



Complete, fold and seal
(see note 2 below)

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Instructions to Candidates

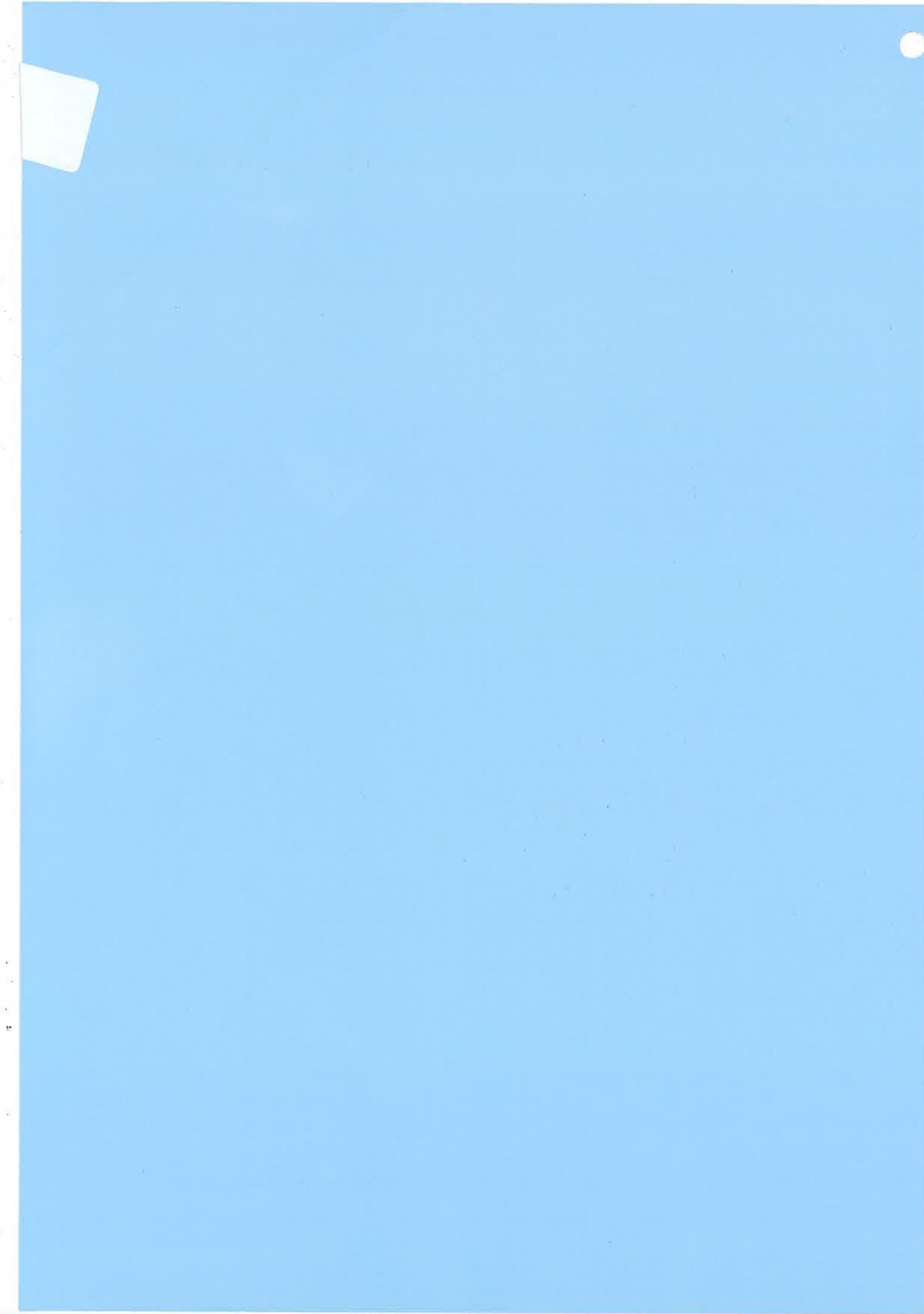
1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it retyped and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

1	Student Number	1701199
2	Title of Examination Paper	M5XQ2064
3	Module Code	↓ CAE and Stress ↑
4	Date and Time of Examination	
5	Examination Venue	1Q 310
6	Seat Number	6957
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	20
2	18
3	11
Total	49

(Gweler yr ochr arall am y fersiwn Cymraeg)

8172



$$1. \quad P = \frac{F}{A}$$

$$a) \quad \begin{aligned} \uparrow F &= PA \\ &= P d L \end{aligned}$$

$$\downarrow F = 2 \sigma_H \cdot L t$$

$$2 \sigma_H L t = P d L$$

$$2 \sigma_H = \frac{P d}{t}$$

$$\sigma_H = \frac{P d}{2 t}$$

10

$$b) \quad \begin{aligned} \sigma_H &= 200 \times 10^6 \text{ Pa} \\ d &= 3.5 \\ t &= 0.0005 \text{ m} \end{aligned}$$

$$q \quad \sigma_H = \frac{P d}{2 t}$$

$$P = \frac{\sigma_H 2 t}{d}$$

$$= \frac{200 \times 10^6 \times 2 \times 0.0005}{3.5}$$

$$= \underline{\underline{57.14 \text{ kPa}}}$$

i)

At sea level:

$$101 - 57.14 = 43.86 \text{ kPa}$$

From table 1:

$$\text{Altitude} = \underline{\underline{20,000 \text{ feet}}}$$

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ii) Pressure at 8,000 ft from table 1:
75.3

$$\therefore 75.3 - 57.14 = 18.16 \text{ kPa}$$

From table 1:

Altitude = 40,000 feet

c) Pressurizing the cabins drops the pressure difference between the cabin and the atmosphere at elevated altitudes. This results in lower hoop stresses. As a result, the structure is able to travel at higher altitudes where air density is lower and as such, the fuel economy of the air-plane is improved.

d)

$$\uparrow F = PA = P \frac{\pi d^2}{4}$$

$$\downarrow F = \sigma_H \pi d t$$

$$\sigma_H \pi d t = \frac{P \pi d^2}{4}$$

$$\sigma_H = \frac{P \pi d^2}{4 \pi d t}$$

$$\therefore \sigma_H = \frac{P d}{4 t}$$

- However, spheres have much bigger footprint. ~~It is this~~ which means that volume-wise, it is much more cost effective to use a cylinder.

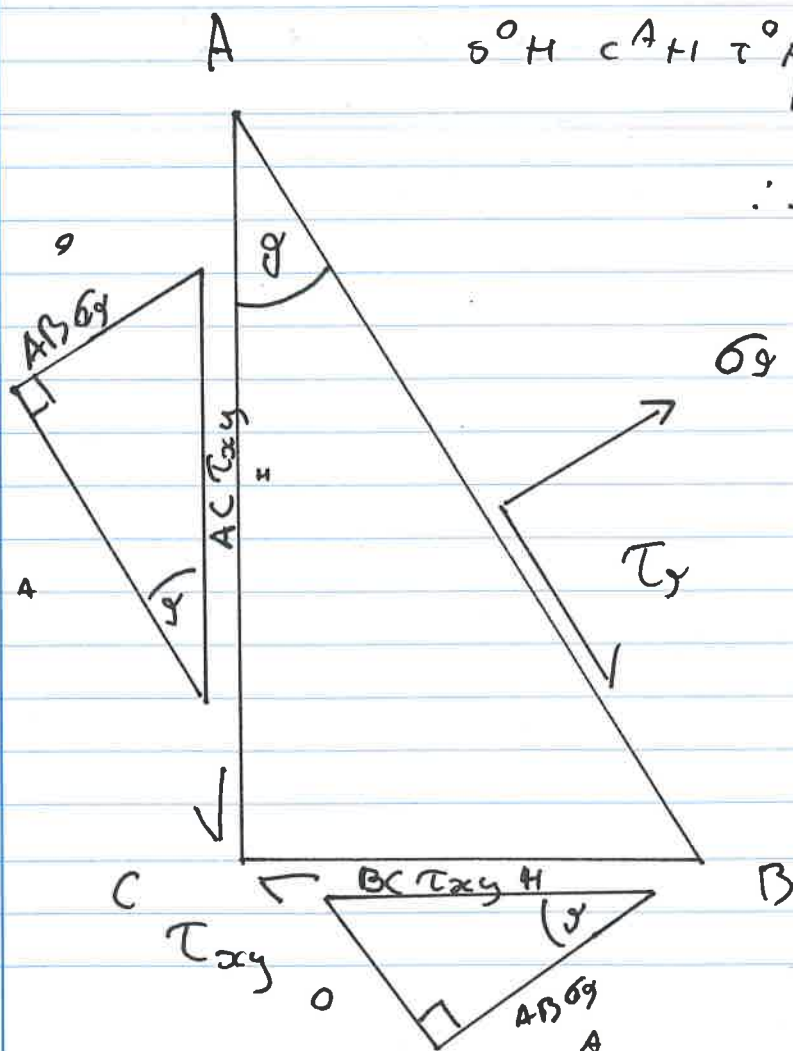
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2.

- a - Lowest

6)

i)



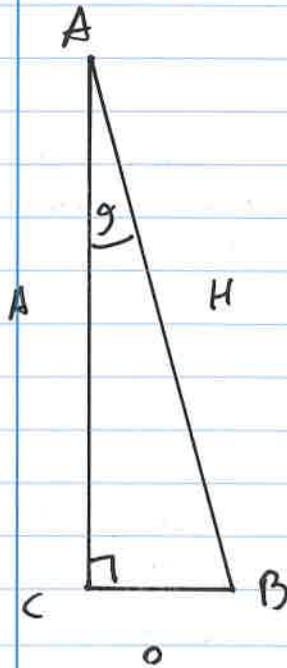
$$\sin \theta = \frac{AB \sin \theta}{AC \cos \theta}$$

$$\cos \theta = \frac{AB \cdot \sigma_y}{BC \cdot \tau_{xy}}$$

$$\therefore AB \text{ bis } BC \text{ transversal}$$

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

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



$$\sin \theta = \frac{BC}{AB}, \cos \theta = \frac{AC}{AB}, \tan \theta = \frac{BC}{AC}$$

~~$$\therefore \sigma_y = \tau_{xy} \sin \theta \cos \theta + \tau_{xy} \cos \theta \tan \theta$$~~

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

$$\sin \theta \cos \theta = \frac{1}{2} \sin 2\theta$$

~~$$\therefore \sigma_y = 2\tau_{xy}$$~~

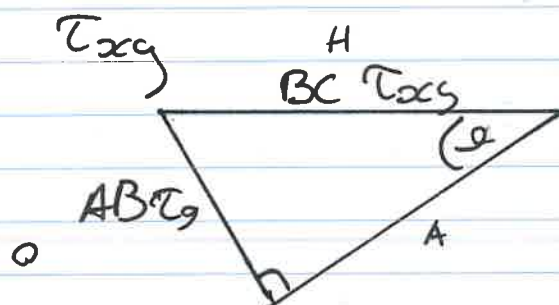
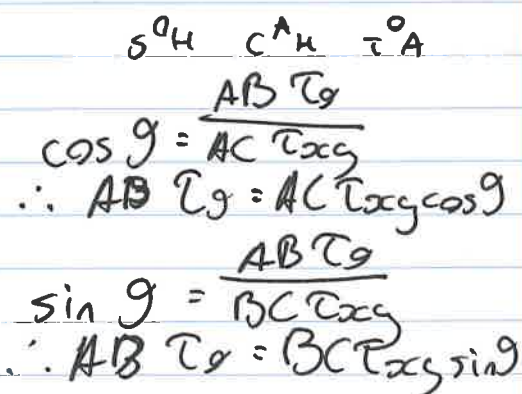
$$\sigma_y = 2 \tau_{xy} \sin \theta \cos \theta$$

$$\therefore \sigma_y = \cancel{2} \tau_{xy} \left(\cancel{\frac{1}{2}} \sin 2\theta \right)$$

$$\underline{\underline{\sigma_y = \tau_{xy} \sin 2\theta}}$$

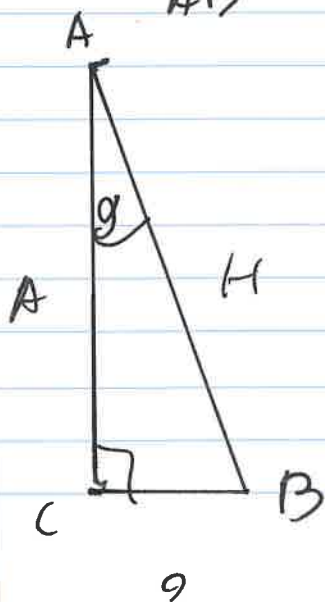
(5)

ii



$$\therefore AB T_g = -AC T_{xy} \cos \theta + BC T_{xy} \sin \theta$$

$$T_g = \frac{AC}{AB} T_{xy} \cos \theta + \frac{BC}{AB} T_{xy} \sin \theta$$



$$\sin \theta = \frac{BC}{AB}, \cos \theta = \frac{AC}{AB}, \tan \theta = \frac{BC}{AC}$$

$$\therefore T_g = \cos \theta T_{xy} \cos \theta + \sin \theta T_{yx} \sin \theta$$

$$\tau_g = \tau_{ocg} \cos^2 \theta + \tau_{ocg} \sin^2 \theta$$

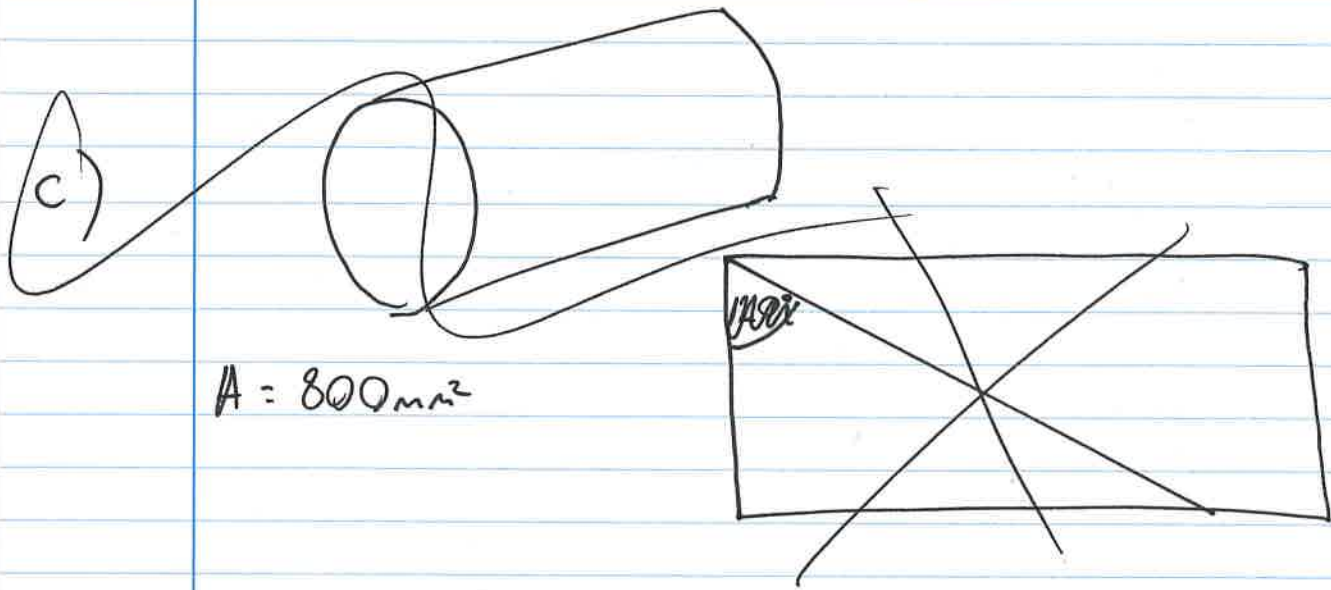
$$\tau_g = \tau_{ocg} (\cos^2 \theta + \sin^2 \theta)$$

$$\sin^2 y + \cos^2 y = -\cos 2y$$

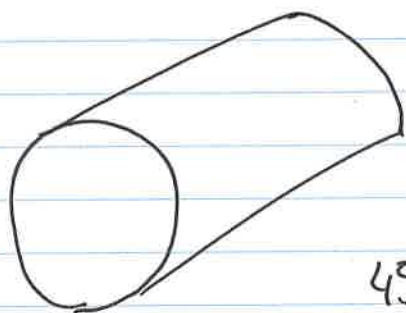
$$= mTg = T \cos \theta (-\cos 2\theta)$$

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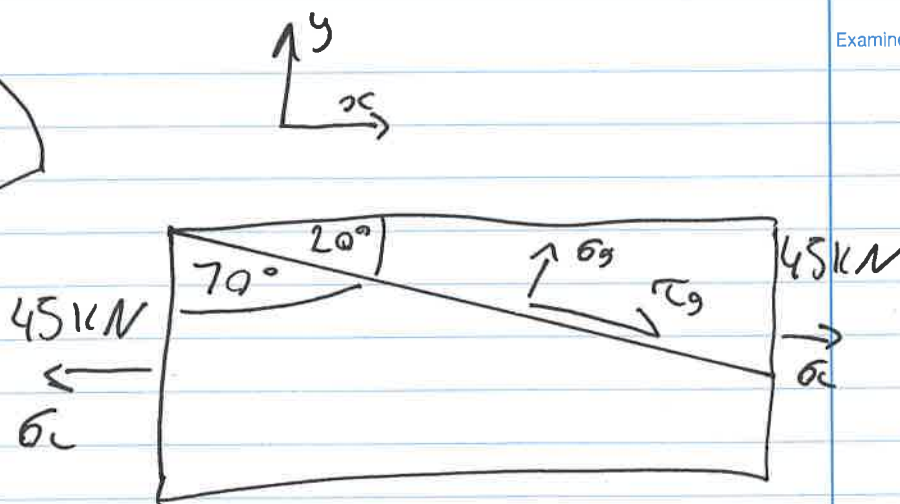
$$\underline{\tau_{\theta} = -\tau_{xy} \cos 2\theta}$$



c)



$$A = 800 \text{ mm}^2$$



$$\sigma = \frac{F}{A}$$

$$A = 800 \times 10^{-6} \text{ m}^2$$

$$\sigma_c = \frac{45 \times 10^3}{800 \times 10^{-6}} = 56.25 \text{ MPa}$$

$$\sigma_y = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y) \cos 2\theta$$

$$\sigma_y = \frac{1}{2}(56.25 + 0) + \frac{1}{2}(56.25 - 0) \cos(2 \times 70)$$

$$\sigma_y = 6.58 \text{ MPa}$$

$$\tau_y = \frac{1}{2}(\sigma_x - \sigma_y) \sin 2\theta$$

$$= \frac{1}{2}(56.25 - 0) \sin(2 \times 70)$$

$$= 18.08 \text{ MPa}$$

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Question No.

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- a) Analysis problem always has a single answer, whereas the Design problem's answer develops as the project develops. This is because ^{thus, throughout} the Design problem process, ~~new~~ the design might become not financially viable, un-safe or the design itself might be inferior to other designs which are already available. Therefore, the Analysis problem is sequential whereas Design problem is iterative.

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b)

Design problem is iterative because it requires the concept to be developed. Naturally, as that happens, new information is collected about the performance of the design and how it compares to other designs. It is very common to find that ~~the~~ the new information causes the ~~the~~ design team to realize crucial aspects of either the design or the problem. This then causes the team to take a different 'path' to what they have originally intended. As such, that process is iterative. Furthermore, since the 'path' is not clear, it may take the team many 'tries' before they can move onto the next step.

Whereas the Analysis problem is sequential primarily due to the fact that the 'path' is clear. Therefore, there are known steps which have to be followed in line, or, sequentially.

⑤

c) The general model which has the following steps: define the problem, gather relevant information, create multiple solutions, analysis and choose a solution and implement and test the solution. The advantage of this approach is that it combines the ~~st~~ general ~~ideology~~ ~~the~~ ideology of the other 3 common models. As such, this model is likely to produce a well performing product which ~~which has~~ have little or no problems/oversights.

On the other hand, since this model is ~~g~~so generalized, it might not be the most efficient for the specific task. Therefore, it is likely to cost more and take more time to complete it.

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