Mark schemes

red supergiant  
\textit{do not} accept \textit{red giant}  

supernova  

black hole  

(a) all correct  

\begin{itemize}
\item M
\item L
\item L
\end{itemize}

\textit{allow 1 mark for one correct}  

(b) speed  

\textit{accept 'velocity'}  

(c) (i) \textit{any one} from:
\begin{itemize}
\item it's natural
\item slowest
\item furthest (from the centre of the Earth)
\end{itemize}

\textit{accept 'others are artificial / made by humans'}  

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

\textit{accept 'there is a negative correlation (between them)'}

\textit{do not accept 'they are inversely proportional'}  

(a) fusion  

\textit{do not credit any response which looks like 'fission'}  

of hydrogen / H (atoms)

\textit{credit only if 1st mark point scores}  

(b) fusion of other / lighter atoms / elements

\textit{reference to big bang nullifies both marks}  

during supernova / explosion of star(s)
(c) the (available) evidence: supports this idea
   or
does not contradict this idea
   or
can be extrapolated to this idea
   or
   (electromagnetic) spectrum from other stars is similar to sun

(a) Y
    accept cannot be X as size is increasing

shows Universe expanding
    this scores if Y or Z is chosen
    accept exploding outwards

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

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

(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)
(a) Earth
Sun
Milky Way
Universe

*all four in correct order*
*allow 1 mark for Earth and Universe in correct places*

(b) equal to

1

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

*ignore implosion*

1

(ii) only very massive stars become supernova

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

(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*

(iii) increase

  accept becomes radio waves

universe continues to accelerate outwards

  accept as universe continues to expand

or

greater red-shift

(a) a protostar is at a lower temperature

  or

  a protostar does not emit radiation /energy

  as (nuclear) fusion reactions have not started

  accept heat or light for energy

(b) by (nuclear) fusion

  accept nuclei fuse (together)
  
  nuclear fusion and fission negates this mark

  of hydrogen to helium
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

8
(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

(ii) origin / start / beginning / creation
accept expansion

9
(a) (i) towards the centre of the circle
accept inwards
accept a correct description
‘along the string’ is insufficient

(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

(b) (i) each may (also) affect the speed
accept results for speed
so only one independent variable
accept only one variable affects dependent variable
‘fair test’ is insufficient
‘they are control variables’ is insufficient
(ii) continuous
    both required
    dependent

(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

(c) speed increases with centripetal force
    accept positive correlation
    do not accept proportional

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

(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

(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

(b) temperature decreases / (relative) luminosity increases as it changes to a red
giant
    if both temperature and luminosity are given both must be correct

    temperature increases / (relative) luminosity decreases as it changes to a
    white dwarf
    if both temperature and luminosity are given both must be correct
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

red supergiant

1

supernova

1

black hole

1

(a) (i) Universe began at a (very) small (initial) point

‘it’ refers to Universe

1

‘explosion’ sent matter outwards or

‘explosion’ causing Universe to expand

accept gas / dust for matter

accept rapid expansion for explosion

1

(ii) light shows a red shift

owtte

the term red shift on its own does not score a mark

1

galaxies moving away (from the Earth)

‘it’ refers to light ‘they’ refers to galaxies

accept star for galaxy

accept not accept planet for galaxy

1

(b) check reliability / validity of data

accept check data

accept collect more data

1
amend theory
or
discount the data
accept replace old theory with new theory

(c) answer involves (religious) belief
or
no / insufficient evidence
accept it cannot be tested

1

(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
(a) any one from:

- above the atmosphere
  
  *accept no atmospheric pollution*

- no clouds in the way

- no light pollution
  
  *answers in terms of being closer to space negate*
  
  *answers in terms of looking at the Earth negate*

(b) (i) red-shift

(ii) expanding

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

(ii) C

- it is furthest from the Earth
  
  *only scores if C is chosen*

- or

- it is furthest away

- or

- has the largest red-shift

- or

- it is moving (away) the fastest

(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*

(b) (i) M is closer (to the Earth) than N

(i) M is moving (away from the Earth) slower than N
(ii) 520

*an answer between 510 and 530 inclusive gains 1 mark*

(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*

(c) wavelength is decreased

frequency is increased


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

*accept nebula for dust and gas*

*accept hydrogen for gas*

*mention of air negates this mark*

pulled together by:

- gravitational attraction
  
  or

- gravitational forces
  
  or

- gravity

(b) forces (in the star) are balanced

*accept equal and opposite for balanced*

*accept in equilibrium for balanced*
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

17

(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

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(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

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(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