926.

Problem 45.39E (HRW)

According to Wien's law the relation between temperature T of a cavity radiator and the wavelength $\lambda_{\max}$ at which it radiates most strongly is

$$\lambda_{\max} T = 2898\ \mu\text{m.K}\ .$$

The microwave background radiation peaks in intensity at a wavelength of 1.1 mm. (a) *We have to find the temperature to which it corresponds*. (b) *About* 300,000 y *after the Big Bang, the universe became transparent to electromagnetic radiation*. *Its temperature then was about* 10^5 K. *We have to find the wavelength at which the background radiation was then most intense*.

Solution:

(a)

According to Wien's law the relation between temperature T of a cavity radiator and the wavelength $\lambda_{\max}$ at which it radiates most strongly is

$$\lambda_{\max} T = 2898\ \mu\text{m.K}\ .$$

The microwave background radiation peaks in intensity at a wavelength of 1.1 mm. Therefore, from Wien's law we note that the temperature of the universe then was

$$T = \frac{2898 \times 10^{-6}\ \mu\text{m K}}{1.1 \times 10^{-3}\ \mu\text{m}} = 2.63\ \text{K}.$$

(b)

About 300,000 y after the Big Bang, the universe became transparent to electromagnetic radiation. Its temperature then was about 10^5 K. The wavelength at which the background radiation was then most intense was

$$\lambda_{\max} T = 2898\ \mu\text{m.K},$$

$$\lambda_{\max} = \frac{2898\ \mu\text{m.K}}{10^5\ \text{K}} = 28.98\ \text{nm}.$$