Calculate the charge on the oil drop

When a charged oil drop was allowed to fall in air in the absence of any electric fields, it rapidly reached a terminal velocity of 6.5×10^{-5} m/s. The drop fell between two parallel horizontal plates held 8.0mm apart. When the voltage across the plates was 430V, the drop was observed to remain stationary.

Calculate the charge on the oil drop. You may assume that the drag force on the oil drop was given by $\boldsymbol{D = 6\mu\pi rv}$ where μ is the dynamic viscosity of air (1.81×10^{-5} kg/ms), $\boldsymbol{r}$ is the radius of the drop and $\boldsymbol{v}$ is its speed. The oil drop is spherical, and the oil has a density of 890kg/m^3.

HINT 1 – during terminal velocity, the forces on the oil drop must be in balance. Use the information above to write a formula relating the radius of the drop to the terminal velocity. Thus work out the radius of the oil drop.

Now that you know the drop's radius, you can work out its mass.

HINT 2 – when the drop is held stationary by the electric field, write an equation expressing the equality of the electric force and the weight of the drop. Use this to work out the charge on the drop.