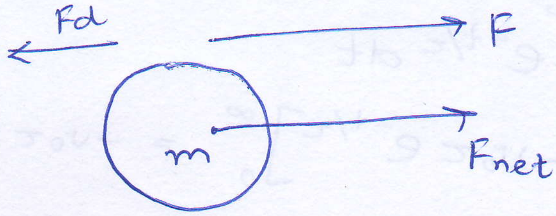


$$F_{net} = m\frac{dv}{dt}$$

$$F - \gamma v = m\frac{dv}{dt}$$

Given at $t=0$, $F=0$ and $v=v_0$

Hence Equation of motion is

$$m\frac{dv}{dt} = -\gamma v$$

$$\Rightarrow \frac{dv}{v} = -\frac{\gamma}{m}dt$$

$$\Rightarrow \int_{v_0}^{v}\frac{dv}{v} = -\gamma\int_0^t dt \Rightarrow \left[\ln v\right]_{v_0}^{v} = -\frac{\gamma}{m}\left[t\right]_0^t$$

$$\Rightarrow \ln\frac{v}{v_0} = -\frac{\gamma}{m}t \Rightarrow \boxed{v = v_0 e^{-\frac{\gamma}{m}t} = v_0 e^{-t/\tau}}$$

where $\tau = \frac{m}{\gamma}$

$$\tau = \frac{m}{\gamma} = \frac{4}{3}\frac{\cancel{\pi} \cancel{r^3} r^2 \rho}{6\cancel{\pi}\eta \cancel{r}} = \frac{4\rho r^2}{18\eta}$$

$$= \frac{4\times1000\times1\times10^{-12}}{18\times10^{-3}} = \frac{40\times10^{-10}}{18\times10^{-3}}\,s$$

$$= \frac{40}{18}\times10^{-7} \simeq 2.22\times10^{-7}s$$

$$\simeq 22.7\times10^{-6}s$$

$$\simeq 20\,\mu s$$

Distance travelled by bacteria before stopping is given by

$$x = \int_0^\infty v\,dt = v_0\int_0^\infty e^{-t/\tau}dt$$

$$\Rightarrow x = v_0 \int_0^{\infty} e^{-t/\tau}\, dt$$

$$= \left[-v_0 \tau e^{-t/\tau} \right]_0^{\infty} = -v_0\tau e^{-\infty} - (-v_0 \tau e^{-0})$$

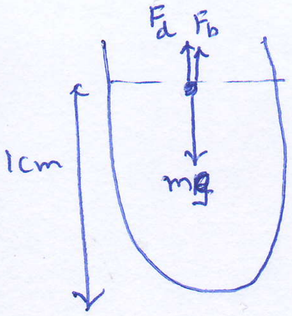
$$\Rightarrow \quad x = v_0 \tau$$

$$= 25\times10^{-6} \frac{m}{s} \times 20\times10^{-6} s$$

$$= 500 \times 10^{-12} m$$

$$\simeq 5\times10^{-10} m$$

$$\simeq 5 \text{Å}$$



$$F_{net} = F_g - F_b = \gamma v$$

$$\Rightarrow \gamma v = F_g - F_b$$

$$= mg - \rho V g$$

$$= mg - \rho \frac{4}{3} \pi r^3 g$$

$m = 100\,KDa$, $r = 3\,nm$, $g = 10\,m/s^2$

$$\Rightarrow \gamma v = 1.6\times10^{-27}\times100\times1000\times10 - 1000\times\frac{4}{3}\times3.14\times27\times10^{-27}\times10$$

$$= 1.6\times10^{-21} - \frac{339.12}{3}\times10^{-23}$$

$$= 1.6\times10^{-21} - 1.13\times10^{2}\times10^{-23}$$

$$= 1.6\times10^{-21} - 1.13\times10^{-21}\ N$$

$$= 4.7\times10^{-22}\ N$$

$$\Rightarrow v = \frac{4.7\times10^{-22}}{6\times3.14\times10^{-3}\times3\times10^{-9}} = \frac{4.7\times10^{-22}}{56.52\times10^{-12}}$$

$$= \frac{470\times10^{-24}}{56.52\times10^{-12}} \simeq 8.3\times10^{-12}\ m/s$$

$\therefore$ Time required for sedimentation $= \frac{x}{v}$

$$= \frac{1\times10^{-2}}{8.3\times10^{-12}}\,s = \frac{10}{8.3}\times\frac{10^{-3}}{10^{-12}}\,s \simeq 1.2\times10^{9}\,s$$

$$\simeq 38.05\ \text{years}$$