Solution 3:

1). For 4-fold square planar structure, R_a / (R_a + R_c) = Sin45^o.
So, R_c / R_a = sqrt(2) – 1 = 0.414. This gives the minimum cation/anion radius ratio.

2). N has a half-filled 2p orbital. A p^3 electron configuration is more stable than a p^4.
N: $1s^2 2s^2 2p^3$, O: $1s^2 2s^2 2p^4$

3). Absolute Luminosity of the Sun = L_0
$R_{Earth\ orbit}$ = 1.5 x 10^8 km = 1.5 x 10^{11} m
$R_{Jupiter\ orbit}$ = 7.8 x 10^8 km = 7.8 x 10^{11} m

$$L_{observed} = \frac{L_0}{4\pi R_{earthorbit}^{\ \ 2}} = 1.5\, {}^{kW}\!/_{m^2} = \frac{L_0}{4\pi\left(1.5\times10^{11}\right)^2}$$

$$L_0 = 1.5\left(2.827\times10^{23}\right) = 4.2\times10^{23}\,kW$$

$$L_{observed}^{Jupiter} = \frac{4.2\times10^{23}\,kW}{4\pi R_{earthorbit}^{\ \ 2}} = \frac{4.2\times10^{23}\,kW}{4\pi\left(7.8\times10^{11}\right)^2} = 0.55\, {}^{kW}\!/_{m^2}$$

The idea is similar to the calculation based on Cepheid Variables. Both apparent luminosity and square of the distance are proportional to absolute luminosity. However, in the calculation of Cepheid Variables distance, we use their pulse periods to determine their average absolute luminosity.

4). λ'/λ = 1 + ν/c
550/440 = 1 + ν/c
So, ν = 0.25 c
ν = 0.25 * 3.0 * 10^8 = 0.75 * 10^8 m/s = 7.5 * 10^4 km/s

5). d = ν/H
= (7.5 * 10^4 km/s) / (22 km/sec/10^6 light years)
= 3.4 * 10^9 light years
= 3.4 * 10^9 * 3.0 * 10^8 * π * 10^7 m
= 3.2 * 10^{25} m = 3.2 * 10^{22} km

6). Concentrations are measured in molality(M) (moles of solute per kg of water).
$[Na^+]$ = concentration of Na^+ ions = (moles Na^+ initially + moles Na^+ added)/1 kg H_2O
$[Na^+]$ = (0.10 + 6.00) / 1 = 6.10 M (mole/kg)
$\sigma_{[Na+]}^{\ 2}$ = 0.005^2 + 0.010^2 = 0.000125   {Addition rules}
$\sigma_{[Na+]}$ = 0.011 M
K_{sp} = $[Na^+]$ * $[Cl^-]$
$[Cl^-]$ = K_{sp} / $[Na^+]$ = 38.0 / 6.10 = 6.23 M

$$\frac{\sigma_{[Cl^-]}^{\ \ 2}}{\left[Cl^-\right]^2} = \frac{\sigma_{[Na^+]}^{\ \ 2}}{\left[Na^+\right]^2} + \frac{\sigma_{[K_{sp}]}^{\ \ 2}}{\left[K_{sp}\right]^2} = \frac{0.011^2}{6.10^2} + \frac{0.1^2}{38.0^2} = 3.252\times10^{-6} + 6.925\times10^{-6}$$

$$\frac{\sigma_{[Cl^-]}^{\ \ 2}}{\left[Cl^-\right]^2} = 1.0177\times10^{-5}$$

$$\sigma_{[Cl^-]}{}^2 = 1.0177\times10^{-5}(6.23M)^2 = 3.95\times10^{-4}$$
$$\sigma_{[Cl^-]} = 0.02M$$

Using the General Case (partial derivatives):

$$\left(\frac{\partial[Cl^-]}{\partial K_{sp}}\right) = \frac{1}{[Na^+]}, \left(\frac{\partial[Cl^-]}{\partial[Na^+]}\right) = \frac{K_{sp}}{[Na^+]^2}$$
$$\sigma_{[Cl^-]}{}^2 = \sigma_{K_{sp}}{}^2\left(\frac{\partial[Cl^-]}{\partial K_{sp}}\right)^2 + \sigma_{[Na^+]}{}^2\left(\frac{\partial[Cl^-]}{\partial[Na^+]}\right)^2$$
$$\sigma_{[Cl^-]}{}^2 = 0.1^2\left(\frac{1}{6.10}\right) + (0.011)^2\,\frac{38.0}{6.10^2}$$
$$\sigma_{[Cl^-]}{}^2 = 0.000268745 + 0.000123569$$
$$\sigma_{[Cl^-]}{}^2 = 3.923\times10^{-4}$$
$$\sigma_{[Cl^-]} = 0.02M$$

Because the weight of water remains 1 kg, we need to add 6.2 ± 0.02 moles of Cl^- to precipitate NaCl.