(Total 6 marks)

2.

Scientists can use the visible light spectrum from distant stars to determine whether the stars are moving.

The visible light spectrum from stars includes dark lines at specific wavelengths.

- (a) The diagram shows the visible light spectrum from the Sun and from four other stars, **A**, **B**, **C** and **D**.



- (i) Which star, **A**, **B**, **C** or **D**, is moving away from the Earth?

(1)

(ii) How does the speed of star **B** compare with the speed of star **D**?

Tick (✓) **one** box.

	Tick (✓)
The speed of star B is greater than the speed of star D .	
The speed of star B is less than the speed of star D .	
The speed of star B is the same as the speed of star D .	

(1)

(b) A radio wave is emitted by a star.
The radio wave has a wavelength of 1500 m and a frequency of 200 000 Hz.

Calculate the speed of this radio wave.

Choose the correct unit from the list below.

m m/s m/s²

Speed = _____ unit _____

(3)

(Total 5 marks)

3.

(a) Scientists have observed that the wavelengths of the light from galaxies moving away from the Earth are longer than expected.

(i) What name is given to this observation?

(1)

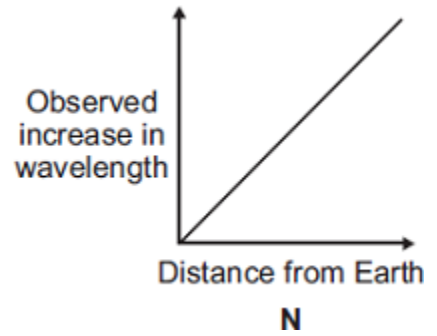
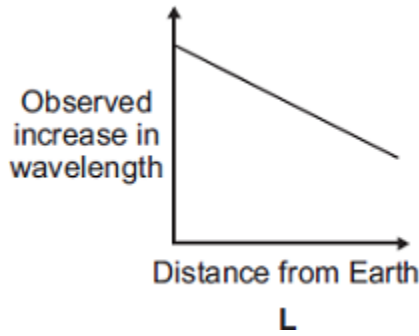
(ii) Draw a ring around the correct answer to complete each sentence.

This observation gives scientists evidence that

light can be stretched.
galaxies are changing colour.
the Universe is expanding.

(1)

- (iii) There is a pattern linking the size of the observed increase in the wavelengths of light from a galaxy and the distance the galaxy is from the Earth.



Which **one** of the graphs, **L**, **M** or **N**, shows the correct pattern?

Write the correct answer in the box.

(1)

- (b) Observations help scientists answer questions about the Universe.

Scientists **cannot** answer every question.

Which **one** of the following questions **cannot** be answered by scientists?

Tick (✓) **one** box.

How old is the Universe?

Why was the Universe created?

How fast does light travel through the Universe?

(1)

(Total 4 marks)

4.

Galaxies emit all types of electromagnetic wave.

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

(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?

(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?

(2)

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

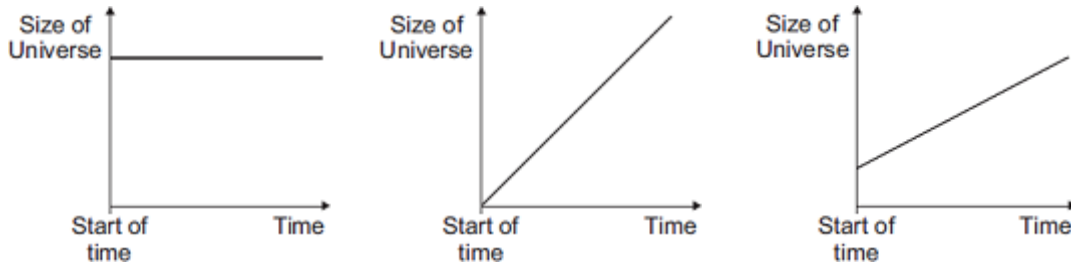
(1)

(Total 9 marks)

5.

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

(a) The graphs **X**, **Y** and **Z**, show how the size of the Universe may have changed with time.



Which graph would the 'big bang' theory suggest is correct?

Write your answer, **X**, **Y** or **Z**, in the box.

Explain the reason for your answer.

(3)

(b) In 1948, an alternative to the 'big bang' theory, called the 'steady state' theory, was developed.
The 'steady state' theory suggested that the Universe, although expanding, has always existed without a beginning in time.

(i) Complete the following sentence by drawing a ring around the correct line in the box.

The measurement of red-shift in the light from distant galaxies provides evidence

to support

only the 'big bang' theory.
only the 'steady state' theory.
both the 'big bang' and 'steady state' theories.

(1)

(ii) In 1965, scientists rejected the 'steady state' theory in favour of the 'big bang' theory.

Suggest what might cause scientists to stop supporting one theory and to start supporting an alternative theory.

(1)

(Total 5 marks)

6.

Light is given out by the Sun and a distant galaxy.

(a) Compared to the light from the Sun, the light from the distant galaxy has moved towards the red end of the spectrum.

(i) What name is given to this effect?

(1)

(ii) Complete the following sentence by drawing a ring around the line in the box that is correct.

The fact that light from a distant galaxy seems to move towards the red end of

the spectrum gives scientists evidence that

galaxies are shrinking
galaxies are changing colour
the universe is expanding

(1)

(b) Scientists have a theory that the universe began from a very small point and then exploded outwards.

(i) What name is given to this theory?

(ii) Which statement gives a reason why scientists think that the universe began with an explosion?

Put a tick (✓) in the box next to your choice.

At the moment it is the best way of explaining our scientific knowledge.

It can be proved using equations.

People felt the explosion.

(1)

(Total 4 marks)

7.

Explain, in as much detail as you can, the scientific evidence for the “big bang” theory of the origin of the Universe.

(Total 5 marks)