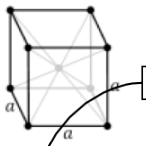
Questions 1 - Calculation of basic crystal properties

Body-centred cubic (bcc) :



Nearest neighbour atoms : 8

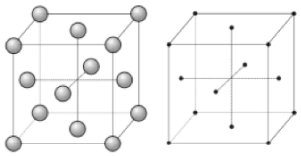
Atoms in a unit cell : 2

Filling rate : 68 %

$$\boxed{2}\times\frac{4}{3}\pi r^3 \Big/ a^3 = 2\times\frac{4}{3}\pi\left(\frac{\sqrt{3}a}{4}\right)^3 \Big/ a^3 = \frac{\sqrt{3}\pi}{8}$$

atom radius — cubic volume

Face-centred cubic (fcc) :

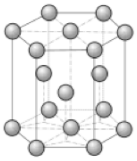


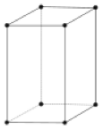
Nearest neighbour atoms :

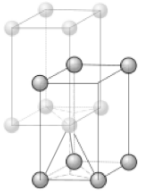
Atoms in a unit cell :

Filling rate :

Hexagonal close-packed (hcp) structure :







regular tetrahedron

Nearest neighbour atoms :

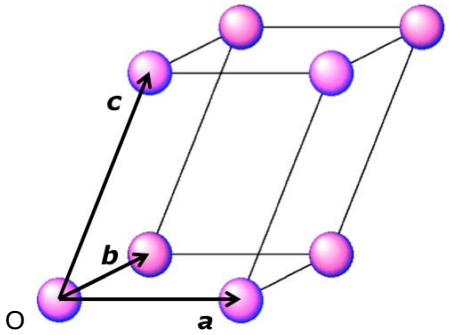
Atoms in a unit cell :

Filling rate :

Questions 2 - Miller Indices

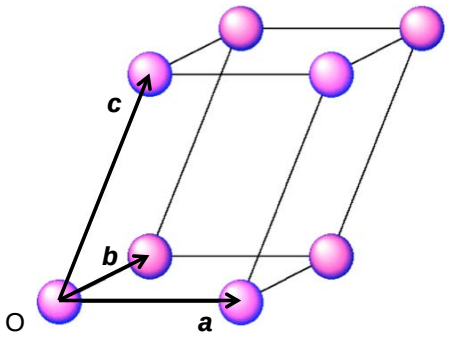
1. Indicate the following lattice orientations :

   [102], [210] and [311]



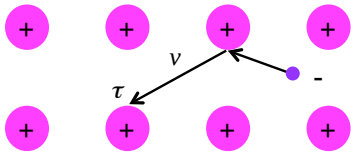
2. Indicate the following lattice planes :

   (102), (110) and (111)



Questions 3 - Relaxation Time

Resistive force by collision :



Equation of motion with resistive force mv/τ

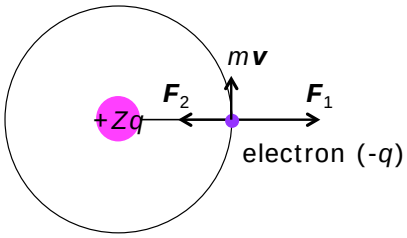
$$m\frac{dv}{dt} = -qE - \frac{m}{\tau}v$$

For the initial condition v = 0 at t = 0, obtain the following condition :

$$v = -\frac{q\tau}{m}E\left[1-\exp\left(-t/\tau\right)\right]$$

Questions 4 - Electron Potential Energy

Calculate potential energy of an isolated atom :



Centrifugal force : $\boldsymbol{F}_1$ =

Coulomb force : $\boldsymbol{F}_2$ =

For a stable electron rotation : $|\boldsymbol{F}_1| = |\boldsymbol{F}_2|$

Electron kinetic energy :

Electron potential energy : $V = -A/r$