

1) a) $F = P \cdot A$
 $= P \cdot dL$
 $F = 2\sigma_H \cdot tL$
 $\therefore 2\sigma_H tL = PdL$
 $\therefore 2\sigma_H t = Pd$
 $\therefore \sigma_H = \frac{Pd}{2t}$

b) It is the limiting factor as σ_H sees twice the forces as σ_{long} , such as longitudinal. This changes the design & production process

c) $\rho = \frac{m}{V}$

$\rho = 1.0240 \text{ g} = 1024 \text{ m}^3/\text{kg}$

d) $P = \rho gh$
 $h = \frac{P}{\rho g} \therefore h =$

$P = \frac{2\sigma_H t}{d} = \frac{2(200 \times 10^6)(0.0049)}{4.9} =$

~~XXXXXXXXXXXXXXXXXXXX~~

$P = 400 \text{ kPa}$

$P = 400000 \times 2.1$

$P = 840000 \rightarrow \text{w/safety factor of } 2.1$

$P = \rho gh$

$\therefore h = \frac{P}{\rho g} = \frac{840000}{(1024)(9.81)}$

$h = 82.33 \text{ m}$

e) $0.1 \text{ mPa} = 100000 \text{ Pa} = 100 \text{ kPa} + 840 \text{ kPa} = h = \frac{940000}{(1024)(9.81)} = 93.57 \text{ m}$

1)f) $\sigma_p = 2 \text{ mpa} = 200000 \text{ Pa} = 200 \text{ KPa}$

$$h = \frac{P}{(\rho g)}$$

$$\therefore \frac{1040000}{1040 (9.81)}$$

$$\therefore h = 101.93 \text{ meters}$$

EEF

g) The values in d, e, f are increasing which shows that it is following the right trend, as increasing the pressure inside, decreases the pressure difference from inside to outside, allowing deeper depths to be reached

f) Results may differ in the real scenario as the densities of the water varies constantly, and submarines are not shaped like perfect cylinders

2a) A = Define the problem

- this should start w/ a clear and unambiguous definition of the problem. once this has been done, the following needs to be defined:
 - Establish customer needs - what is the problem that the product solves?
 - ~~develop a problem statement~~
 - develop a problem statement - this should be broad enough not to preclude possible solutions but will specifically address the needs
 - Criteria for success - involves input from many roles including managers, scientists, marketing & manufacturing

B = Gather Relevant info

- At this stage items such as the following should be considered
 - Is the problem real & its statement accurate?
 - Is there a need for a solution or is there already one out there?
 - What are existing solutions?
 - What is wrong w/ the way it is already being solved?
 - What companies are already producing something to solve it?
 - What are the economic factors in the solution?
 - What will customers pay?
 - What other factors are important to the solution (safety, aesthetics, enviro)

C = Generate multiple solutions

- At this stage the following should be considered
 - creative brainstorming
 - Synthesis of new ideas
 - Design teams should be free to take risks
 - People from different disciplines should be involved

D = Analyse & select solution

- following Analysis should be carried out
 - functional analysis
 - industrial design/ergonomics
 - mech/strength analysis
 - electrical/electromagnetic



- manufacturing/testing
- safety & reliability
- ergonomic & market analysis
- Regulations & standards

E: Test & Implement solution

- following should be considered
 - prototyping & testing under real conditions. These can be used to correlate the analytical work carried out in step 4, to gain confidence in the testing in this stage.
 - use contemporary manufacturing techniques
 - Documentation - This may be relevant if legislation & govt testing is needed, or how testing was performed
 - Apply for patents

- b) Design problems are usually more vague than analysis problems. Analysis problems have one answer, where design problems have systems specifying specific needs and solutions. Solving a design problem is usually an iterative process, the solution to the problem evolves, and there may be continual refinement to the ~~prob~~ design. Obstacles may come up such as cost, safety, feasibility, and this shows it is cyclic, as the process would start again, with different objectives & solutions

(Q4)

a)

$$AB \sigma_\theta = AC \tau_{xy} \sin \theta + BC \tau_{xy} \cos \theta$$

$$\therefore \sigma_\theta = \frac{AC}{AB} \tau_{xy} \sin \theta + \frac{BC}{AB} \tau_{xy} \cos \theta$$

$$\therefore \sigma_\theta = \tau_{xy} \sin \theta \cos \theta + \tau_{xy} \sin \theta \cos \theta$$

$$\therefore \sigma_\theta = 2 \tau_{xy} \sin \theta \cos \theta$$

$$\therefore \sigma_\theta = 2 \tau_{xy} \cdot \frac{1}{2} \sin 2\theta$$

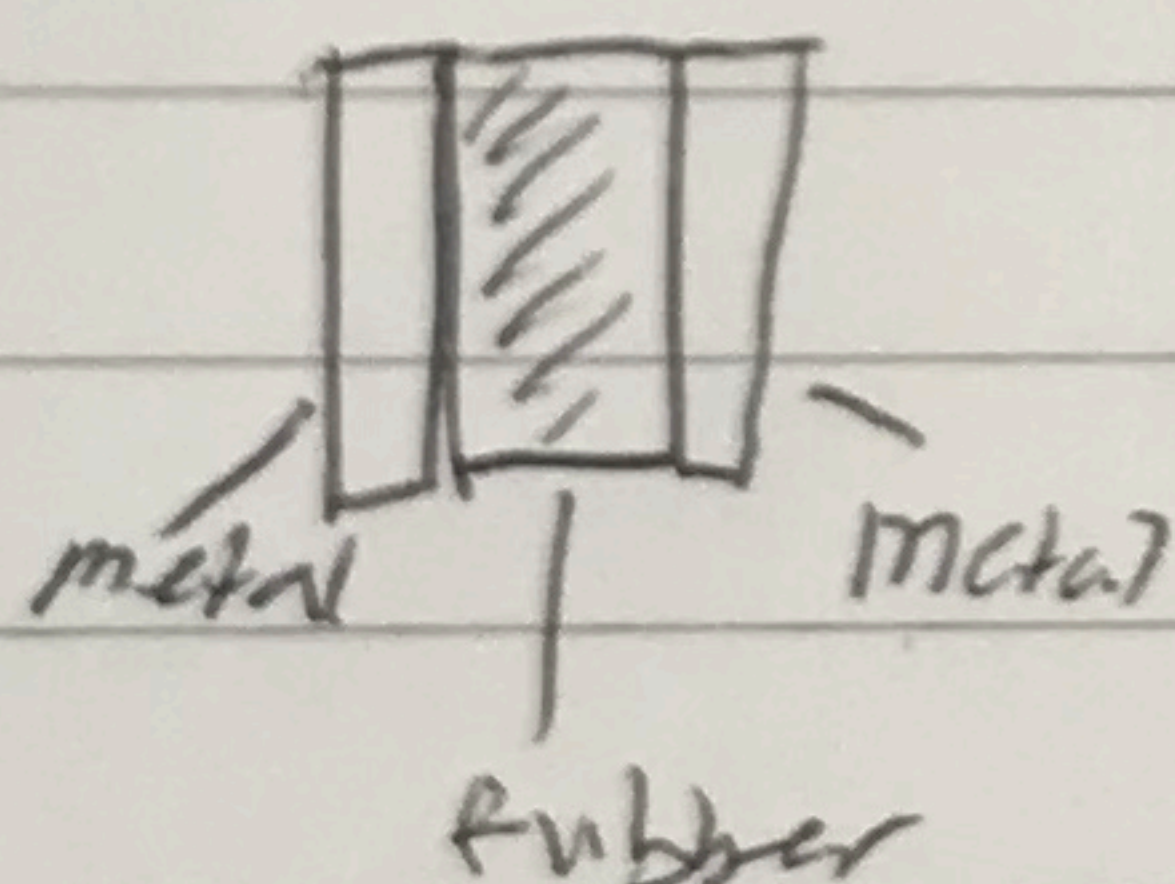
$$\therefore \sigma_\theta = \tau_{xy} \sin 2\theta$$

b) $\sigma_\theta = 83 \cdot (\sin 2 \cdot 58) = \text{~~74.59 MN/m}^2~~ 74.59 \text{ MN/m}^2$

c) $\tau_\theta = -\tau_{xy} \cos 2\theta$

$$\tau_\theta = -83 (\cos 2 \cdot 58) = 36.38 \text{ MN/m}^2$$

d) A piece of metal being cut by shears, a scissor like tool, or two pieces of metal with rubber in the middle connecting them



e) This is ~~quite~~ unlikely to happen because the both sides of metal would have to be pulled apart with the same force, however in the real world, equal forces exactly are applied, and there is a possibility the direction isn't straight. Dotted lines represent possible imbalances of force

