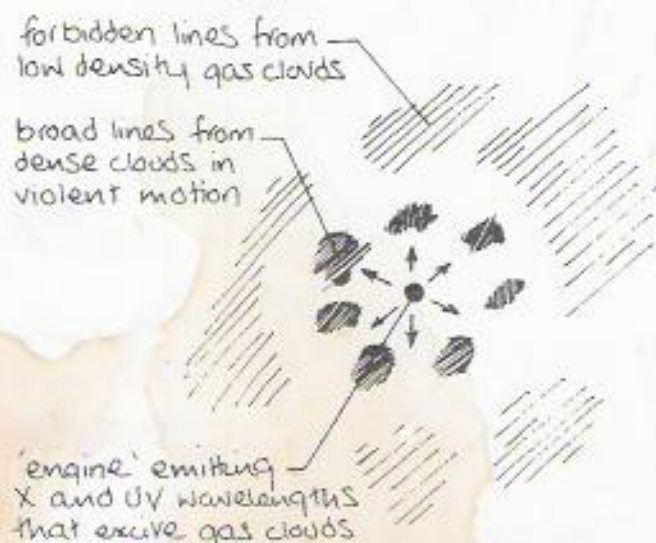


(b) Model of an AGN [Figures 3.26–3.29]



Question 9

[Book 4 subsections are given.]

(a) The three problems are

- the homogeneity of the density of matter [or energy] throughout the Universe
- the isotropy of the microwave background radiation
- the density being close to critical (within a factor of 10).

The first two are problems because they imply that well separated regions of the Universe have managed to equalize their densities and temperatures, even though it would appear that they could not have yet been in contact with each other. The third is a problem because even a tiny initial difference from the critical density would have been enormously magnified by the cosmological expansion. [2.6.1–2.6.3]

(b) The inflationary model proposes that soon after $t = 0$ [more precisely, at $t = 10^{-35}$ s, though the figure would, at most, carry only a bonus mark] there was a period of exceptionally rapid expansion called inflation. This occurred because at that time the temperature [or energy] had fallen just to the point where the strong nuclear force separated from the electro-weak force, causing a phase change.

In the inflation scenario, before the inflation event, densities and temperatures were equalized throughout what is now the observable Universe. Inflation then expanded space at speeds far in excess of the speed of light, and this expansion was then followed by the slower (continuing) cosmological (Hubble) expansion. Thus, because of the inflationary expansion, regions that are too far apart to have been in contact since, *were* in contact earlier. This solves the first two problems.

The third problem is solved because inflation is accompanied by the production of matter [or energy] to an extent that raises the density to a value exceedingly close to the critical value. [A geometrical argument, as in Figure 2.11, would do as well.]

[Note that this is the nearest thing to an essay-type question that you are likely to encounter. It is, however, a very short essay in two clear parts.]

[2.6.4]