Problem 1.

A shallow spherical shell (Radius = 80 ft, ϕ=30°) is subject to a uniform load of 40 lb / ft^2 (includes dead, live load and safety factors). The shell will be supported either by a tension ring at its bottom or by buttresses, located approximately every 8 ft.

a. If buttresses are chosen, how many buttresses will be required to support the sphere? (based on geometry)

r = R x sin30°, r = 80 x 0.5 = 40 ft
length of circle: 2 π r = 2 x 3.14 x 40 = 251.33 ft
number of buttresses: 251.33/8 = 32; each buttress every 7.85 ft

b. What will be the horizontal, vertical and resultant force that each buttress will carry?

N_ϕ= Rw/(1+cos30°)=80 x 40 / (1+0.866) = 1,715 lb/ft
Every buttress: 1,715 lb/ft x 7.85 ft = 13,469 lb total force
Horizontal component: 13,469 cos30° = 11,664 lb
Vertical component: 13,469 sin30° = 6,734 lb

c. What will be the axial force in the cable, if a cable is used for the tension ring?

T=p_T r = N_ϕ cos30° 40'= 1,715 x 0.866 lb/ft x 40 ft = 59,405 lb