

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) furthest from the Earth

accept galaxy for stars

or

it is moving away the fastest

ignore reference to universe expanding

1

(c) (i) all matter compressed to / starts at / comes from a single point
*do **not** accept increasing gravitational pull*

accept everything / the universe for all matter

1

(massive) explosion sends matter outwards

accept explosion causes universe to expand

*ignore explosion creates the universe **or** further reference to star / Earth formation*

1

(ii) check validity / reliability of the evidence

or

change the theory to match the new evidence

accept comparison of new and old evidence

1

[6]

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

1

(galaxy) moving away 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]

- 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

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]

- 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]

- 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]

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

- (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]

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]

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) $1.2 \times 10^7 / 12\,000\,000$
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

(iii) (Universe is) expanding

1

[9]