

## 9.7.1 The rainbow

The rainbow is an example of the dispersion of sunlight by the water drops in the atmosphere. This is a phenomenon due to combined effect of dispersion, refraction and reflection of sunlight by spherical water droplets of rain. The conditions for observing a rainbow are that the Sun should be shining in one part of the sky (say near western horizon) while it is raining in the opposite part of the sky (say eastern horizon). An observer can therefore see a rainbow only when his back is towards the Sun.

In order to understand the formation of rainbows, consider Fig. 9.25(a). Sunlight is first refracted as it enters a raindrop, which causes the different wavelengths (colours) of white light to separate. Longer wavelength of light (red) are bent the least while the shorter wavelength (violet) are bent the most. Next, these component rays strike the inner surface of the water drop and get internally reflected if the angle between the refracted ray and normal to the drop surface is greater than the critical angle ( $48^\circ$  in this case). The reflected light is refracted again when it comes out of the drop, as shown in the figure. It is found that the violet light emerges at an angle of  $40^\circ$  related to the incoming sunlight and red light emerges at an angle of  $42^\circ$ . For other colours, angles lie in between these two values.

Figure 9.25(b) explains the formation of primary rainbow. We see that red light from drop 1 and violet light from drop 2 reach the observer's eye. The violet from drop 1 and red light from drop 2 are directed at level above or below the observer. Thus the observer sees a rainbow with red colour on the top and violet on the bottom. The primary rainbow is a result of three-step process, that is, refraction, reflection and refraction.

**PHYSICS**

Formation of rainbows  
<http://www.eo.ucar.edu/rainbows>  
<http://www.atoptics.co.uk/bows.htm>

