2-11. With the aid of a diagram, describe a refracting telescope.

The diagram at the right displays the principal components of a refractor. Parallel light rays from a star enter the objective lens of the refractor where they are bent. As a consequence they intersect at the refractor’s focal plane, beyond which they diverge and enter an eyepiece lens where they are again bent and rendered parallel. The lens of the observer’s eye then focuses them into an image upon the retina of the observer.

2-19. What is a charge coupled device (CCD)? Why have CCDs replaced photographic film [plates] for recording astronomical images?

A CCD is an electronic device made of a semiconductor wherein adjacent small light sensitive sensors or pixels each records the number of photons which fall upon it making it possible to capture a picture with a high degree of resolution. CCDs have replaced photographic plates because they are much more sensitive to light than such a plate, detecting about 80 per cent of the photons which fall upon them compared with less than 2 per cent for the best photographic emulsions.

2-20. Why can radio astronomers make observations at any time during the day, whereas optical astronomers are mostly limited to observing at night. (*Hint: Does your radio work any better or worse in the daytime than at night?)

The daytime sky is very bright in visible light, totally overwhelming the starlight which is present in the daytime sky just as it is at night. However at radio wavelengths the sky is dark both during the day and at night so radio astronomers have no need to limit their observations to nighttime hours.

2-21. Why must astronomers use satellites and Earth-orbiting observatories to study the heavens at X-ray and gamma-ray wavelengths?

The earth’s atmosphere is totally opaque to X-rays and gamma-rays. Such radiation does not reach the surface of the earth and must therefore be observed from above earth’s atmosphere.