

Name of the Student: _____

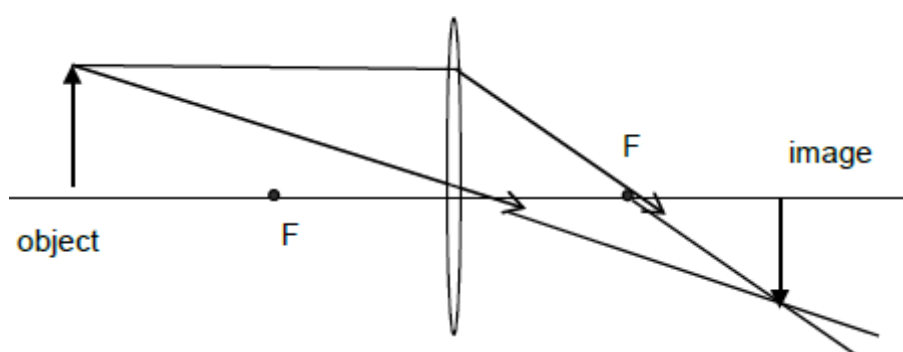
Max. Marks : 25 Marks

Time : 25 Minutes

Mark Schemes

Q1.

(a)



Arrows are not essential

Condone only one focus if it is the one used for the construction ray.

Construction ray must have focus labelled to get the mark.

Lose the second mark if the image is same size or magnified

Image line is needed for second mark.

One construction ray correct ✓

Other construction ray to form diminished image ✓

(The parallel construction ray must pass through a labelled F)

Object, image labelled correctly. ✓

3

(b) $u = 128 \text{ cm}$

Allow c.e. for incorrect v

$$v = 200 - 128 = 72 \text{ cm} \quad \checkmark$$

Condone u and v the wrong way round.

$$\text{Use of } \frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\text{To give } \frac{1}{f} = \frac{1}{128} + \frac{1}{72}$$

$$f = 46 \text{ cm} \quad \checkmark$$

2

(c) Objective.

No credit for unsupported answer.

As $M = f_o / f_e$, for magnification $f_o > f_e$

As telescope length = $f_o + f_e$, lens must be objective (so that telescope not too long.) ✓

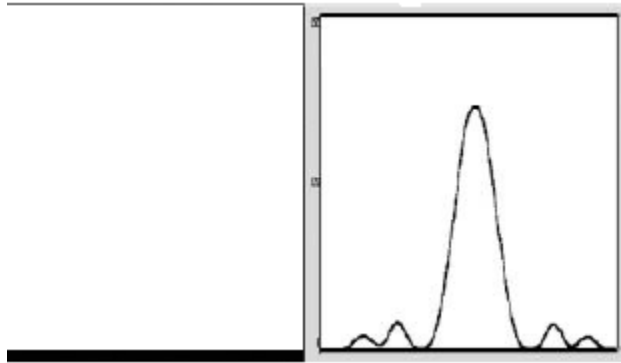
2

[7]

Q2.

- (a) (i) central maximum at least twice the height of adjacent maxima ✓
Allow graph to be above angle axis

Subsequent narrower maxima ✓



Any further maxima should not get bigger.

2

- (ii) Two sources will be (just) resolved if the central maximum of the diffraction pattern of one coincides ✓

Central max and first min may be labelled on diagram in ai

with the first minimum of the other. ✓

If they use the term 1st maximum it must be clear that it is the central maximum

Second mark is for correct part of the second diffraction pattern.

Clearly labelled diagram can get both marks.

2

- (b) Use of $R_s = 2GM/c^2$

*Allow ce for **one** from:*

missing out million; missing out mass of Sun; square in equation, but no square of speed of light in calculation

to give
$$R_s = 2 \times 6.67 \times 10^{-11} \times 4.1 \times 10^6 \times 2 \times 10^{30} / (3 \times 10^8)^2 \quad \checkmark$$
$$= 1.2 \times 10^{10} \text{m} \quad \checkmark$$

2sf ✓

Sf mark stands alone but must be a number (not just stated 2 sf)

3

- (c) (i) use of $\theta = \lambda/D$

The first mark is for calculating the wavelength

to give
$$\theta = (3 \times 10^8 / 230 \times 10^9) \quad \checkmark / 5000 \times 10^3$$

$$= 2.6 \times 10^{-10} \text{ (rad)} \quad \checkmark$$

The second mark is for the use of the equation to give the final answer

Allow c.e. for an a.e. in the first mark.
If frequency used treat as p.e. – no marks

2

(ii) use of $s = r\theta$

First mark is for the angle subtended (5.12×10^{-11})

to give $\theta = 5 \times 1.2 \times 10^{10} / (25\,000 \times 9.46 \times 10^{15}) \quad \checkmark$
 $= 2.5 \times 10^{-10} \text{ (rad)} \quad \checkmark$

Second mark is for showing that this is $5 \times$ answer to c(i).

which is (approximately) the answer to ci

Alternatives:

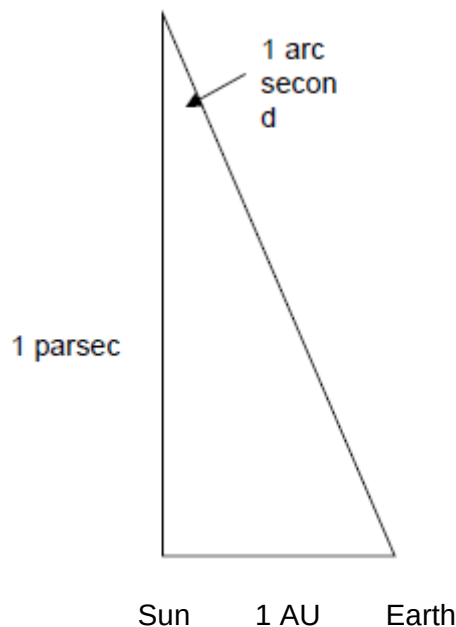
Calculate size of object that could just be resolved at this distance, and showing that this is $5 \times$ radius of black hole.

2

[11]

Q3.

- (a) Diagram showing Earth, Sun and star, with 1AU clearly marked, and 1 arc second angle at the star, with distance between Sun and star as one parsec.



1 pc is the distance at which 1AU subtends an angle of 1 arc second

A diagram with fewer labels can be supported by a correct statement.

If either the angle or base are incorrect, 1 max.

Right angle does not need to be at the Sun. Triangle does not need to be a right angle.

Parsec could be the hypotenuse.

Ignore writing if the diagram is correct.

Base can be either Sun, Earth, or 1AU.

No diagram, 1 max.

2

(b) $d = 1 / p$

$= 1 / 0.002 \text{ parsec}$

$= 500 \text{ pc} \quad \checkmark$

$$= 500 \times 3.1 \times 10^{16} \text{ m}$$

$$= 2 \times 10^{19} \text{ m} \quad \checkmark \quad 1\text{sf} \quad \checkmark$$

Allow ce for d in pc.

If $\tan(0.002 / 3600) = 1\text{AU} / d$ used, allow ce for wrong value of 1AU.

Allow use of tan or sin.

3

- (c) (i) Two components are 178 pc apart
or

Distance apart too great

(for gravity to have any significant effect between them)

*Penalise attempts to hedge bets by references to apparent magnitude
or class.*

1

- (ii) More distant star will not appear to move as much as nearest star (against the fixed background)

Allow discussions involving parallax.

Give credit to correct diagram.

1

[7]