



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Examination Answer Books

12 Pages

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 typed 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	PIS1140
2	Title of Examination Paper	CAE and Stress Analysis
3	Module Code	MSX02064
4	Date and Time of Examination	9 May 2019 12:00
5	Examination Venue	112 IQ
6	Seat Number	
7	Number of Answer Books handed in	1

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(Gweler yr ochr arall am y fersiwn Cymraeg)

**Complete, fold and seal
(see note 2 below)**

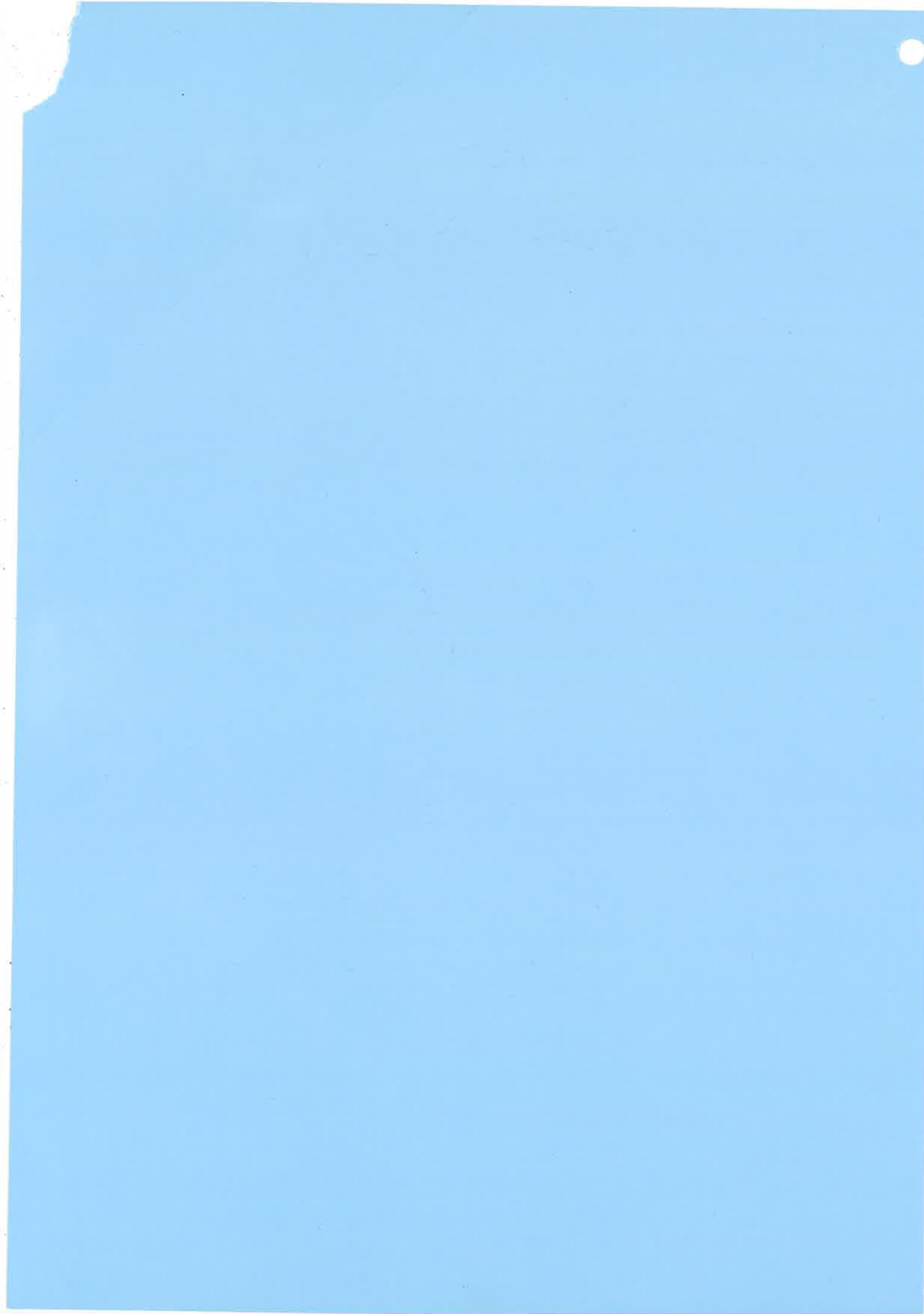
SURNAME:

SURNAME: Chappell

FORENAME(S):

FORENAME(S): Raoul

65%



a) ① a) Derive $\sigma_H = \frac{P d L}{2 t}$

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{Force} = \text{Stress} \times \text{Area}$$

$$\text{resistive force} = \sigma_H \times 2 L t$$

$$\text{Force due to pressure} = P d L$$

$$\text{Force due to pressure} = \text{resistive force}$$

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

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

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

✓ ④

b) b) I)

$$\sigma_{H \max} = 200 \times 10^6 \text{ Pa}$$

$$d = 3.5 \text{ m}$$

$$t = 0.5 \times 10^{-3} \text{ m}$$

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

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

$$P = \frac{200 \times 10^6 \times 2 \times 0.5 \times 10^{-3}}{3.5}$$

$$P = 57.1428 \text{ kPa}$$

$$\text{max pressure difference} = 57.143 \text{ kPa}$$

~~P @ Sea Level~~

$$P \text{ at Sea Level} - \Delta P_{\max} = 43.857 \text{ kPa}$$

$$\frac{P_{at 20000ft} - P_{at 25000ft}}{10} = \Delta P / 500ft$$

$$\Delta P / 500ft = 18.157 / 44.7 \times 0.9 kPa$$

$$\begin{aligned} \therefore P_{at 20500ft} &= 18.157 \times 45.7 kPa \\ &= 44.8 kPa \\ 21500ft &= 43.9 kPa \\ 22000 &= 43 kPa \end{aligned}$$

$$\therefore \text{max altitude} = 21500ft \text{ (to nearest 500ft)}$$

b) II) max ΔP remains the same

$$P_{at 8000ft} - \Delta P_{max} = 18.157 kPa$$

$$\frac{P_{at 40000ft} - P_{at 45000ft}}{10} = \Delta P / 500ft$$

$$\Delta P / 500ft = 0.42 kPa$$

$$P_{at 40500ft} = 18.28 kPa$$

$$P_{at 41000ft} = 17.86 kPa$$

$$\therefore \text{max altitude} = 40500ft$$

d) higher flying altitude where air density is lower allowing higher velocity travel and less fuel expenditure due to less drag

d) Derive $\sigma_H = \frac{P d}{4t}$

$$\begin{aligned} \text{Force due to pressure} &= \text{Pressure} \times \text{Area} \\ &= P \frac{\pi d^2}{4} = \frac{P \pi d^2}{4} \end{aligned}$$

$$\text{Resistive force} = \sigma_H \times \pi d t$$

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

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

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

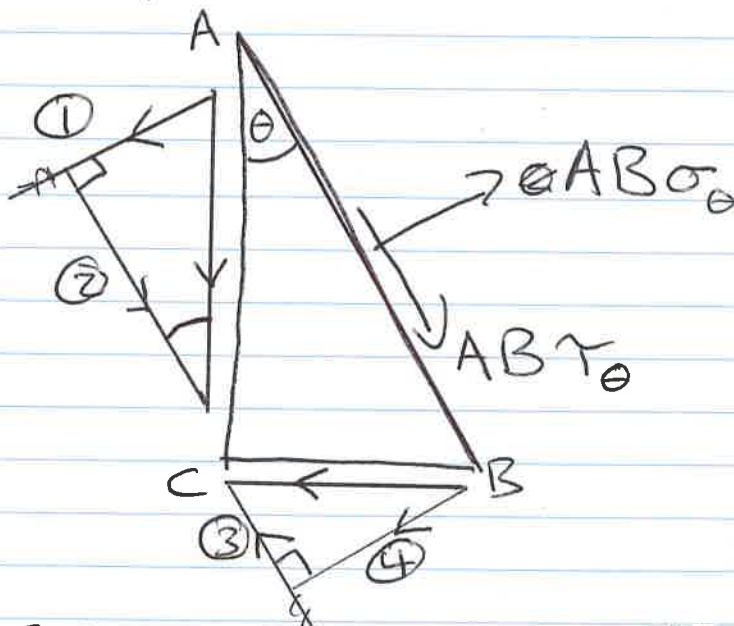
e) Spherical tanks are able to withstand higher pressures required to keep the ~~crack~~ crack oil from solidifying

② a) Principle stress is the maximum and minimum stress values acting plane perpendicular to the principle stress combining both normal and shear stress

$$\sigma_{1,2} = \frac{1}{2} \left[(\sigma_x + \sigma_y) \pm \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2} \right]$$

Principle plane is the plane on which the principle stress acts

b) i)



$$\begin{aligned} \text{① } AC \tau_{xy} \sin \theta & \quad \sin \theta = \frac{BC}{AB} \\ \text{② } AC \tau_{xy} \cos \theta & \\ \text{③ } BC \tau_{xy} \sin \theta & \quad \cos \theta = \frac{AC}{AB} \\ \text{④ } BC \tau_{xy} \cos \theta & \end{aligned}$$

$$AB \sigma_{\theta} = \text{①} + \text{④} = AC \tau_{xy} \sin \theta + BC \tau_{xy} \cos \theta$$

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

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

$$\sigma_{\theta} = \tau_{xy} * (2 \sin \theta \cos \theta)$$

$$\sigma_{\theta} = \tau_{xy} * (2 \times \frac{1}{2} \sin 2\theta)$$

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

b) II) $AB T_{\theta} + AC \tau_{xy} \cos \theta = BC \tau_{xy} \sin \theta$

$$AB T_{\theta} = BC \tau_{xy} \sin \theta - AC \tau_{xy} \cos \theta$$

$$T_{\theta} = \frac{BC}{AB} \tau_{xy} \sin \theta - \frac{AC}{AB} \tau_{xy} \cos \theta$$

$$T_{\theta} = \tau_{xy} \sin^2 \theta - \tau_{xy} \cos^2 \theta$$

$$T_{\theta} = \tau_{xy} (\sin^2 \theta - \cos^2 \theta)$$

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

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

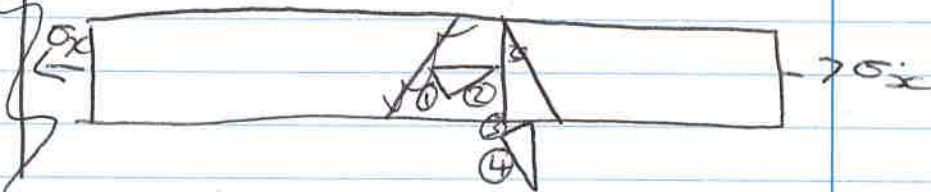
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$$\textcircled{2} c) \text{ Ten. Stress} = \frac{\text{Force}}{\text{Area}} = \frac{45000}{8 \times 10^{-4}}$$

$$\text{Ten. Stress } 56250000 \text{ Pa} = 56.25 \text{ MPa}$$

- ~~① AC $\cos \theta$ $\sin \theta$~~
- ~~② AC $\sigma_x \cos \theta$~~
- ~~③ BC $\sigma_y \sin \theta$~~
- ~~④ BC $\sigma_y \cos \theta$~~

Taking the tensile stress was acting in the x direction



$$\sigma_\theta = \frac{1}{2}(56.25 \times 10^6) +$$

$$\sigma_\theta = \frac{AC}{AB} \sigma_x \cos \theta + \frac{BC}{AB} \sigma_y \sin \theta$$

$$\sigma_\theta = \frac{AC}{AB} \sigma_x \cos \theta + \frac{BC}{AB} \sigma_y \sin \theta$$

$$\sigma_\theta = \cos^2 \theta \sigma_x + \sin^2 \theta \sigma_y$$

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

$$\sigma_\theta = 0.5(56.25 \times 10^6) + 0.5(56.25 \times 10^6) \cos 2\theta$$

$$\sigma_\theta = 54436393 \text{ Pa}$$

$$\sigma_\theta = 54.44 \text{ MPa}$$

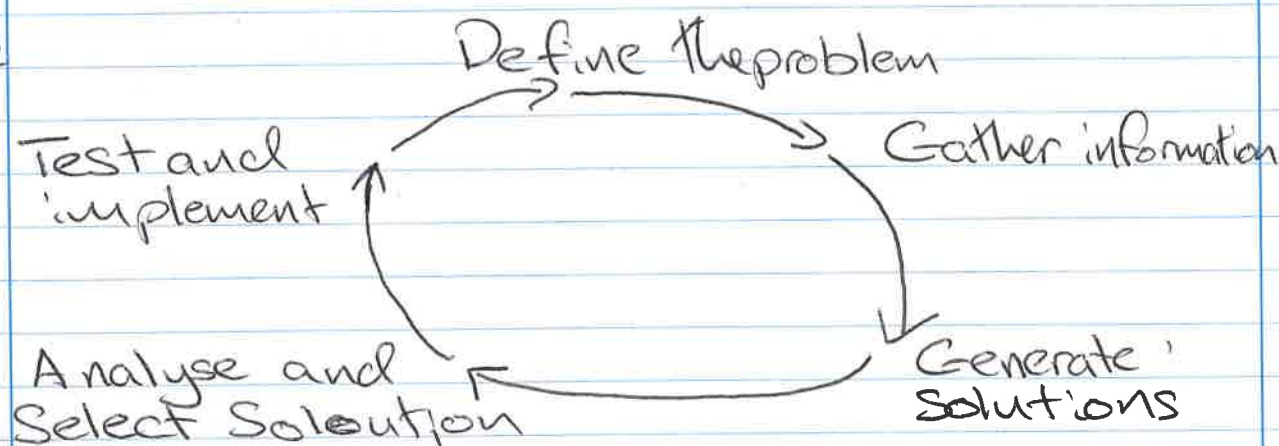
$$\tau_\theta = \frac{1}{2}(\sigma_x - \sigma_y) \sin 2\theta$$

$$\tau_\theta = 0.5(56.25 \times 10^6) \sin 2\theta$$

$$\tau_\theta = 9576564.013 \text{ Pa}$$

$$\tau_\theta = 9.58 \text{ MPa}$$

③c



Define the problem

- ▷ ~~is~~ is a solution necessary
- ▷ find out what the customer wants/needs

Gather information

- ▷ are there any current solutions
- Pros and cons of each
- ▷

Generate Solutions

- ▷ ~~creat~~ design multiple solutions to solve the problem

Analyse and select solution

- ▷ run in depth analysis on each solution as to how it solves the problem and how this may affect other aspects of the problem eg stronger but much heavier

Test and implement

Test physical testing can often show errors that were made during previous stages "garbage in = garbage out"

③c an advantage to this process is that the information on what's required of the solution is gathered early

3

③a a design problem is a problem with something like ergonomics or ~~user~~ usability whereas an analysis problem ~~is~~ includes stress failures, plastic deformation etc

1

Question No.

Examiner Only

Arholwr yn unig

Rhif y Cwestiwn

Question No.

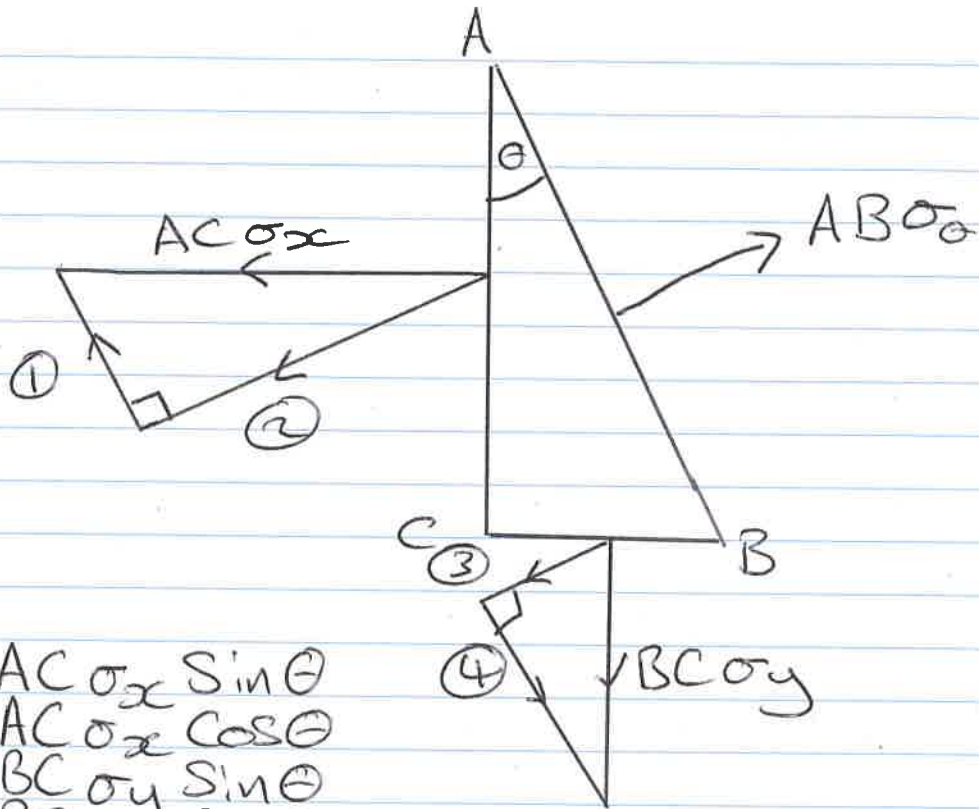
Examiner Only

Arholwr yn unig

hif y Cwestiwn

Question No.

Examiner Only

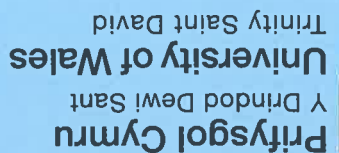


- ① $AC \sigma_x \sin \theta$
- ② $AC \sigma_x \cos \theta$
- ③ $BC \sigma_y \sin \theta$
- ④ $BC \sigma_y \cos \theta$

$$AB \sigma_\theta = AC \sigma_x \cos \theta + BC \sigma_y \sin \theta$$

$$\sigma_\theta = \sigma_x \cos^2 \theta + \sigma_y \sin^2 \theta$$





12 Tudalen

CYFENW:

ENW(AU) CYNTAF:

1. Rhaid i'r atebion fod mewn llawysgriften ddarlennadwy. Gall yr Arholwyr naili ai anwybyddu sgript annarllennadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.
2. Ysgrifennwch eich atebion mewn inc.
3. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thynnwch llinell drwyddynt.
4. Ni ddylid rhwygo unrhyw ran o'r llyfr. hwn; rhaid ei gyflwyno yn gyfan.
5. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyllwyr/gwylwyr.
6. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

7	Nifer y Llyfrau Atebion a gyflwynwyd	
6	Rhif Sedd	
5	Lleoliad yr Arholiad	
4	Dyddiad ac Amser yr Archoliad	
3	Cod y Modwl	
2	Teitl y Papur Arholiad	
1	Rhif Myfyrwr	

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(See the other side for English version)