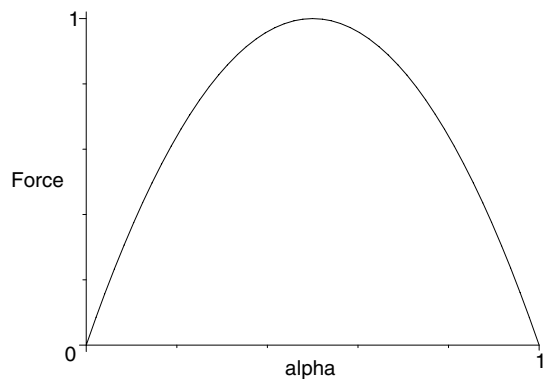


30. (a) The two charges are $q = \alpha Q$ (where α is a pure number presumably less than 1 and greater than zero) and $Q - q = (1 - \alpha)Q$. Thus, Eq. 22-4 gives

$$F = \frac{1}{4\pi\epsilon_0} \frac{(\alpha Q)((1 - \alpha)Q)}{d^2} = \frac{Q^2\alpha(1 - \alpha)}{4\pi\epsilon_0 d^2} .$$

- (b) The graph below, of F versus α , has been scaled so that the maximum is 1. In actuality, the maximum value of the force is $F_{\max} = Q^2/16\pi\epsilon_0 d^2$.



- (c) It is clear that $\alpha = \frac{1}{2}$ gives the maximum value of F .
 (d) Seeking the half-height points on the graph is difficult without grid lines or some of the special tracing features found in a variety of modern calculators. It is not difficult to algebraically solve for the half-height points (this involves the use of the quadratic formula). The results are

$$\begin{aligned} \alpha_1 &= \frac{1}{2} \left(1 - \frac{1}{\sqrt{2}} \right) \approx 0.15 \quad \text{and} \\ \alpha_2 &= \frac{1}{2} \left(1 + \frac{1}{\sqrt{2}} \right) \approx 0.85 . \end{aligned}$$