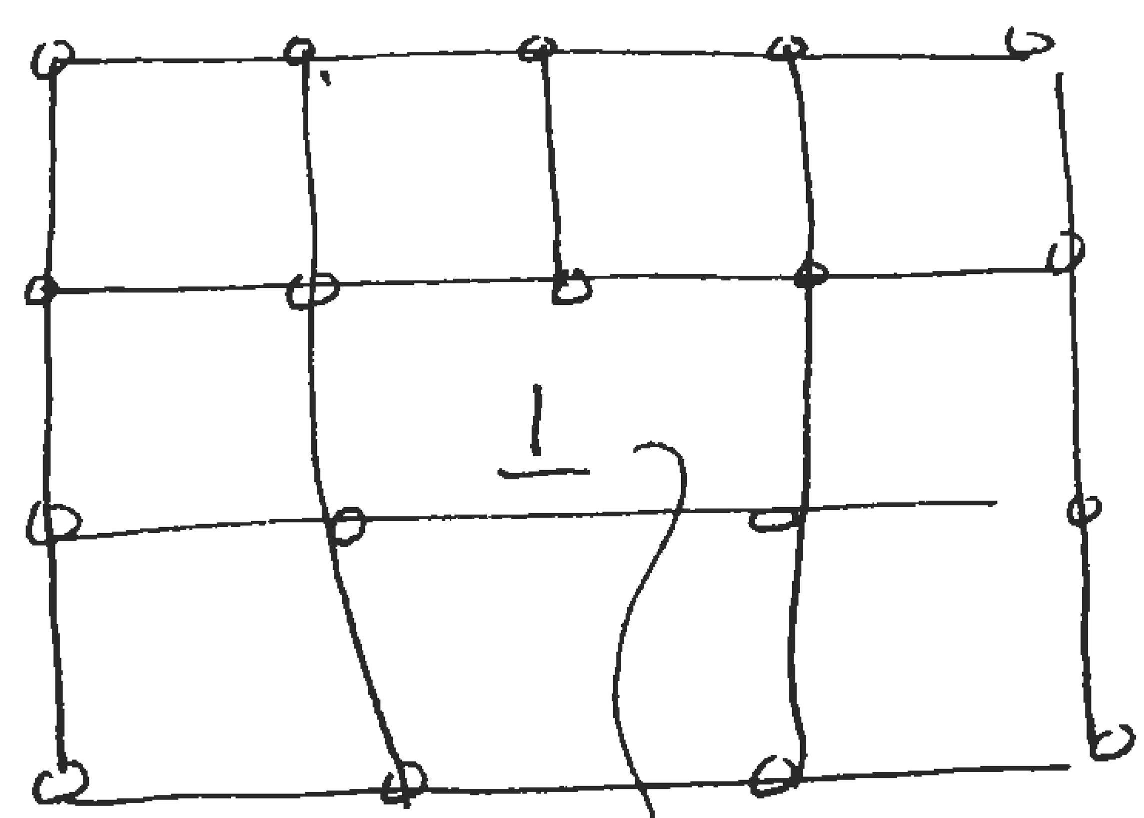
M15

a) A dislocation is a defect in a crystal lattice consisting of an extra half-plane of atoms (edge dislocation).



Application of a shear stress allows the dislocation to move by breaking one row of atoms at a time.

b) Rolling allows the billet of metal to be reduced in thickness. The hot rolling allows large reductions in thickness by allowing creep and diffusion processes to occur. The final step of cold rolling allows work hardening to occur which increases the strength of the resulting material.

MIS

c) Polycrystalline material contains grain boundaries which increase the resistance to dislocation motion. There are no such boundaries in a single crystal.

d) The toughness of engineering alloys to a large extent reflects the contribution of plasticity to energy absorption at the crack tip. Lower yield stress materials tend to have higher toughnesses as they have more plastically deforming material at the crack tip.

e) Carbon and glass are brittle materials. Their strength is determined by the size of flaws (cracks) present. By drawing the fibers down to a small diameter the maximum flaw size is limited and a high strength results.

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f) Duralumin is an Al(Cu) alloy which is hardened by $CuAl_2$ precipitates. The extent to hardening is proportional to $\propto \frac{1}{L}$ the spacing of the precipitate particles.

The time dependence of the hardness reflects the growth of the particles from the solid solution. At short times the particles are too small to be effective at pinning dislocations. At very long times the particles have grown so large that "L" is also large. Thus there is a maximum at intermediate times when the particles are large enough to be effective and are still closely spaced.