

1. (a) power (received) proportional to area **(1)**  
collecting area proportional to  $d^2$  **(1)** 2
- (b) energy per unit area at dish =  $\frac{7.5 \times 10^{-16}}{\pi(60)^2}$  **(1)**  
total energy =  $\frac{7.5 \times 10^{-16}}{\pi(60)^2} \times 4\pi(2.5 \times 10^{28})^2$  **(1)**  
=  $5.2 \times 10^{38}$  W **(1)** 3 **[5]**
2. (a)  $\frac{\lambda}{20} = 0.05$  and  $\lambda = 1.0$  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)**  
larger 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]**

3. 3 marks for any of the following 3 features

- compared with optical reflecting telescopes, radio telescopes:
- are much longer
- have a much lower resolving power
- are not as affected by the atmosphere and so their positioning is less critical
- have only one reflecting surface rather than two
- have a similar structure in that a concave reflecting surface reflects the em radiation to a detector at the focal point

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**explanations of resolving power**

radio telescopes have a lower resolving power:

because the ratio of wavelength to telescope diameter is larger (1)

because radio wavelengths are very much larger than optical wavelengths (even though the diameters of radio telescopes are larger) (1)

**explanations of collecting power:**

collecting power depends on the area of the objective which is much larger for radio telescopes (depends on the square of the diameter) (1)

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[6]