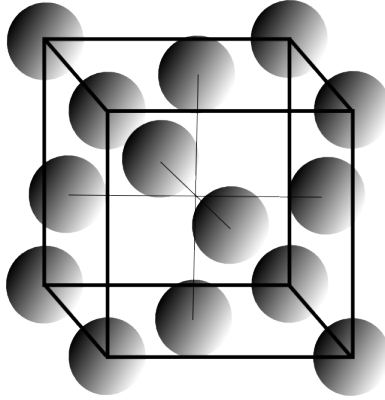
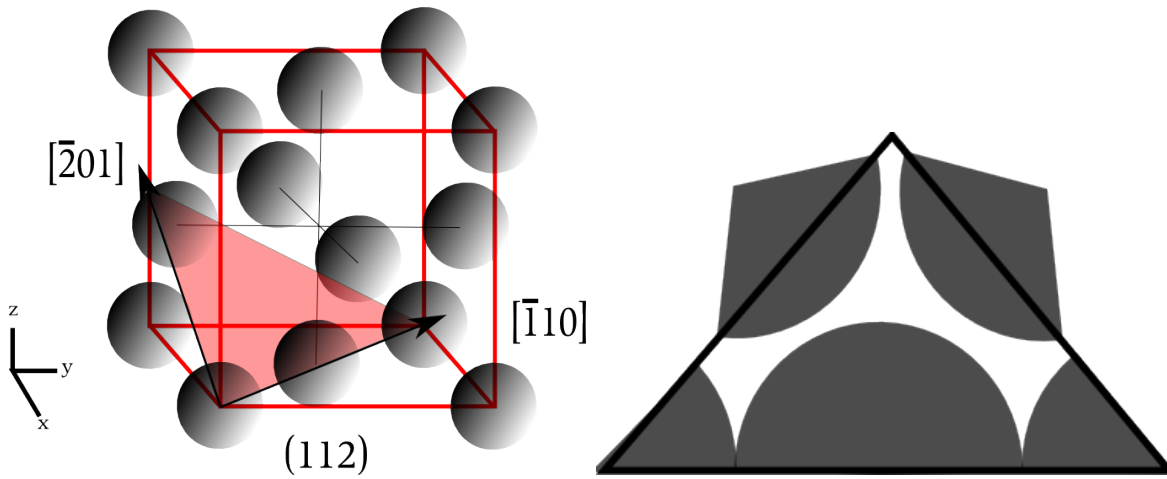


1. Using the crystal structure provided, please sketch and indicate the following: a) a (112) plane, b) any two directions in the (112) plane, and c) the atomic cross sections cutting through this plane (the sketch does not need to be perfect!). (20 pts total):



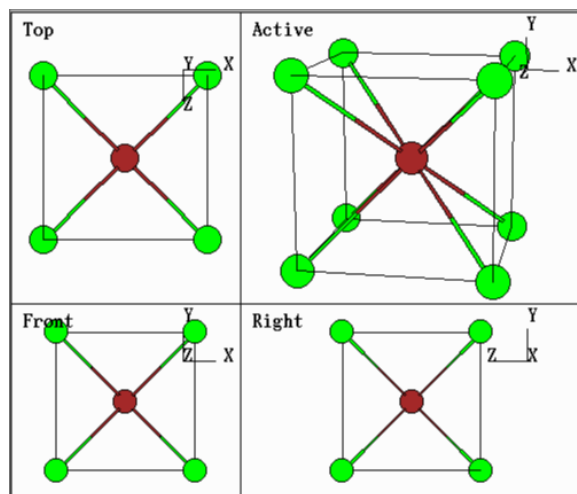
*Answer:*



2. The CsCl structure is shown. Assume that the simple cubic arrangement of Cl atoms touch along cube edges. The ionic radius of Cl (-1) is 184 pm. State if the following ions are likely to form the CsCl structure when combined with Cl and state your reasoning. (40 pts total):

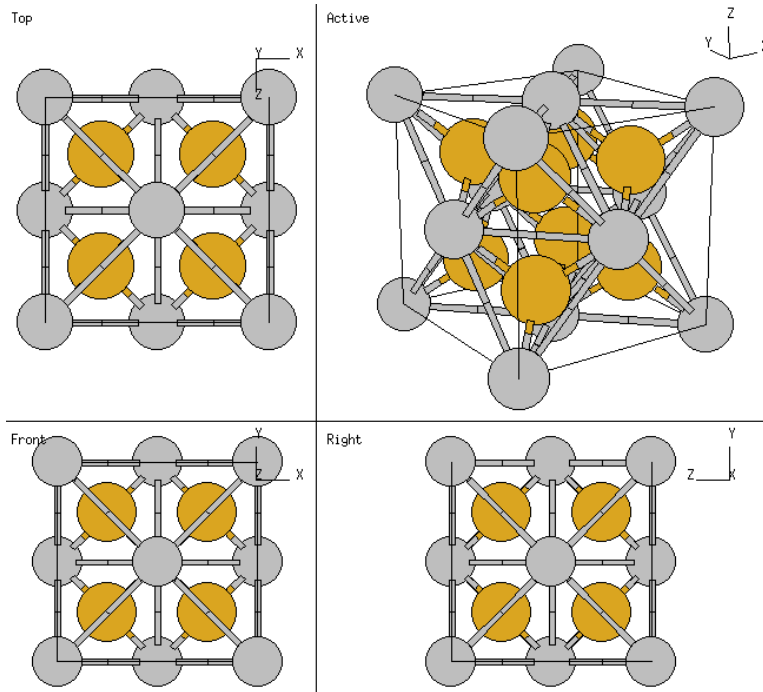
Ion	Ionic Radius (pm)
Li (+1)	76
K (+1)	138
Ca (+2)	100
Fr (+1)	180
Rb (+1)	152
Na (+1)	102

Table 1: Some ionic radii.



*A structure will have a coordination number of 8 when the cation to anion radius falls between 0.732 and 1. In this case, any ion with an atomic radius greater than 134 will form the CsCl structure. K, Fr, and Rb are the choices.*

3. Calculate the theoretical density of  $\text{CaF}_2$  using the structure shown below. **Count the number of atoms in the unit cell carefully!** The lattice parameter is  $5.4631 \times 10^{-8}$  cm. The density is defined as:  $\rho = (n \cdot A)/(V_c \cdot N_A)$ . The atomic mass of Ca is 40.08 g/mol and the atomic mass of F is 19.00 g/mol. Avagadro's number is  $6.022 \times 10^{23}$  atoms/mol. (40 pts total):



*The theoretical density of the unit cell is given by:*

$$\rho = \frac{n_1 A_1 + n_2 A_2}{V_c \cdot N_A} = \frac{8 \cdot 19.00 + 4 \cdot 40.08}{(5.4631 \times 10^{-8})^3 \cdot 6.02 \times 10^{23}} = \frac{\text{atom} \cdot \text{g/mol}}{\text{cm}^3 \cdot \text{atom/mol}} = 3.18 \text{ g/cm}^3 \quad (1)$$

*Note that there are 8 fluorine atoms and 4 calcium atoms present in this unit cell!*