CHAPTER 22

Observing our universe

Answers to revision questions

1. (a) For wavebands other than light, the atmosphere acts as a shield, absorbing or reflecting most or all of the radiation from space. The exception to this is in the radio waveband for frequencies between about 300 MHz–300 GHz, which the atmosphere does not absorb or reflect.

   (b) Astronomical observatories have been placed in orbit around the Earth, allowing the detection and analysis of the previously unavailable wavebands.

2. Changing from a 20 cm to a 40 cm diameter lens is a doubling in diameter and hence a quadrupling in area.

   The resolution is given by $R = \frac{2.1 \times 10^5 \lambda}{D}$, so that a doubling in D yields a halving of R, the angle of resolution, so that objects with half the previous angle of separation can now be viewed.

   The sensitivity is proportional to the light gathering power, which in turn is proportional to the area of the primary lens. The new sensitivity is four times the previous value.

3. In adaptive optics, the way in which the atmosphere is affecting light from space is analysed in real time by a wavefront sensor, which directs corrections to the telescope's primary mirror, again in real time. The corrections can be made at up to 100 times each second to minimise the 'seeing' by the atmosphere.

4. Adaptive optics uses rapid, real-time corrections to the telescope's mirror, whereas active optics uses a slower feedback system to adjust the telescope's mirror for deformities caused by temperature change and shape variations.

5. Even the largest single radio astronomy dishes have a comparatively low resolving ability due to the longer wavelengths associated with radio waves. Interferometry effectively lengthens the diameter of the telescope so that the observations might have comparable resolution to visible light telescopes observing wavelengths seven orders of magnitude (i.e. 10^7) times shorter than radio waves.

6. Refer to websites such as NASA (http://www.nasa.gov) as well as those listed in this chapter.

7. As for question 6, there are numerous websites with detailed information on observatories that exist now or are in the planning stages.

8. As for the previous questions, there are numerous sites that give background information on this topic. The non-stick frying pan, using teflon, is a by-product of the space era. The demands of space exploration have led to the need to develop better communications, heat shields, safety devices etc. A major benefit to society of space research has been in the field of remote sensing and observing: weather satellites, ozone monitoring, pollution monitoring, mineral exploration, search and rescue systems (EPIRBs) and mapping satellites, to name a few. GPS navigation is possible now because of the ability to send satellites into set orbits around the Earth.