M1.(a) red–shift

1

(b) the further away from the Earth, the faster a galaxy is moving

1

(c) **strength**as the balloon expands the dots get further apart, representing the galaxies moving apart

1

weaknessdots are only on the surface of the balloon, galaxies are throughout the universe**or**there is a limit to how far the balloon can expand

1

(d) both theories suggest that the Universe is expanding

1

(e) new evidence / observations that cannot be explained by Theory 1

accept specific example of new evidence ie CMBR

1

[6]

M2.(a) wavelength correctly shown

1

PhysicsAndMathsTutor.com

(b) (i) increased

1

decreased

1

(ii) 17-18 inclusive

1

evidence of measurement divided by 3 or mean of 3 separate measurements

1

mm

accept cm if consistent with answer

1

(c) (i) red shift

1

(ii) moving away

1

(iii) the furthest galaxies show the biggest red shift

1

(meaning that) the furthest galaxies are moving fastest

1

(so the) Universe is expanding

PhysicsAndMathsTutor.com

1

(extrapolating backwards this suggests that) the Universe started from an initial point

1

(iv) cosmic microwave background radiation

allow CMBR

1

[13]

M3. (a) **Y**

*accept cannot be **X** as size is increasing*

1

PhysicsAndMathsTutor.com

shows Universe expanding

*this scores if **Y** or **Z** is chosen*

accept exploding outwards

1

from a (very small) point

*this only scores if **Y** is chosen*

accept from zero (size)

answers in terms of planets

negate the last two mark points

1

(b) (i) both the 'big bang' and 'steady state' theories

1

(ii) (new) evidence that supports / disproves a theory

accept proves for supports

or

(new) evidence not supported by current theory

accept there may be more evidence supporting one (theory) than the other (theory)

accept new evidence specific to this question eg measurement of CBR

or

some types of star only found in distant parts of Universe (steady state suggests should be same throughout Universe)

1

[5]

PhysicsAndMathsTutor.com

Q1. 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?

.....

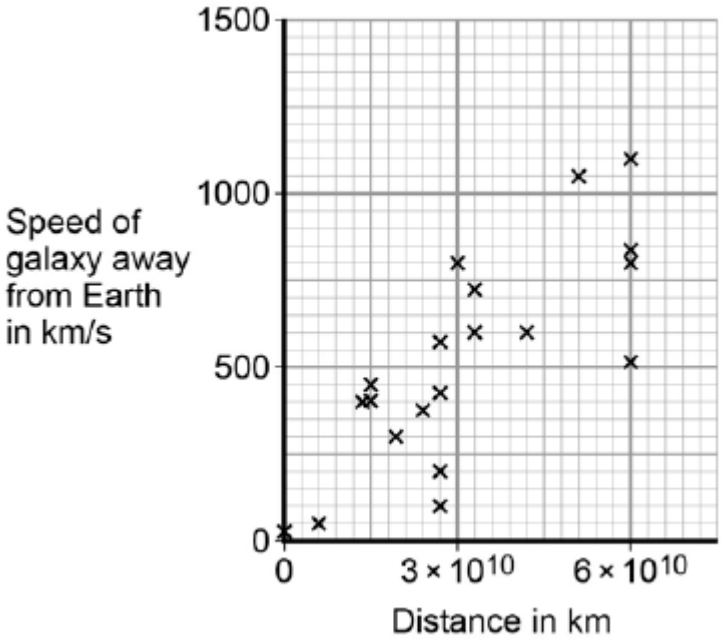
.....

(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)

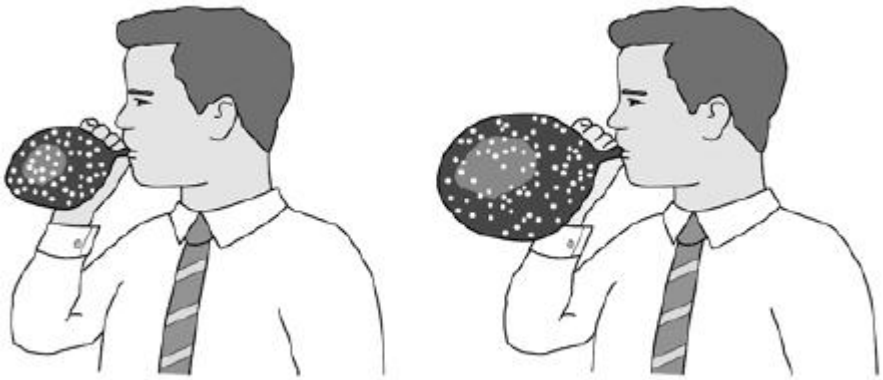
PhysicsAndMathsTutor.com

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

PhysicsAndMathsTutor.com

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.

.....

.....

.....

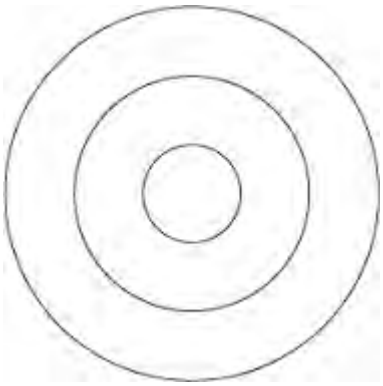
(1)
(Total 6 marks)

PhysicsAndMathsTutor.com

Q2.A teacher demonstrates the production of circular waves in a ripple tank.

Diagram 1 shows the waves at an instant in time.

Diagram 1



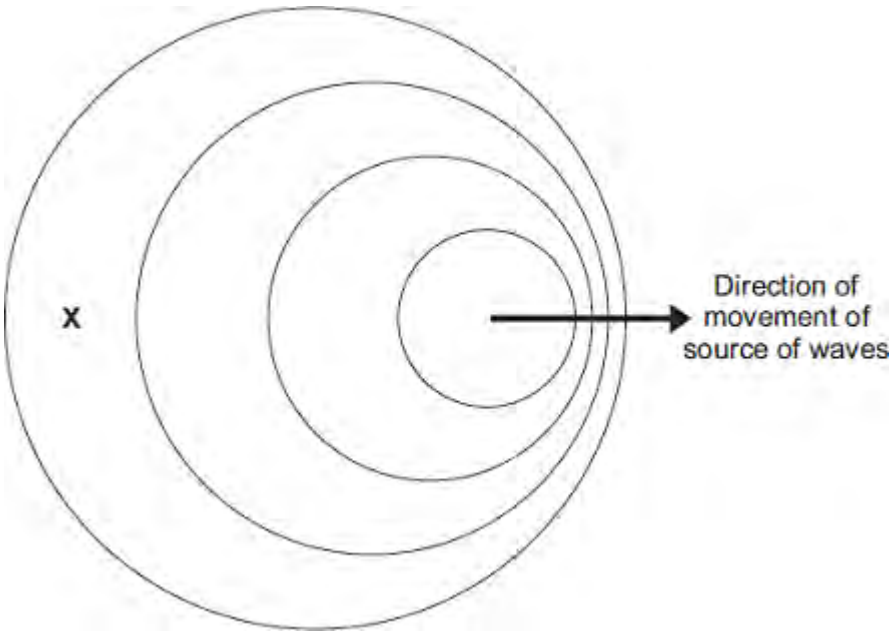
(a) Show on **Diagram 1** the wavelength of the waves.

(1)

(b) The teacher moves the source of the waves across the ripple tank.

Diagram 2 shows the waves at an instant in time.

Diagram 2
(Actual size)



PhysicsAndMathsTutor.com

(i) Use the correct answer from the box to complete each sentence.

decreased	**increased**	**stayed the same**

In **Diagram 2**, the observed wavelength of the waves at **X**

has ..... .

In **Diagram 2**, the frequency of the waves at **X**

has ..... .

(2)

(ii) Take measurements from **Diagram 2** to determine the wavelength of the waves received at **X**.

Give the unit.

.....

.....

Wavelength = ...

(3)

(c) The teacher uses the waves in the ripple tank to model the changes in the wavelengths of light observed from distant galaxies.

When observed from the Earth, there is an increase in the wavelength of light from distant galaxies.

(i) State the name of this effect.

.....

(1)

(ii) What does this increase in wavelength tell us about the movement of most

PhysicsAndMathsTutor.com

galaxies?

.....

.....

(1)

(iii) Explain how this observation supports the Big Bang theory of the formation of the Universe.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(iv) State **one** other piece of evidence that supports the Big Bang theory of the formation of the Universe.

.....

.....

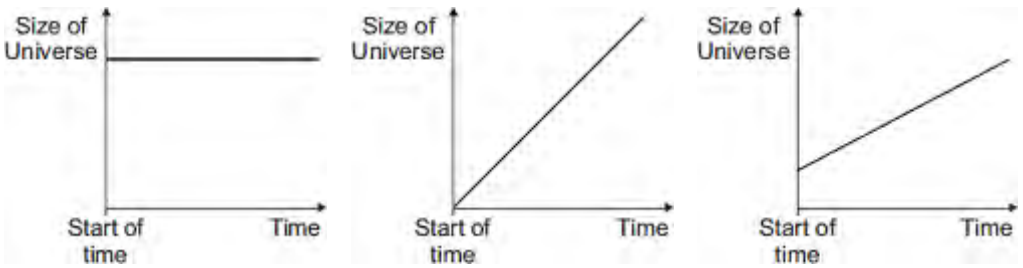
(1)

(Total 13 marks)

PhysicsAndMathsTutor.com

Q3. 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

only the ‘big bang’ theory.

PhysicsAndMathsTutor.com

to support	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)

PhysicsAndMathsTutor.com

M1. (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) <u>furthest</u> from the Earth

accept galaxy for stars

or

it is moving <u>away</u> the fast<u>est</u>

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) <u>explosion</u> sends matter outwards

accept <u>explosion</u> 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]

PhysicsAndMathsTutor.com

M2. (a) longer wavelength waves **or** light moved towards red end of spectrum

1

(galaxy) moving <u>away</u> 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]

PhysicsAndMathsTutor.com

M3. (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

PhysicsAndMathsTutor.com

1

[8]

M4. (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]

PhysicsAndMathsTutor.com

M5. (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]

PhysicsAndMathsTutor.com

M6. (a) big bang theory – universe started at one point *(*then expanded*)*

1

steady state theory – universe has no origin / has always existed

accept an answer in terms of mass
eg steady state theory mass is created

1

(b) (i) wavelength *(*of light*)* increases

accept answers in terms of frequency decrease
*accept wavelength stretched but **not** wave stretched*

or wavelength */* light moves to red end of spectrum

*do **not** accept galaxy moves to the red end of the spectrum*
*do **not** accept light becomes red / redder*

1

(ii) red-shift is evidence / supports idea of expanding universe

accept prove for support

1

both theories use the idea / accept / explain why the universe is expanding

1

(c) to find evidence to support one or both theories

accept prove for support
accept to gain more knowledge about the universe

or to find evidence to disprove one or both theories

1

(d) answer involves (religious) belief

accept it cannot be tested

or no / insufficient evidence

1

[7]

PhysicsAndMathsTutor.com

M7. (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

[2]

M8. (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

PhysicsAndMathsTutor.com

(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]

PhysicsAndMathsTutor.com

M9. (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) increas
accept becomes radio waves

1

universe continues to accelerate outwards
accept as universe continues to expand

or

greater red-shift

1

[7]

PhysicsAndMathsTutor.com

M10. (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) 1.2×10^7 / 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

PhysicsAndMathsTutor.com

(iii) (Universe is) expanding

1

[9]

PhysicsAndMathsTutor.com

Q1. (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.

.....

.....

.....

PhysicsAndMathsTutor.com

.....

(2)

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

.....

.....

.....

(1)
(Total 6 marks)

PhysicsAndMathsTutor.com

Q2. (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)

PhysicsAndMathsTutor.com

Q3. (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* ?

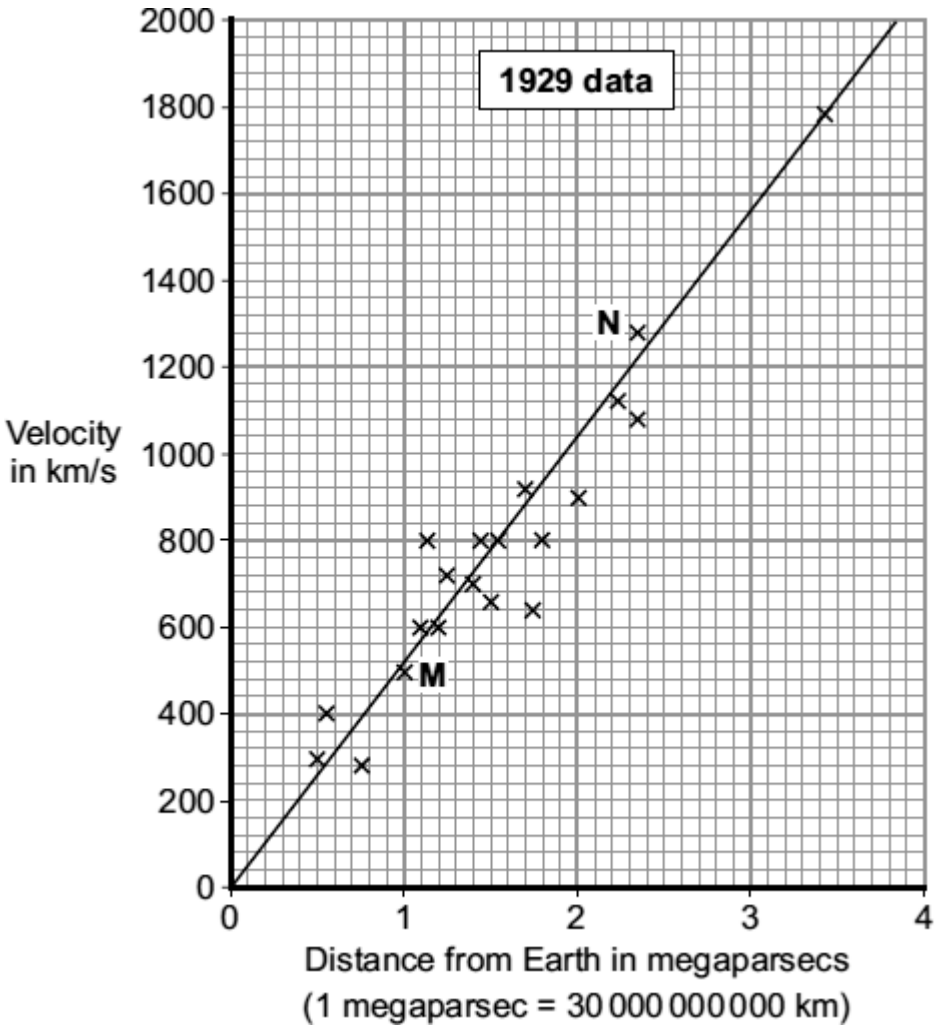
.....

.....

(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**

PhysicsAndMathsTutor.com

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.

.....

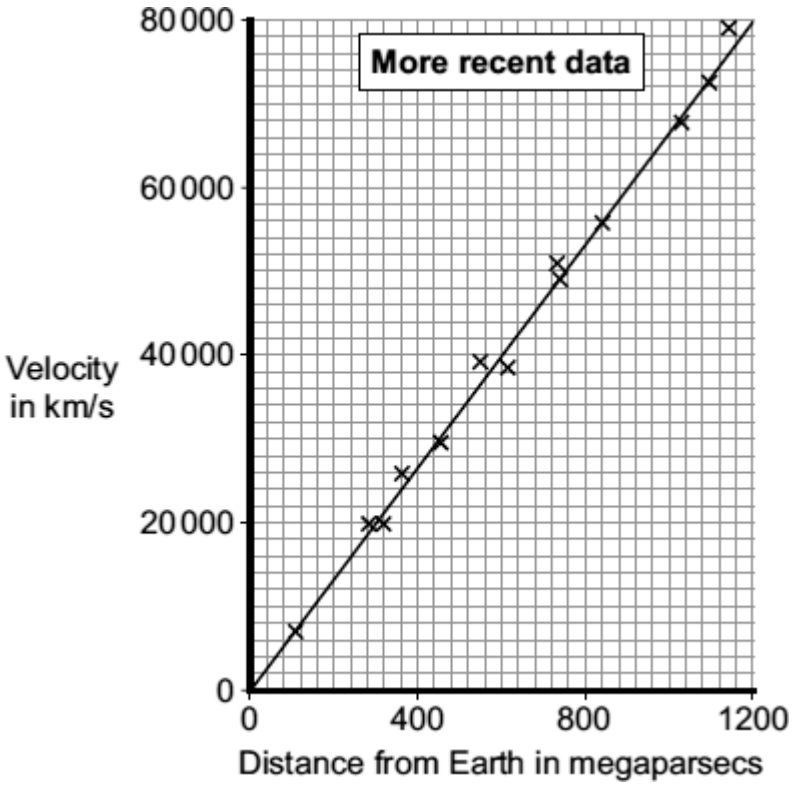
.....

Hubble constant = ... km/s per megaparsec

(2)

(iii) More recently, data has been obtained from more distant galaxies.

PhysicsAndMathsTutor.com



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?

.....

PhysicsAndMathsTutor.com

.....

.....

.....

(2)
(Total 8 marks)

PhysicsAndMathsTutor.com

Q4. 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.

.....

.....

.....

.....

.....

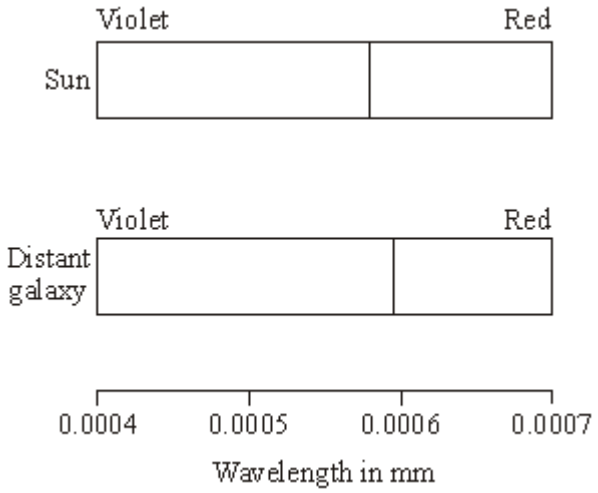
.....

(3)

(Total 4 marks)

PhysicsAndMathsTutor.com

Q5. 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.

.....

.....

.....

.....

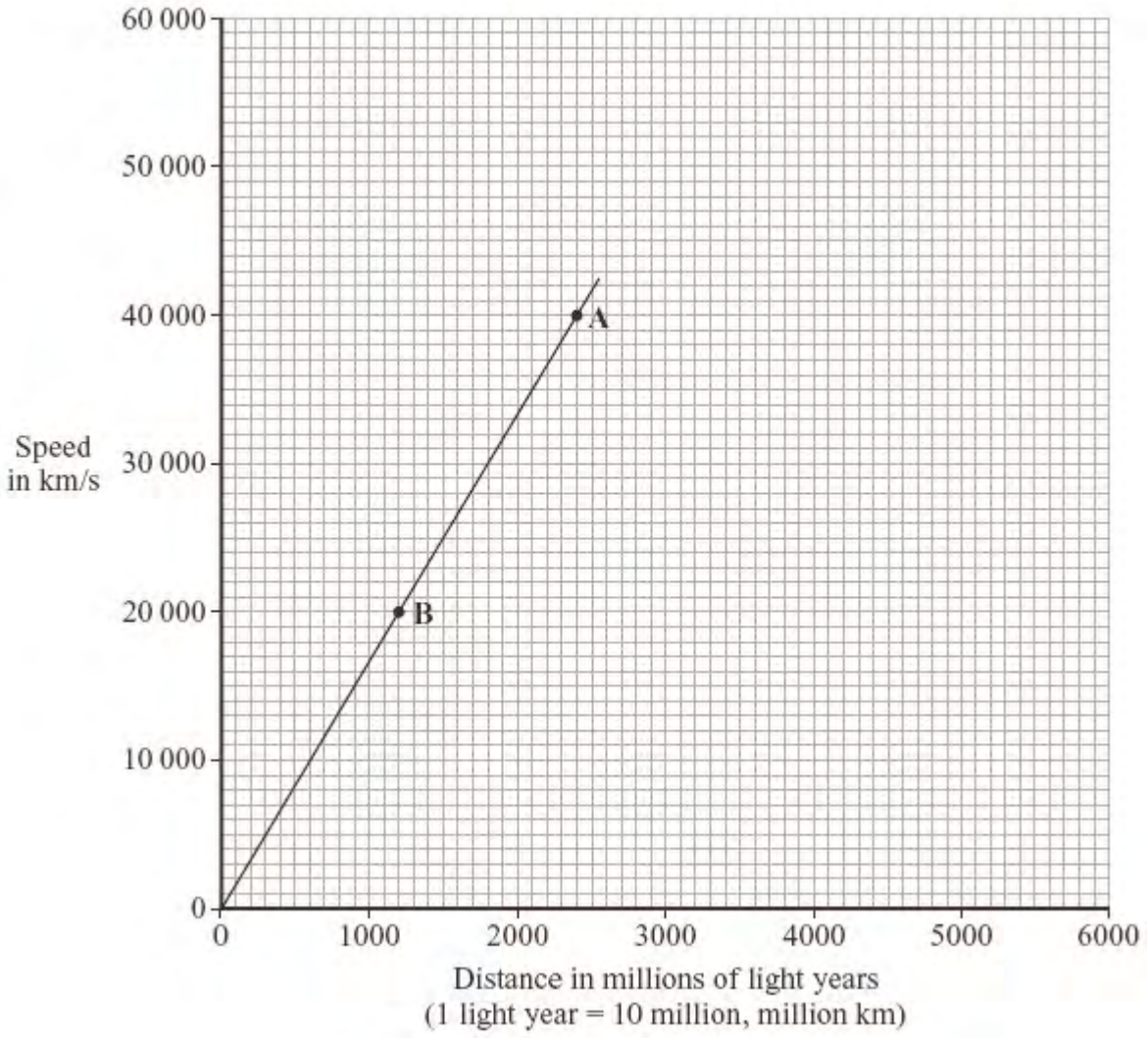
.....

.....

(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.

PhysicsAndMathsTutor.com



(i) How does the visible light spectrum from galaxy **A** look different from the visible light spectrum from galaxy **B**?

.....

.....

(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.

PhysicsAndMathsTutor.com

.....

.....

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

(2)

(Total 6 marks)

PhysicsAndMathsTutor.com

Q6. The ‘steady state’ theory was once a popular alternative to the ‘big bang’ theory.

The ‘steady state’ theory suggested that the universe, although expanding, had no origin and it has always existed. As the universe expands, a small amount of matter is created to keep the universe looking exactly the same all of the time.

(a) When considering the origin of the universe, what is the difference between the ‘big bang’ theory and the ‘steady state’ theory?

.....

.....

.....

.....

(2)

(b) The light from distant galaxies shows a *red-shift*.

(i) What is *red-shift*?

.....

.....

(1)

(ii) Why does red-shift provide evidence to support both the ‘big-bang’ theory and the ‘steady state’ theory?

.....

.....

.....

.....

(2)

(c) The ‘steady state’ theory was important in encouraging new research into the universe.

PhysicsAndMathsTutor.com

Suggest a reason why scientists were keen to carry out new research.

.....

.....

(1)

(d) 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)

PhysicsAndMathsTutor.com

Q7. Optical telescopes may be used to observe galaxies. Some optical telescopes are on the Earth and some are on satellites in space.

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 2 marks)

PhysicsAndMathsTutor.com

Q8. 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:

PhysicsAndMathsTutor.com

Why was the Universe created?

Suggest a reason why this question **cannot** be answered by scientists.

.....

.....

(1)

(Total 7 marks)

PhysicsAndMathsTutor.com

Q9. (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.

.....

PhysicsAndMathsTutor.com

.....

(2)
(Total 7 marks)

PhysicsAndMathsTutor.com

Q10. 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)

PhysicsAndMathsTutor.com

(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)

PhysicsAndMathsTutor.com

M1. giant

1

supernova

1

neutron

1

[3]

M2. (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]

PhysicsAndMathsTutor.com

M3. (a) Earth

Sun

Milky Way

Universe

all four in correct order
*allow **1** mark for Earth <u>and</u> Universe in correct places*

2

(b) equal to

1

(c) (i) explosion (of a star)
ignore implosion

1

(ii) only very massive stars become supernova

1

Mira large enough but sun too small
*allow **1** mark for each statement*
Sun too small to give a supernova
or
Mira large enough to give a supernova

1

[6]

PhysicsAndMathsTutor.com

M4. (a) (i) gases (1)

gravity (1)

correct order essential for credit

2

(ii) fusion

1

(iii) billions

1

(b) Milky Way

u.c. initials not essential

1

[5]

M5. red supergiant

1

supernova

1

black hole

1

[3]

PhysicsAndMathsTutor.com

M6. (a) all correct

M
L
L

*allow **1** mark for one correct*

2

(b) speed

accept 'velocity'

1

(c) (i) any **one** from:

- it's natural
- slowest
- furthest (from the centre of the Earth)

accept 'others are artificial / made by humans'

1

(ii) as the (average) distance decreases the speed increases

accept 'there is a negative correlation (between them)'
*do **not** accept 'they are inversely proportional'*

1

[5]

PhysicsAndMathsTutor.com

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

- Earth is at the centre (not the Sun)
- there are fewer planets

accept there is no asteroid belt shown

accept there are only 5 planets (and not 8)

accept other planets have no moons shown

1

(b) Shows the moon in orbit around the Earth

accept the planets have circular orbits

1

(c) circular

accept elliptical

1

(d) gravity

1

(e) Mira is much more massive

1

[5]

PhysicsAndMathsTutor.com

M8. red supergiant

*do **not** accept red giant*

1

supernova

1

black hole

1

[3]

M9. (a) main sequence star

correct order only

1

supernova

1

(b) balanced by

1

[3]

PhysicsAndMathsTutor.com

M10. (a) (enough) dust / gas (from space)

1

are pulled together

1

by gravitational attraction

1

(b) fusion

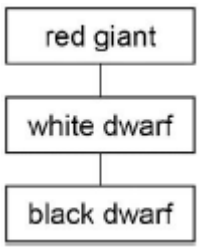
accept fusion circled in box

1

(c) forces within it are balanced

1

(d)



correct order only

1

ignore reference to planetary nebula

1

1

[8]

PhysicsAndMathsTutor.com

Q1. Complete the following sentences by choosing the correct words from the box. Each word may be used once or not at all.

dwarf	**giant**	**neutron**	**proton**	**supernova**

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)

PhysicsAndMathsTutor.com

Q2. 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)

PhysicsAndMathsTutor.com

Q3. Starting with the smallest, list the following in order of increasing size.

Universe **Earth** **Milky Way** **Sun**

Smallest .....

.....

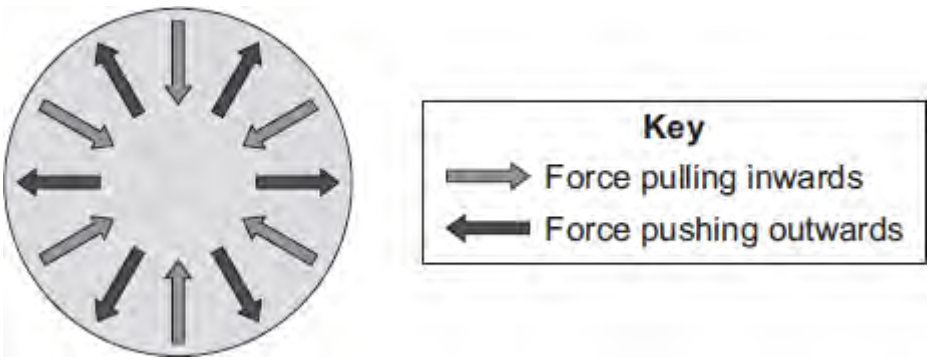
.....

Largest .....

(2)

(b) Stars pass through different stages during their life cycle.

The diagram shows the forces acting on the Sun during the stable stage of its life cycle.



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

During the stable stage of the Sun's life cycle, the forces pulling inwards

are

smaller than
equal to
bigger than

the forces pushing outwards.

(1)

(c) During its life cycle, the Sun will never go through a *supernova* stage but the star

PhysicsAndMathsTutor.com

Mira will.

(i) What is a *supernova?*

.....

(1)

(ii) Explain why the Sun will not go through the *supernova* stage but the star Mira will.

.....

.....

.....

.....

(2)

(Total 6 marks)

PhysicsAndMathsTutor.com

Q4. (a) Choose the best words from the box to complete the following sentences.

billions	**fission**	**friction**	**fusion**	**gases**
gravity	**liquids**	**millions**	**thousands**	

(i) Stars form when enough dust and ..... from

space are pulled together by ..... .

(2)

(ii) Stars are able to give out energy for millions of years by the process of

.....

(1)

(iii) The Sun is one of many ..... of stars in our galaxy.

(1)

(b) What is the name of our galaxy?

.....

(1)

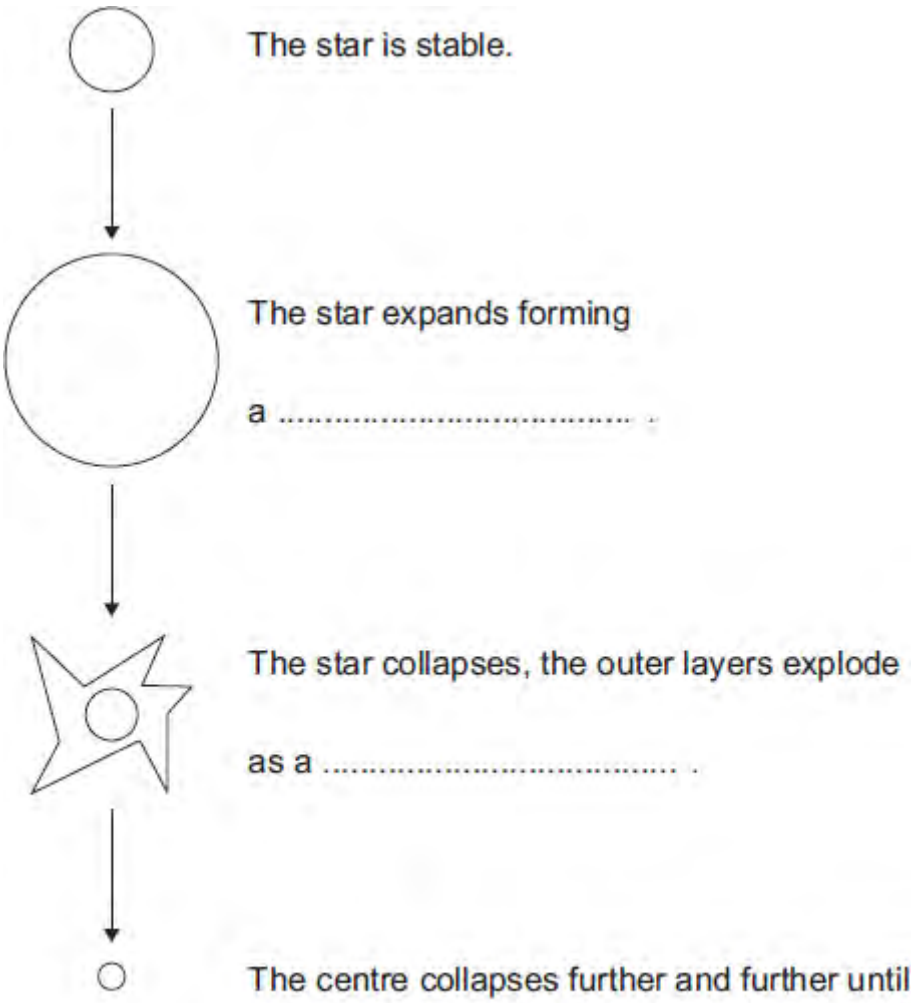
(Total 5 marks)

PhysicsAndMathsTutor.com

Q5. The diagram shows part of the lifecycle of a very large star.

Use words or phrases from the box to complete the sentences contained in the diagram.

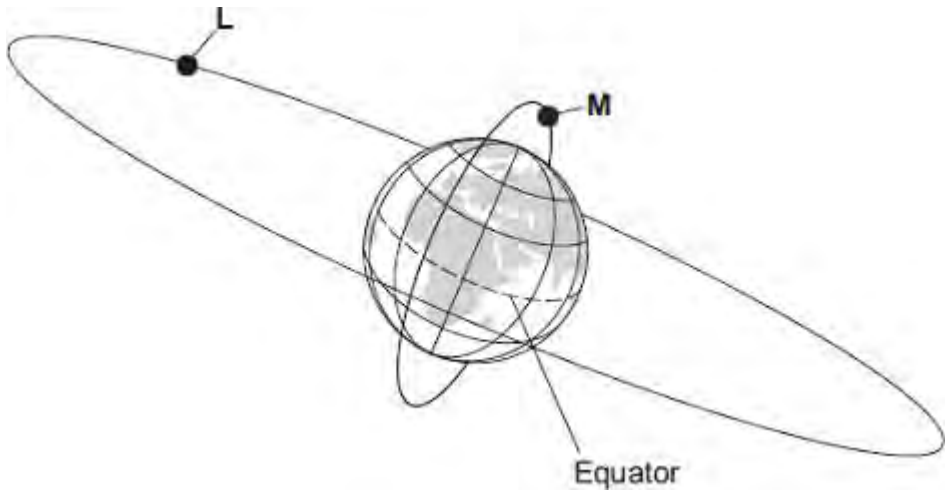
black hole	**red supergiant**	**supernova**	**white dwarf**



(Total 3 marks)

PhysicsAndMathsTutor.com

Q6. The diagram, which is not to scale, shows two satellites, **L** and **M**, orbiting the Earth.



(a) Complete the following table.

Each letter, **L** or **M**, may be used once, more than once, or not at all.

Statement about the satellite	**Letter for the satellite**
It is used as a monitoring satellite.	
It is a geostationary satellite.	
It takes 24 hours to complete its orbit.	

(2)

(b) Complete the following sentence.

To stay in its present orbit around the Earth, each satellite must move at

a particular ..... .

(1)

(c) Thousands of satellites are now in orbit around the Earth. A student used the internet to collect information about some of them.

Name of satellite	**Average distance from the centre of the Earth in**	**Speed in kilometres per second**	**Time taken to orbit the Earth**

PhysicsAndMathsTutor.com

	kilometres		
The Moon	391 400	1.01	28 days
GEO	42 200	3.07	1 day
Navstar	26 600	3.87	12 hours
Lageos	12 300	5.70	3.8 hours
HST	7 000	7.56	97 mins
ISS	6 700	7.68	92 mins

(i) The Moon takes a longer time than any of the other satellites to orbit the Earth.

Give **one** other way in which the Moon is different from the other satellites in the table.

.....

.....

(1)

(ii) What conclusion on the relationship between the *average distance* and *speed* can the student come to on the basis of this data?

.....

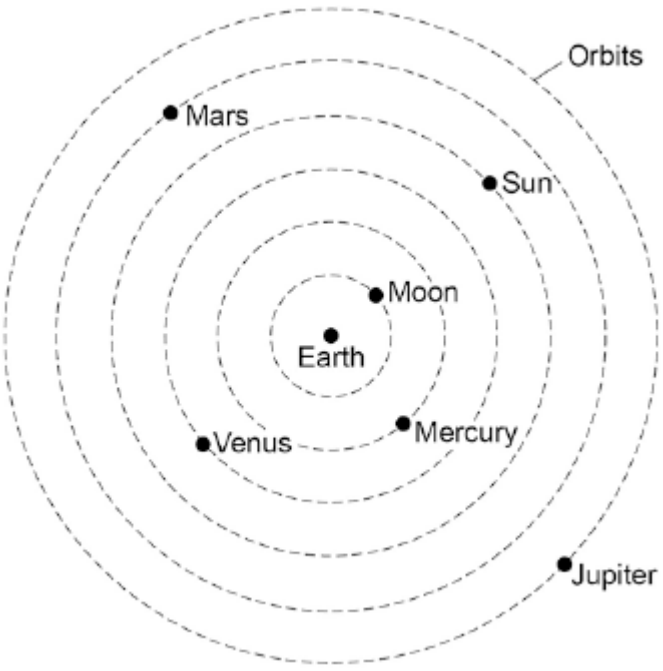
.....

(1)

(Total 5 marks)

PhysicsAndMathsTutor.com

Q7. The figure below shows what scientists over 1000 years ago thought the solar system was like.



(a) Give **one** way that the historical model of the solar system shown in the figure above is different from what we now know about the solar system.

.....

.....

(1)

(b) Give **one** way that the solar system shown in the figure above is the same as what we now know about the solar system.

.....

.....

(1)

(c) The first artificial satellite to orbit the Earth was launched into space in 1957.

Describe the orbit of an artificial satellite.

.....

.....

(1)

PhysicsAndMathsTutor.com

(d) What provides the force needed to keep a satellite in its orbit?

Tick **one** box.

friction ☐

gravity ☐

tension ☐

(1)

(e) All stars go through a lifecycle.

The star Mira will go through a supernova stage in its lifecycle but the Sun will not.

How is the star Mira different to the Sun?

.....

.....

(1)

(Total 5 marks)

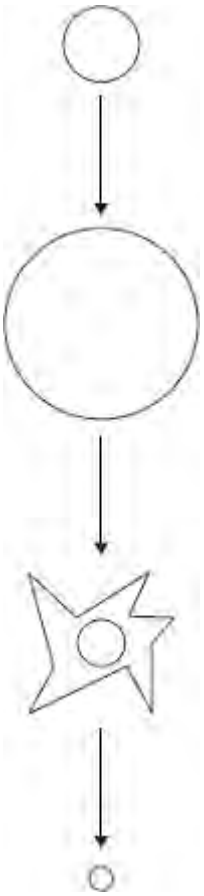
PhysicsAndMathsTutor.com

Q8. The diagram shows part of the lifecycle of a very large star.

Use words or phrases from the box to complete the sentences contained in the diagram.

black hole	**red supergiant**	**supernova**	**white dwarf**

(3)



The star is stable.

The star expands forming

a ..... .

The star collapses, the outer layers explode

as a ..... .

The centre collapses further and further until

it finally forms a ..... .

(Total 3 marks)

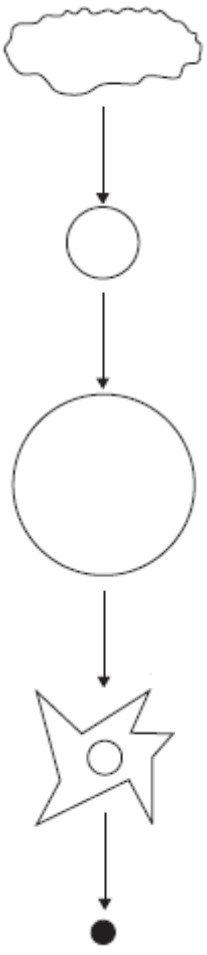
PhysicsAndMathsTutor.com

Q9.(a) **Figure 1** shows the life cycle of a very large star.

Use the correct answers from the box to complete the sentences in **Figure 1**.

main sequence star	**neutron star**	**supernova**	**white dwarf**

Figure 1



Gas and dust join together to become a protostar.

The star is stable as a ..... .

The star expands to become a red super giant.

The outer layers of the star explode as a ..... .

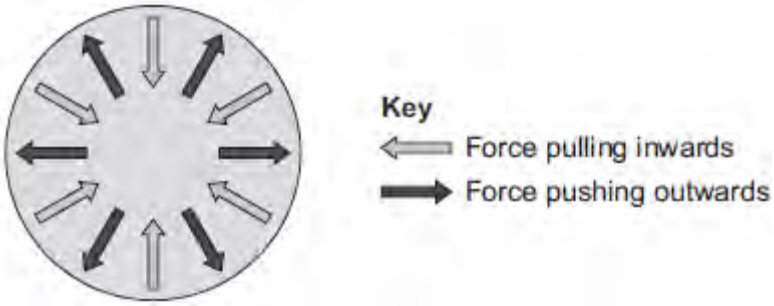
The core of the star shrinks and a black hole is formed.

(2)

(b) **Figure 2** shows the forces acting on a star when the star is stable.

Figure 2

PhysicsAndMathsTutor.com



Draw a ring around the correct answer to complete the sentence.

When a star is stable, the forces pushing outwards are

bigger than
smaller than
balanced by

the forces pulling inwards.

(1)
(Total 3 marks)

PhysicsAndMathsTutor.com

Q10. Astronomers claim that there are about 300 billion stars in the Milky Way.

(a) Describe how stars are formed.

.....

.....

.....

.....

.....

.....

(3)

(b) Use the correct answer from the box to complete the sentence.

decay	**fission**	**fusion**

Energy is released in stars by the process of nuclear ..... .

(1)

(c) State why a star is stable during the 'main sequence' period of its life cycle.

.....

.....

(1)

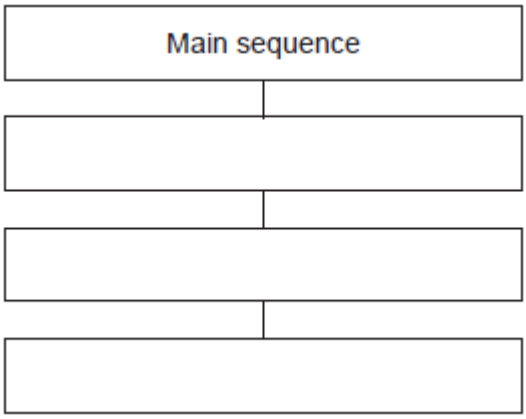
(d) The life cycle of a star after the 'main sequence' period depends on the size of the star.

A particular star is the same size as the Sun.

What are the stages, after the main sequence, in the life cycle of this star?

State them in order by writing in the boxes.

PhysicsAndMathsTutor.com



(3)
(Total 8 marks)

PhysicsAndMathsTutor.com

M1. (a) (i) the bigger the <u>masses</u> (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) <u>radiation 'pressure'</u> 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 <u>red giant</u>

2

[6]

M2. (i) from a (giant) cloud of gas or hydrogen

PhysicsAndMathsTutor.com

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]

PhysicsAndMathsTutor.com

M3. (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]

M4. (a) converted into helium

PhysicsAndMathsTutor.com

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]

PhysicsAndMathsTutor.com

M5. (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]

M6. (a) runs out of hydrogen (in its core)

PhysicsAndMathsTutor.com

accept nuclear fusion slows down

*do **not** accept fuel for hydrogen*

*do **not** accept nuclear fusion stops*

ignore reference to radiation pressure / unbalanced forces

1

(b) temperature decreases / (relative)luminosity increases as it changes to a redgiant

if both temperature and luminosity are given both must be correct

1

temperature increases / (relative) luminosity decreases as it changes to awhite dwarf

if both temperature and luminosity are given both must be correct

1

correct change in temperature **and** (relative) luminosity as Sun changes to ared giant and then to a white dwarf

*an answer changes to a red giant and then white dwarf with no mention or an incorrect mention of temperature or (relative) luminosity change gains **1** mark only if no other marks awarded*

ignore correct or incorrect stages given beyond white dwarf

1

[4]

PhysicsAndMathsTutor.com

M7. (a) fusion (1)

of hydrogen/H (atoms)(1)

*do **not** credit any response which looks like 'fission' **or** the 'word' 'fussion'*

credit only if a nuclear reaction

2

(b) fusion of other/lighter atoms/elements (1)

reference to big bang nullifies both marks

during super nova/explosion of star(s) (1)

2

(c) explosion of star(s)/super nova (1)

reference to big bang nullifies both marks reference to the star running out of energy/material nullifies both marks

at the end of the 'life' of star(s) / when they 'die' (1)

2

[6]

M8. (a) (enough) <u>dust and gas</u> (from space)

accept nebula for dust and gas

PhysicsAndMathsTutor.com

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 <u>balanced</u>

accept equal and opposite for balanced
accept in equilibrium for balanced

1

forces identified as gravity and <u>radiation pressure</u>

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

PhysicsAndMathsTutor.com

*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]

PhysicsAndMathsTutor.com

M9. (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]

M10. (a) a protostar is at a lower temperature

PhysicsAndMathsTutor.com

or
a protostar does not emit radiation /energy

1

as (nuclear) fusion reactions have not started

accept heat or light for energy

1

(b) by (nuclear) fusion

accept nuclei fuse (together)

nuclear fusion and fission negates this mark

1

of hydrogen to helium

1

elements heavier than iron are formed in a supernova

accept a specific example e.g. heavier elements such as gold are formed in a supernova

accept heavier elements (up to iron) formed in red giant/red super giant

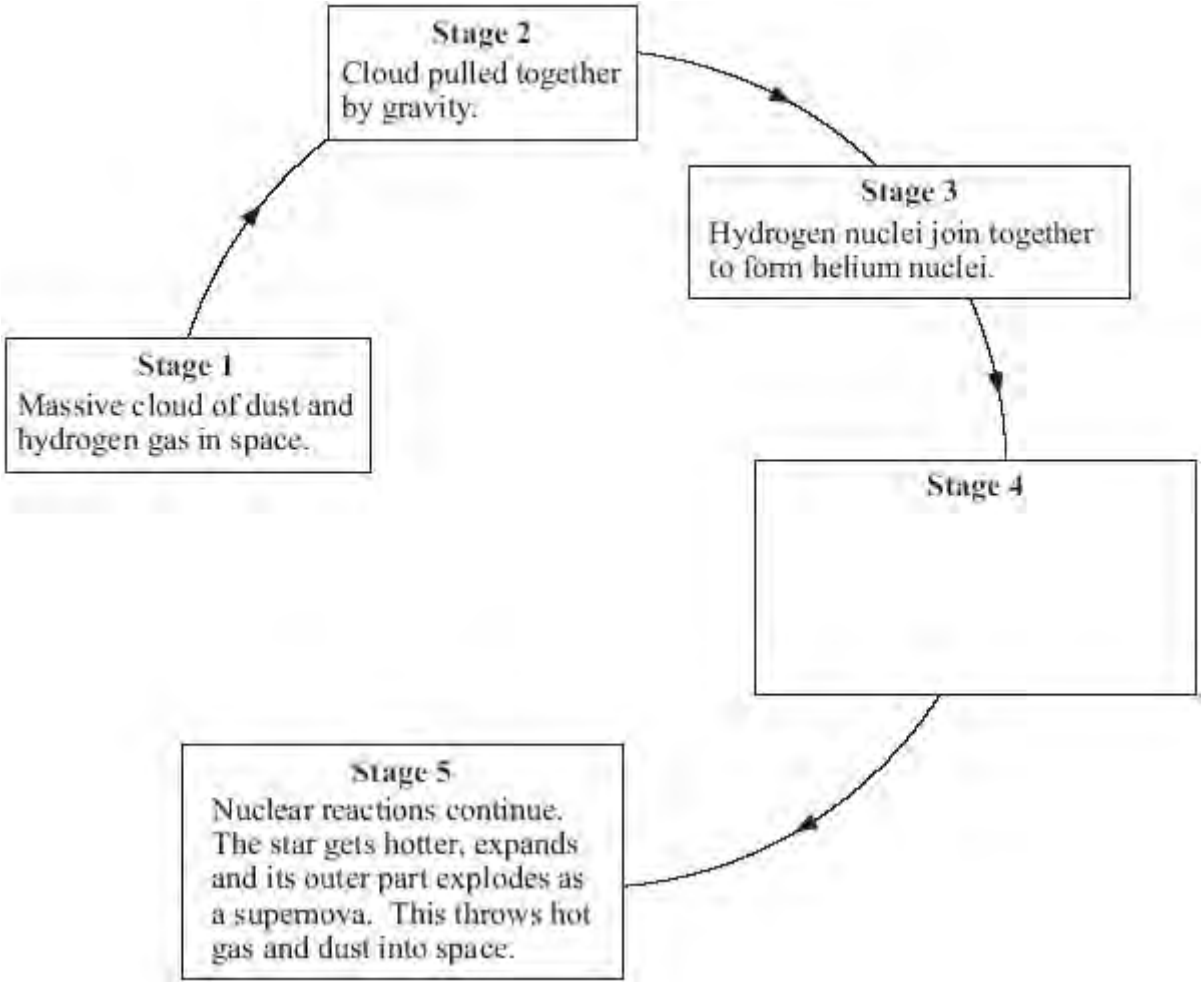
reference to burning (hydrogen) negates the first 2 marks

1

[5]

PhysicsAndMathsTutor.com

Q1. 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)

PhysicsAndMathsTutor.com

(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)

PhysicsAndMathsTutor.com

Q2. (i) Explain how stars like the Sun were formed.

.....

.....

.....

(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".

.....

.....

.....

.....

.....

(3)
(Total 5 marks)

PhysicsAndMathsTutor.com

Q3. (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)

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

.....

.....

.....

.....

.....

(3)
(Total 5 marks)

PhysicsAndMathsTutor.com

Q4. Stars do not stay the same forever.

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

.....

.....

(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.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

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

(i) Where did these atoms come from?

.....

.....

(1)

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

.....

(1)

(Total 7 marks)

PhysicsAndMathsTutor.com

Q5. (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?

PhysicsAndMathsTutor.com

.....

(1)

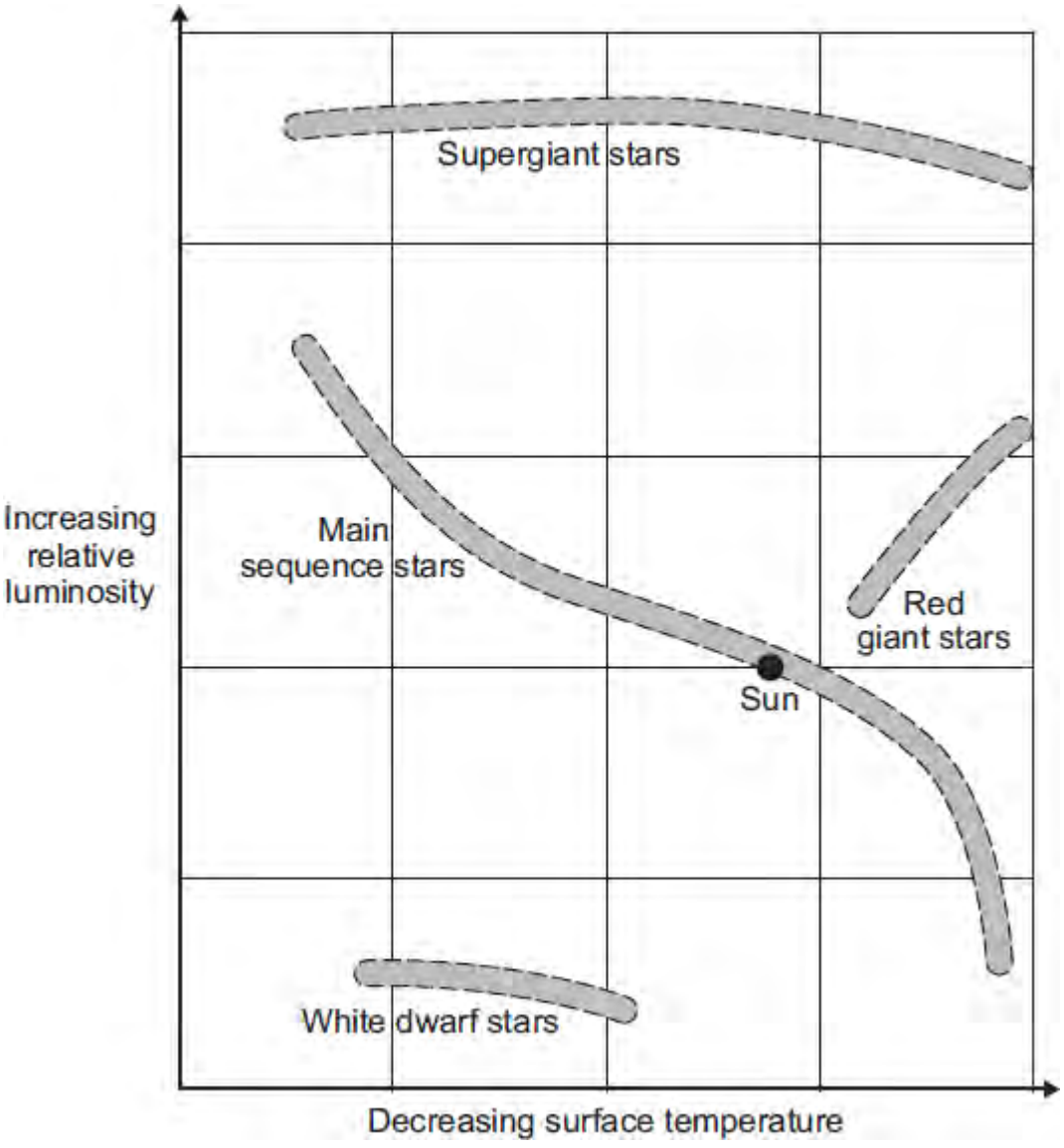
(Total 6 marks)

PhysicsAndMathsTutor.com

Q6. The diagram, drawn below, places stars in one of four groups.

Where a star is placed on the diagram is determined by the surface temperature and relative luminosity of the star.

A star with a relative luminosity of 1, emits the same amount of energy every second as the Sun.



(a) The Sun will spend most of its life cycle as a main sequence star. This is the stable period of the Sun's life cycle.

What happens to cause the stable period in the life cycle of a star to end?

.....

.....

(1)

PhysicsAndMathsTutor.com

(b) Use the information in the diagram to describe what will happen to the Sun after the stable period ends.

.....

.....

.....

.....

.....

.....

.....

(3)
(Total 4 marks)

PhysicsAndMathsTutor.com

Q7. Read this statement from a website.

Immediately after the 'big bang', at the start of the Universe, there were only atoms of the element hydrogen (H). Now the Universe contains atoms of over one hundred elements.

(a) Explain how atoms of the element helium (He) are formed in a star.

.....

.....

.....

.....

(2)

(b) Explain how atoms of very heavy elements, such as gold (Au), were formed.

.....

.....

.....

.....

(2)

(c) Explain how, and when, atoms of different elements may be distributed throughout the Universe.

.....

.....

.....

.....

(2)
(Total 6 marks)

PhysicsAndMathsTutor.com

Q8. 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)

PhysicsAndMathsTutor.com

Q9. (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)

PhysicsAndMathsTutor.com

Q10. (a) As part of its life cycle, a star changes from being a protostar to a main sequence star.

Explain the difference between a protostar and a main sequence star.

.....

.....

.....

.....

(2)

(b) The early Universe contained only atoms of hydrogen. The Universe now contains atoms of over one hundred different elements.

Explain how the different elements now contained in the Universe were formed.

.....

.....

.....

.....

.....

.....

(3)
(Total 5 marks)

PhysicsAndMathsTutor.com