Q 1 A binary alloy of X and Y elements have been developed for a certain application. calculate the unit cell edge length for this alloy if the crystal structure is found to be BCC and it contains 85 wt% of X. (3 marks)

	x	y
Atomic weight	55.85 g/mol	50.94 g/mol
density	7.87 g/cm^3	6.10 g/cm^3

Q 2 Determine the ASTM grain size number if 25 grains per square inch are measured at a magnification of 75X. (2 marks)

b. list two types of microscopes that could be used for metals? (1 mark)

Q 3 What do materials Scientists and Engineers study? (explain it using a diagram) (1 marks)

Q 4 list one application for biomaterials and one for semiconductors? (2 marks)

Q 5 write down the electron configuration of Chromium (Cr) atomic number 24? (1 mark)

Q 6 plot the relationship between the interatomic separation and the bonding energy? (1 mark)

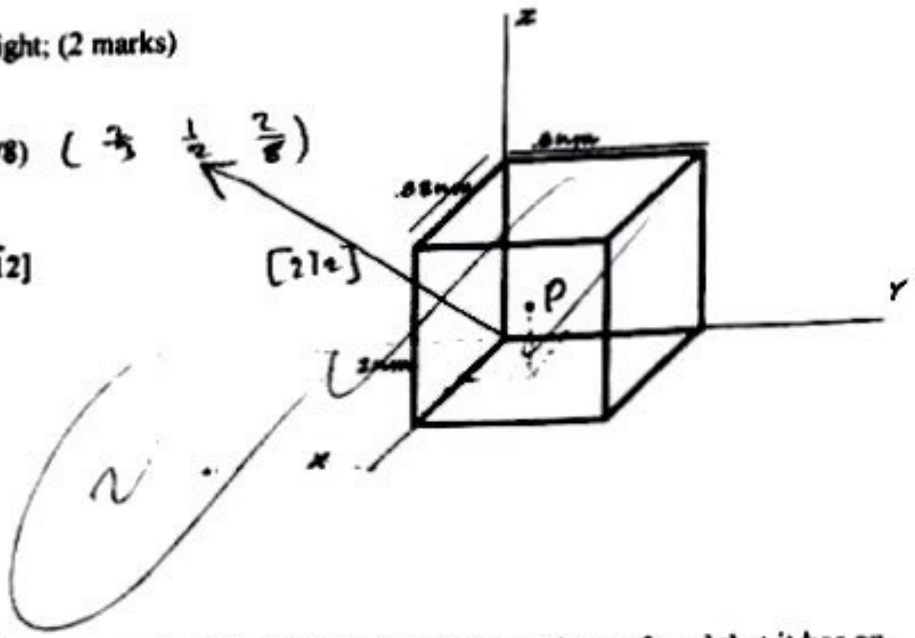
Q 7 Fill in the blanks: (10 marks)

1. Two nitrogen atoms form an N_2 molecule by sharing (1/ 2/ 3) electrons
2. ceramics are most frequently oxides, nitrides and .....
3. Normally, the maximum allowable concentration of interstitial impurity atoms is less than .....
4. For the screw dislocation, burger vector and the dislocation line are found to be .....
5. The directionality of the physical properties is termed .....
6. ..... boundaries of grain is formed when a small angle of an edge dislocation are formed.
7. The electronegativities of Ti and O are 1.5 and 3.5 respectively. The percent ionic character of the interatomic bond for the TiO_2 compound is .....
8. Refer to table 3.1 , "Cu" can make a substitutional solid solution with .....
9. The melting temperature of HF is (higher/ lower) than HCl. why?

Q 8 For the cubic unit cell to the right; (2 marks)

a. label the point (2/3 1/2 2/8)

b. Draw the direction [$2\bar{1}2$]

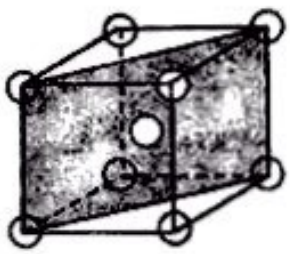


Q 9 Metal X was subjected to an X- ray wave with a length of 0.154 nm where it was found that it has an FCC crystal structure, it was noted that diffraction occurred at angles of (32, 38, 54 and 62) respectively. Assume the reflection order "n" = 1.

(a) Draw an X- ray diffraction pattern for this metal showing the first four plane indices. (2 marks)

(b) Determine the atomic radius for metal X in nm? (2 marks)

Q 10 Calculate the planner density in terms of R (atomic radius) for the plane below if the number of atoms centered on it is 2 atoms. (2 marks)



Q 11 For the following stacking sequences found in FCC metals, cite the type of planar defect that exist and rewrite indicating the position of the defect. (1 mark)

...A B C A B C B A C B A.....

Question (1): BCC a ?? n = 2

$$\rho_{avg} = \frac{n A_{avg}}{V_c N_A}$$

$$\rho_{avg} = \frac{100}{\frac{c_1}{\rho_1} + \frac{c_2}{\rho_2}} = \frac{100}{\frac{85}{7.88} + \frac{15}{6.10}} = 7.54\ g/cm^3$$

$$A_{avg} = \frac{100}{\frac{c_1}{A_1} + \frac{c_2}{A_2}} = \frac{100}{\frac{85}{53.85} + \frac{15}{5.94}} = 55.05\ g/mol$$

$$\rho_{avg} = \frac{n A_{avg}}{V_c N_A} \Rightarrow 7.54 = \frac{2 \times 55.05}{V_c \times 6.023 \times 10^{23}}$$

$$V_c = 2.424 \times 10^{-23}\ cm^3$$

$$V_c = a^3 \Rightarrow a = 2.89 \times 10^{-8}\ cm$$

Question (2): ASTM, n = ?? $N' = 25$, $M = 75x$

$$N'\left(\frac{M}{100}\right)^2 = (0.155) * 10^{(0.301)(n-1)}$$

$$25\left(\frac{75}{100}\right)^2 = (0.155) * 10^{(0.301)(n-1)}$$

$$\log(14.0625) = \log(0.155) + (0.301)n - 0.301$$

$$1.148 = -0.8096 + (0.301)n - 0.301$$

$$2.2586 = (0.301)n \Rightarrow \boxed{n = 7.5}$$

b- 1- reflective optical microscope.

2. scanning electron microscope.

Question ③

Processing → structure → properties → Performance

Question ④

Bio materials → replace a part of human's body without causing damage.

semiconductors → to increase conductivity for Electricity and heat

Question ⑤ : $Cr: 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Question ⑥ :

Question ⑦:

1- 3

2- Carbides.

3- 15%

4- Parallel

5- Anisotropy.

6- Tilt.

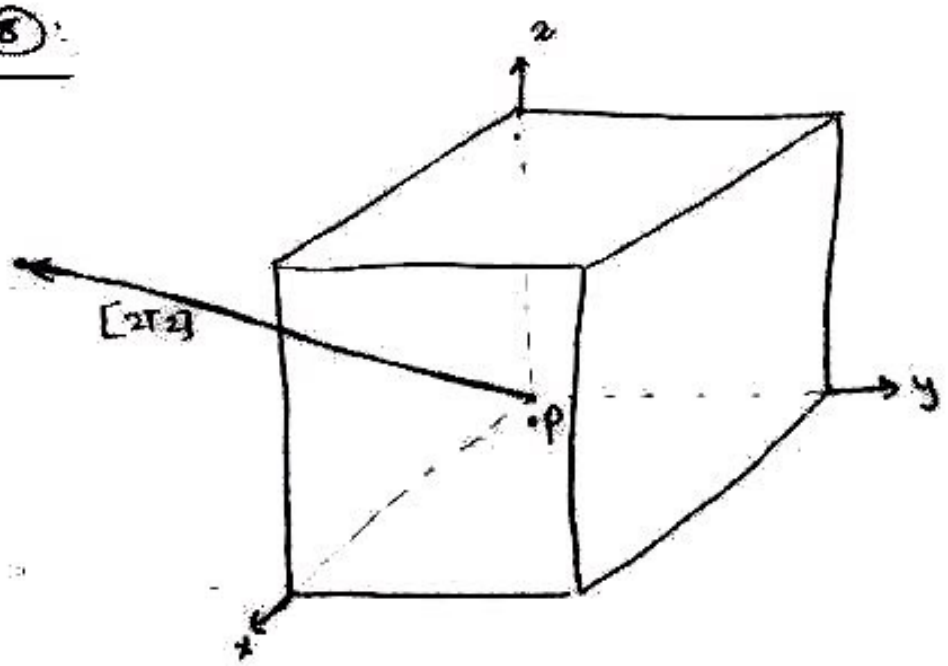
7- %IC = $\left[1 - \exp\left[-(0.25)(X_A - X_B)^2\right]\right] \times 100$

$X_A = 1.5$ $X_B = 3.5$

8- Nickel.

9- Higher, because it has a higher electronegativity.

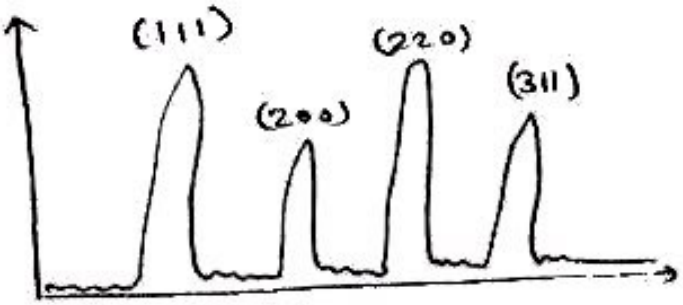
Question ⑧:



Question (9): X-ray $\lambda = 0.154\ nm$ FCC

$2\theta = 32, 38, 54, 62$ $n = 1$

(a)



(b) $n\lambda = 2d \sin\theta$, $\theta = 16$

$0.154 = 2d \sin 16$

$d = 0.279\ nm$

$$d = \frac{a}{\sqrt{l^2 + k^2 + L^2}} \Rightarrow a = (0.279) * \sqrt{3}$$

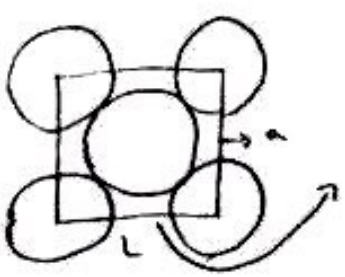
$a = 0.48\ nm$

$a = 2\sqrt{2}\ R \Rightarrow R = \frac{0.48}{2\sqrt{2}} = 0.169\ nm$

Question (10): Planar density? in terms of R

atoms = 2

planar density = $\frac{\text{number of atoms}}{\text{area of plane}}$



$a^2 + a^2 = L^2$

$L = \sqrt{2}\,a$

BCC

$a = \frac{4R}{\sqrt{3}}$

Area = $a * \sqrt{2}a = a^2\sqrt{2}$

$= \frac{16R^2}{3} \times \sqrt{2} = 7.54R^3$

$PD = \frac{2}{7.54R^3}$

Question (11) : Twin boundary