How to calculate the diffusion coefficient D given a sedimentation coefficient s, a frictional ratio k and partial specific volume $\bar{v}$, but not the molecular weight M. We have:

Diffusion coefficient and sedimentation coefficient:

$$D = \frac{RT}{Nf} \quad \text{Equ. 1} \qquad s = \frac{M(1-\bar{v}\rho)}{Nf} \quad \text{Equ. 2} \qquad \frac{s}{D} = \frac{M(1-\bar{v}\rho)}{RT} \quad \text{Equ. 3}$$

(Svedberg's law)

Frictional coefficient of a sphere ($f/f_0 = 1$):

$$f_0 = 6\pi\eta r \quad \text{Equ. 4}$$

(Stokes – Einstein Equation, where η is the viscosity of the solvent.

For the volume of a sphere we have:

$$Vol_{sphere} = \frac{4}{3}\pi r^3 \quad \text{Equ. 5}$$

or

$$\frac{M\bar{v}}{N} = Vol_{sphere} \quad \text{Equ. 6}$$

and for the frictional ratio we have:

$$\frac{f}{f_0} = k \quad \text{Equ. 7}$$

For a spherical particle, $f/f_0 = 1$, and the radius of the sphere in Equ. 5 matches the radius of the sphere with the volume calculated in Equ. 6, and they can be equated and a molar mass can be calculated:

$$M = \frac{4N\pi r^3}{3\bar{v}} \quad \text{Equ. 8}$$

and from Eqn 4 we have:

$$r = \frac{f_0}{6\pi\eta} \quad \text{Equ. 9}$$

Substitute Eqn. 9 into Eqn. 8 to get:

$$M_0 = \frac{4N\pi}{3\bar{v}}\left(\frac{f_0}{6\pi\eta}\right)^3 \quad \text{Equ. 10}$$

solve Eq. 2 for M and equate with Eq. 10:

$$M_0 = \frac{sNf_0}{(1-\bar{v}\rho)} = \frac{4N\pi}{3\bar{v}}\left(\frac{f_0}{6\pi\eta}\right)^3 \quad \text{Equ. 11}$$

This is only true if s is appropriate for f0

If we parameterize the diffusion coefficient from the frictional ratio, vbar and *s*, we can use Equ. 1 to calculate *D*. In order to do so, we need to first figure out what f_0 is. We can do that using Equ. 4, which relates f_0, and therefore ultimately *D*, to the radius of a sphere. But which sphere? It has to be the sphere that has the same volume as the particle sedimenting with molar mass *M* and partial specific volume, vbar. But we do not have *M* explicitely. *M* appears in Equ. 2, and also in Equ. 8. Substituting the Stokes Einstein relationship into Equ. 8 we get an equation that can be solved for f_0 as a function of *s* and vbar alone:

$$\frac{s N f_0}{(1-\bar{v}\rho)} = \frac{4 N \pi}{3\bar{v}} \left(\frac{f_0}{6\pi\eta}\right)^3$$

Equ. 12

solving for f_0 we get:

$$\frac{s N}{(1-\bar{v}\rho)} = \frac{4 N \pi}{3\bar{v}} \frac{f_0^2}{(6\pi\eta)^3}$$

Equ. 13

Simplifying further:

$$9\eta\pi\sqrt{\frac{2\bar{v} s \eta}{(1-\bar{v}\rho)}} = f_0$$

Equ. 14

The corresponding D for a given f_0 can be easily determined from Equ. 1.

Once f_0 is available, any other *f* can be determined from the frictional ratio (Equ. 7), just use Equ. 1 to derive *D*. Once both *s* and *D* are available, together with the partial specific volume, *M* can also be derived by solving Equ. 3 for *M*.