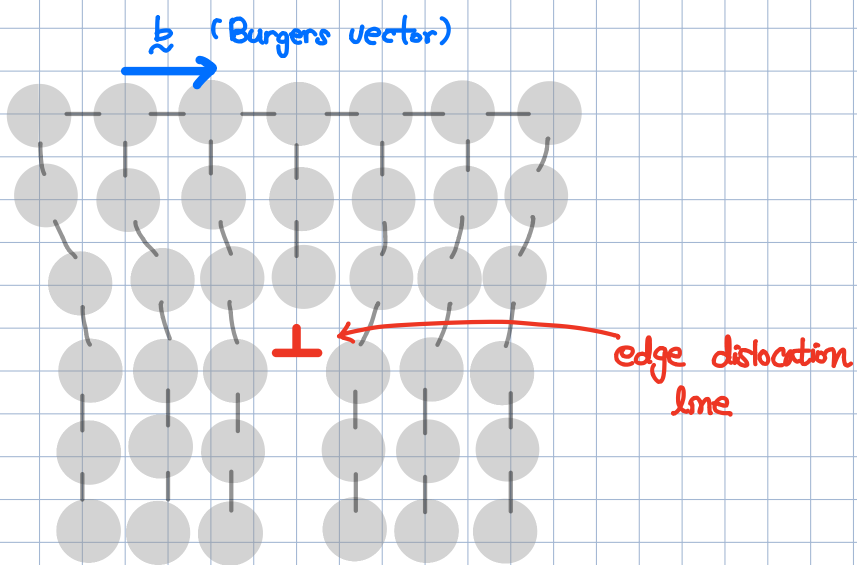
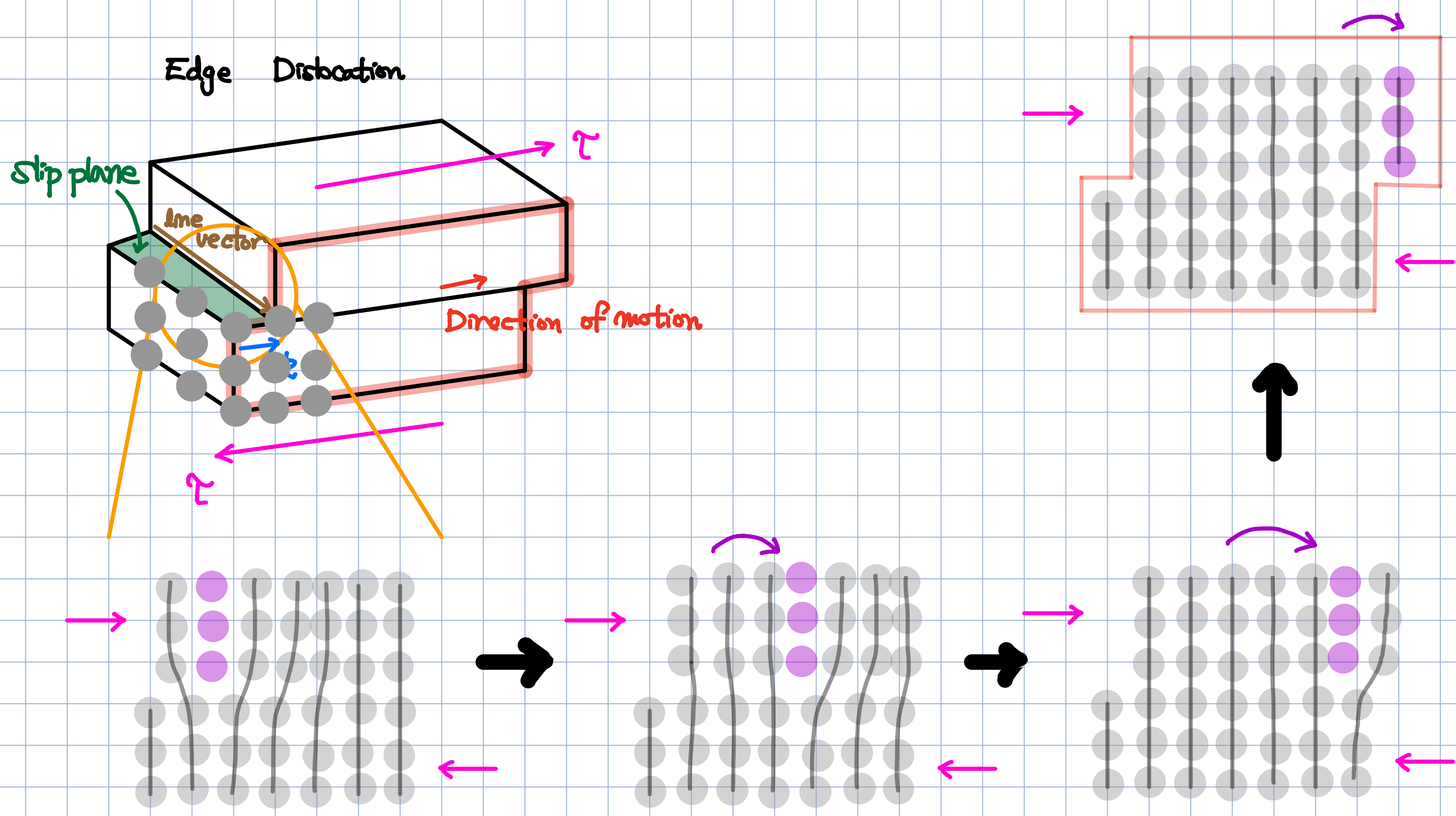
Problem 1:

Consider an aluminum alloy with the following properties:

Young's Modulus:	$E = 70\ GPa$
Shear Modulus:	$G = 26\ GPa$
Poisson's ratio:	$v = 0.27$
Lattice parameter:	$a = 0.4\ nm$

a) Derive the expression for shear stress, τ, to bow a dislocation (of line vector l and Burger's vector b) through a radius R. Assume a line tension of $T \sim 1/2Gb^2$, where G is the shear modulus.





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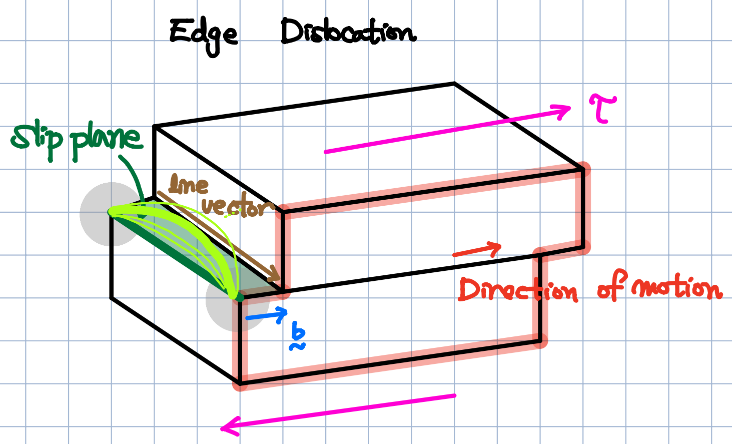
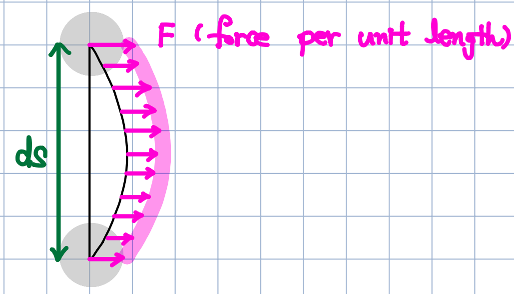
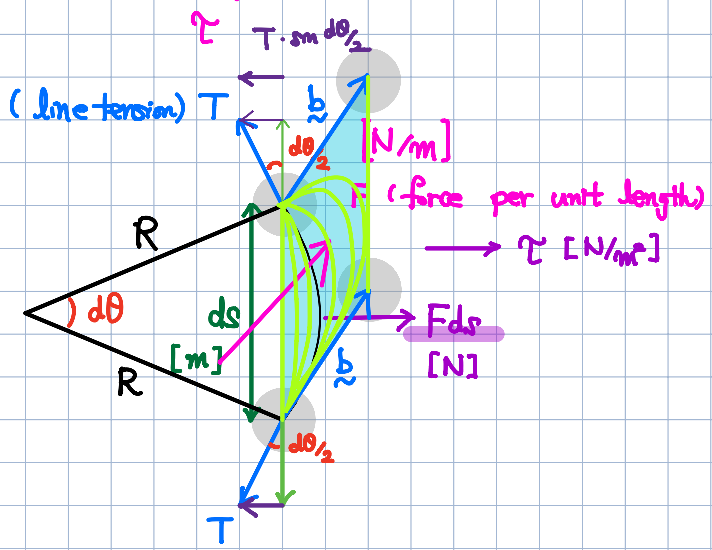
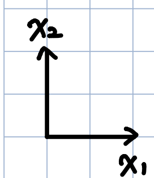






$ds \approx R\,d\theta$



$\Sigma F_{x_1} = 0$; $\quad + F\,ds \; - T\sin\frac{d\theta}{2} \times 2 = 0$

$F\,ds = T(\sin d\theta/2) \times 2 \quad \leftarrow \; d\theta \approx 0, \; \sin\frac{d\theta}{2} \approx d\theta/2$

$= T(d\theta/2) \times 2$

$\therefore F\,ds = T\,d\theta$

- Force dislocation outbound: $F\,ds = \tau \times \text{Area} \quad \leftarrow \; b\,ds$

  $[N] \quad [N/m^2]$

  $= \tau \cdot b\,ds$

$F = \tau \cdot b$

$$F\,ds = T\,d\theta \quad \longleftarrow \quad F = \tau \cdot b$$

$$\tau \cdot b\,ds = T\,d\theta \quad \longleftarrow \quad ds = R\,d\theta$$

$$\tau \cdot b \cdot R\,d\theta = T\,d\theta$$

$$\therefore\ \tau = \frac{T}{bR} \quad \longleftarrow \quad T = \tfrac{1}{2}Gb^2$$

$$= \frac{\tfrac{1}{2}Gb^2}{bR}$$

$$\tau = \frac{Gb}{2R}$$

Ans.