



Exampro GCSE Physics

P1 -Big Bang, Red-shift and Doppler Effect
Higher Tier

Name:

Class:

Author:

Date:

Time: 63

Marks: 63

Comments:

Q1. (a) Observation of the spectra from distant galaxies provides evidence to support the 'Big Bang' theory.

(i) Complete the following sentence.

Many scientists think that the 'Big Bang' theory describes the

.....

(1)

(ii) Tick (✓) **one** box to complete the sentence.

The discovery of cosmic microwave background radiation was important because it ...

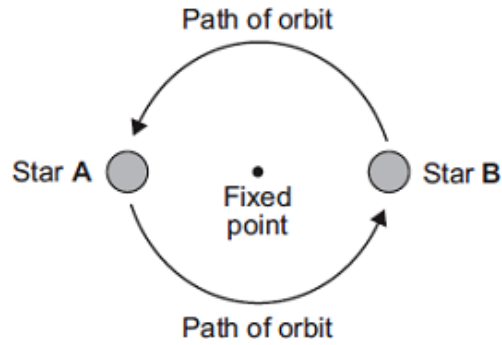
proved the 'Big Bang' theory to be correct.

provided more evidence to support the 'Big Bang' theory.

proved the Universe will continue to expand forever.

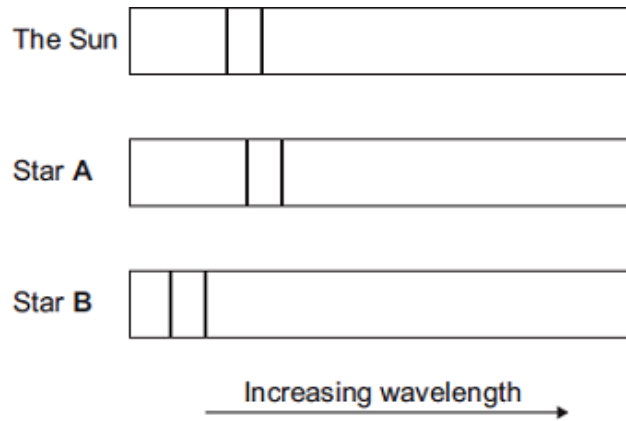
(1)

- (b) Many stars are part of a binary star system. Binary star systems have two stars.



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

The diagram shows the position of two dark lines in the spectrum from the Sun. It also shows the same lines in the spectra from two stars **A** and **B** in a binary star system at the same point in time.



- (i) What name is given to the effect shown in the spectrum from star **A**?

.....

(1)

- (ii) Scientists have concluded that the two stars in a binary star system orbit around a fixed point between the two stars.

A comparison of the spectra from the two stars in a binary star system provides evidence to support this conclusion.

Explain how.

.....
.....
.....
.....
.....
.....
.....
.....
.....

(3)
(Total 6 marks)

Q2. 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.

Use the correct equation from the Physics Equations Sheet.

.....
.....
.....

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)

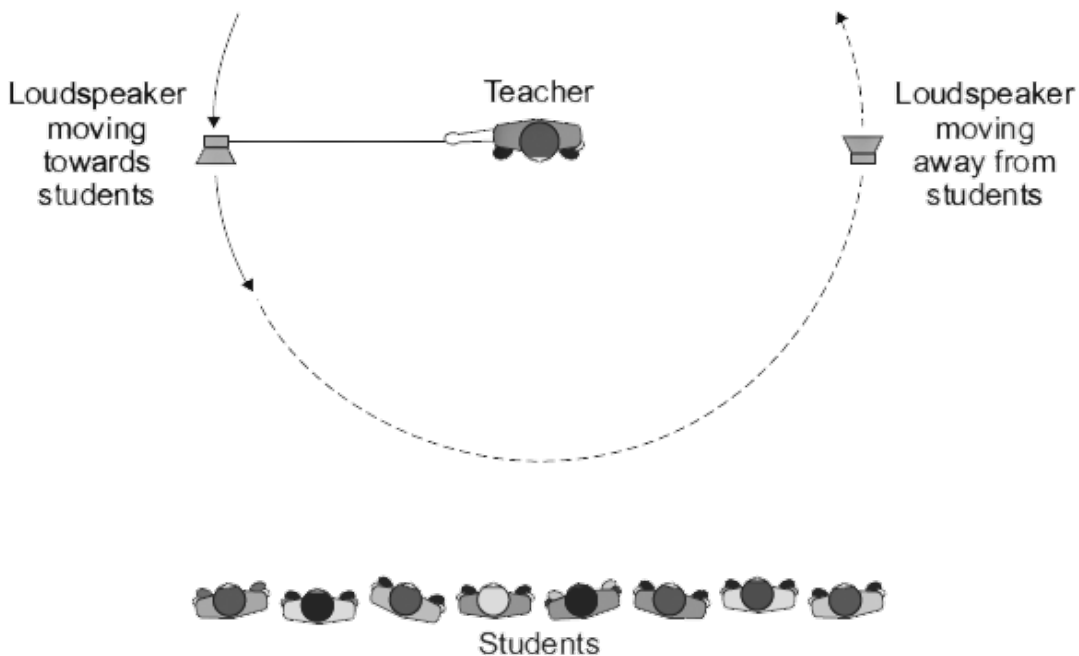
(iii) What does the observation of red-shift suggest is happening to the Universe?

.....

(1)

(Total 9 marks)

Q3. The diagram shows a teacher using a loudspeaker to demonstrate the Doppler effect. The loudspeaker, which produces a note of constant frequency, is swung around in a circle.



(a) What is the Doppler effect?

.....
.....
.....
.....

(2)

(b) This demonstration of the Doppler effect can be used as a model for the *red-shift* observed in the light spectra from distant galaxies.

What is red-shift and what does the size of the red-shift tell us about distant galaxies?

.....
.....
.....
.....
.....
.....
.....
.....

(3)

(Total 5 marks)

Q4. The Big Bang theory attempts to explain the origin of the Universe.

(i) What is the Big Bang theory?

.....
.....

(1)

(ii) What can be predicted from the Big Bang theory about the size of the Universe?

.....

(1)

(Total 2 marks)

Q5. (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?

.....
.....
.....
.....

(2)

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

.....

(1)

(Total 3 marks)

Q6. (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.

.....
.....
.....
.....

(2)

(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?

.....
.....

(1)

(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*?

.....
.....

(1)

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

.....
.....

(1)

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

(i) Describe the 'big bang' theory.

.....
.....
.....
.....

(2)

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

.....
.....
.....

(1)

(Total 8 marks)

Q7. (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?

.....
.....
.....
.....
.....
.....

(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?

.....
.....

(1)

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

.....
.....

(1)

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

.....

Give a reason for your answer.

.....
.....

(2)

(Total 7 marks)

Q8. (a) In 1929, the astronomer Edwin Hubble observed that the light from galaxies that are moving away from the Earth showed a *red-shift*.

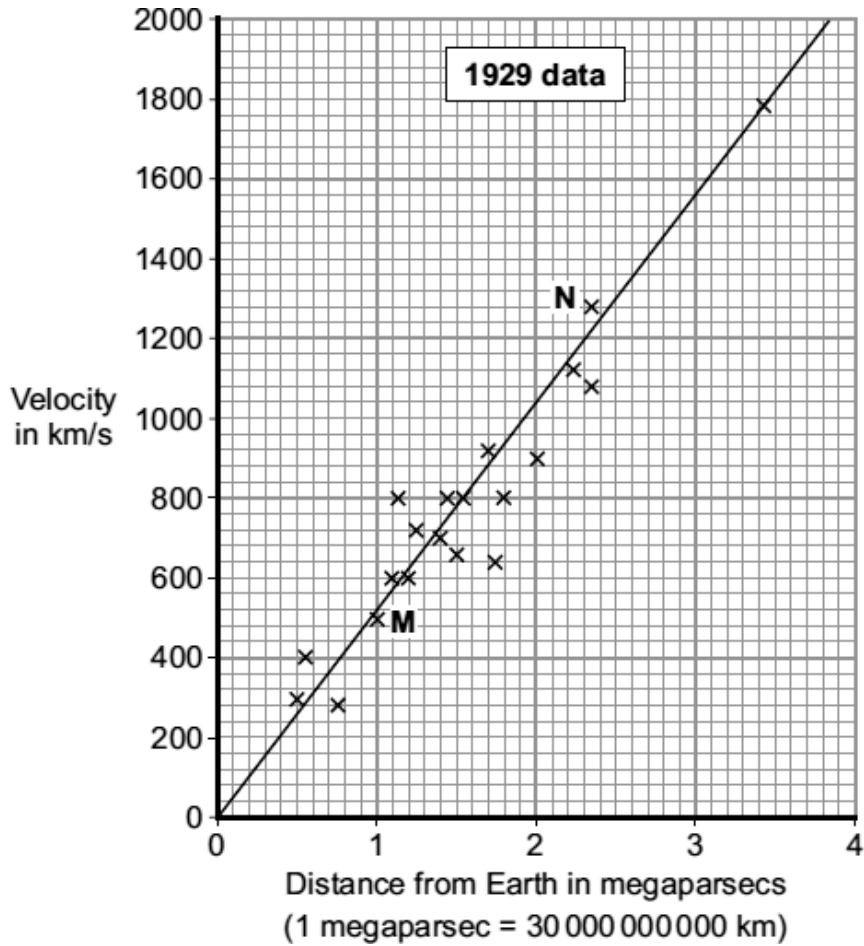
What is *red-shift* ?

.....
.....

(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**?

.....

.....

.....

(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.

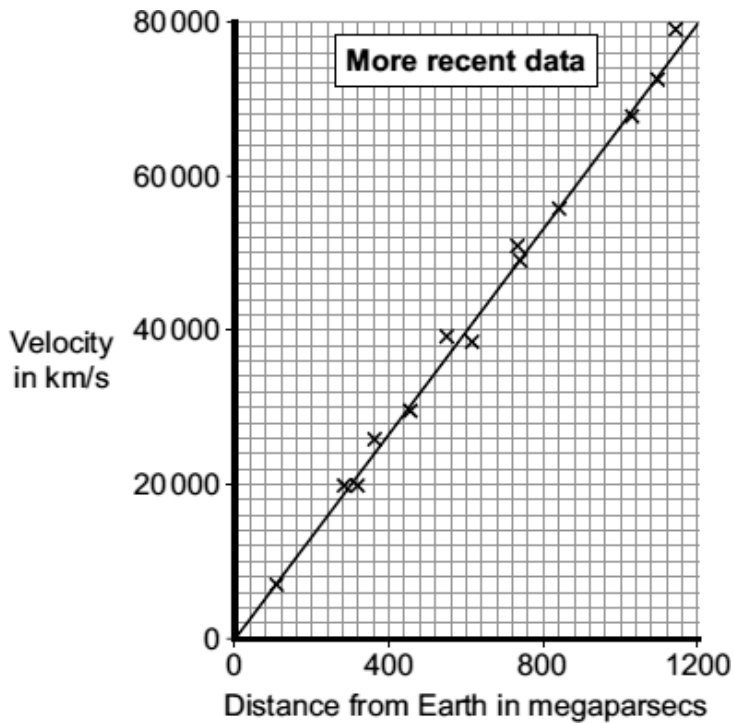
Show clearly how you obtained your answer.

.....

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?

.....
.....
.....
.....

(2)
(Total 8 marks)

Q9. Optical telescopes may be used to observe galaxies. Some optical telescopes are on the Earth and some are on satellites in space.

- (a) How is the image produced by an optical telescope on a satellite in space better than the image produced by an optical telescope on the Earth?

.....

Give a reason for your answer.

.....
.....

(2)

- (b) 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)

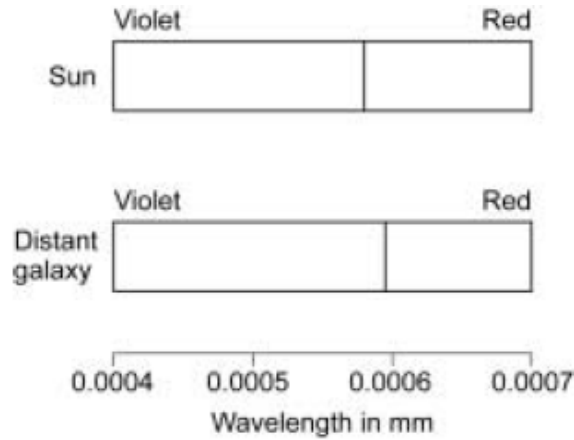
- (ii) Complete the following passage.

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 4 marks)

Q10. 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 initial point.

.....

(3)

(b) Name **one** other piece of evidence that supports the theory that the Universe began from a very small initial point.

.....

(1)

(Total 4 marks)

Q11. The 'Big Bang' theory is one theory of the origin of the Universe.

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

.....

(2)

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

Explain how.

.....
.....
.....
.....

(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?

.....
.....
.....
.....

(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)

- M1.** (a) (i) origin of the Universe
accept (why) the Universe is expanding
*do **not** accept origin of the Earth* 1
- (ii) provided more evidence to support the 'Big Bang' theory 1
- (b) (i) red-shift
accept Doppler (shift) 1
- (ii) (at the point in time shown the observed spectrum from) star A (shows it) is moving away from the Earth
accept star A is moving away
star A shows red-shift is insufficient 1
- light from star B shows a decrease in wavelength
accept light from star B shows blue-shift
accept light from star B shows an increase in frequency 1
- so star B is moving towards Earth 1
- [6]**

- M2.** (a) (i) gamma
accept correct symbol 1
- (ii) any **one** from:
- (ultraviolet has a) higher frequency
ultraviolet cannot be seen is insufficient
 - (ultraviolet has a) greater energy
 - (ultraviolet has a) shorter wavelength
ignore ultraviolet causes cancer etc
- 1
- (b) $1.2 \times 10^7 / 12\,000\,000$
allow 1 mark for correct substitution, ie $3 \times 10^8 = f \times 25$ 2
- hertz / Hz / kHz / MHz
*do **not** accept hz **or** HZ*
*answers 12 000 kHz **or** 12 MHz gain 3 marks*
for full credit the numerical answer and unit must be consistent 1

- (c) (i) away (from each other)
accept away (from the Earth)
accept receding 1
- (ii) distance (from the Earth)
accept how far away (it is) 1
- speed galaxy is moving 1
- (iii) (Universe is) expanding 1
- [9]**

- M3.** (a) change in (observed) wavelength / frequency
accept specific change eg increase
accept pitch for frequency provided the source is sound 1

when source of waves / observer moves (relative to each other)
accept specific example of source
accept specific example of movement
for both marks a specific change in wavelength / frequency must
be linked to a correct specific movement of source / observer 1

- (b) (observed) increase in wavelength of light (from distant galaxies)
accept a correct description eg wavelength(s) of light
(from distant galaxies) moves towards red end of spectrum

or
 (observed) decrease in the frequency of light (from distant galaxies)
(pattern) of (black) lines in (visible) spectrum move towards red
end
galaxy looks red negates this first mark point 1

because the galaxy is moving away from the Earth / us 1

the bigger the red-shift the faster the galaxy is moving
accept bigger the red-shift the further the galaxy is from the Earth 1

[5]

- M4.** (i) an enormous explosion causing matter to spread from one point 1

- (ii) it is increasing **or** expanding 1 [2]
- M5.** (a) longer wavelength waves **or** light moved towards red end of spectrum 1
- (galaxy) moving away from the Earth **or** space is expanding **or** the galaxy and Earth are moving apart
accept us for Earth
*do **not** accept galaxies expanding* 1
- (b) big bang 1 [3]
- M6.** (a) wavelength increases
accept the crests are further apart
ignore waves are further apart 1
- frequency decreases
accept pitch decreases
ignore references to amplitude 1
- (b) stars / galaxies / sources emit all / different types of electromagnetic waves / radiation
accept two or more named electromagnetic waves
accept answers in terms of frequencies / wavelengths 1
- (c) (i) wavelength (of light) increases
accept frequency decreases
or
light moves to red end of spectrum
*accept redder but do **not** accept red alone* 1
- (ii) it is the star (detected) furthest from the Earth
accept galaxy for stars
or
it is moving away the fastest
ignore reference to universe expanding 1

(d) (i) all matter compressed to / starts at / comes from a single point
*do **not** accept increasing gravitational pull*
accept everything / the universe for all matter 1

(massive) explosion sends matter outwards
accept explosion causes universe to expand
*ignore explosion creates the universe **or** further reference to star / Earth formation* 1

(ii) check validity / reliability of the evidence
or
change the theory to match the new evidence
accept comparison of new and old evidence 1

[8]

M7. (a) any **three** from:

- red-shift shows galaxies are moving away (from each other / the Earth)
- more distant galaxies show bigger red-shift

or

more distant galaxies show a greater increase in wavelength
accept correct reference to frequency in place of wavelength

- (in all directions) more distant galaxies are moving away faster
accept (suggests) universe is expanding
- suggests single point of origin (of the universe) 3

(b) (i) (radiation produced shortly after) 'Big Bang'
accept beginning of time / beginning of the universe for 'Big Bang' 1

(ii) any **one** from:

- can only be explained by 'Big Bang'
- existence predicted by 'Big Bang'
- provides (further) evidence for 'Big Bang'
ignore proves 'Big Bang' (theory)
ignore reference to red-shift

1

(iii) increase
accept becomes radio waves 1

universe continues to accelerate outwards
accept as universe continues to expand

or

greater red-shift

1

[7]

M8. (a) wavelength (of light appears to) increase

accept frequency (appears to) decrease

accept light moves to the red end of the spectrum

*do **not** accept it moves to the red end of the spectrum*

*do **not** accept light becomes redder*

1

(b) (i) **M** is closer (to the Earth) than **N**

1

M is moving (away from the Earth) slower than **N**

1

(ii) 520

an answer between 510 and 530 inclusive gains 1 mark

2

(iii) more recent

no mark for this but must be given to gain reason mark

data more reliable

accept data is more accurate

or

improved equipment / techniques

more technology is insufficient

or

data obtained from more (distant) galaxies

accept a wider range of data

accept data closer to the line of best fit

***or** data less scattered*

accept no anomalous result(s)

accept all data fits the pattern

1

(c) wavelength is decreased

1

frequency is increased

1

[8]

- M9.** (a) clearer / more detailed / sharper / less distorted image
image is better is insufficient 1
ignore image is bigger
- any **one** from:
- no light pollution
accept no clouds to prevent observations
 - light is not scattered by the atmosphere
accept air for atmosphere
accept (image) not distorted by the atmosphere
accept (light) does not have to pass through the atmosphere
*do **not** accept in terms of distance* 1
- (b) (i) bigger the red-shift, further the galaxy is from the Earth
accept red-shift and distance are directly proportional
accept there is a positive correlation 1
- (ii) origin / start / beginning / creation
accept expansion 1
- [4]
- M10.** (a) the observed wavelength of the dark line from the distant galaxy has increased 1
- therefore the distant galaxy must be moving away from the Earth 1
- suggesting the Universe is expanding outwards from a small initial point 1
- (b) existence of cosmic microwave background radiation
accept existence of CMBR 1
- [4]
- M11.** (a) (i) Universe began at a (very) small (initial) point
'it' refers to Universe 1

'explosion' sent matter outwards

or

'explosion' causing Universe to expand

accept gas / dust for matter

accept rapid expansion for explosion

1

(ii) light shows a red shift

owtte

the term red shift on its own does not score a mark

1

galaxies moving away (from the Earth)

'it' refers to light

'they' refers to galaxies

accept star for galaxy

*do **not** accept planet for galaxy*

1

(b) check reliability / validity of data

accept check data

accept collect more data

1

amend theory

or

discount the data

accept replace old theory with new theory

1

(c) answer involves (religious) belief

or

no / insufficient evidence

accept it cannot be tested

1

[7]

