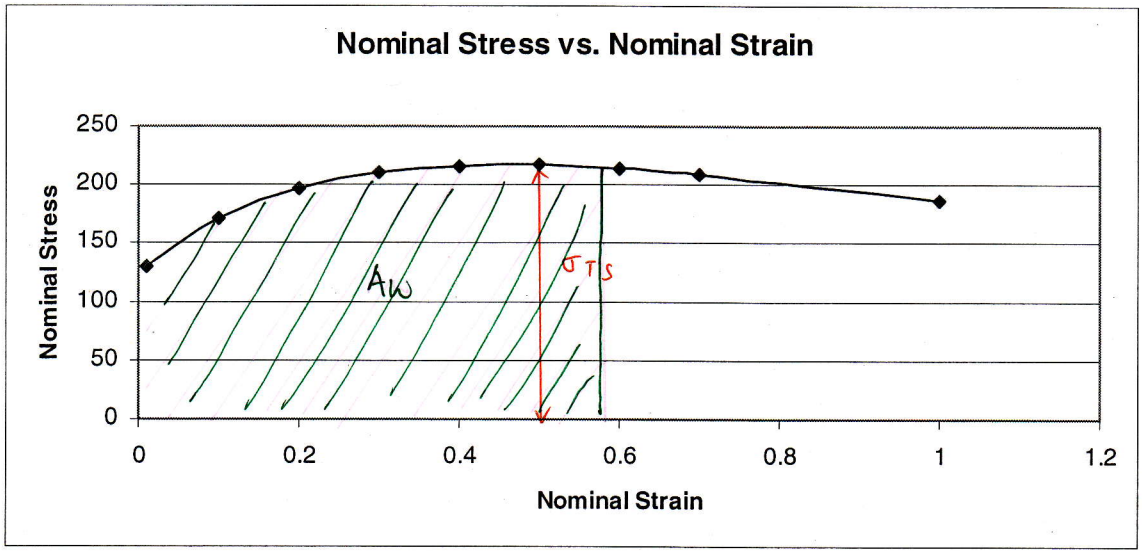
MAE 160
HW3 Solutions

#1.

Nominal Strain ε_n	Nominal Strain +0.08 $\varepsilon_n + 0.08$	Hardness (MNm^(-2)) H	True Stress (MNm^(-2)) $\sigma_T = H/3$	Nominal Stress (MNm^(-2)) $\sigma_n = \frac{\sigma_T}{(1+\varepsilon_n)}$
0.01	0.09	423	141	129.3577982
0.1	0.18	606	202	171.1864407
0.2	0.28	756	252	196.875
0.3	0.38	870	290	210.1449275
0.4	0.48	957	319	215.5405405
0.5	0.58	1029	343	217.0886076
0.6	0.68	1080	360	214.2857143
0.7	0.78	1116	372	208.988764
1	1.08	1170	390	187.5



#2

(a) 217 MPa

(b) approximately 0.58

(c) % area reduction: $\frac{A_o - A}{A_o} = \frac{\Delta A}{A_o}$

$A_o l_o = A l$

$\frac{A_o}{A} = \frac{l}{l_o} = \frac{l_o + \Delta l}{l_o} = 1 + \frac{\Delta l}{l_o} = 1 + \varepsilon_h$

$\frac{A}{A_o} = \frac{1}{(1+\varepsilon_h)}$

$\frac{A - A_o}{A_o} = \frac{A}{A_o} - 1 = \frac{1}{(1+\varepsilon_h)} - 1 = \frac{1 - 1 - \varepsilon_h}{1+\varepsilon_h} = \frac{-\varepsilon_h}{1+\varepsilon_h}$

$\simeq 38\%$

#1. ⓓ

A_W – area of work required to initiate tensile failure.

$$U = \int_0^{0.58} \sigma \, d\varepsilon$$

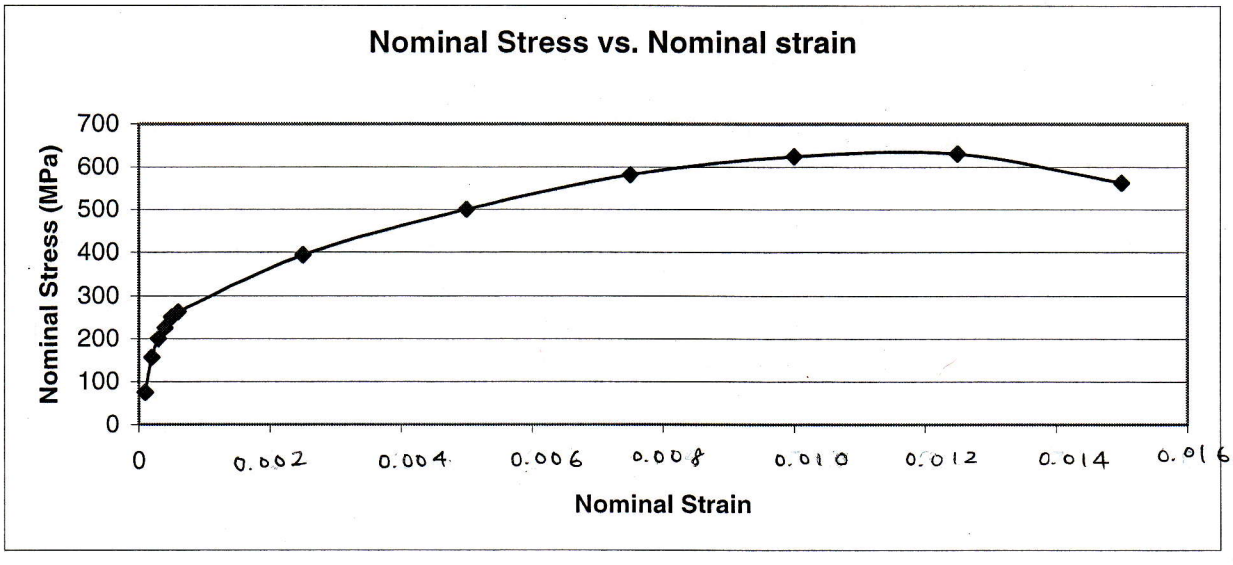
use trapezoidal approximation,

$$= \frac{1}{2}\left[(0+129.4)\times(0.09) + (129.4+171.2)\times(0.1) + (171.2+196.9)\times(0.1) \right.$$
$$\left. + (196.9+210.1)\times(0.1) + (210.1+215.5)\times(0.1) + (215.5+217.1)\times(0.1 \right.$$

$$\approx 109 \text{ MJ}$$

3

Extension ΔL (mm)	Load (kN)	Nominal Strain ε_n	Nominal Stress σ_n = Load/(Ao) (MPa)
0.05	12	0.001	75
0.1	25	0.002	156.25
0.15	32	0.003	200
0.2	36	0.004	225
0.25	40	0.005	250
0.3	42	0.006	262.5
1.25	63	0.025	393.75
2.5	80	0.05	500
3.75	93	0.075	581.25
5	100	0.1	625
6.25	101	0.125	631.25
7.5	90	0.15	562.5



(a) $\sigma_{TS} = 630$ MPa

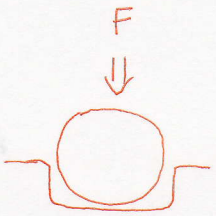
Working stress = $0.25 \times 630 \simeq 160$ MPa

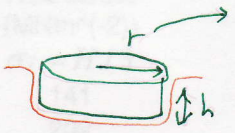
(b) 0.1% proff stress ~ 218 MPa

Working stress = $0.6 \times 218 \simeq 131$ MPa

4

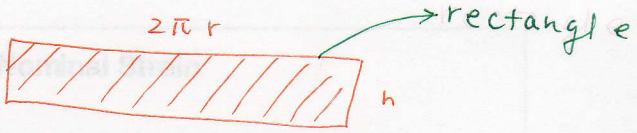
$$\text{Hardness} = \frac{\text{Force}}{\left(\begin{array}{c}\text{projected}\\ \text{area of}\\ \text{the indent}\end{array}\right)}$$





Approximate it as a cylinder with radius r height h

$$\text{Hardness} = \frac{F}{2\pi r h}$$



projected area = $2\pi r h$