10.3 a) Estimate the energy of the innermost $e^-$ of Pb.
   b) Find $r_{mp}$ for it

   For Pb, $Z = 82$

   a) $\Rightarrow \epsilon_{1s,Pb} = -\frac{Z^2 e^2}{a_B} = -(82)^2 (13.6) = 91.4$ keV

   b) $r_{mp} \approx \frac{n^2 a_B}{Z_{eff}} = \frac{(1)^2 (5.29 \times 10^{-11} \text{ m})}{82} = 6.45 \times 10^{-13} \text{ m}$

   $r_{mp} = 645 \text{ fm}$

10.5 Na has filled 1s, 2s, 3p states and one in 3s. Use the IPA for the outermost $e^-$ in the 3d state.
   a) Find $U(r)$
   b) Find $E_{3d}$ & compare to observed value of -1.52 eV.

   a) For outer $e^-$, $Z_{eff} \approx 1$ for perfect shielding

   $U(r) = -\frac{Ze^2}{a_B r} = \frac{ke^2}{r}$

   b) The energy is

   $E = -\frac{Z^2 e^2}{n^2} \approx - (1)^2 (13.6) \approx 1.51$ eV

   This is not as tightly bound as observed because the shielding of the inner $e^-$ is not quite so perfect so $Z_{eff} > 1.0.$