Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Mark Schemes

Q1.

(a) (i) $d = \frac{50 \times 10^6}{3.26} = 15.3 \times 10^6$ (pc)

(ii) (use of $v = Hd$ gives) $v = 65 \times 10^{-6}$ (km s^{-1} pc^{-1}) $\times 15.3 \times 10^6$ **(1)**

≈ (1000 km s^{-1})

(iii) (use of $\frac{\Delta\lambda}{\lambda} = -\frac{v}{c}$ gives) $\Delta\lambda = \frac{1000 \times 10^3}{3 \times 10^8} \times 656.3$ (nm) = 2.19 (nm) **(1)**

(allow C.E. for value of v from (ii)

λ_{galaxy} = 656.3 + 2.19 = 658.5 nm **(1)**

4

(b) for the furthest point of the Universe, $d = \frac{c}{H}$ **(1)**

age of Universe = $\frac{d}{c} = \frac{1}{H}$ **(1)**

[or use of $v = Hd$ and $t = \frac{d}{v}$ **(1)**

if all started from same point t = age of Universe = $\frac{1}{H}$ **(1)**]
assumption: that H remains constant

3

[7]

Q2.

(a) $\frac{\lambda}{20}$ = 0.05 and λ = 1.0 m **(1)**

1

(b) $\theta = \frac{\lambda}{D}$ **(1)**

$= \frac{0.06}{76} = 7.9 \times 10^{-4}$ rad **(1)**

2

(c) advantage 1:

power $\propto D^2$ $\therefore$ much more power detected by

larger diameter telescope **(1)**

ratio of power detected = $\left(\frac{76}{13}\right)^2$ = 34 **(1)**

advantage 2:

resolving power $\propto$ D $\therefore$ larger diameter has greater

resolving power **(1)**

ratio of resolving power = $\frac{76}{13}$ = 5.8 **(1)**

(inverse accepted if angle referred to)

4

[7]

Q3.

(a) (i) apparent magnitude: brightness as seen from Earth **(1)**

(ii) absolute magnitude: inherent brightness or brightness seen from 10 pc **(1)**

2

(b) (i) distance = $\frac{470}{3.26}$ = 144 (pc) **(1)**

(ii) $m - M = 5 \log \left(\frac{d}{10}\right)$ **(1)**

$m = -4.2 + 5 \log \left(\frac{144}{10}\right)$ = 1.6 **(1)**

(allow C.E. for value of *d* from (i))

(iii) Elnath **(1)**
reason: (either by calculation or reference to – 4.2 being brighter than – 3.2)
Elnath is actually dimmer than Bellatrix **(1)**
but appears to have same brightness, so must be closer **(1)**

6

[8]