8. (a) \( 1 \text{Å} = 10 \text{nm} \)

\( k = 1.38 \times 10^{-23} \frac{\text{J}}{\text{K}} \) (note: 1 J = Kg m^2 s^{-2})

From table given on front inside cover

\[
M_{\text{Li}} = \left( \frac{\text{6.94}}{\text{mol}} \right) \left( \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \right) \left( \frac{1 \text{ kg}}{1000 \text{ g}} \right) = 1.15 \times 10^{-22} \text{ kg}
\]

\[
V = \sqrt{\frac{8(1.38 \times 10^{-23} \text{ J/K})(2100 \text{ K})}{\pi(1.15 \times 10^{-22} \text{ Kg})}} = 2.53 \times 10^{-3} \text{ m/s}
\]

\[
\Delta \lambda = \frac{V \lambda}{C} = \frac{(2.53 \times 10^{-3} \text{ m/s})(470.776 \times 10^{-9} \text{ m})}{3.00 \times 10^8 \text{ m/s}} = 5.66 \times 10^{-12} \text{ m} = 5.66 \text{ pm}
\]

(b) \( 6.94 \times 10^{-12} \text{ m} \) or \( 6.94 \text{ pm} \)
1. (a) a cation that preferentially binds to a chemical interent, releasing the analyte for analysis
(b) a chemical species such as EDTA that complexes out the analyte and is volatile enough to be driven off in the flame
(c) provides high concentration of electrons in the flame, helping to prevent ionization of the analyte (e.g., Group IA metals)
(d) vaporization and decomposition of the sample into individual atoms
(e) high concentrations of atoms in the flame results in linewidth broadening due to collisions
(f) the negative cathode has a hollow interior where ionized inert gas cations collide with the surface, sputtering off atoms. Made of the same material as the analyte. The sputtered atoms have electrons in the excited state as a result of the collision. The excited electrons decay back to the ground state emitting characteristic wavelengths
(g) see (f)
(h) SKIP
(i) overlapping spectral lines
(j) see (a) and (b)
(k) SKIP
(l) atoms moving towards or away from the monochromator are detected with higher or lower frequencies respectively, resulting in linewidth broadening
3. More complete atomization results in a larger signal and lower LOD.

5. Helps distinguish between constant flame background and modulated signal by either passing the detector signal through a capacitor or using a lock-in amp.

8. (1) Higher T using acetylene - O₂ fuel
    (2) Try a releasing or protecting agent
    (3) Try adding K as a source of electrons to reduce ionization

11. \[ R = \frac{\lambda}{\Delta \lambda} = \frac{500 \text{ nm}}{0.002 \text{ nm}} = 2.5 \times 10^5 \text{ and in addition} \]
    \[ R = mN \text{ for a grating so} \]
    \[ 2.5 \times 10^5 = (1) N \text{ so } N = 2.5 \times 10^5 \text{ illuminated grooves} \]
    \[ \text{Size of grating needed} = \frac{2.5 \times 10^5 \text{ grooves}}{2400 \text{ grooves/mm}} = 104 \text{ mm} \]

13. (a) Chemical interference since Fe\(_2\)(SO\(_4\))\(_3\) is insoluble
    (b) Try protecting, releasing agents or higher T flame.
14. Need to use the Boltzmann Distribution:

\[ \frac{N_i}{N_0} = \frac{P_i}{P_0} \exp \left( - \frac{E_i}{kT} \right) \]

\( P_i = 3 \) since 3 p-orbitals
\( P_0 = 1 \) since initially in a 3s orbital

\( E_i \) can be obtained using emission \( \lambda \)'s in Fig. 8-1:

\( \text{Na} = 589.3 \text{ (average of 589.6 and 589.0)} \)
\( \text{Mg} = 280.0 \text{ (average of 280.3 and 279.6)} \)

\[ E_{\text{Na}} = \frac{h \nu}{\lambda} = \frac{(6.63 \times 10^{-34} \text{ Js})(5.00 \times 10^{-8} \text{ m/s})}{589.3 \times 10^{-9} \text{ m}} \]
\[ = 3.38 \times 10^{-19} \text{ J} \]
\[ E_{\text{Mg}} = 7.10 \times 10^{-19} \text{ J} \]

at 2100 K

\( \text{Na}: \frac{N_i}{N_0} = 3 \exp \left[ - \frac{3.38 \times 10^{-19} \text{ J}}{(1.38 \times 10^{-23} \text{ J/K})(2100 \text{ K})} \right] \]
\[ = 2.6 \times 10^{-5} \]

\( \text{Mg}: \frac{N_i}{N_0} = 6.9 \times 10^{-11} \)
at 6000 K (skip 2800K)

Na: \( \frac{N_i}{N_0} = 5.1 \times 10^{-2} \)

Mg: \( \frac{N_i}{N_0} = 5.7 \times 10^{-4} \)

So when time changed \( \frac{6000K}{2100K} \) or 2.86 \%, the populations fluctuated \( \frac{5.1 \times 10^{-2}}{2.6 \times 10^{-5}} \) or 190,000 \% for Na and \( \frac{5.7 \times 10^{-4}}{6.9 \times 10^{-2}} \) or 8.3 \times 10^{8} \% for Mg !!!
2. To do flame AAS, a separate lamp is required for each element, whereas in ICP emission spectrophotometry, a 2-dimensional detector and an echelle grating - or a polychromator - is all that is required.

4. For the echelle grating, \( D^{-1} = \frac{2d \cos \beta}{\lambda F} \)

\[ \beta = 63^\circ 26' \approx 63.43^\circ \]

\[ d = \frac{1\text{ mm}}{120\text{ gr}} = \frac{10^6\text{ mm}^{-1}}{120} = 9333\text{ mm}^{-1} \]

\[ F = 8.5\text{ m} = 850\text{ mm} \]

(a) \( D^{-1} = \frac{2(9333\text{ mm}) \cos (63.43^\circ)}{(8.5 \times 850\text{ mm})} = 0.29\text{ mm/mm} \)

(b) \( D^{-1} = 0.097\text{ mm/mm} \)
1. \( \lambda_0 = \frac{hc}{Ve} = \frac{12,398 \text{ A}^0 \cdot V}{V} = \frac{12,398 \text{ A}^0 \cdot V}{90 \times 10^3 \text{ V}} \)
   \[ = 0.14 \text{ Å} \]

2. (d) from Table 12-1, p. 305, \( K_B = 0.184 \text{ Å} \) and \( L_B = 1.282 \text{ Å} \)

   The minimum voltage required can be obtained from eqn 12-2 -
   \[ K_B: \quad V = \frac{12,398 \text{ Å}^0 \cdot V}{0.184 \text{ Å}} \approx 67.4 \text{ kV} \]
   \[ L_B: \quad V = \frac{12,398 \text{ Å}^0 \cdot V}{1.282 \text{ Å}} \Rightarrow 9.67 \text{ kV} \]

9. (c) using Bragg eqn, p. 310 and \( d = 2.820 \text{ Å} \) for NaCl (p. 313)

   \[ n\lambda = 2d \sin \Theta \quad \text{or} \quad 2\Theta = 2\sin^{-1} \left( \frac{n\lambda}{2d} \right) \quad \text{use } n = 1 \quad (\text{1st order}) \]
   
   Fe: \[ 2\Theta = 2 \sin^{-1} \left( \frac{1.76 \text{ Å}}{2(2.820 \text{ Å})} \right) = 36.4^\circ \]
   
   Se: \[ 2\Theta = 20.3^\circ \]
   
   Ag: \[ 2\Theta = 10.1^\circ \]