Questions 1 - Calculation of basic crystal properties

Body-centred cubic (bcc):

- Nearest neighbour atoms: 8
- Atoms in a unit cell: 2
- Filling rate: 68%

\[
\frac{2 \times \frac{4}{3} \pi r^3}{a^3} = 2 \times \frac{4}{3} \pi \left(\frac{\sqrt{2}a}{4}\right)^3 \frac{\sqrt{2}a}{3} = \frac{\sqrt{2}}{8}
\]

Hexagonal close-packed (hcp) structure:

- Nearest neighbour atoms:
- Atoms in a unit cell: 6
- Filling rate: 68%

Face-centred cubic (fcc):

- 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:

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

Equation of motion with resistive force \( m v / \tau \)

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

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

Questions 4 - Electron Potential Energy

Calculate potential energy of an isolated atom:

Centrifugal force: \( F_1 = \)

Coulomb force: \( F_2 = \)

For a stable electron rotation: \(|F_1| = |F_2|\)

Electron kinetic energy:

Electron potential energy: \( V = -A/r \)