Two equal drops are falling through air with a steady velocity of 5cm/s .if two drops coalesce, then new terminal velocity will be ?

Solution:

Let r be the radius of each drop. The (steady) terminal velocity v of a drop of radius r and density ρ, falling through air is given by

$$\mathrm{v} = \frac{2}{9} \cdot \frac{\mathrm{r}^2(\rho - \sigma)\mathrm{g}}{\eta},$$

where σ is density and η the viscosity of air. Thus

$$\mathrm{v} \propto \mathrm{r}^2 = \mathrm{kr}^2$$

Now, the volume of each drop $\left(\frac{4}{3}\right)\pi\mathrm{r}^2$.

The volume of coalesced drop $= 2 \times \left(\frac{4}{3}\right)\pi\mathrm{r}^2 = \left(\frac{4}{3}\right)\pi\left(2^{\frac{1}{3}}\mathrm{r}\right)^3$

Radius of the coalesced drop $= (2)^{\frac{1}{3}}\mathrm{r}$

Hence, the terminal velocity of the coalesced drop is:

$$\mathrm{v}' = \mathrm{k}\left((2)^{\frac{1}{3}}\mathrm{r}\right)^2 = (2)^{\frac{2}{3}}\mathrm{kr}^2 = (2)^{\frac{2}{3}}\mathrm{v} = (2)^{\frac{2}{3}} \cdot 5\,\frac{\mathrm{cm}}{\mathrm{s}} = 7.94\,\frac{\mathrm{cm}}{\mathrm{s}}$$

Answer: new terminal velocity will be $\mathrm{v}' = 7.94\,\frac{\mathrm{cm}}{\mathrm{s}}$.