Mark schemes

Q1.

(a) Milky Way

1

(b) distance = 300 000 × 500

1

d = 150 000 000 (km)

1

*an answer of 150 000 000 scores **2** marks*

(c) 3

1

(d) accept any number greater than 1.0 and less than 12.0

1

(e) $\frac{9}{0.6}$

1

15

1

*an answer of 15 scores **2** marks*

[7]

Q2.

(a) (force of) gravity causes the satellite to accelerate (towards the Earth)

allow satellite is (constantly) accelerating

1

the acceleration causes a change in direction

acceleration causes a change in speed negates this mark point

1

velocity changes because direction changes

1

(b) length of orbit taken from graph = 42 100 (km)

1

42 100 = 7.73 × time
or
$\text{time} = \frac{42100}{7.73}$

allow
their distance = 7.73 × time

1

time (1 orbit) = 5446(s)

allow a value consistent with their distance

1

$$\text{number of orbits} = \left(\frac{24 \times 3600}{5446}\right)$$

= 15.86

$$\text{allow } \left(\frac{24}{1.51}\right) = 15.86$$

allow a value consistent with their distance

1

number of orbits = 15

allow a value consistent with their distance
*an answer of 16 scores **4** marks*

1

or

length of orbit taken from graph = 42 100 (km) (1)

$$7.73 = \frac{\text{distance}}{24 \times 3600} \text{ (1)}$$

distance = 667 872 (km) (1)

$$\text{number of orbits} = \left(\frac{667872}{42100}\right)$$

= 15.86 (1)

allow a value consistent with their two distances

number of orbits = 15 (1)

allow a value consistent with their two distances
up to full marks can be awarded for a method calculating velocity in km/h and time in hours
*an answer of 15 scores **5** marks*

(c) the predicted data is very close to the actual data

1

(d) supported the prediction (made by Bode)

allow predicted and actual values are very close

1

so provides evidence that the equation is true / correct / works / accurate

allow proves for provides evidence

1

[11]

Q3.

(a) dwarf planet

1

(b) nebula

correct order only

1

gravity

1

(c) (becomes a) red giant

1

(d) the greater the distance (from the Sun) the greater the time taken to orbit the Sun

1

(e) any value between 3 and 7 inclusive

1

(f) because some planets do not fit the pattern

1

named planet that does not fit pattern

eg Venus

1

reason why named planet does not fit pattern

its temperature is higher than expected

or

Uranus: its temperature is lower than expected

or

Neptune: its temperature is higher than expected

or

Mercury: its temperature is lower than expected

1

[9]

Q4.

(a) gamma rays

1

(b) can travel through the atmosphere

1

(c) explosion of a red super giant

or

a supernova

1

(d) 1.2×10^9 Hz

1

(e) $3.0 \times 10^8 = 1.2 \times 10^9 \times \lambda$

*an answer of 0.25 (m) scores **3** marks*

*allow ecf from **(d)***

1

$$\lambda = \frac{3.0 \times 10^8}{1.2 \times 10^9}$$

1

λ = 0.25 (m)

1

(g) same as the radio wave

1

(f) expansion due to fusion energy

1

in equilibrium with gravitational collapse

*forces acting inwards equal forces acting outwards gains **1** mark*

1

(h)

Level 2: Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3-4
Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1-2
No relevant content	0
Indicative content • Sun goes from main sequence to red giant • then from red giant to white dwarf • when the Sun changes to a red giant the surface temperature will decrease • and the relative luminosity will increase • when changing from a red giant to a white dwarf the surface temperature increases • and the relative luminosity decreases	

4

[14]

Q5.

(a) gravity

1

(b) as the wire moves through the Earth's magnetic field

1

a potential difference is induced between the ends of the wire

1

the wire must be part of a complete circuit

1

(c) new trace shows:

twice the frequency

1

twice the amplitude

1

(d) dynamo

dc generator is insufficient

1

(e) the alternator pd changes polarity, the 2nd type of generator does not

1

(f) $\frac{230}{V_s} = \frac{690}{57}$

1

$V_s = \frac{230 \times 57}{690}$

1

V_s = 19 (V)

*an answer of 19 (V) scores **3** marks*

1

[11]

Q6.

(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]

Q7.

(a) gas

correct order only

1

gravity

1

protostar

accept correct word circled in box provided no answer given in answer space

1

(b) the explosion of a massive star

1

(c) The telescopes and measuring instruments were not sensitive enough.

1

[5]

Q8.

(a) (i) (enough) dust and gas (from space) is pulled together

accept nebula for dust and gas
accept hydrogen for gas
accept gas on its own
dust on its own is insufficient
mention of air negates this mark

1

by:
gravitational attraction
or
gravitational forces
or
gravitaty

ignore any (correct) stages beyond this

1

(ii) joining of two (atomic) nuclei (to form a larger one)

do not accept atoms for nuclei

1

(iii) more sensitive astronomical instruments / telescopes
or
infrared telescopes developed

accept better technology
more knowledge is insufficient

1

(b) (i) (other) planets / solar systems

do not accept galaxy
moons is insufficient

1

(ii) provided evidence to support theory

accept proves the theory

1

(c) elements heavier than iron are formed only when a (massive) star explodes

accept materials for elements

accept supernova for star explodes

accept stars can only fuse elements up to (and including) iron

1

[7]

Q9.

(a) hydrogen

1

(b) supernova

1

(c) red super giant

1

(d) any **four** from:

- fusion takes place within stars
- hydrogen formed into helium
- fusion continued and formed larger elements
- elements heavier than iron were formed in supernova
- (heavy) elements were scattered by the supernova explosion.

accept light elements formed

4

[7]

Q10.

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

1

are pulled together

1

by gravitational attraction

1

(b) fusion

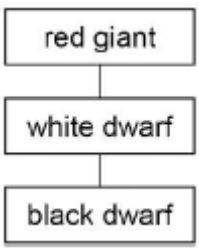
accept fusion circled in box

1

(c) forces within it are balanced

1

(d)



correct order only

1

ignore reference to planetary nebula

1
1

[8]

Q11.

(a) main sequence star

correct order only

1

supernova

1

(b) balanced by

1

[3]

Q12.

(a) gravitational attraction (between the satellite and the Earth)

allow gravity

allow weight of the satellite

1

(b) any **two** from:

- mass of satellite
- speed / velocity (of satellite)
- radius of orbit / circle

allow height above the Earth

radius / height alone is insufficient

2

(c) (i) increasing the height (above the Earth's surface) increases the time (for one orbit)

allow a positive correlation

allow as one gets bigger, the other gets bigger, or vice versa

ignore they are directly proportional

1

(ii) there is no relationship / correlation

1

(d) Isaac Newton was a respected scientist who had made new discoveries before

1

[6]

Q13.

red supergiant

*do **not** accept red giant*

1

supernova

1

black hole

1

[3]

Q14.

(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]

Q15.

(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]

Q16.

(a) a protostar is at a lower temperature

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 <u>iron</u> are formed in a <u>supernova</u>

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]

Q17.

(a) (i) towards the centre of the circle

accept inwards

accept a correct description

'along the string' is insufficient

1

(ii) tension (in the string)

accept pull of the string

'the string' is insufficient

or

weight (on the end of the string)

'the student' is insufficient

'turning action' is insufficient

1

(b) (i) each may (also) affect the speed

accept results for speed

1

so only one independent variable

accept only one variable affects dependent variable

'fair test' is insufficient

'they are control variables' is insufficient

1

(ii) continuous

both required

dependent

1

(iii) reduces (absolute) timing error (for one rotation)

accept too fast to time one

or

increases / improves reliability / accuracy (for one rotation)

ignore checking for anomalous results

to work out an average is insufficient

1

(c) speed increases with centripetal force

accept positive correlation

*do **not** accept proportional*

1

(d) (i) gravitational pull (of the Earth)

accept gravity

1

(ii) **No**

both parts required – however this may have been subsumed within the reason

geostationary orbits once every 24 hours

accept a correct comparative description

1

[9]

Q18.

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

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 red giant

if both temperature and luminosity are given both must be correct

1

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

if both temperature and luminosity are given both must be correct

1

correct change in temperature **and** (relative) luminosity as Sun changes to a red 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]

Q19.

red supergiant

1

supernova

1

black hole

1

[3]

Q20.

(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]

Q21.

(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]

Q22.

(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]

Q23.

(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]

Q24.

(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]

Q25.

(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]

Q26.

(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]

Q27.

giant

1

supernova

1

neutron

1

[3]

Q28.

(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]

Q29.

(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]

Q30.

(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]

Q31.

(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]

Q32.

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

[2]

Q33.

(i) the nuclei
of hydrogen/smaller atoms
join to make helium/larger atoms

for 1 mark each

3

(ii) the mass of the large nucleus (atom) is less than the mass of the smaller nuclei (atoms)

for 1 mark

mass loss converted into energy or small mass loss given a large amount of energy

for 1 mark

2

[5]

Q34.

(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]

Q35.

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]