1. The following data were gathered for the steady state creep rate of polycrystalline Al_2O_3. All grain sizes are 10 µm except * which are 30 µm.

	Temp °C	Stress MPa	strain rate 10^{-4}/hr.
	1400	10	0.3
	1400	10	0.011*
	1425	10	0.8
	1450	10	1.6
	1475	10	3.0
(1)	1500	1	0.5
(2)	1500	2	1.1
(3)	1500	5	2.6
(4)	1500	10	5.1
	1500	10	0.19*
	1500	15	8.0
	1525	10	11.0
	1575	10	54.6
	1600	10	121.5
	1600	10	13.5*

For steady state creep determine

(a) the stress ~~compo~~ exponent.

(b) the activation energy

(c) the grain size exponent

(d) the creep mechanism.

For steady state creep rate

$$\dot{\varepsilon} = \frac{ADGb}{KT}\left(\frac{b}{d}\right)^m\left(\frac{\sigma}{G}\right)^n$$

(a) at same temp & same grain size

$$\frac{\dot{\varepsilon}_1}{\dot{\varepsilon}_2} = \left(\frac{\sigma_1}{\sigma_2}\right)^n$$

Consider ① ② ③ ④ set of values

① ②

$$\frac{.5}{1.1} = \left(\frac{1}{2}\right)^n \qquad n = 1.1$$

② ③

$$\frac{1.1}{2.6} = \left(\frac{2}{5}\right)^n \qquad n = .94 \qquad \Rightarrow n = 1$$

③ ④

$$\frac{2.6}{5.1} = \left(\frac{5}{10}\right)^n \qquad n = .97$$

(b)

$$\Delta H = \frac{R \ln\left(\dot{\varepsilon}_1/\dot{\varepsilon}_2\right)}{\frac{1}{T_2} - \frac{1}{T_1}}$$

Consider the data for const stress, & same grain size

T °C	$\dot{\varepsilon}$ [hr⁻¹]
1400	$.3 \times 10^{-4}$
1500	5.1×10^{-4}

& grain size = 10 um

stress = 10 MPa

$$\Delta H = \frac{8.314 \ln\left(\frac{.3 \times 10^{-4}}{5.1 \times 10^{-4}}\right)}{\frac{1}{1773} - \frac{1}{1673}} = \frac{-23.56}{-3.37 \times 10^{-5}}$$

$$= 6.99 \times 10^5 \text{ J}$$

°C	
1400	$.011 \times 10^{-4}$ /hr
1600	13.5×10^{-4} /hr.

$$\Delta H = \frac{8.314 \ln\left(\frac{.011}{13.5}\right)}{\frac{1}{1873} - \frac{1}{1673}} = \frac{~~6.77 \times 10^{-3}~~ \; -59.1}{-6.38 \times 10^{-5}}$$

$$= 9.26 \times 10^{5} \text{ J}$$

T °C	$\dot{\varepsilon}$ /hr $\times 10^{-4}$
1400	.3
1425	.8
1450	1.6
1475	3
1500	5.1
1525	11.0
15~~75~~	54.6
1600	121.5

$$\dot{\varepsilon} = A \exp\left(-\frac{\Delta H}{RT}\right)$$

$$\ln \dot{\varepsilon} = \ln A - \frac{\Delta H}{RT}$$

$$-\ln \dot{\varepsilon} = \frac{\Delta H}{R}\left(\frac{1}{T}\right) - \ln A$$

make a plot $(-\ln \dot{\varepsilon})$ vs. $\frac{1}{T}$ — slope $= \frac{\Delta H}{R}$

from slope get $\underline{\Delta H}$