Name:

Date:

P8 - Test 6
SPACE PHYSICS
Advanced

GCSE

PHYSICS

AQA - Triple Science

Mark

Grade

Materials

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1. (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 ...

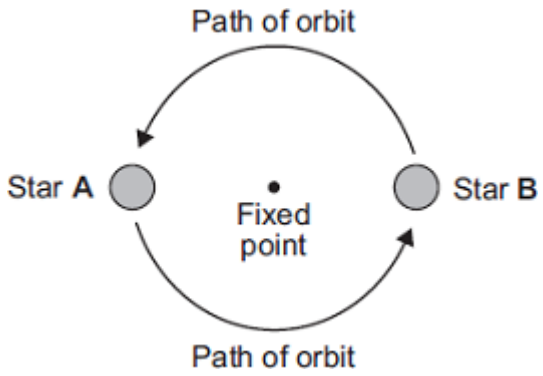
proved the 'Big Bang' theory to be correct. ☐

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

proved the Universe will continue to expand forever. ☐

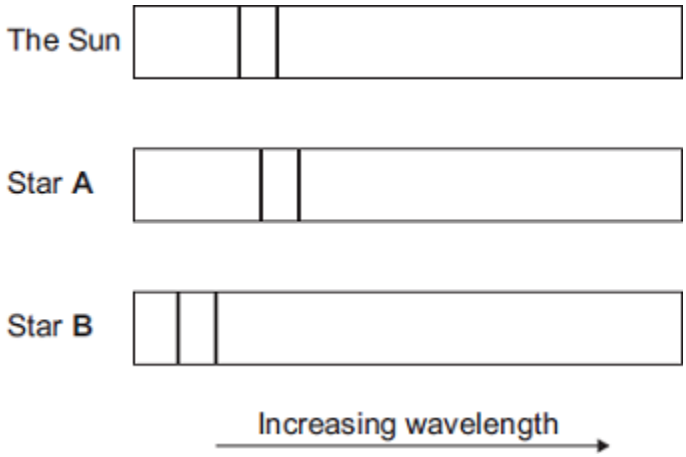
(1)

(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)

2. 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)

3. (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)

4. (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* ?

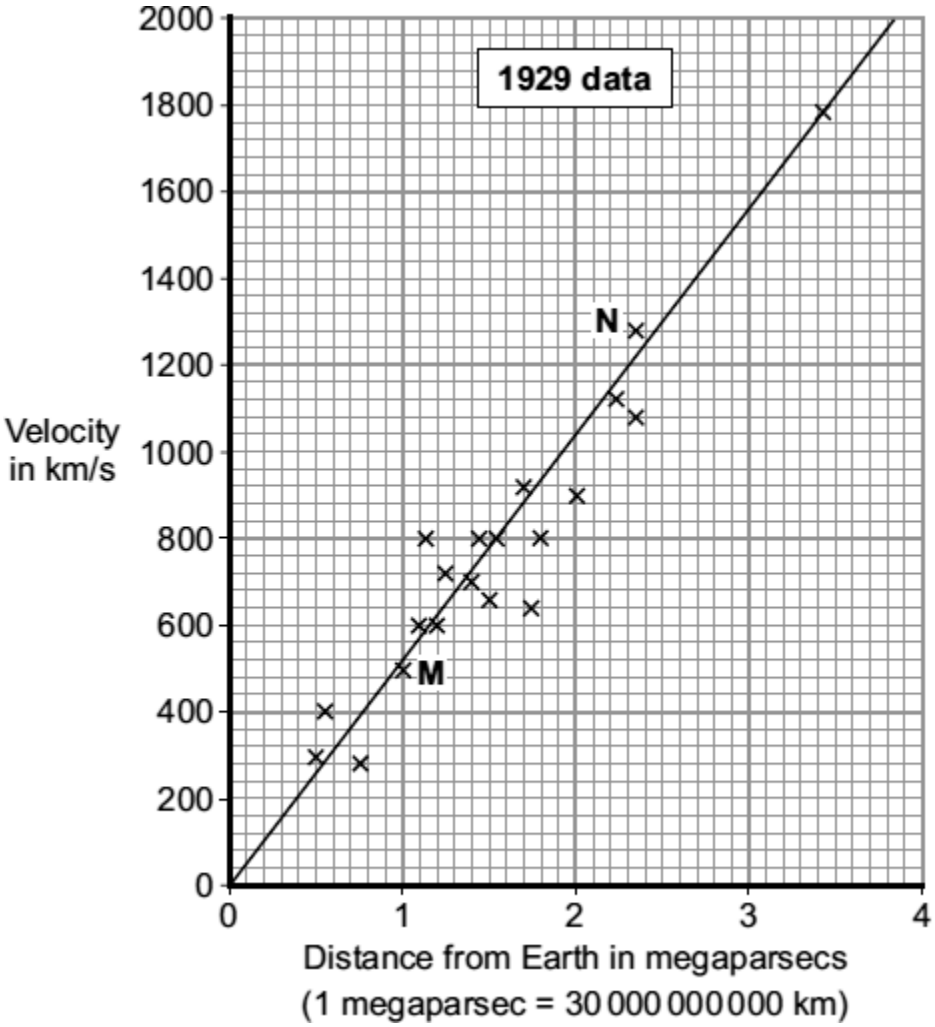
_____

_____

(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.

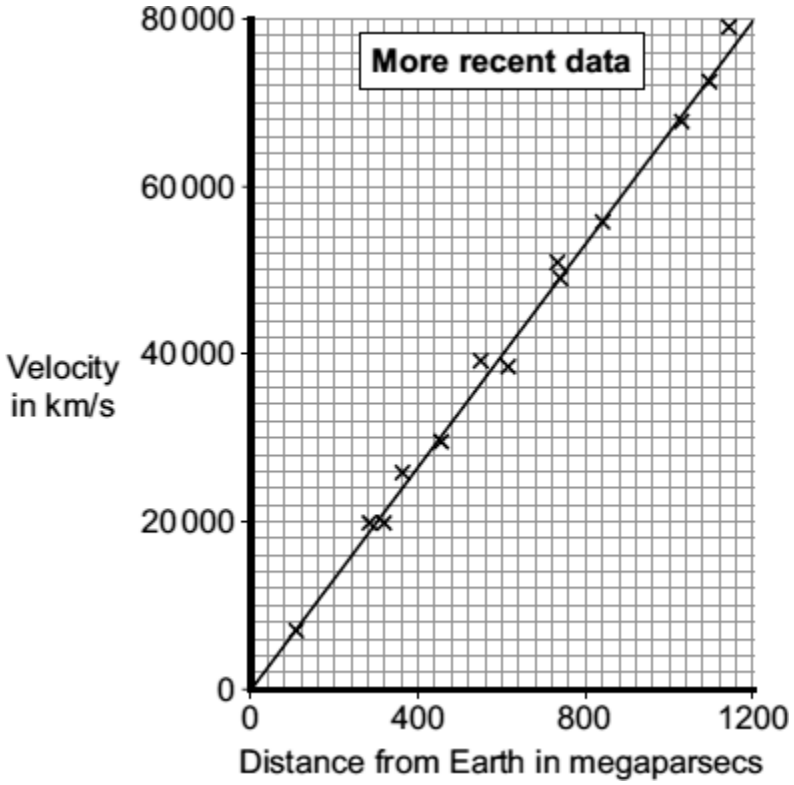
_____

_____

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)

5. (a) Explain how stars produce energy.

_____

_____

_____

_____

(2)

(b) What evidence is there to suggest that the Sun was formed from the material produced when an earlier star exploded?

_____

_____

(1)

(c) It is thought that gases from the massive star Cygnus X-1 are spiralling into a black hole.

(i) Explain what is meant by the term *black hole*.

_____

_____

(2)

(ii) What is produced as the gases from a star spiral into a black hole?

_____

(1)

(Total 6 marks)

6. (a) Most of the Sun is hydrogen. Inside the core of the sun, hydrogen is being converted to helium. What name is given to this process and why is the process so important?

_____

_____

_____

(2)

(b) Describe what will happen to the Sun as the core runs out of hydrogen.

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

7. (a) The Sun is at the stable stage of its life.

Explain, in terms of the forces acting on the Sun, what this means.

_____

_____

_____

_____

_____

_____

(3)

(b) At the end of the stable stage of its life a star will change.

Describe and explain the changes that could take place.

(6)

(Total 9 marks)

8. The energy radiated by a **main sequence** star like the Sun is released by a nuclear fusion reaction in its core.

Read the following information about this reaction then use it to answer the questions below.

- The net result of the nuclear fusion reaction is that four hydrogen nuclei produce one helium nucleus. There is a loss of mass of 0.7%.
- For nuclear fusion to occur nuclei must collide at very high speeds.
- The energy released during the reaction can be calculated as shown:

energy released [J] = loss of mass [kg] × (speed of light [m/s^2])

(The speed of light is 3×10^8 m/s)

(a) Calculate the energy released when 1g of hydrogen fuses to form helium.

(*Show your working*.)

(4)

(b) The table shows the lifetimes and surface temperatures of main sequence stars with different masses.

MASS OF STAR [SUN = 1]	LIFETIME ON MAIN SEQUENCE [MILLION OF YEARS]	SURFACE TEMPERATURE * [KELVIN]
0.5	200 000	4000
1	10 000	6000
3	500	11 000
15	15	30 000

[* The higher the surface temperature of a star, the higher the temperature and pressure in its core.]

(i) Describe the relationship between the lifetime of a main sequence star and its mass.

_____

_____

_____

(2)

(ii) Suggest an explanation for this relationship.

_____

_____

_____

_____

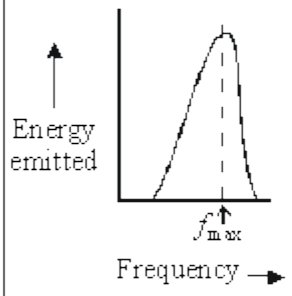
_____

(3)

(Total 9 marks)

9. Read the following information about cosmic microwave background radiation.

Then use it to answer the questions below.

A Microwave "noise" reaches Earth with almost the same intensity from every direction. It is called cosmic microwave background radiation.	**B** All bodies with a temperature above zero kelvin (–273°C) emit electromagnetic radiation.	**C** Measurements made by the COBE satellite showed that there are very slight "ripples" in the cosmic microwave background radiation.
D Bodies which emit radiation do so across a range of frequencies, as shown on the graph.  	**E** Radiation in the microwave region of the electromagnetic spectrum reaches Earth from many stars and galaxies.	**F** In 1965, the astronomers Penzias and Wilson stopped trying to eliminate "noise" from their microwave detectors and studied it instead.
G The frequency at which a body radiates most energy (f_{max}) is directly proportional to the kelvin temperature.	**H** Cosmic microwave background radiation has an energy profile matching a temperature of 3 kelvin (–270°C).	**I** Because of the expansion of the Universe, the temperature of radiation from the time of the big bang will now be only a few kelvin.
J The early universe could not have been completely uniform otherwise galaxies would never have formed.		

(You may find it helpful to begin by deciding which items of information belong to which question.)

(a) Explain, as fully as you can, why the frequency profile of electromagnetic radiation is an indication of temperature.

(3)

(b) Describe, in as much detail as you can, what cosmic microwave background radiation is and how it was discovered.

(3)

(c) Explain, as fully as you can, how cosmic microwave background radiation fits in with the idea that the Universe, as it now is, began with a big bang.

(4)

(d) Some people think that Penzias and Wilson's discovery of cosmic microwave background radiation was just lucky. Others disagree.

What do you think? Give reasons for your answer.

_____

_____

_____

_____

(2)

(Total 12 marks)