Answer on Question #65018-Physics-Other

Heinz Doofenshmirtz uses his Static Electro-Amplifinator to put a charge on Balloony1 and an identical ordinary balloon (the same charge is applied to each balloon). The two balloons then repel one another so that when Doofenshmirtz holds them by their strings (the length of string for each balloon is 85.0 cm) the total angle between the balloons is 28.0∘. The helium in each balloon provides a net buoyant force of 1.35×10−1 N directly upward (to be clear, the difference between the buoyant force up and the gravitational force down is 1.35 × 10−1 N for each balloon). What is the charge on each balloon?

Solution

We have:

$$\tan 28.0° = \frac{F_{el}}{F_b - W}.$$

$$F_{el} = \frac{kq^2}{r^2}$$

$$r = 2l \sin 28.0°$$

Thus,

$$(F_b - W) \tan 28.0° = \frac{kq^2}{4l^2 \sin^2 28.0°}$$

The charge on each balloon is

$$q = \frac{4l^2}{k} \sin^2 28.0° (F_b - W) \tan 28.0° = \frac{4(0.85)^2}{(8.99 \cdot 10^9)} \sin^2 28.0° (0.135) \tan 28.0° = 5.09 \cdot 10^{-12} \, C.$$

Answer: $5.09 \cdot 10^{-12} \, C$.