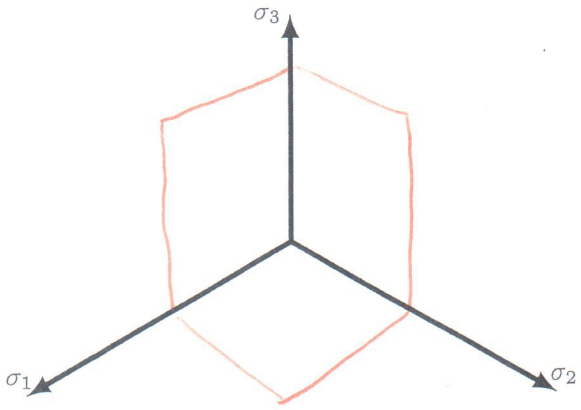
Problem 1

(5 points each) Short answer:

(i) Sketch a Mohr-Coulomb failure surface in the π-plane on the figure.



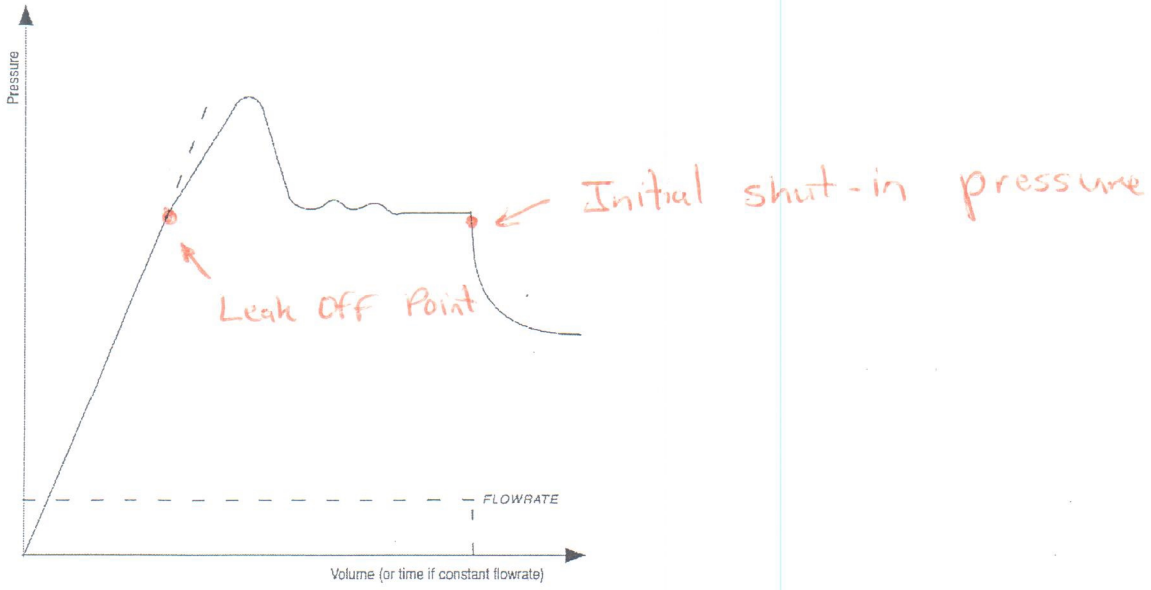
(ii) List two reasons why tensile strength is relatively unimportant in reservoir geomechanics.

1. The entire crust of the Earth is under compressive stress.

2. Rocks have negligible tensile strength.

Problem 1 continued on next page...

(iii) On the figure below that schematically represents an extended leakoff-test

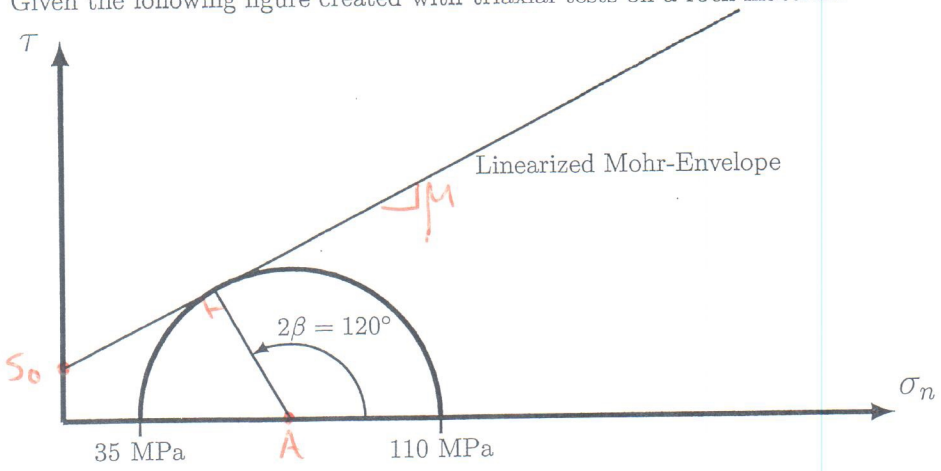


Label the **leak-off point** and the **initial shut-in pressure**.

Problem 2

(20 points)

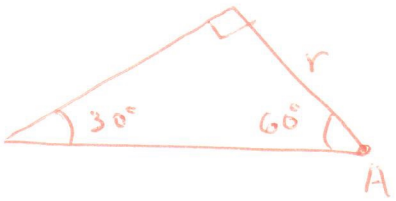
Given the following figure created with triaxial tests on a rock material:



Give the unconfined compressive strength of the material.

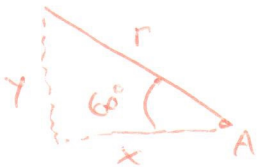
From problem geometry

$\mu = \tan 30^\circ = \frac{1}{\sqrt{3}}$



$A = \frac{110+35}{2} = \frac{145}{2}$

$r = \frac{110-35}{2} = \frac{75}{2}$



$x = r\cos(60^\circ) = \frac{75}{4}$

$\sigma_n = A - x = \frac{215}{4}$

$\tau = y = r\sin(60^\circ) = \frac{75\sqrt{3}}{4}$

$S_0 = \tau - \sigma_n \mu = \frac{5}{2\sqrt{3}}$

$C_0 = 2S_0\left(\sqrt{\mu^2+1} + \mu\right) = 5 \text{ MPa}$ ///

Problem 2 continued on next page...

Problem 3

(20 points) Lab strength tests on *dry rock samples*, i.e. no pore fluid, with peak shear strength values have been fit to the linear relationship $S_1 = 30$ MPa $+ 5$ MPa S_3. What is the unconfined compressive strength C_0 and internal friction coefficient μ_I for this rock.

$C_0 = 30$ MPa

$n = 5$

$$\mu = \frac{n-1}{2\sqrt{n}} \approx 0.89$$

This page provided for additional calculations

Problem 4

(**20 points**) Given the geographical stress,

$$\mathbf{S}_G = \begin{bmatrix} 47.5 & -12.5 & 0 \\ -12.5 & 47.5 & 0 \\ 0 & 0 & 40 \end{bmatrix} \text{ MPa}$$

For a wellbore deviated 35° from vertical along an azimuth oriented directly to the north-east, find the wellbore stress tensor, $\mathbf{S}_B$.

Using code:

$$S_b = \begin{bmatrix} 36.6 & 0 & -2.3 \\ 0 & 60 & 0 \\ -2.3 & 0 & 38.3 \end{bmatrix}$$