Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

(a) Quasars are produced by (supermassive) black holes. ✔

These black holes are at the centre of (active) galaxies (active galactic nuclei.) ✔

2

(b) Using v = cz gives

$v = 3 \times 10^8 \times 0.0415$ ✔ $= 1.25 \times 10^7 = 1.25 \times 10^4$ kms^{-1}

Using 1pc = 3.26 lyr

$d = 5.81 \times 10^8$ lyr $= 5.81 \times 10^8/3.26$ ✔ $= 1.78 \times 10^8$ pc

$= 1.78 \times 10^2$ Mpc ($= 5.5 \times 10^{24}$ m)

Using v = Hd

($H = v/d = 1.25 \times 10^4/1.78 \times 10^2 = 70$ kms^{-1} Mpc^{-1})

Age of Universe = 1/H = d/v ✔

$= 5.81 \times 10^8 \times 9.47 \times 10^{15}/1.25 \times 10^7 = 4.42 \times 10^{17}$ s ✔

The first mark is for use of zc.
The second mark is for a calculation of d.
The third mark is for using the idea that the age of the Universe is 1/H.
The fourth mark is for the answer.
Allow own H for 3rd and 4th marks.

4

(c) Both quasar and galaxy should have same brightness (and therefore similar received power) ✔

Use of Inverse square law eg

Power of quasar/(distance to quasar)^2 = power of galaxy / (distance to galaxy)^2 ✔

Or $1000/d^2 = 1/1$

So distance to quasar = $(1000)^{½}$ = about 30 times greater than distance to galaxy ✔

The first mark is for relating the similar "brightness". Accept intensity.
Accept in form of equation linking quasar and galaxy.

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The second mark is for applying the inverse square law. Simply quoting it does not get this mark.

The final mark is for coming to a valid conclusion related to the distance to the quasar compared to the distance to the galaxy.

Do not accept answers involving square roots.

These are standalone marks.

1
2

[9]

Q2.

(a) B brighter with support (eg diameter of B bigger) ✔

(The brightness of the image is determined by the collecting power and) collecting power related to D^2 or area ✔

Calculation of areas or d^2 ✔

Allow 'reflecting telescope' B

An unsupported answer gains no marks

Ignore references to resolving power or unit W

1

(b) Two objects will just be resolved when the first minimum/edge of the airy disc in the diffraction pattern of one image ✔

Correct diagrams can gain both marks

1

Coincides with central maximum/centre of the airy disc of the other. ✔

Ignore references to formula

1

(c) B is better because it has a larger diameter ✔

Minimum angular separation/angular resolution depends on 1/D

No mark awarded for an unsupported answer

The first is for arguing that B is better due to larger diameter

The second mark is for identifying the relationship between angular resolution and diameter

Correct calculations can gain both marks, using any wavelength

Max 2

[7]

Q3.

(a) Absolute magnitude scale gettingg more negative going up

and

Time scale with 0 along axis, going up to between 10 and 400 ✔

The first mark is for the scales

Line drawn going up and down, with LHS steeper than steepest part of RHS ✔

The second is for the curve

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Line drawn increasing quickly with peak at absolute magnitude between -18 and -20 ✔

The third is for the value of the peak

3

(b) Object whose absolute magnitude is known (and whose apparent magnitude can be measured.) ✔

Do not allow fixed or constant for 'known'

But condone predictable

Do not allow 'directly measured'

Condone intrinsic or inherent brightness, or luminosity for absolute magnitude

1

(c) Measurements of supernovae do not agree with predictions (from Hubble's Law) ✔

1

So Universe must be expanding at increasing rate/accelerating ✔

1

(Controversial as) no known energy source for expansion or reference to dark energy ✔

1

[7]

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