Red shift and the Universe

Mark Scheme

Name: _____

Class: _____

Date: _____

Time: **63 minutes**

Marks: **63 marks**

Comments:

Mark schemes

1 (i) an enormous explosion causing matter to spread from one point

1

(ii) it is increasing **or** expanding

1

[2]

2 (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]

3 light from (distant) galaxies shows shift to red end of spectrum
wavelength increased explained by galaxies moving away from us
more distant galaxies have greater recession speed seen in all directions
suggests universe is **expanding** any sensible reference to similar effect on Earth

any 6 for 1 mark each

[6]

4 (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]

5 (a) 12.7

1

(b) the further away, the faster it is moving away

1

(c) all galaxies have been moving away from us for approximately the same length of time

1

therefore they were all probably produced at the same time

1

[4]

6 (a) (i) origin of the Universe

accept (why) the Universe is expanding

*do **not** accept origin of the Earth*

1

(ii) provided more evidence to support the 'Big Bang' theory

1

(b) (i) red-shift

accept Doppler (shift)

1

(ii) (at the point in time shown the observed spectrum from) star A (shows it) is moving away from the Earth

accept star A is moving away

star A shows red-shift is insufficient

1

light from star B shows a decrease in wavelength

accept light from star B shows blue-shift

accept light from star B shows an increase in frequency

1

so star B is moving towards Earth

1

[6]

7

(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]

8

(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]

9

(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

(iii) (Universe is) expanding

1

[9]

10 (a) *answer includes items*:
B D G

each for 1 mark

3

(b) *answer includes items*:
A E F [allow H here for a <u>further</u> mark]

each for 1 mark

3

(c) answer includes items:
C H* I J

*each for 1 mark [*unless already credited in (b)]*

4

(d) ideas that:

- lucky in the sense that they weren't initially looking for the background radiation [others were!!!]
- more than just lucky in that they investigated it and didn't just ignore it

each for 1 mark

[NB Reference to letters only, not a prose answer, gain only ½ mark each. Total rounded down]

2

[12]