Name of the Student:_____
Max. Marks : 25 Marks **Time : 25 Minutes**

Mark Schemes

Q1.

(a) 2 rays brought to red focus and two rays brought to blue focus on PA

Blue ray focus closer to lens than red ray ✔

Accept one ray of each colour provided they pass through the PA
Accept rays that stop at the PA
Accept violet for blue
Accept any two colours in the right order
Accept initials for colours
Accept hand-drawn rays unless obviously curved
Rays can bend at centre of lens or at either (or both) surfaces(s)

1

(b) Concave convex ✔

1

(c) The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer. Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.

Mark	Criteria
6	All 4 aspects analysed, including calculation of resolving power/ratio of resolving powers for two telescopes. 6 marks can be awarded even if there is an error and/or parts of one aspect missing.
5	A good attempt to analyse 3 aspects, which must include quantitative or algebraic discussion of resolution **or** collecting power
4	Two aspects successfully discussed and one partially discussed. Whilst there will be gaps, there should only be an occasional error.
3	Two aspects discussed, or one discussed and two others covered partially. There may be several errors and omissions in the discussion.
2	Only one aspect discussed successfully, or makes a partial attempt at more than one

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	aspect.
1	None of the four aspects covered without significant error; at least one relevant comment.
0	No relevant analysis.

The following statements are likely to be present.

A Structure

Similarity: both use reflecting (parabolic) surface.L1

Difference: Radio – no secondary reflector, detector placed at focal point of primary, wire mesh for dish L1

Treat as neutral: radio telescope arrays, optical only during dark

B Positioning

Similarity: both capable of being on Earth's surface as little absorption by atmosphere at optical or radio wavelengths. The presence of both on the planet can be inferred if reference is made to altitude. L2

Difference: Light pollution requires optical telescopes to be away from centres of population; distortions due to atmosphere require optical to be high up; obscuration by clouds requires optical to be high up or in dry places/radio telescopes need to be located in a (radio) quiet area/radio can be at lower altitude. L2

Treat as neutral: comments about placing either A or B in space,

C Collecting power

D^2: much larger D for radio means much greater collecting power /8× greater (but sources tend to be very weak) compared to optical.

CPB/CPA = $110^2/39.3^2 = 7.8$

D Resolving power

λ/D; B large D but extremely large λ means generally low resolving power compared to A.

So A likely to provide more detailed image.

Evidence of calculations, eg

For optical min λ angle = 8.9×10^{-9} rad

For radio min λ angle = 2.3×10^{-5} rad

(could compare max λ angle; 4.6×10^{-8} and 9.1×10^{-3})

6

[8]

Q2.

(a) Scale labelled from +15 up to –10 ✔

+15 bottom of white dwarves at the maximum. –10 top of giants at the lowest.

1

(b) S between 5000 K and horizontal section of bottom line of main sequence. ✔$_1$

Within main sequence and at 'correct' abs mag 5 ✔$_2$

Marks are independent

For the second mark the S should be closer to +5 than 0 or +10 on 'correct' scale.

If only "S" is seen, assume middle of the "S". If a clearly labelled dot or

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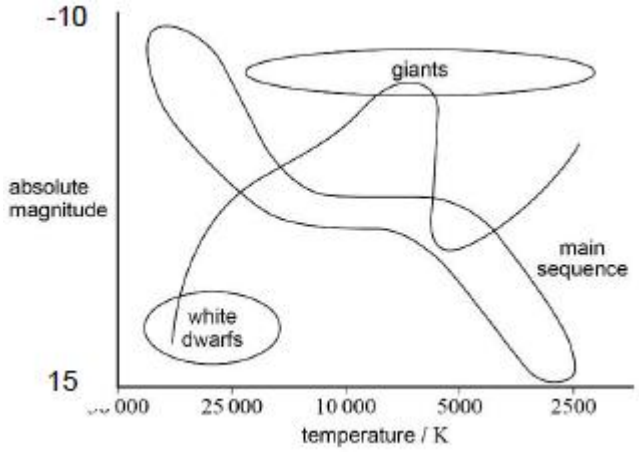
× *is seen, that should be used for marking.*

2

(c) Line drawn coming from the right to S, ✔$_1$

Line drawn from S up to giants and round to white dwarfs ✔$_2$



Accept convoluted lines. Must touch giants and dwarves but does not need to go into area.

Arrows are not required, but penalise any that go in the wrong direction with max 1.

2

(d) Point P to the right and above their S ✔

Accept P on same horizontal level as S

1

(e) Absolute magnitude of supernova (is about –20), beyond scale of HR diagram OR

Supernova is shortlived / varies so cannot be assigned a position ✔$_1$

Temperature of a supernova (peak) is too high (greater than 50 000 K) ✔$_2$

Black hole – escape velocity greater than c

OR

no light emitted /absolute magnitude too dim to fit on scale ✔$_3$

Temperature of a black hole would be too low (less than 2500 K ✔$_4$

Accept "too hot"/"too cold" for temperature

Insist on "absolute magnitude" not "brightness".

Condone: A supernova does not last very long.

Do not accept 'absolute magnitude would be zero'

Max 3

Max 3

[9]

Q3.

(a) D = 0.305 m ✔

Use of $\theta = \lambda / D$

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To give $\lambda = 1.8 \times 10^{-6} \times 0.305$

$= 5.5 \times 10^{-7}$ m ✔

The first mark is for the correct D.
The second mark is for the final answer.
Allow 1 max for one POT error.
Allow ecf for incorrect D unless 5.03 m used.
Award full credit if factor of 1.22 included (to give 4.5×10^{-7} m).

1
1

(b) $M = 3.2 \times 10^{-4} / 1.8 \times 10^{-6}$ ✔

=178

Use of M = fo/fe to give

fe = fo/M = 5.03/178 ✔

= 0.028 m ✔

The first mark is for evidence of use of angular magnification equation.
The second mark is for evidence of the use of the magnification focal lengths equation.
The third is for the final answer. Do not credit 0.03.
Allow ecf for M.
Allow 2 max for one POT error.

1
1
1

(c) Either

Telescope can resolve objects down to 1.8×10^{-6} rad

At 3.0×10^{4} km, this angle is subtended by an object of size 3.0×10^{4} km $\times 1.8 \times 10^{-6}$ rad = 54 m ✔

This is 54/325 = 1/6th size of asteroid ✔

would not be suitable for viewing detail ✔

OR

Angular size of asteroid = $325/3 \times 10^{7} = 1.1 \times 10^{-5}$ ✔

As $1.1 \times 10^{-5} > 1.8 \times 10^{-6}$ asteroid can be seen / $1.1 \times 10^{-5} / 1.8 \times 10^{-6}$ 6 times minimum angular resolution ✔

Too small for detail to be seen ✔

The first mark is for the calculation.
The second mark is for the comparison. Allow ecf. The angular resolution of the telescope should be quoted.
The third mark is for reaching the judgement.
This mark cannot be given if simple statement that asteroid can be seen.
Condone correct use of sin and tan.

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Full credit can also be given if they use magnification and compare angular size with the resolution of the eye.

1
2

[8]

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