(14.4) Calculate the macroscopic cross-section for reaction of natural uranium with thermal neutrons. See Figures 16.1 and 19.5.

Data, constants, and units:

$N_A := 6.022137 \cdot 10^{23} \cdot mole^{-1}$ $M_U := 238.03 \cdot gm \cdot mole^{-1}$ $barn := 10^{-28} \cdot m^2$

$x_{234} := 0.0055 \cdot \%$ $x_{235} := 0.7200 \cdot \%$ $x_{238} := 1 - x_{234} - x_{235}$ $x_{238} = 0.993$

$\rho_U := 18.95 \cdot gm \cdot cm^{-3}$

From Fig. 20.4: $\sigma_{234} := 100 \cdot barn$

From Fig. 19.5: $\sigma_{235} := (99 + 582) \cdot barn$ $\sigma_{238} := 2.7 \cdot barn$

Calculations:

$N_v := \frac{\rho_U}{M_U} \cdot N_A$ $S_{macr} := N_v \cdot \left( x_{234} \cdot \sigma_{234} + x_{235} \cdot \sigma_{235} + x_{238} \cdot \sigma_{238} \right)$

$S_{macr} = 36.4 \cdot m^{-1}$

A better alternative to Fig. 19.5 is Table 19.2, although the result will practically be the same:

From Table 19.2: $\sigma_{235} := (98.6 + 582.2) \cdot barn$ $\sigma_{238} := 2.70 \cdot barn$

Calculations:

$N_v := \frac{\rho_U}{M_U} \cdot N_A$ $S_{macr} := N_v \cdot \left( x_{234} \cdot \sigma_{234} + x_{235} \cdot \sigma_{235} + x_{238} \cdot \sigma_{238} \right)$

$S_{macr} = 36.4 \cdot m^{-1}$