1. Calculate the interplanar spacing for a (321) plane in a simple cubic lattice whose lattice constant is 4.2×10^{-10}m. (1 mark)

SOL. $a = b = c = 4.2 \times 10^{-10}$m

and $$d_{hkl} = \frac{a}{\sqrt{(h^2 + k^2 + l^2)}}$$

For the plane (321), $h = 3$, $k = 2$ and $l = 1$

$$\therefore \quad d_{321} = \frac{4.2 \times 10^{-10}}{\sqrt{(3^2 + 2^2 + 1^2)}}\, m = \mathbf{1.1 \times 10^{-10}\, m}$$

2. A NaCl crystal is used as a diffraction grating with X-rays. For the d_{121} spacing of the chloride ions, the angle of diffraction 2θ is 60. If the lattice constant of the crystal is 0.73 nm, what is the wavelength of X-rays?. (1 mark)

$$n\lambda = 2d\sin\theta$$

Here θ=30, a=0.73 nm, n=1

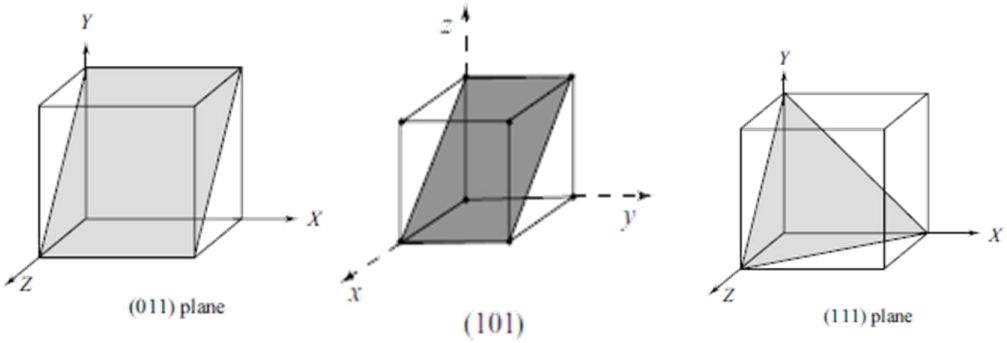
$$d_{121} = 0.73/\sqrt{(1^2+2^2+1^2)} = 0.298 \text{ nm}$$

$$\lambda = 2*0.298*1/2 = 0.298 \text{ nm}$$

3. In a crystal whose primitives are 1.1 Å, 1.2 Å and 1.8 Å. A plane (111) cuts an intercept of 1.4 Å along the X-axis. Find the lengths of intercepts along the Y and Z axes (1 mark)

The y and z intercepts are 1.527 Å and 2.291 Å

4. Draw the following planes in a cubic unit cell (0 1 1), (1 0 1) and (1 1 1).



5. Copper has sc structure of atomic radius 0.1278 nm. Calculate the interplanar spacing for (1 2 1) plane. (1 mark)

r=0.1278 nm and interplanar spacing d=?

$$\textbf{Atomic Radius r = a/2 and } \boldsymbol{d} = \frac{\boldsymbol{a}}{\sqrt{\boldsymbol{h^2+K^2+l^2}}}$$

d= 0.2556/2.44949=0.1043 nm

6. Determine the Coulomb interaction energy for a NaCl. Given that the distance between oppositely charged ions is 2.6 Å.

We know that,

Coulomb interaction energy

$$U = -\frac{e^2}{4\pi\varepsilon_0 R}$$

Substitute the value of $e = 1.6 \times 10^{-19}$, $\varepsilon_0 = 8.85 \times 10^{-12}$ and

R =2.6*10^{-10} m

U= ─8.8537x10^{-19} J or 5.526 ev

7. What are point defects? Explain, in detail, the different types of point defects with suitable sketches. (2 marks)

8. Define the terms coordination number, atomic radius, and packing density. Calculate the above factors for a simple cubic, body centred cubic and face centred cubic crystals (2 marks)