19. (a) We use the Rayleigh criteria. If L is the distance from the observer to the objects, then the smallest separation D they can have and still be resolvable is $D = L\theta_{\mathrm{R}}$, where θ_R is measured in radians. The small angle approximation is made. Thus,

$$D = \frac{1.22L\lambda}{d} = \frac{1.22(8.0 \times 10^{10}\,\mathrm{m})(550 \times 10^{-9}\,\mathrm{m})}{5.0 \times 10^{-3}\,\mathrm{m}} = 1.1 \times 10^{7}\,\mathrm{m} = 1.1 \times 10^{4}\ \mathrm{km}\ .$$

This distance is greater than the diameter of Mars; therefore, one part of the planet's surface cannot be resolved from another part.

(b) Now $d = 5.1\,\mathrm{m}$ and

$$D = \frac{1.22(8.0 \times 10^{10}\,\mathrm{m})(550 \times 10^{-9}\,\mathrm{m})}{5.1\,\mathrm{m}} = 1.1 \times 10^{4}\,\mathrm{m} = 11\ \mathrm{km}\ .$$