795.

Problem 53.9 (RHK)

The density of gold is $19.3\ \mathrm{g\ cm^{-3}}$. *Each atom contributes one conduction electron. We have to calculate the Fermi energy of gold. The molar mass of gold is* $196.9\ \mathrm{g\ mol^{-1}}$.

Solution:

As each gold atom contributes one conduction electron, the number density of conduction electrons will be equal to the number density of gold atoms. The number density of gold atoms can be calculated from the relation

$$n_{\mathrm{Au}} = \frac{N_{\mathrm{A}}\rho_{\mathrm{Au}}}{M_{\mathrm{Au}}} = \frac{6.02\times10^{23}\times19.3\times10^{3}}{196.9\times10^{-3}}\ \mathrm{m^{-3}}$$

$$= 5.9\times10^{28}\,\mathrm{m^{-3}}\ .$$

The expression for Fermi energy in terms of number density of conduction electrons, n is

$$E_F = \frac{h^2}{8m}\left(\frac{3n}{\pi}\right)^{2/3}.$$

Therefore, the Fermi energy of gold will be

$$E_F = \frac{\left(6.63\times10^{-34}\right)^2}{8\times9.11\times10^{-31}} \times \left(\frac{3\times5.9\times10^{28}}{\pi}\right)^{2/3} \text{ J}$$

$$= 8.84\times10^{-19} \text{ J}$$

$$= 8.84\times10^{-19}\times6.242\times10^{18} \text{ eV} = 5.52 \text{ eV} .$$

The Fermi energy E_F of gold is 5.52 eV.