* Problem #1

a) look for highest ultimate stress - AISI 4142 quenched -

b) highest capacity of material to absorb energy w/in elastic range (most area under elastic curve)

- AISI 4142 quenched

c) highest capacity of material to absorb energy w/o fracture (most area under whole curve)

- AISI 1020 hot rolled -

d) the stiffness is noted as young's modulus

- all three materials appear to have the same Young's Modulus.

* Problem #2

Given: $S_y = 60$ kpsi $\quad \epsilon_y = .002$

Use: $\sigma_y = E\epsilon$, and $U = \int_0^{\epsilon_y} \sigma_y \, d\epsilon \sim R_m \cong \frac{1}{2} S_y \epsilon$

$$E = \frac{\sigma}{\epsilon} = \frac{60 \text{ kpsi}}{.002} = \boxed{30 \text{ MPsi}}$$

$$U = \frac{1}{2} S_y \epsilon = \frac{1}{2}(60 \text{ kpsi})(.002) = \boxed{60 \text{ Mpsi}}$$

* Problem #3

Given: $S_y = 100$ kpsi $\quad \epsilon_y = 0.006$

Use: $\sigma = E\epsilon$ and $R_m \sim \frac{1}{2} \frac{S_y^2}{E}$

$$R_m \sim \frac{1}{2} \frac{S_y^2}{\frac{S_y}{\epsilon}} \rightarrow R_m \sim \frac{1}{2} S_y \epsilon$$

$$R_m \cong \frac{1}{2}(100 \text{ kpsi})(0.006) = \boxed{300 \text{ psi}}$$

* Problem # 4

Given: $\sigma_y = 414$ MPa $\quad \Delta L/L = 15\% = .15 = \epsilon_f$

$\sigma_u = 689$ MPa

Is it ductile?

Yes...

- substantial amount of elongation
- small difference between yield and ultimate strength; brittle material breaks at or near yield stress

mod. of toughess, T_m?

Use: $T_m = \int_0^{\epsilon_f} \sigma \, d\epsilon \sim \frac{S_y + S_u}{2} \epsilon_f$

$$T_m = \frac{414 \text{ MPa} + 689 \text{ MPa}}{2} (.15) = \boxed{82.7 \text{ MPa}}$$

mod. of resilience, R_m?

Use: $R_m = \frac{S_e^2}{2E}$ ... assume $S_y = S_e$

$E_{steel} = 207$ GPa

$$R_m = \frac{(414 \text{ MPa})^2}{2(207 \text{ GPa})} = \boxed{414 \text{ kPa}}$$

* Problem # 5

Given: $H_B = 340$ HB $\quad$ Use: $S_u = K_B H_B$

$K_{B_{STEEL}} \sim 500$

$$S_u = (500)(340)[\text{psi}] = \boxed{170 \text{ kpsi}}$$

* Problem #6

Given: $H_{b_{anneal}} = 217$ Bhn

$H_{b_{normal}} = 363$ Bhn

Use: $S_u = K_b H_b$ $\quad$ $S_y = 1.05\, S_u - 30{,}000\,psi$

$K_{b_{steel}} \sim 500$

Part 1: $S_{u_{annealed}} = 500(217)[psi] = \boxed{108.5\ kpsi}$

$S_{y_{annealed}} = 1.05(108.5\,kpsi) - 30\,kpsi = \boxed{83.9\ kpsi}$

Part 2: $S_{u_{normalized}} = 500(363)[psi] = \boxed{181.5\ kpsi}$

$S_{y_{normalized}} = 1.05(181.5\,kpsi) - 30\,kpsi = \boxed{160.6\ kpsi}$

- Theoretically, the normalized steel exhibits a higher S_u and S_y.
- More experimental data would be useful in finalizing the relationship between the two
- Equation (3.12) is a good estimate of stress-relieved (<u>not</u> cold-worked) steels

* Problem #7

Given: 1020 steel, 1040 steel, 4340 steel
2024-T4 aluminum
Nylon (6/6), acetal

Find: material properties of each (tensile strength, yield strength, elongation & hardness)

See Appendix C-4a for normalized steel in 1" round section

see Appendix C-10 for wrought Al alloy for ½ inch sizes

see Appendix C-18a for plastics

i.e.

Material with highest tensile strength, yield strength & hardness with lowest elongation is best for some applications

→ **4340 steel**

answers may vary