Name: _____

Class: _____

Date: _____

Space Physics part 5 AQA Triple Physics

Time: **84 minutes**

Marks: **84 marks**

Comments:

1. 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)

2. (a) Scientists use telescopes to observe stars and galaxies.
Some telescopes are on Earth, but some are on satellites in space.

Why do telescopes in space give better images than telescopes on the Earth?

_____

_____

(1)

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

(i) What name is given to this observation?

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

blue-shift	☐
green-shift	☐
red-shift	☐

(1)

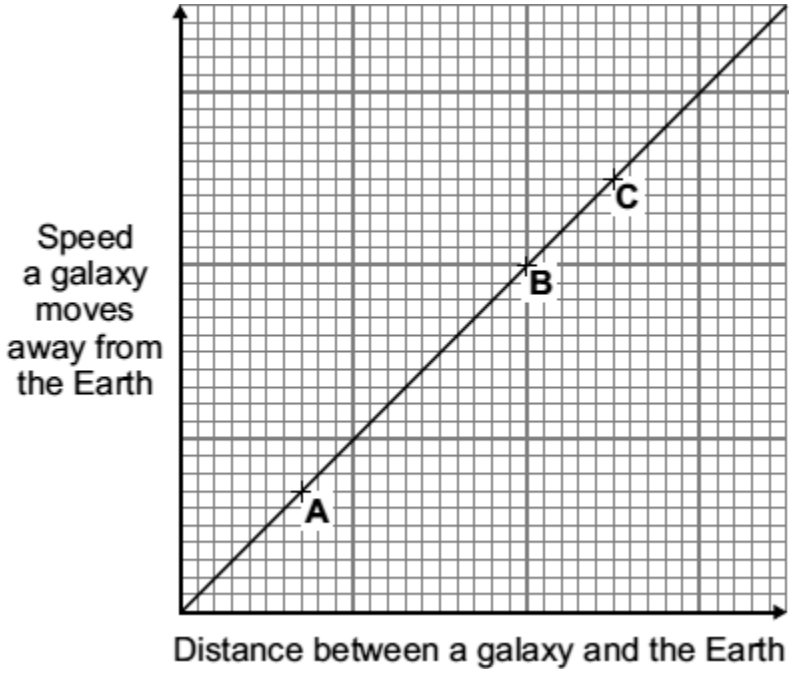
(ii) Complete the following sentence by drawing a ring around the correct line in the box.

This observation gives evidence for the idea that the universe is

shrinking.
not changing.
expanding.

(1)

(c) Use the graph to answer the following questions.



(i) What is the link between the speed that a galaxy moves away from the Earth and the distance between the galaxy and the Earth?

_____

_____

(1)

(ii) The positions of three galaxies, **A**, **B** and **C**, are marked on the graph.

From which galaxy, **A**, **B** or **C**, would the wavelength of the light reaching the Earth seem to have changed the most?

Galaxy _____

Give a reason for your answer.

_____

_____

_____

_____

(2)

(Total 6 marks)

3. (a) Our star, the Sun, is stable.

Explain what the conditions need to be for a star to remain stable.

(2)

(b) Shortly after the 'big bang', hydrogen was the only element in the Universe.

Explain how the other elements came to be formed.

(3)

(Total 5 marks)

4. Every star goes through a 'life cycle'.

(a) Describe how a star forms.

(2)

(b) During a long period of its life, a star remains in a stable state.

Explain why a star remains stable.

(2)

(c) Some stars are much more massive than the Sun.

Describe what will happen to a star, originally much more massive than the Sun, after it reaches its red giant stage.

(2)

(Total 6 marks)

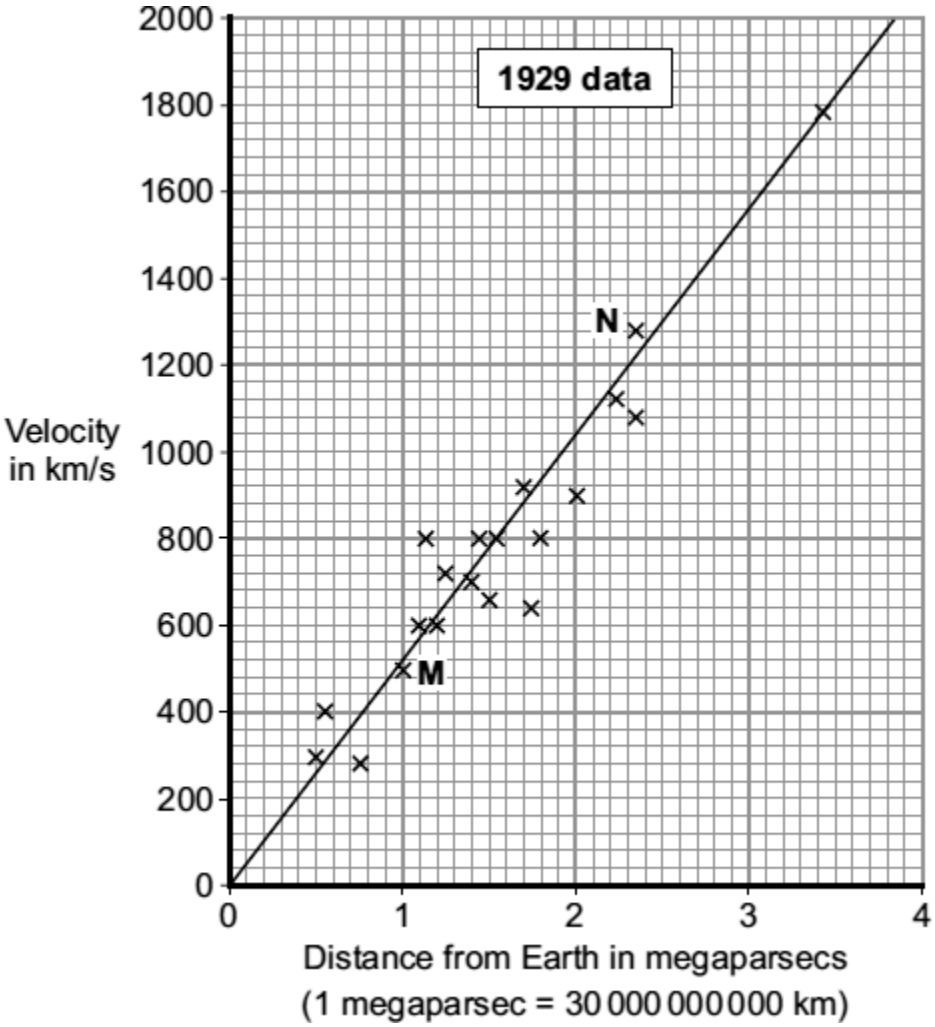
5. (a) In 1929, the astronomer Edwin Hubble observed that the light from galaxies that are moving away from the Earth showed a *red-shift*.

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.

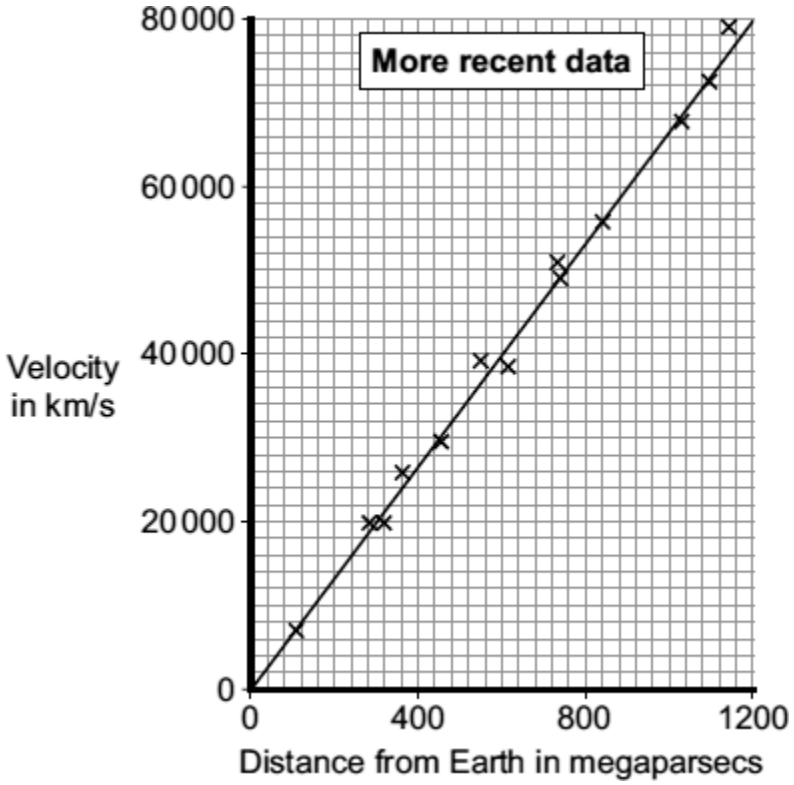
_____

_____

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)

6. This passage is from a science magazine.

> *A star forms when enough dust and gas are pulled together. Masses smaller than a star may also be formed when dust and gas are pulled together.*

(a) What is the force which pulls the dust and gas together?

_____

(1)

(b) Complete the sentences.

(i) The smaller masses may be attracted by the star and become

_____ .

(1)

(ii) Our nearest star, the Sun, is stable because the gravitational forces

and the radiation pressure are _____ .

(1)

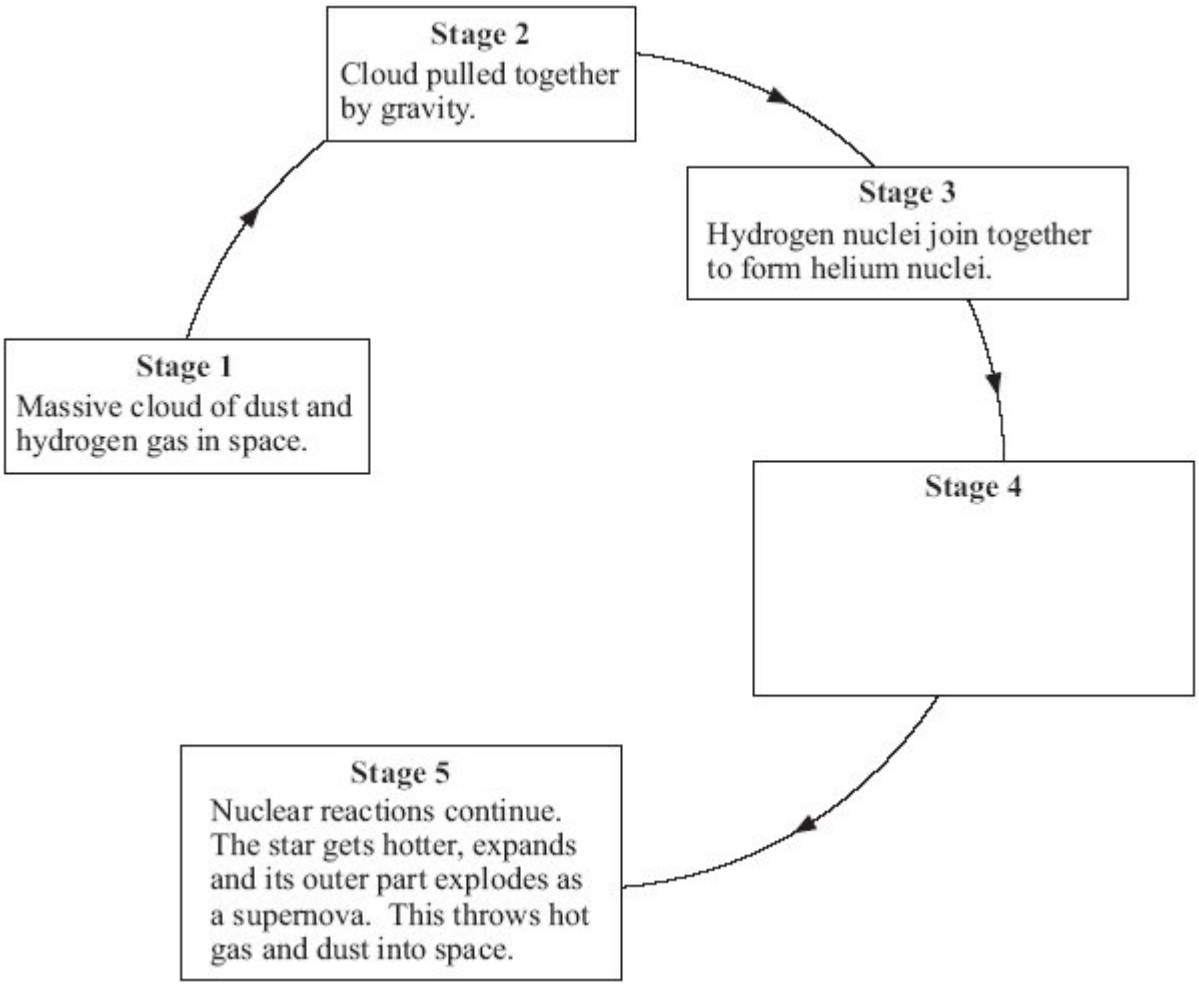
(iii) The Sun is one of billions of stars in the galaxy called the

_____ .

(1)

(Total 4 marks)

7. The diagram shows part of the life cycle of a star which is much bigger than the Sun.



(a) (i) What is the relationship between the masses of the dust and gas in the cloud in **Stage 2** and the force of gravity between them?

_____

_____

(1)

(ii) What is the relationship between the distance apart of the dust and gas in the cloud in **Stage 2** and the force of gravity between them?

_____

_____

(1)

(b) In **Stage 3** the star remains stable for millions of years.

Explain why.

_____

_____

_____

_____

_____

(2)

(c) What happens in **Stage 4**?

_____

_____

_____

_____

_____

(2)

(Total 6 marks)

8. (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?

_____

_____

(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*?

_____

_____

(1)

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

_____

_____

(1)

(c) 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 6 marks)

9. (a) Explain how stars produce energy.

_____

_____

_____

_____

(2)

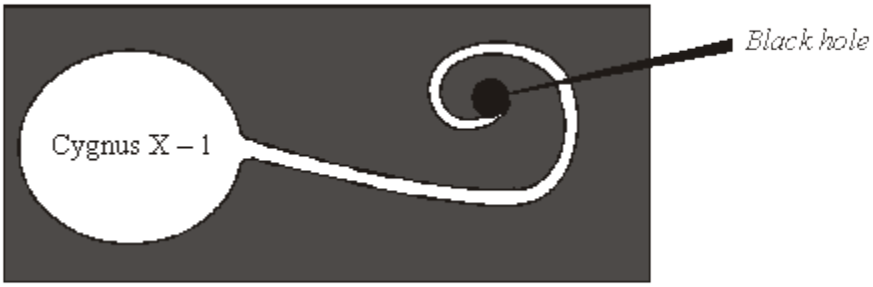
(b) What evidence is there to suggest that the Sun was formed from the material produced when an earlier star exploded?

_____

_____

(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)

10. 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?

_____

(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.

_____

_____

(2)

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

_____

_____

_____

_____

_____

(4)

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

(1)

(Total 8 marks)

11. 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.

(Total 6 marks)

12. (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)

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

_____

_____

_____

_____

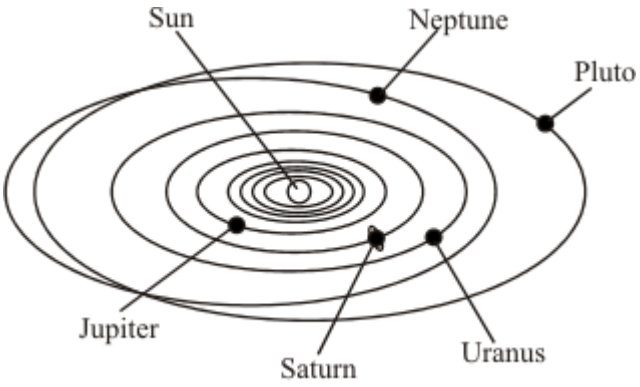
_____

_____

_____

(Total 4 marks)

14. 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?

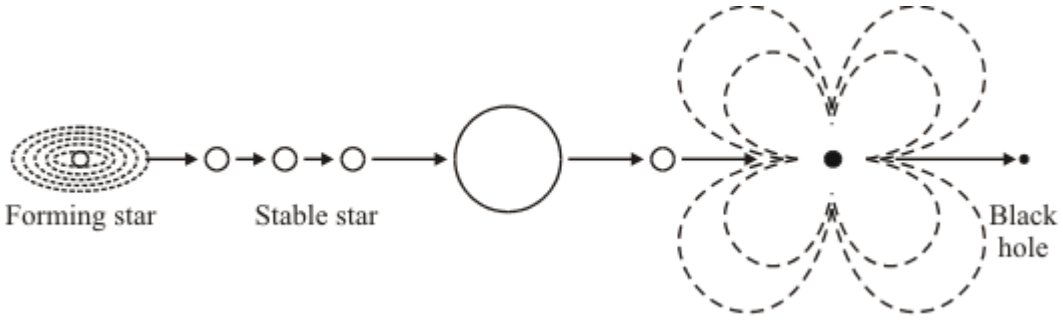
_____

_____

_____

(1)

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



Describe, in as much detail as you can, what forces allow a stable star to exist and how the star may eventually form a black hole.

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.

(6)

(Total 7 marks)

1. (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]

2. (a) any **one** from:

- above the atmosphere
  accept no atmospheric pollution
- no clouds in the way
- no light pollution
  answers in terms of being closer to space negate
  answers in terms of looking at the Earth negate

1

(b) (i) red-shift

1

(ii) expanding

1

(c) (i) as one gets bigger the other gets bigger
accept (directly) proportional
accept positive correlation

1

(ii) **C**

1

it is furthest from the Earth
*only scores if **C** is chosen*
or
it is furthest away
or
has the largest red-shift
or
it is moving (away) the fastest

1

[6]

3. (a) gravitational force(s) (1)
accept 'gravity'

balanced by (force(s) due to) radiation pressure (1)
accept equal

2

(b) by (nuclear) fusion (1)

of hydrogen to helium (other light elements) (1)

allow 'low density' for light

accept hydrogen nuclei / atoms form helium

response must clearly link one element(s) producing others

fusion to produce helium (2)

heavy element / elements heavier than iron are only produced (by fusion) in a supernova (1)

allow dense for heavy

ignore any reference to elements undergoing radioactive decay (to form other elements)

3

[5]

4. (a) (enough) dust and gas (from space)

accept nebula for dust and gas

accept hydrogen for gas

mention of air negates this mark

1

pulled together by:

- gravitational attraction
  or
- gravitational forces
  or
- gravity

1

(b) forces (in the star) are balanced

accept equal and opposite for balanced

accept in equilibrium for balanced

1

forces identified as gravity and radiation pressure

both forces are required

*gravitational forces inwards balance / equal radiation pressure outwards for **2** marks*

*accept for **2** marks an answer in terms of sufficient hydrogen to keep the fusion reactions going*

*accept for **1** mark an answer in terms of sufficient fuel to keep the fusion reactions going*

1

(c) (explodes as) a supernova

1

any **one** from:

- outer layer(s) thrown into space
  *do **not** accept just 'thrown into space'*
- scatters dust and gas into space (for the formation of new stars)
  *do **not** accept just 'dust and gas'*
- elements distributed throughout space
  *do **not** accept just 'distributed'*
- matter left behind / core may form a neutron star
  *do **not** accept just 'neutron star'*
- a black hole will form if the gravitational forces are enormous / sufficient mass is left behind
  *do **not** accept just 'black hole'*
  *do **not** accept any references to 'dark bodies' or 'black dwarfs'*
  black hole forms if star is large enough is insufficient

1

[6]

5. (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]

6. (a) gravitational

accept gravity

*do **not** accept weight*

1

(b) (i) planet(s)

accept comet(s)

accept asteroid(s)

*do **not** accept moon(s)*

1

(ii) balanced

accept equal / the same / are in equilibrium

1

(iii) Milky Way

accept milky way

1

[4]

7. (a) (i) the bigger the masses (of the dust and gases then) the bigger the force / gravity (between them)

accept the converse

1

(ii) the greater the distance (between the dust and gases then) the smaller the force / gravity (between them)

accept the converse

1

(b) radiation 'pressure' and gravity / gravitational attraction
these are balanced / in equilibrium

1

must be in correct context
*do **not** accept are equal*

or there is sufficient / a lot of hydrogen / fuel to last a very long time

second mark consequent on first

1

(c) any **two** from:

- hydrogen runs out / is used up
- nuclei larger than helium nuclei formed

  *accept bigger atoms are formed however do **not** accept any specific mention of an atom with a mass greater than that of iron*
- (star expands to) / become(s) a red giant

2

[6]

8. (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]

9. (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]

10. (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]

11. 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]

12. (a) fusion

accept fussion

1

energy producing process

accept heat and/or light for energy
accept fussion

1

(b) up to **2** points from:

__3__ marks for 3 points in sequence with no contradiction

- expands

__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]

13. 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]

14. (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]