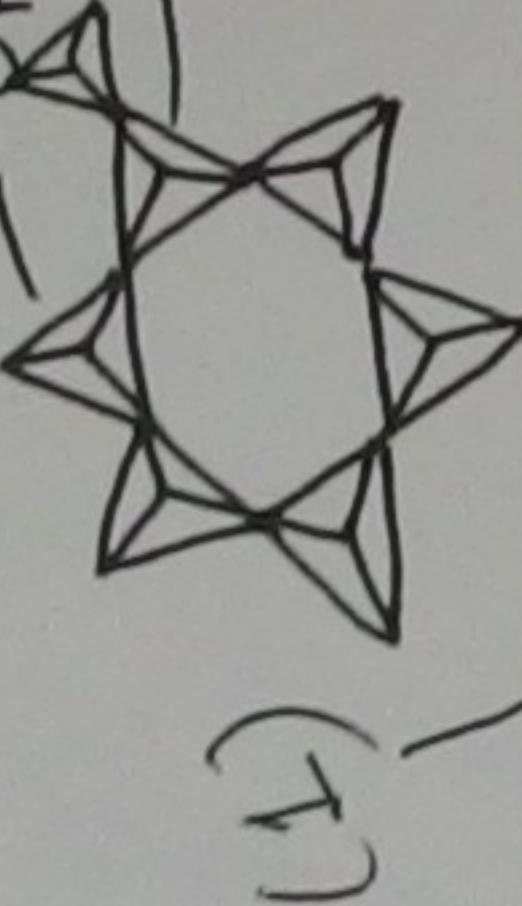
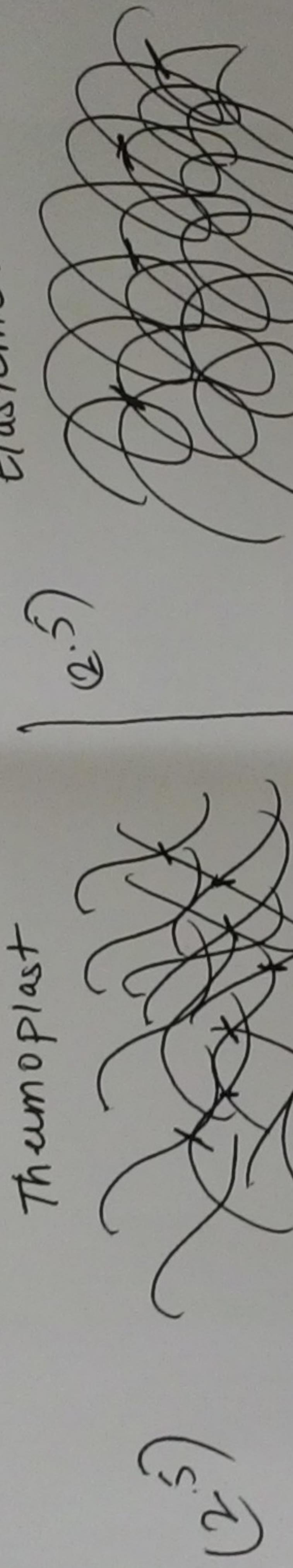
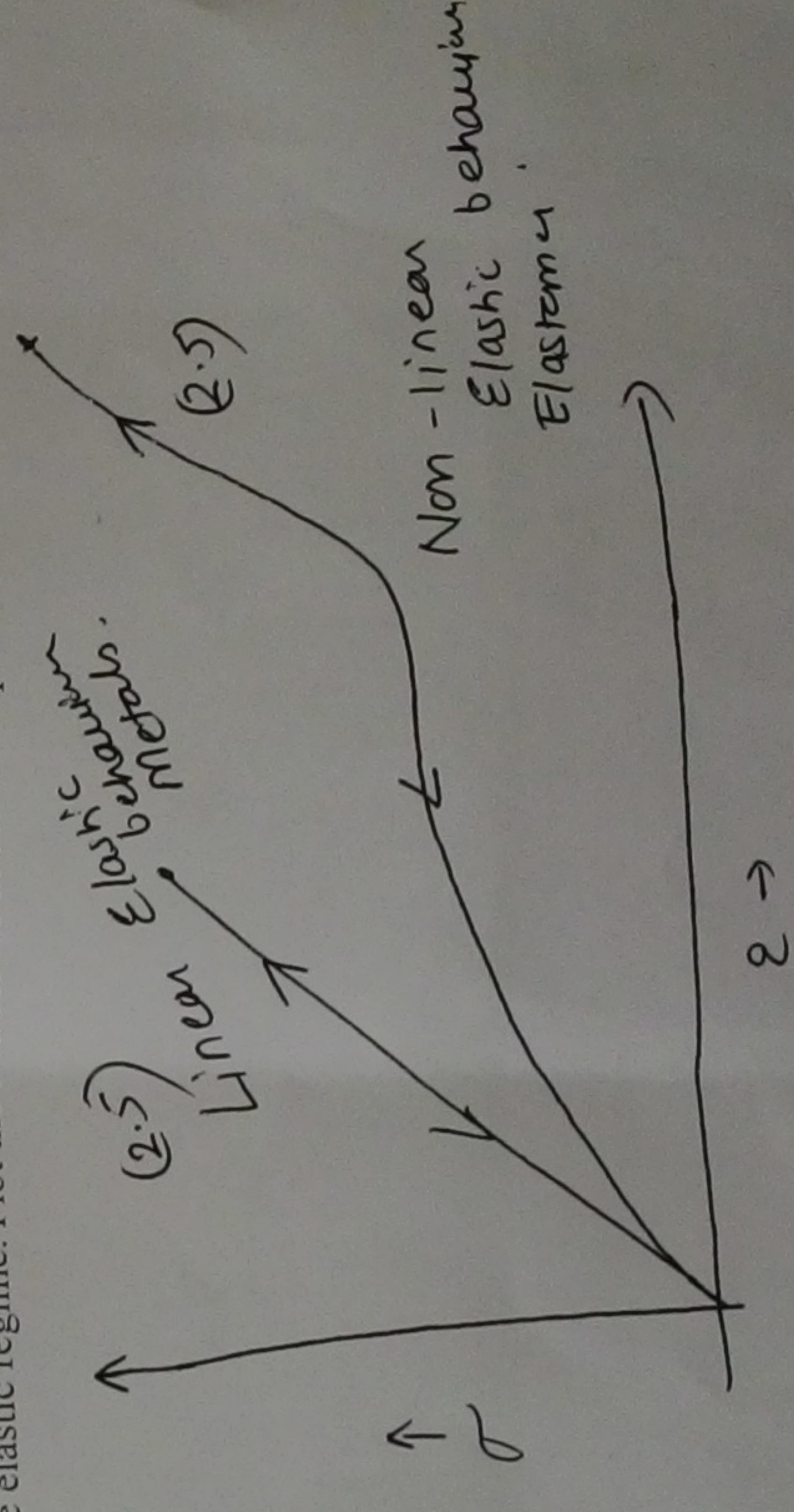


4. i) Show schematically the structure of a crystalline silica. Justify your drawing with appropriate reasons.
- (1) Upright tetrahedra

 Hexagonal crystal of SiO_2 placed alternately such that upright & inverted tetrahedra share their vertices. Arrangement maintains max cation - cation distance.
- (2) Upright & inverted tetrahedra in this configuration maintains max cation - cation distance.

- ii) Show schematically how the structure of a thermoplast differs from an elastomer?



iii) Show schematically the stress strain response of a pure metal and an elastomer in the elastic regime. Plot the two curves in the same plot.
 ~ 100-200 monomer units.



SEM

APT 102: Introduction to Materials Science and Engineering

Name: _____

Group No.: _____

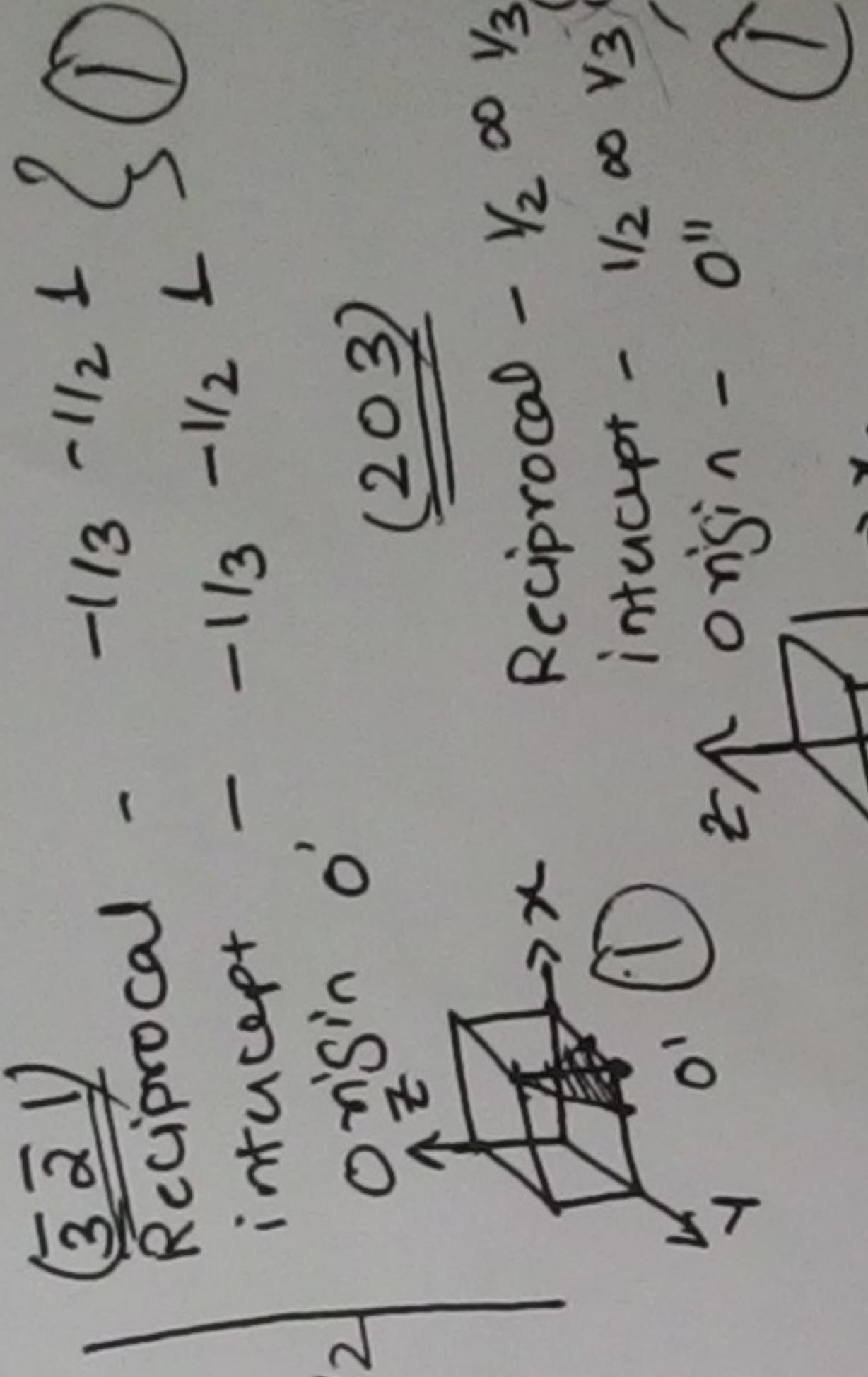
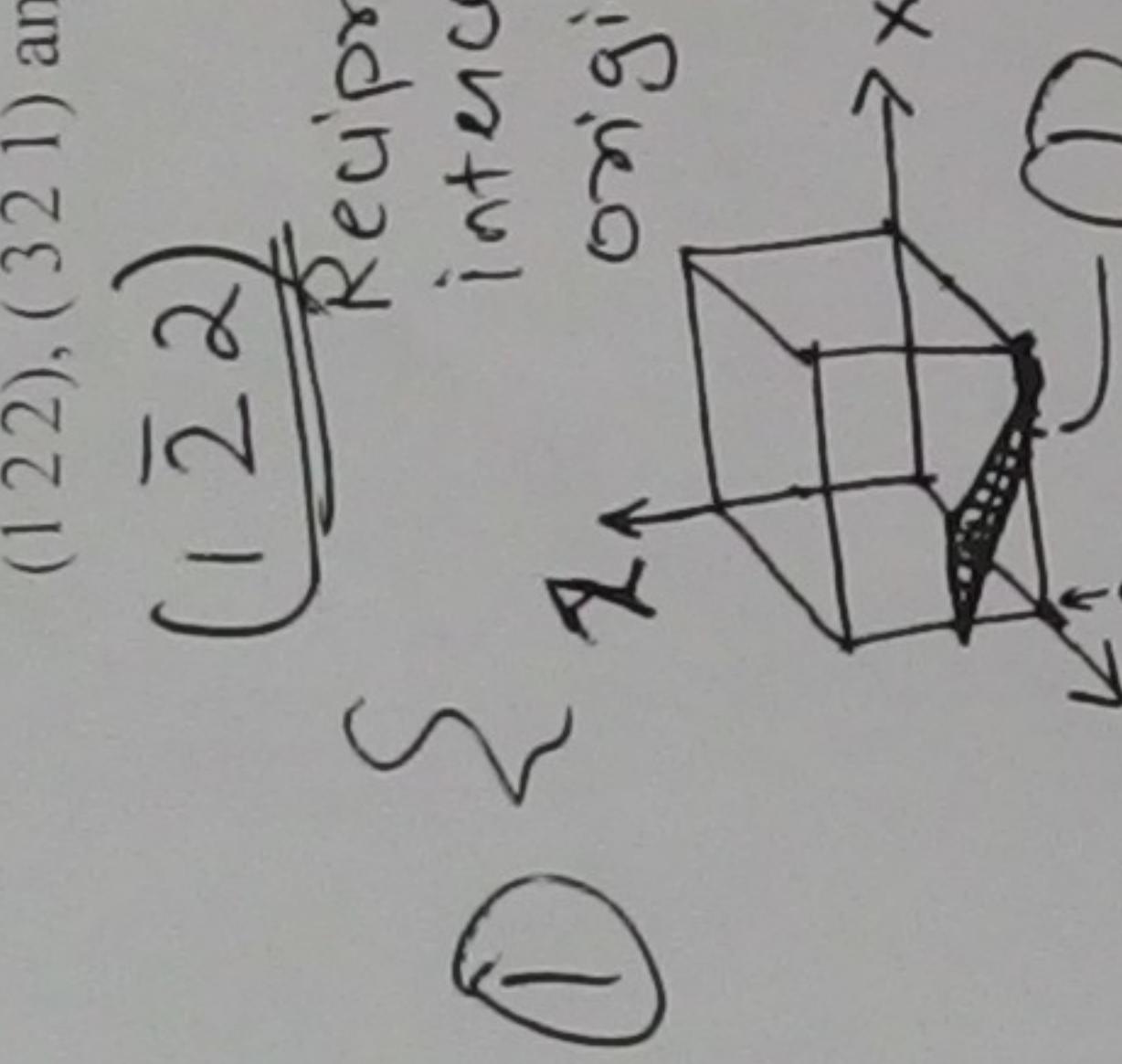
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Marks: 60

Minor-1

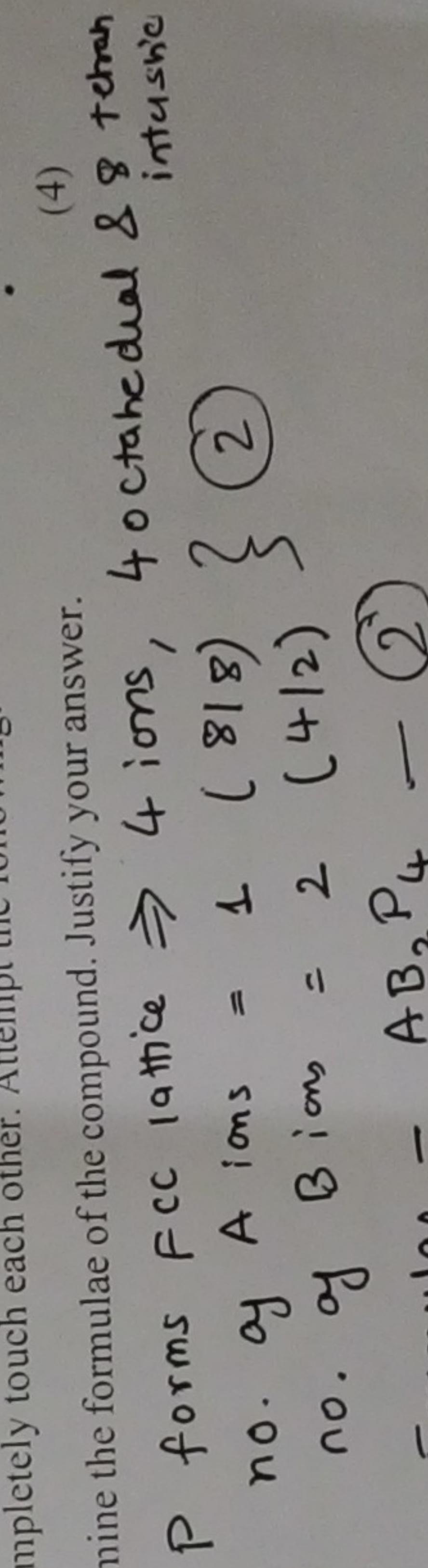
3. i) Draw each of the following planes in a separate unit cell. Show the axes and origin clearly. For step marking show all the necessary steps.

($\bar{1}\bar{2}2$), ($\bar{3}\bar{2}1$) and (203)



ii) Consider a compound $A_xB_yP_z$, where anion P forms a FCC lattice with A occupying $1/8$ of the tetrahedral interstices and B occupying $\frac{1}{2}$ of the octahedral interstices. Assume that the anions can completely touch each other. Attempt the following:

- a) Determine the formulae of the compound. Justify your answer.



- b) Calculate the packing factor of the compound.

(5)

Packing factor =
$$\frac{4 \times V_p + 2 V_B + 1 V_A}{V_A \beta_2 \rho_4} - ①$$

$$= 4 \times \frac{4}{3} \pi (r_p)^3 + 2 \times \frac{4}{3} \pi (0.414 r_p)^3 - ①$$

$$+ 1 \cdot \frac{4}{3} \pi (0.225 r_p)^3$$

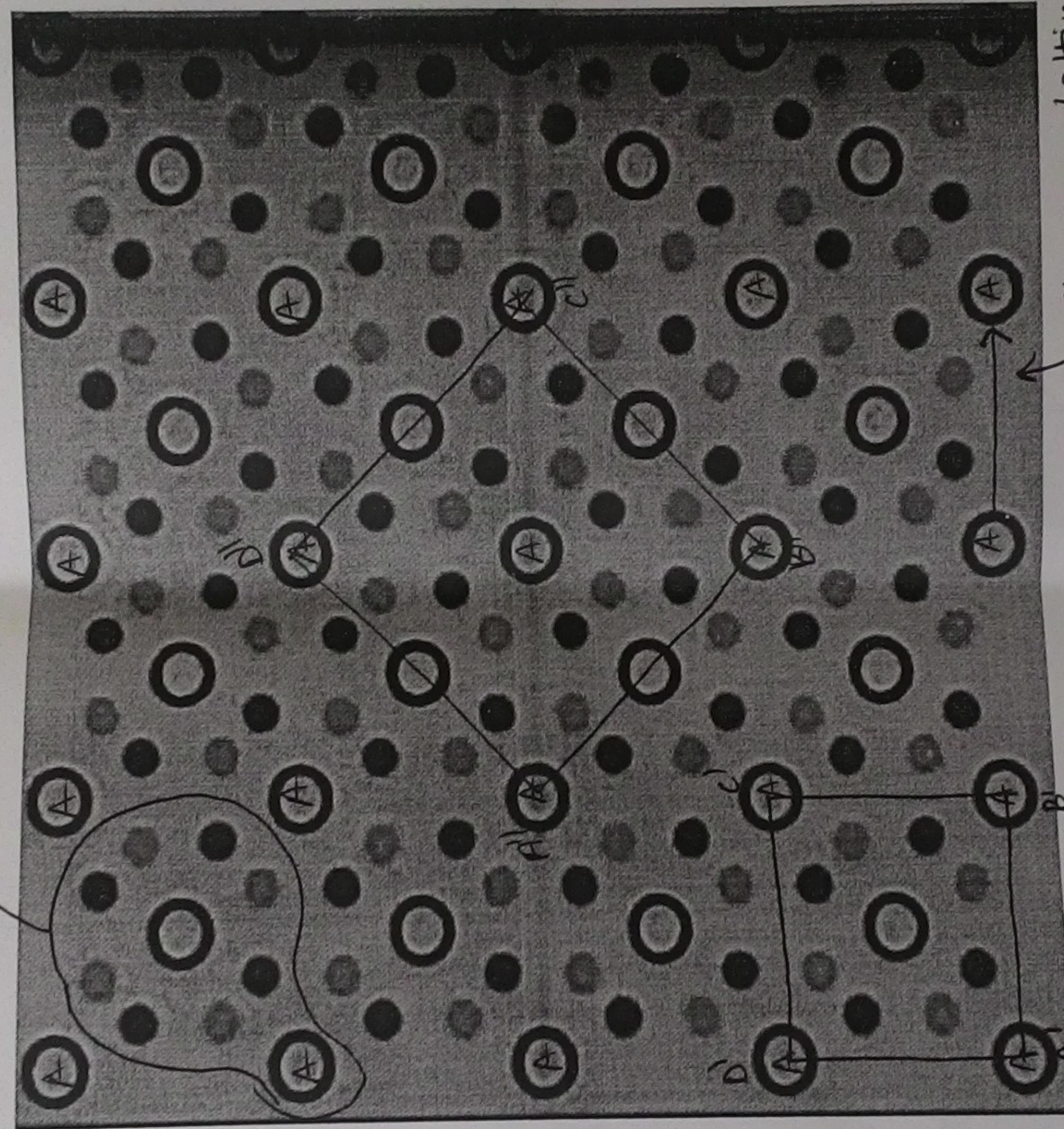
$$\frac{d^3 \rho_{A,B,P}}$$

For FCC $\alpha_{A,B,P} = 2\sqrt{2} r_p$ — ②

After solving = 0.77.

$$\underline{\underline{PF}} = 77\% \cdot \frac{\text{Ans.}}{M}$$

Motif



Shortest lattice translation vector.

Point A — lattice points
Conv. Unit cell (smallest size & highest symmetry)

A'B'C'D' — non-conv. Unit cell.

A''B''C''D'' — square lattice,
primitive

AT 10

S

Master Copy — Solution.

API 102 Introduction to Materials Science and Engineering

Group No.:

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Name:

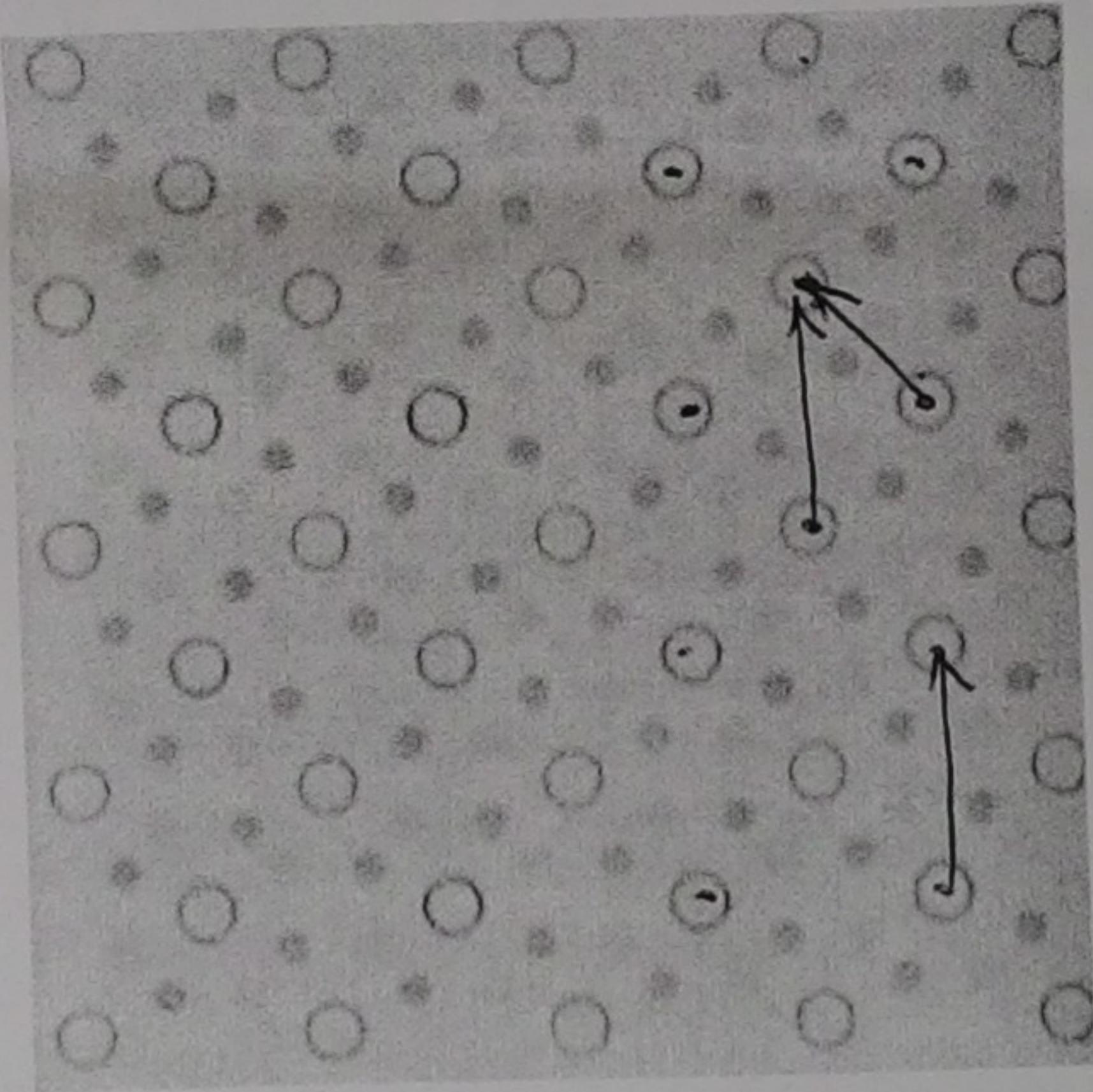
Minor-I

Instructions:

- Please read the question paper carefully.
- Wherever needed, draw clear diagrams with appropriate labels and axes.
- For step-wise marking, you need to provide step-wise answers.

1. i) For a 2D pattern shown below answer the following questions:

- Choose a reference point and mark all other equivalent points to form the lattice of the structure
- Draw the conventional unit cell and a non-conventional unit cell.
- Name the lattice of the structure? What is the motif?
- What is the number of lattice points per cell?
→ d)
- Draw a shortest lattice translation vector.



Sol'n last page.

- ii) Show that $\left. \frac{dG}{dT} \right|_V = -S$. For step marking show all the steps.

$$\begin{aligned}
 G &= H - TS & \text{(1)} \\
 &= (\bar{E} + PV) - TS & \text{(1)} \\
 dG &= dE + PdV + VdP - TdS - SdT \\
 dG &= (dq - PdV) + PdV + VdP - TdS - SdT \\
 dG &= TdS + VdP - TdS - SdT \\
 H &= E + PV \\
 \frac{dS}{\mu} &= \frac{\partial q}{T} = \frac{\partial H}{T} = \frac{C_p dT}{T} \quad dG = VdP - SdT \\
 dS &= \frac{dq}{T}
 \end{aligned}$$

1

SAM

2. i) A diffraction pattern of a cubic crystal of lattice parameter $a = 3.61 \text{ \AA}$ is obtained with a monochromatic X-ray beam of wavelength 1.54 \AA . The first four peaks appear at Bragg angles of $21.64^\circ, 25.207^\circ, 37.049^\circ$ and 45.011° respectively. Find out

a) Miller indices of diffracting planes giving these peaks

$\sin\theta$	$\sin^2\theta$	$\sin^2\theta_0$	(x_3)	$\hbar\kappa\ell$
21.64	0.368	0.135	1	111
25.207	0.425	0.1806	1.337	200
37.049	0.602	0.362	2.68	222
45.011	0.707	0.499	3.68	111

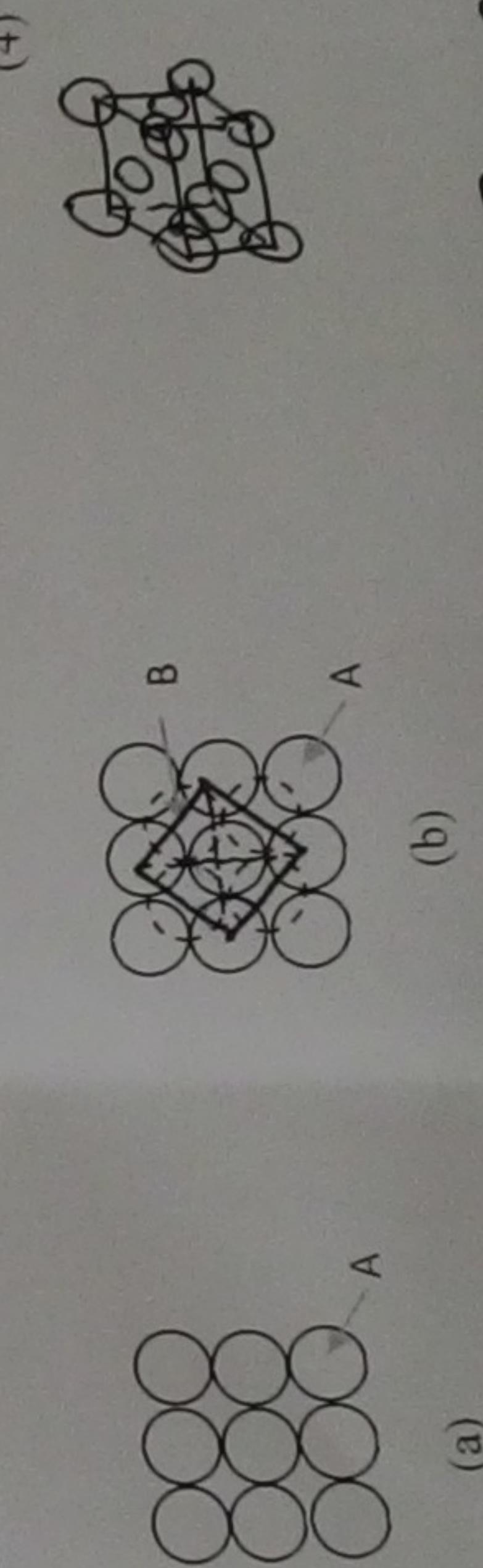
Miller indices
of diffracting plane

$$\hbar^2 + k^2 + \ell^2 = \left(\frac{c^2}{4a^2}\right)^1 \sin^2\theta$$

$$\sin^2\theta \propto \hbar^2 + k^2 + \ell^2$$

- b) Crystal structure of material with reasons
 FCC as $(\hbar\kappa\ell)$ are unmixed i.e. either all odd
 or all even

ii) The atoms in A layer are stacked similar to the schematic drawing shown in Figure (a). Is this layer a close packed layer of atoms? Explain your answer. The crevices obtained from A layer atoms can be filled with another B layer atoms as shown in Figure (b). In this manner, layer atoms would form a 3D crystal. Identify the crystal structure obtained for the same.



- Part A:
 No, it is not a close packed layer. For a close packed layer, the maximum coordination should be 12. Here only 4 atoms are touching each other. Hence the configuration of atoms on one of the faces here is not close packed.
- Part B:
 The configuration of atoms on one of the faces here is close packed. The coordination number is 12. Remember to see face diagonal.