**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)**

**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?

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

**(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.**          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)**

**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)**

**Q5.**          *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.*

          Explain briefly how stars like the Sun are thought to have been formed.

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**(Total 2 marks)**

**Q6.**          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.

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**(2)**

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

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**(2)**

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

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**(2)**

**(Total 6 marks)**

##

          Read the passage.

|  |
| --- |
| In the Solar System, the inner planets, such as the Earth, contain elements which are eavier than the elements hydrogen and helium.Our star, the Sun, is a medium sized star. If a star is much more massive than the Sun it will eventually swell into a red giant, start to contract, continue to contract 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.

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**(3)**

**(Total 4 marks)**

**Q8.**          The statement in the box is from an article in a science magazine.

|  |
| --- |
| Scientists think that all the elements on Earth are also present throughout the Universe. |

(a)     (i)      Name the process by which these elements were formed.

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

**(1)**

(ii)     Where did the elements form?

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

**(1)**

(iii)     What caused these elements to be distributed throughout the Universe?

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

**(1)**

(b)     Scientists have only examined a tiny fraction of the Universe. What is the basis for the statement in the science magazine?

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

**(1)**

**(Total 4 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.**          (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*.

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

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

**(2)**

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

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

**(1)**

**(Total 6 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 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?

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

**(Total 1 mark)**

**Q13.**          One theory of the origin of the Universe was that billions of years ago all matter was in one place, then it exploded (‘big bang’).
Describe, in as much detail as you can, how our star (the Sun) formed from the time when there was just dust and gas (mostly hydrogen) up to now when it is in its 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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**(Total 5 marks)**

**Q14.**          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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.....................................................................................................................................

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**(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.*

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**(6)**

**(Total 7 marks)**

**Q15.**          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)**

**Q16.**          (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)**

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

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**(3)**

**(Total 5 marks)**

**Q17.**          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)**

**Q18.**          (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)**

**Q19.**          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?

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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)**

**Q20.**          Describe briefly how stars such as the Sun are formed.

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**(Total 2 marks)**

**Q21.**          Describe, in as much detail as you can, the life history of a star like our Sun.

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**(Total 6 marks)**

**Q22.**          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.

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

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

**(2)**

(c)     What happens in **Stage 4**?

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

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

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

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

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

**(2)**

**(Total 6 marks)**

**M1.**          giant

**1**

          supernova

**1**

          neutron

**1**

**[3]**

**M2.**          (a)     dust

*accept ‘solid (s)’*

**1**

          space

*accept ‘from supernova / supernovum / supernovas’*

**1**

(b)     By atoms joining together

*only one ticked or otherwise unambiguously identified*

**1**

(c)     Milky Way (galaxy)

**1**

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

*only one ticked or otherwise unambiguously identified*

**1**

**[5]**

**M3.**          (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]**

**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.**          *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*

*Maximum of* ***1*** *mark if ideas not well expressed*

          any **two** from:

          dust and gas **or** remnants of a super nova

*accept hydrogen for dust and gas
do* ***not*** *accept hydrogen burns*

          pulled together by (force of) gravity

          nuclear fusion starts

*although candidates may include more detail these points are essential to score the credit*

**[2]**

**M6.**          (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]**

**M7.**          (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]**

**M8.**          (a)     (i)      (nuclear) fusion

*allow minor misspellings but do* ***not*** *credit any response which could be fission*

**1**

(ii)     (in) stars

*accept supernova / red giants / white dwarves*

*do* ***not*** *allow the Sun*

**1**

(iii)     (by) supernova / explosion of star

*do* ***not*** *credit just ‘explosion(s)’*

**1**

(b)     the (available) evidence:
supports this idea
**or** does not contradict this idea
**or** can be extrapolated to this idea

**1**

**[4]**

**M9.**          (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]**

**M10.**          (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]**

**M11.**          (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]**

**M12.**          any **one** of

          \* between (stage) 2 and (stage) 3
\* (in) the main sequence
\* (in) the main stable period
\* (it is a) yellow dwarf

**[1]**

**M13.**          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]**

**M14.**          (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]**

**M15.**          (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]**

**M16.**          (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]**

**M17.**          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]**

**M18.**          (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]**

**M19.**          (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]**

**M20.**          formed from dust or gas (unless in atmosphere) which is pulled together by
gravitational forces high temperature inside

**[2]**

**M21.**          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]**

**M22.**          (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]**

**E1.**          In this question the evolution of a star after the steady state phase was well known. However a large number of candidates gave ‘red dwarf’ as an initial answer, perhaps indicating a greater knowledge of science fiction than science fact.

**E2.**          (a)     The majority of candidates gained at least 1 mark.

(b)     Just under a third of candidates knew that stars are able to give out energy for millions of years by atoms joining together.

(c)     Three quarters of candidates correctly identified ‘The Milky Way’.

(d)     Just over a third of candidates selected the correct reason.

**E3.**          (a)     A large majority of candidates identified the force as gravitational.

(b)     (i)      A small minority of candidates were able to offer a correct response with ‘bigger stars’ as a popular incorrect answer.

(ii)     A majority of candidates were able to offer a correct response.

(iii)     A majority of candidates scored the mark but it is of concern that some candidates suggested universe, Earth or moon as possible names for our galaxy.

**E4.**          There was a very good response to this question on stars with a majority of candidates gaining the marks, or mark, in each of the four parts.

**E5.**          **Foundation Tier**

          Most answers were in terms of only gas being involved in some massive explosion. A significant number of candidates stated that the stars were formed from exploding planets. Only a small number of candidates mentioned gravity pulling dust and gas together and very few mentioned nuclear fusion.

          **Higher Tier**

          This question was very well answered by most candidates.

          A good number of candidates gave a correct explanation of how stars like the Sun are formed. Common errors included ‘Big Bang’, ‘rocks’ or ‘burning gases’, and confusion between fusion and fission.

**E6.**          Many candidates ‘confused’ chemical reactions with nuclear reactions. They should note that there are nuclear fusion reactions and nuclear fission reactions. Candidates who did not clearly refer to the correct term did not gain credit.

**E7.**          (a)     Nearly all candidates recognised that the reference at the end of the passage is to a supernova, though some suggested the big bang.

(b)     Most responses were disappointing and did not gain any marks. Few candidates answered in terms of elements and consequently even fewer explained that atoms of the heaviest elements can only be formed by nuclear fusion at the very high temperatures of a supernova.

**E8.**          A significant proportion of candidates seemed to think that the answer to at least one part of a question on this subject must be ‘big bang’.

(a)     (i)      This question was generally well answered and though fusion was often spelled with a double ‘s’ there were few obvious fudges between ‘fusion’ and ‘fission’.

(ii)     Just under half of candidates failed to answer the question and instead gave more details of the process of nuclear fusion; however the most popular incorrect response was ‘big bang’.

(iii)     There was a surprising range of answers to this item, with ‘gravity’ and ‘big bang’ being the most common wrong answers.

(b)     Few candidates were confident that this statement is supported by the available evidence or is not contradicted by the available evidence or that the available evidence extrapolates to this idea. Many candidates simply wrote down something they thought they knew about the universe.

**E9.**          Answers to this question seemed either centre dependent or interest dependent, with some candidates scoring highly and some scoring virtually no marks. In part (a) the term fusion was not well known with many candidates incorrectly referring to ‘burning’. Part (b) was often confused, with some candidates eventually getting to the correct answer having presumably spotted the ‘at least 5 times bigger than the Sun’ in brackets. Part (c) either scored full marks or none.

**E10.**          (a)     A number of candidates confused the way stars produce energy with the way in which stars are formed. There was more confusion between ‘fusion’ and ‘fission’, but many knew that hydrogen and helium were involved. Less able candidates talked about stars burning (often hydrogen) or reflecting light. Some candidates had stars reflecting light from the Sun.

(b)     This part was very poorly answered; very few candidates knew that the presence of heavier elements was the evidence required.

(c)     (i)      Many candidates could describe the black hole correctly, although the less able candidates talked about things being ‘sucked in’.

(ii)     Hardly any candidates knew that X-rays were produced as the gases from a star spiralled into the black hole.

**E11.**          The quality of the answers given varied enormously. Some were excellent, whilst others bore more resemblance to the science fiction imagination of a 16 year old.

**E12.**          Few candidates got this question correct. A very small minority gave excellent answers.

**E13.**          Responses were generally disappointing. Too many candidates simply restated information from the stem and then went on to describe the sequence of events once the main stable period had ended. Many candidates could describe how ‘dust and gas’ were pulled together by gravity, but then wrote very vague explanations of what happened next. A minority of candidates realised that the process that released energy was called ‘nuclear fusion’. There were as many candidates who thought this energy was from the burning of hydrogen. Very few candidates understood the idea that during the main stable period of the Sun the gravitational pull is balanced by expansion forces, caused by the very high temperatures.

**E14.**          There were mostly poor responses to all parts of this question. The sequence of the life cycle of a star was given to candidates in diagrammatic form and many candidates were still unable to describe the sequence in the correct order.

**E15.**          The ‘star story’ continues to present problems for the majority of candidates.

(a)     (i)      Only the most able stated that a supernova was involved or that large gravitational forces were involved. Many answered in terms of ‘light being sucked in’.

(ii)     Few appeared to know about the detection of X-rays produced when gases spiral into a black hole. The majority stated that they can be detected ‘because there is nothing there’.

(b)     (i)      Many answered in terms of dust particles joining together, often due to gravity. Only the best candidates answered in terms of fusion of the nuclei of the lighter elements.

**E16.**          In part (a) the process was rarely named, most candidates knew the process generated energy but many talked of the helium giving energy to the Sun. Descriptions in part (b) varied from precise to completely wrong. Sequencing was not well understood, and the weaker candidates used coloured giants and dwarfs indiscriminately.

**E17.**          The majority of candidates seemed unaware of the account of a star’s lifetime as given in the Specification. Most candidates referred to red giants and white dwarfs but only the best could explain these in terms of forces.

**E18.**          In part (a) only the most able candidates were able to identify the two forces acting on the Sun correctly, though more of them realised that the forces are balanced. A number of candidates referred to the stability of the Solar System.

          The answers to part (b) varied in quality form those where candidates were fortunate to pick up marks by mentioning ‘red giant’, ‘white dwarf’ etc. amongst a lot of mis-ordered or irrelevant information; to those which covered the whole range of possibilities in a well-structured order and could have gained ten marks if these had been available. For the really able candidates, or the candidate with a genuine interest in Astronomy, this must have been a satisfying way to end the examination.

**E19.** Gravity as the attractive force was generally well known but not many were aware of the syllabus statement ‘The very high temperatures inside stars create forces acting in the opposite direction’. Many may have read the question as ‘State the.......... rather than that asked ’Describe the........... The history of stars after the stable period was quite well answered as was the fate of the nearby planet.

**E20.**          This was quite well answered. Many started with dust and gas for the first mark and then correctly attributed the pulling together to gravity. Of those missing the second mark a few gained it for the high temperature generated in a star.

**E22.**          (a)     (i)(ii)  Most candidates were able to express correctly the relationships between gravity and the mass of the dust and gas and between gravity and the distance apart of the dust and gas.

(b)     About half the candidates scored at least one mark as credit was given for an explanation of why the star remains stable or why this period lasts for millions of years. Two marks were given for a response which correctly refers to both aspects, eg ‘the forces acting inside the star are balanced and the star has a vast supply of hydrogen’.

(c)     Just over a third of candidates obtained at least one mark. However, some candidates demonstrated their lack of understanding by suggesting that, in stage 4, nuclear reactions start or that a star is formed.