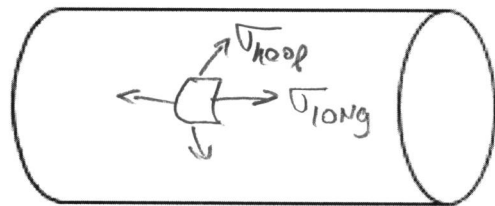


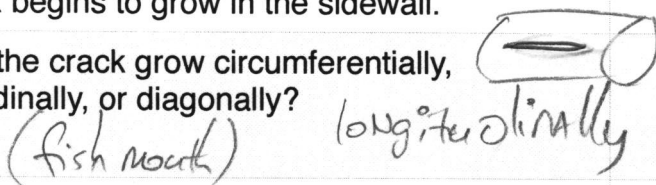
You may use your books and notes. Your signature shows that you agree with the answers. No discussions are allowed between the different teams. Each team returns one signed copy to Prof. Burleigh. Do not go onto a second page.

Name	signature
	Solutions

A cylindrical pressure vessel is cyclically pressurized to an internal pressure  $p = 30 \text{ MPa}$ .  
 wall thickness:  $t = 20 \text{ mm}$ ,  
 diameter =  $1 \text{ m}$   
 $K_{Ic} = 60 \text{ MPa}\cdot\text{m}^{0.5}$   
 A crack begins to grow in the sidewall.



a) Will the crack grow circumferentially, longitudinally, or diagonally?



Which is larger,  $\sigma_{hoop}$  or  $\sigma_{long}$ ?

$$K_{Ic} = \sigma \sqrt{\pi a_c}$$

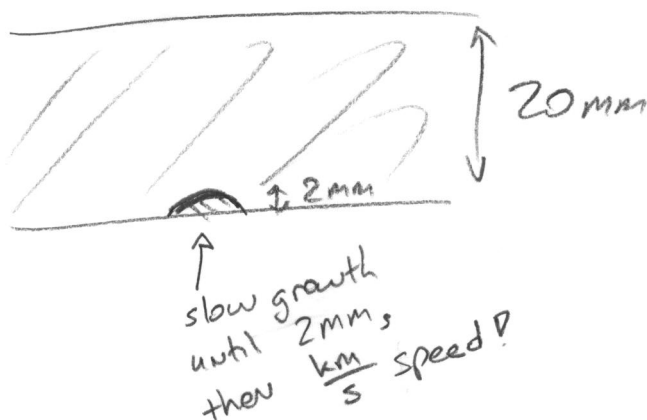
b) As the crack grows in depth, will it develop a leak that harmlessly depressurizes the vessel, or will the vessel explode violently? Confirm your answer with calculations.

$$\sigma_{hoop} = \frac{pr}{t}$$

$$\sigma_{long} = \frac{pr}{2t}$$

$$\sigma_{hoop} = \frac{pr}{t} = \frac{(30 \text{ MPa})(0.5 \text{ m})}{(0.020 \text{ m})} = 750 \text{ MPa} \text{ (B is larger)}$$

$$a_c = \frac{1}{\pi} \left( \frac{K_{Ic}}{\sigma} \right)^2 = \frac{1}{\pi} \left( \frac{60 \text{ MPa}\cdot\text{m}^{0.5}}{750 \text{ MPa}} \right)^2 \left( \frac{10^3 \text{ mm}}{\text{m}} \right) = \underline{\underline{2.04 \text{ mm}}}$$



Crack goes critical  
 At  $a = 2 \text{ mm}$   
 Vessel wall is  $20 \text{ mm}$   
 thick. Therefore violent  
explosion!