



**Space 2**  
33 Questions

Name: \_\_\_\_\_

Class: \_\_\_\_\_

Date: \_\_\_\_\_

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Time:

Marks:

Comments:

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**Q1.**

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?

\_\_\_\_\_

(1)

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

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(3)

(Total 4 marks)

**Q2.**

(a) Complete the **two** spaces in the sentence.

Stars form when enough \_\_\_\_\_ and gas from \_\_\_\_\_ are pulled together by gravitational attraction.

(2)

(b) How are stars able to give out energy for millions of years?

Put a tick (✓) next to the answer.

By atoms joining together

By atoms splitting apart

By burning gases

(1)

- (c) There are many billions of stars in our galaxy. Our Sun is one of these stars. What is the name of our galaxy?

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(1)

(d)

**Why was the Universe created?**

We cannot expect scientists to answer this question. What is the reason for this?

Put a tick (✓) next to the reason.

It will take too long to collect the scientific evidence.

The answer depends on beliefs and opinions, not scientific evidence.

There is not enough scientific evidence.

(1)

**(Total 5 marks)**

**Q3.**

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?

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(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?

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(1)

- (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.

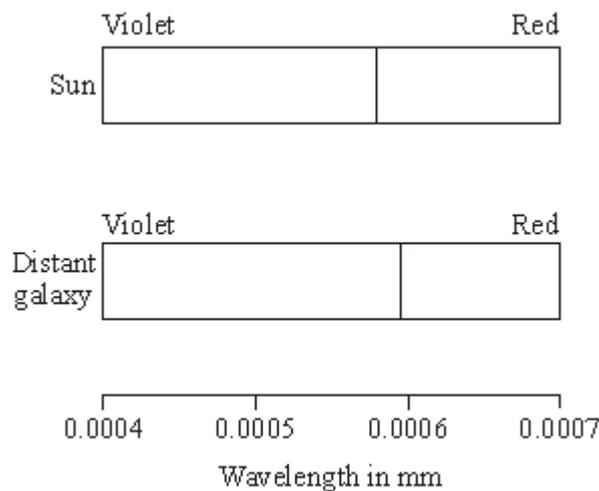
People felt the explosion.

(1)

(Total 4 marks)

**Q4.**

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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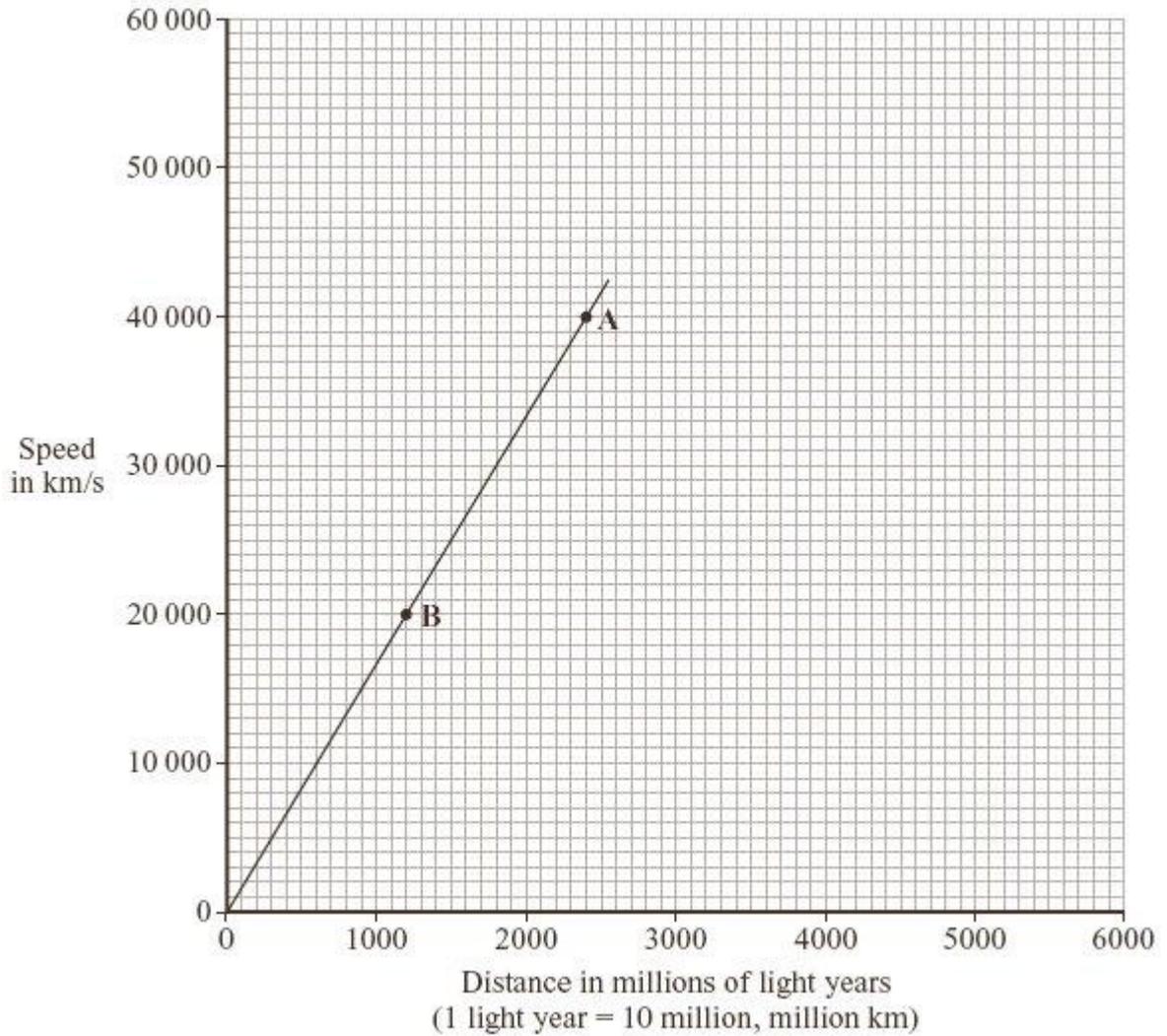
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(3)

- (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**?

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(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.

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

(2)

(Total 6 marks)

### Q5.

- (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?

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(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)

**Q6.**

(a) Explain how stars produce energy.

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(2)

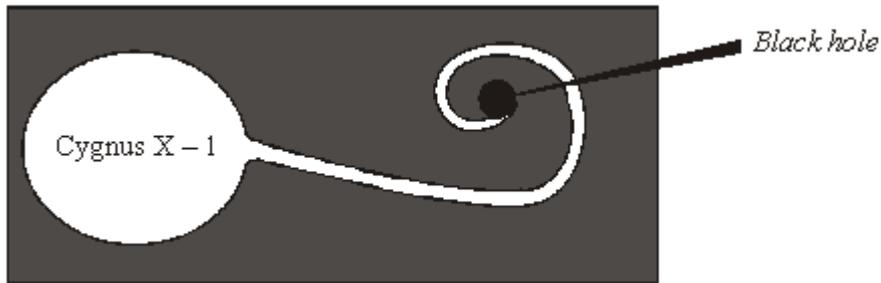
- (b) What evidence is there to suggest that the Sun was formed from the material produced when an earlier star exploded?

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(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*.

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(2)

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

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(1)

**(Total 6 marks)**

**Q7.**

- (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)

**Q8.**

Complete the following sentences by choosing the correct words from the box. Each word may be used once or not at all.

<b>dwarf</b>	<b>giant</b>	<b>neutron</b>	<b>proton</b>	<b>supernova</b>
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If a red \_\_\_\_\_ star is large enough, it may eventually blow up in an explosion called a \_\_\_\_\_, leaving behind a very dense \_\_\_\_\_ star.

(Total 3 marks)

**Q9.**

Stars do not stay the same forever.

(a) Over billions of years the amount of hydrogen in a star decreases. Why?

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(1)

(b) Describe how a massive star (at least five times bigger than the Sun) will change at the end of the main stable period.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(4)

(c) The inner planets of the solar system contain atoms of the heaviest elements.

(i) Where did these atoms come from?

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(1)

- (ii) What does this tell us about the age of the solar system compared with many of the stars in the Universe?

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(1)

(Total 7 marks)

**Q10.**

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

- (i) What is the Big Bang theory?

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(1)

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

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(1)

(Total 2 marks)

**Q11.**

- (i) Explain how stars like the Sun were formed.

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(2)

- (ii) The Sun is made mostly of hydrogen. Eventually the hydrogen will be used up and the Sun will “die”.

Describe what will happen to the Sun from the time the hydrogen is used up until the Sun “dies”.

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(3)

(Total 5 marks)

**Q12.**

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

(i) What is the Universe?

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(1)

(i) What are the main ideas of the Big Bang theory?

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(2)

(iii) What is thought to be happening to the size of the Universe?

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(1)

**(Total 4 marks)**

**Q13.**

(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?

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(2)

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

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(3)

**(Total 5 marks)**

**Q14.**

Stars are formed from massive clouds of dust and gases in space.

(a) What force pulls the clouds of dust and gas together to form stars?

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(1)

- (b) Once formed a star can have a stable life for billions of years. Describe the **two** main forces at work in the star during this period of stability.

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(2)

- (c) What happens to this star once this stable period is over?

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(4)

- (d) Suggest what might then happen to a planet close to this star.

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(1)  
(Total 8 marks)

**Q15.**

Explain how observations at the red end of the spectrum of light from galaxies have led to one theory about the origin of the Universe.

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(Total 6 marks)

**Q16.**

Describe briefly how stars such as the Sun are formed.

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(Total 2 marks)

**Q17.**

Nuclear fusion in the Sun releases large amounts of energy.

- (i) Explain what is meant by nuclear fusion.

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(3)

- (ii) Why is energy released by such nuclear fusion reactions?

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(2)

(Total 5 marks)

**Q18.**

Astronomers believe that the Universe is expanding.

- (i) How might the Universe have started?

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(1)

- (ii) State and explain briefly, **one** piece of scientific evidence which may be used to support this belief.

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(2)

(Total 3 marks)

**Q19.**

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

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

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(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.

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(6)

(Total 9 marks)

**Q20.**

Our Sun is just one of many millions of stars in a galaxy called the Milky Way.

Our Sun is in the main stable period of a star's lifetime. The massive force of gravity draws its matter together. This force is balanced by the very high temperatures, from the fusion of hydrogen atoms, which tend to make the Sun expand. Describe and explain what will happen to the Sun as the hydrogen is eventually used up.

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(Total 3 marks)

**Q21.**

Studies of light from distant galaxies have provided evidence for the theory that the Universe started from one place and is expanding. Explain how.

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**(Total 3 marks)**

**Q22.**

Studying stars gives scientists evidence about the evolution of the Universe.

(a) (i) In astronomy, what is meant by a black hole?

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**(2)**

(ii) How is it possible to detect a black hole?

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**(2)**

(b) The changes which happen in stars result in new elements being formed.

Nuclei of the heaviest elements are found in the Sun.

Describe how these nuclei are formed.

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**(2)**

**(Total 6 marks)**

**Q23.**



(2)

- (b) *To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Explain how red shift provides evidence for the big bang theory.

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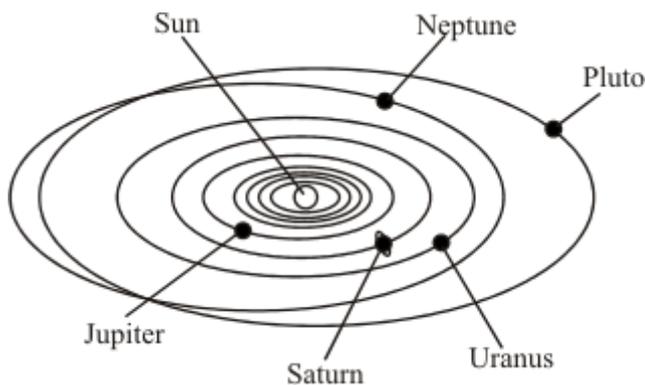
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(3)

(Total 5 marks)

**Q25.**

The Sun at the centre of our solar system is a star.



- (a) The Sun contains nuclei of the heaviest elements. Atoms of these heaviest elements are also present in the planets of the solar system. What does this suggest about the material from which the solar system is formed?

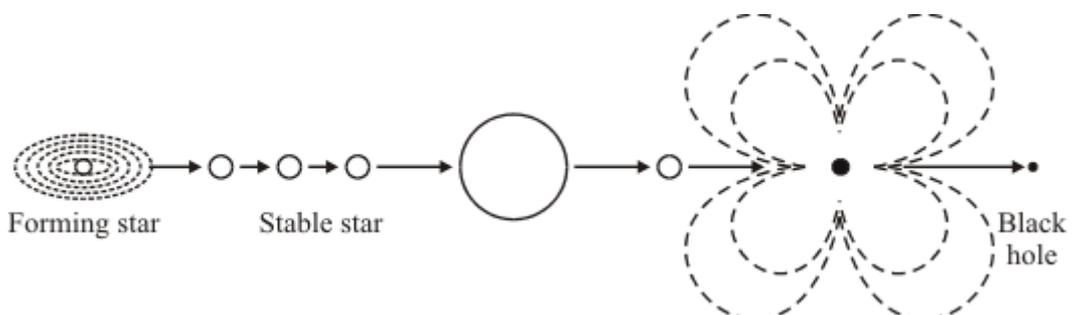
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(1)

- (b) Stars form from gas (mostly hydrogen) and dust.





Abell 1314	4 100	320	12.8
Abell 1978	18 000	1400	12.9
Abell 2255	10 000	770	13.0

(a) Complete the data for Abell 1302.

(1)

(b) Describe the relationship between the distance to a galaxy and the speed at which the galaxy is moving away from us.

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(1)

(c) Explain how the data for time provides evidence for the theory that the origin of the Universe was a huge explosion ('big bang').

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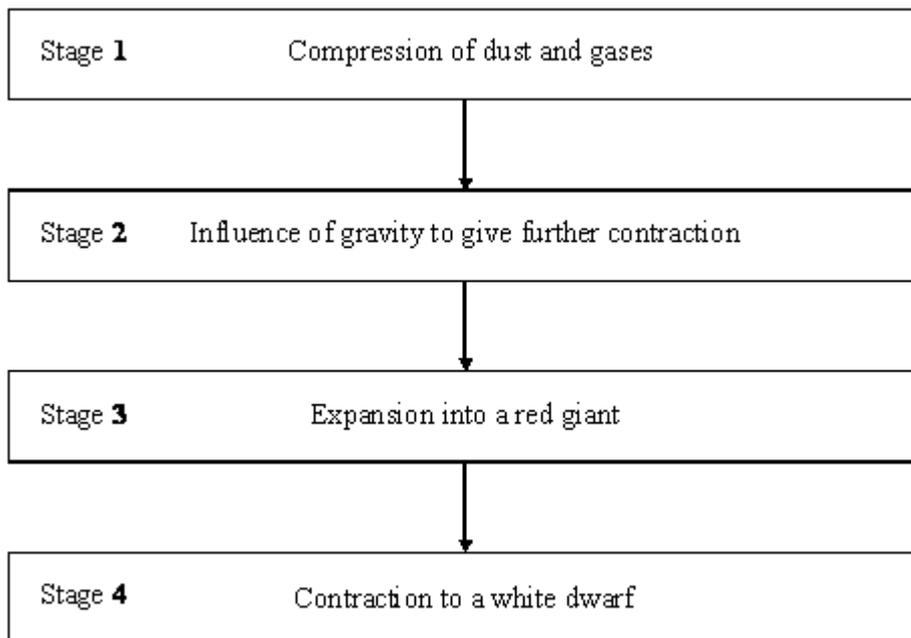
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(2)

(Total 4 marks)

**Q27.**

The flowchart shows four stages thought to occur in the evolution of a star such as our Sun.



At a particular time a star might have reached one of these stages or be between stages or be at a further stage. What period in its evolution has our star, the Sun, reached?

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(Total 1 mark)

**Q28.**

What does the Big Bang theory state? In your answer you may include evidence for the theory.

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(Total 4 marks)

**Q29.**

At the very high temperatures in the sun, hydrogen is converted into helium. It takes four hydrogen nuclei to produce one helium nucleus.

The table shows the relative masses of hydrogen and helium nuclei.

			
Hydrogen nucleus	Helium nucleus		

Nucleus	Relative Mass
hydrogen	1.007825
helium	4.0037

- (a) Use these figures to calculate what happens to the mass of the sun as hydrogen is converted to helium.

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(3)

- (b) Use your answer to part (a) to explain how the sun has been able to radiate huge amounts of energy for billions of years.

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**Q30.**

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:

$$\text{energy released [J]} = \text{loss of mass [kg]} \quad \times \quad (\text{speed of light [m/s}^2\text{)})$$

(The speed of light is  $3 \times 10^8$  m/s)

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

(Show your working.)

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(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.

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(2)

(ii) Suggest an explanation for this relationship.

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(3)

(Total 9 marks)

**Q31.**

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

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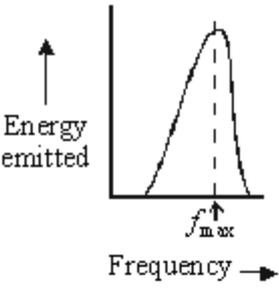
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(Total 5 marks)

**Q32.**

Read the following information about cosmic microwave background radiation.

Then use it to answer the questions below.

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

(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.

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(3)

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

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(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.

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(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.

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(2)

(Total 12 marks)

**Q33.**

Describe, in as much detail as you can, the life history of a star like our Sun.

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**(Total 6 marks)**

## Mark schemes

### Q1.

- (a) (a) supernova (explosion) 1
- (b) solar system contains heavy elements / elements heavier than hydrogen and helium (1)
- these (heavy) elements are / were formed by (nuclear) fusion (1)
- accept minor misspellings for 'fusion'*  
*but **not** anything which could also be 'fission'*
- (at the very high temperature(s)) in a super nova / when stars explode (1) 3

[4]

### Q2.

- (a) dust 1
- accept 'solid (s)'*
- space 1
- accept 'from supernova / supernovum / supernovas'*
- (b) By atoms joining together 1
- only one ticked or otherwise unambiguously identified*
- (c) Milky Way (galaxy) 1
- (d) The answer depends on beliefs and opinions, not scientific evidence. 1
- only one ticked or otherwise unambiguously identified*

[5]

### Q3.

- (a) (i) red shift 1
- accept Doppler effect*
- (ii) the universe is expanding 1
- (b) (i) big bang 1
- (ii) at the moment it is the best way of explaining..... 1

[4]

### Q4.

- (a) line shifts towards red end of spectrum  
*do **not** accept reference to 'red light'*  
*do **not** accept 'red shift' as a stand alone response* 1
- wavelength (appears) to increase 1
- galaxy is moving away (from the Earth)  
*do **not** accept universe expanding*
- or** galaxy moving away from initial point  
*do **not** accept planet on its own* 1
- (b) (i) light from A has a greater red shift  
*accept light from A is more red*  
*do **not** accept reference to blue light* 1
- (ii) 3600 (million light years)  
*allow 1 mark for showing that the line could be extended*  
**or**  
*allow 1 mark for the correct use of a point on the line* 2

[6]

**Q5.**

- (a) 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
- (b) (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
- (c) (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

[6]

### Q6.

(a) any **two** from:

- nuclei / atoms of light elements fuse  
*accept hydrogen or helium for light elements*  
*accept join for fuse*  
*accept for 1 mark, by nuclear fusion*  
*answers about fission negates a mark*
- each (fusion) reaction releases energy / heat / light
- lots of reactions occur

2

(b) presence of nuclei of the heaviest / heavy / heavier elements  
*accept atom for nuclei*

1

(c) (i) (matter / mass) with such a high density / strong gravitational (field)

1

electromagnetic radiation / light is pulled in  
*accept nothing can escape*  
*do **not** accept answers in terms of an empty void*

1

- (ii) X-rays  
*accept e-m radiation / e-m waves*

1

[6]

### Q7.

(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]

**Q8.**

- giant 1
- supernova 1
- neutron 1

[3]

**Q9.**

- (a) converted into helium  
*accept helium created*  
*accept converted into heavier elements*  
*accept used up in nuclear fusion / to produce energy*  
*do **not** accept any reference to burning* 1
- (b) turns / expands into a red giant  
*contradictions negate mark* 1
- contracts **and** explodes **or** becomes a supernova 1
- may form a (dense) neutron star **or** (if enough mass shrinks to) form a black hole  
*accept forms a neutron star and (then) a black hole* 1

**Quality of written communication**

*correct points must be in sequence* 1

- (c) (i) supernova **or** remains of an earlier star  
*ignore super nebula* 1
- (ii) younger **or** not formed at the time of the Big Bang 1

[7]

**Q10.**

- (i) an enormous explosion causing matter to spread from one point 1
- (ii) it is increasing **or** expanding 1

[2]

**Q11.**

- (i) from a (giant) cloud of gas or hydrogen 1
- condensed **or** pulled into a smaller volume by gravity 1

- (ii) any three from:
- fusion decreases or stops
  - collapses rapidly causing the (core) temperature to rise
  - (inward) gravitational forces no longer balance (outward) pressure
  - expands
  - and becomes a red giant
  - it cools
  - then becomes a white dwarf
  - helium may fuse
- if the sequence is incorrect deduct [1] therefore maximum 2 marks*

3

[5]

**Q12.**

- (i) an innumerable collection of galaxies  
*accept any word meaning a large number for innumerable*  
*accept all the galaxies*  
*do **not** accept everything*
- (ii) all matter concentrated at a (single) point  
*accept all matter part of a single 'superatom'*
- single (massive) explosion (sending matter outwards)
- (iii) increasing or expanding

1

1

1

1

[4]

**Q13.**

- (a) fusion  
*accept fussion*
- energy producing process  
*accept heat and/or light for energy*  
*accept fussion*
- (b) up to 2 points from:  
*3 marks for 3 points in sequence with no contradiction*
- expands

1

1

*2 marks for 2 points in sequence with no contradiction*

- cools
- forms a red giant

*1 mark for a correct point which is not contradicted*

up to **2** points from:

*do **not** accept 'it turns red'*

- contracts
- increases in temperature
- forms a white dwarf

*ignore further reference to black dwarfs, black holes, nebulae, supernovae*

3

[5]

**Q14.**

- (a) gravitational attraction  
*for 1 mark*

1

- (b) gravitational (in);  
high internal temperature generates force (out)  
*for 1 mark each*

2

- (c) star expands;  
to form red giant;  
then contracts/collapses;  
to form white dwarf/neutron star/black hole/pulsar;  
they may explode/become supernova  
*any four for 1 mark each*

4

- (d) engulfed by red giant/blown up by star/hit by debris from star; sucked into black hole  
*for 1 mark*

1

[8]

**Q15.**

light from (distant) galaxies shows shift to red end of spectrum  
wavelength increased explained by galaxies moving away from us  
more distant galaxies have greater recession speed seen in all directions  
suggests universe is **expanding** any sensible reference to similar effect on Earth  
*any 6 for 1 mark each*

[6]

**Q16.**

formed from dust or gas (unless in atmosphere) which is pulled together by  
gravitational forces high temperature inside

**Q17.**

- (i) the nuclei  
of hydrogen/smaller atoms  
join to make helium/larger atoms  
*for 1 mark each*

3

- (ii) the mass of the large nucleus (atom) is less than the mass of the smaller nuclei (atoms)  
*for 1 mark*

mass loss converted into energy or small mass loss given a large amount of energy  
*for 1 mark*

2

[5]

**Q18.**

- (i) the Universe might have started with  
an explosion/"Big Bang"

1

- (ii) light from galaxies is shifted to red end of spectrum  
the further away the greater the red shift all galaxies receding furthest fastest  
microwave background echo of big bang  
*for 1 mark each*

2

[3]

**Q19.**

- (a) the Sun is subject to two balancing forces / 2 forces in equilibrium  
the forces are: gravity making it contract **or** inward force due to gravity  
and a force due to temperature / heat / energy / radiation pressure making it  
expand **or** outward force due to temperature / heat / energy / radiation pressure  
*for 1 mark each*

3

- (b) Read all the answer first. Stop after 6 marks.

hydrogen / fuel used up owtte the star will expand and become a red giant  
it will contract under gravity become a white dwarf  
it may explode and become a supernova throwing dust and gas into space  
leaving a dense neutron star / black hole

*(no mark for contradiction)*  
*any six for 1 mark each*

6

[9]

**Q20.**

any **three** from

*max 2 if stages but no explanation*

- the star (Sun) expands because

(inward) gravitational forces no longer balance (outward) force  
*accept the star collapses rapidly causing the core temperature to increase and the star to expand*  
*accept it expands because the forces are unbalanced*

- to become a red giant
- when the fusion stops it contracts / cools  
*accept (when hydrogen is used up) it collapses under gravity*  
*accept when fusion stops it contracts and explodes*
- to become a white dwarf  
*accept to become a supernova / pulsar / neutron star / black hole (only if red giant has exploded)*

[3]

**Q21.**

light from distant galaxies red shifted

*accept longer wavelength for red shifted*

1

further galaxies display greater red shift

1

the further away galaxies are the faster they are moving away from us (our galaxy)

1

[3]

**Q22.**

(a) (i) any **two** from

(matter from) exploded star / supernova

matter so dense / gravity so strong

that electromagnetic radiation / light cannot escape from it

2

(ii) X-rays emitted

1

when gases or matter released from nearby stars spiral into it

1

(b) fusion (of nuclei)

1

of lighter elements / hydrogen helium

1

[6]

**Q23.**

Quality of written communication: One mark for using correct scientific sequence :  
gravity → fusion → balance

1

any **four** from

- (dust and gas) pulled together by gravity
- (star formed when) it is hot enough  
*accept (as mass is pulled together) it gets very hot*
- hydrogen (and helium) nuclei fuse
- (these nuclear fusion reactions) release the energy / heat / light (which is radiated by stars)
- energy causes expansion
- gravitational pull is balanced by the expansion (force)

4

[5]

**Q24.**

(a) any **two** from

- Universe started in one place
- (huge) explosion
- Universe is expanding  
*do not accept big bang*

2

(b) Quality of written communication:  
Links needed between :  
galaxies, red shift, and distance / expansion

1

any **two** from

- light from (galaxies) shifted towards red end of spectrum
- the further away the galaxy, the greater the red shift
- this shows that galaxies are moving away from us
- this suggests that Universe is expanding  
*do not accept light from planets*

2

[5]

**Q25.**

(a) materials produced when earlier stars exploded

*accept the Sun is a second generation star  
accept formed from nebulae*

1

(b) **Quality of written communication:**  
1 mark for correct sequencing balanced forces → expansion → contraction / explosion

1

any **five** from

gravity pulling matter together

*accept idea that a star is very massive so its force of gravity is very strong*

high temperatures that create expansion forces

*nuclear fusion releases energy that causes the very high temperatures*

these forces balance

star expands greatly

since expansion is greater than gravity

*accept fuel runs out*

forms a red giant

*give no further marks if red giant → white dwarf, red dwarf etc*

collapses inwards and explodes outwards

called a supernova

neutron star may form

leaves a small, dense object (a black hole)

*accept nothing can escape from it*

5

[7]

**Q26.**

(a) 12.7

1

(b) the further away, the faster it is moving away

1

(c) all galaxies have been moving away from us for approximately the same length of time

1

therefore they were all probably produced at the same time

1

[4]

**Q27.**

any **one** of

\* between (stage) 2 and (stage) 3

\* (in) the main sequence

\* (in) the main stable period

\* (it is a) yellow dwarf

[1]

**Q28.**

any **four** related points

- \* the Universe (as we know it) started (about) 14 000/15 000 million years ago or (about) 15 billion years ago or between (about) 10 to 20 billion years ago
- \* from one point **or** from a singularity

**or** at the beginning of time

- \* in an enormous outpouring of matter (and energy)
- \* (and) has been expanding ever since
- \* (evidence is that) the galaxies are all moving away from one another
- \* (evidence is that) the more distant a galaxy is the faster it is moving away (from all the other galaxies)
- \* evidence is microwave background

**or** cosmic background radiation

- \* ... relic of an earlier **or** hot phase resulting from (shortly) after the start **or** Big Bang
- \* evidence is red shift
- \* ... of light **or** radiation from (distant) stars **or** galaxies **or** quasars **or** due to Doppler (-Fizeau) effect

*accept bya for billion years ago **or**  
mya for million years ago*

*do not credit vague responses such as it all started with a big explosion*

[4]

**Q29.**

- (a) *evidence of conclusion*  $4 \times 1.007825$  **or** 4.0313  
*each gain 1 mark*

*based on use of data that there is a (very small) loss of mass  
**or** 0.0276 **but** a loss of mass of 0.0276 **for every helium atom or** 0.69%/0.7%  
gains 3 marks*

3

- (b) *idea that* loss of mass results in release of energy  
*gains 1 mark*

**but** small loss of mass results in huge energy release  
*gains 2 marks*

2

[5]

**Q30.**

- (a) it use  $E = mc^2$

mass in kg i.e.  $0.001 \times \frac{0.7}{100}$

*each gains 1 mark*

**but** 000007

*gains 2 marks*

$2.1 \times 10^3$

*gains 3 marks*

evidence of 0.000007

mass in kg (i.e. 0.0007 **or** 0.7/100000)

*each gains 1 mark*

squaring the speed of light

**but**  $6.3 \times 10^{11}$  (*credit alternative ways of stating this*)

*gains 3 marks*

units J/joule

*for 1 further mark*

(N.B credit kJ, MJ, GJ but check power of 10 for full credit)

4

(b) (i) *idea that* the bigger the mass the shorter the life

*gains 1 mark*

**but** *idea that* decrease in life is much more than proportional to increase in mass

**or** more than proportional to mass<sup>2</sup>

*gains 2 marks*

2

(ii) *ideas that:*

greater mass means greater **core** temperature/pressure

greater core temperature/pressure means greater rate of fusion

increase in mass produces a proportionally much greater increase in the rate of fusion

*each for 1 mark*

3

[9]

### Q31.

*ideas that:* galaxies show a red-shift

*gains 1 mark*

**but** more distant galaxies show bigger red-shift

*gains 2 marks*

galaxies moving away/Universe expanding

*gains 1 mark*

**but** more distant galaxies moving away faster

*gains 2 marks*

so all Universe once in one place

*for 1 further mark*

*(only if the previous 2 marks are also gained)*

[5]

**Q32.**

(a) *answer includes items:*

B D G

*each for 1 mark*

3

(b) *answer includes items:*

A E F [allow H here for a further mark]

*each for 1 mark*

3

(c) *answer includes items:*

C H\* I J

*each for 1 mark [\*unless already credited in (b)]*

4

(d) *ideas that:*

- lucky in the sense that they weren't initially looking for the background radiation [others were!!!]
  - more than just lucky in that they investigated it and didn't just ignore it
- each for 1 mark*

[NB Reference to letters only, not a prose answer, gain only ½ mark each.  
Total rounded down]

2

[12]

**Q33.**

*ideas that*

- formed from dust/gases
  - pulled together by gravity
  - massive so very large gravitational forces (pulling inwards)
  - hydrogen → helium / fusion releases energy [not fission or just 'nuclear']
  - high temperature creates high pressure (pushing outwards)
  - long period when forces balance
  - then expands → red giant / red star
  - then contracts to (dense) white dwarf / white star
- [credit if massive enough / more massive than sun, red giant → supernova → (very dense) neutron star but do not accept w.r.t. Sun itself]*  
*[The whole of the (non bracketed part of) each idea must be present in some appropriate for in of words for each mark to be credited. To gain more than a single mark ideas must also be in correct sequence and/or appropriately related.]*

*any six 1 mark each*

[6]