



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

FORENAME(S): Oen

12 Pages

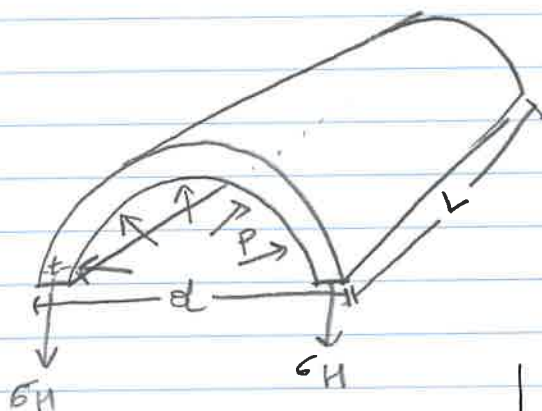
1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense 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.**

	List the numbers of the questions you have attempted	Office Use
Pg 1	Question 1	11
Pg 2	Question 2	8
Pg 4	Question 3	8
	Total	27

452



1. a.)



the vertical forces (surface of cylinder)
 $F \uparrow \Rightarrow \text{pressure} = \text{force} \times \text{area}$
 $\Rightarrow p \times d \times d$

the forces (resistive)
 $F \downarrow \Rightarrow 2\sigma_H = L \times t$

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

$$\sigma_H = \frac{Pd}{2t}$$

b.) Material - Aluminium 7075

$$\sigma_H \leq 200 \text{ MPa}$$

$$\text{Pressure} = \rho gh$$

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

$$\text{thickness} = 0.5 \text{ mm} = 0.0005 \text{ m}$$

$$i.) \sigma_H = \frac{Pd}{2t} \Rightarrow P = \frac{2 \times t \times \sigma_H}{d} = \frac{2 \times 0.0005 \times 200 \times 10^6}{3.5}$$

$$P = \frac{14 \times 10^{12}}{5} = 28 \times 10^{11} \text{ Pa}$$

$$P = \rho gh \Rightarrow \sigma_H = \frac{Pd}{2t} = \frac{200 \times 10^6 \times 3.5}{2 \times 0.0005}$$

$$P = \frac{2t\sigma_H}{d} = \frac{2 \times 0.0005 \times 200 \times 10^6}{3.5} = 28,571.42 \text{ N}$$

$$\approx 28.6 \text{ kN}$$

$$57,142.85 \text{ N}$$

$$ii.) \text{ but, } P = \rho gh$$

$$57,142.85 = 1 \times 9.8 \times h$$

$$h = \frac{57,142.85}{9.8}$$

$$h \approx 5830.9 \text{ metres above ground. } \times$$

$$ii.) \text{ at } 8000 \text{ ft pressure is } 75.3 \text{ KPa}$$

$$\therefore 57,142.85 + 75,300 = 132,442.85 \text{ Pa } \times$$

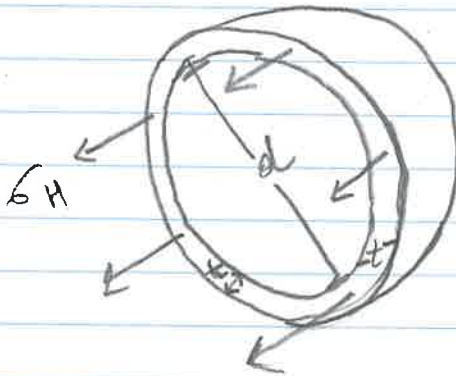
$$\therefore P = \rho gh$$

$$132442.85 = 1 \times 9.8 \times h$$

$$h = 13,514.5 \text{ metres above ground.}$$

- c.) Pressurizing the cabin allows for flying at high altitudes. At high altitudes the air is thinner ~~so~~, the fuel efficiency can be increased by flying higher. The pressurizing of the cabin prevents implosion also. ✓ (2)

d.)



Subjected to internal pressure the ~~hoop stress~~ ^{force} acting on the surface is,

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

the resistive force ~~outside~~ is,

$$\sigma_H = d \times \pi \times t$$

$$\therefore \sigma_H = \frac{P d^2 \pi}{4} \times \frac{1}{\pi d t}$$

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

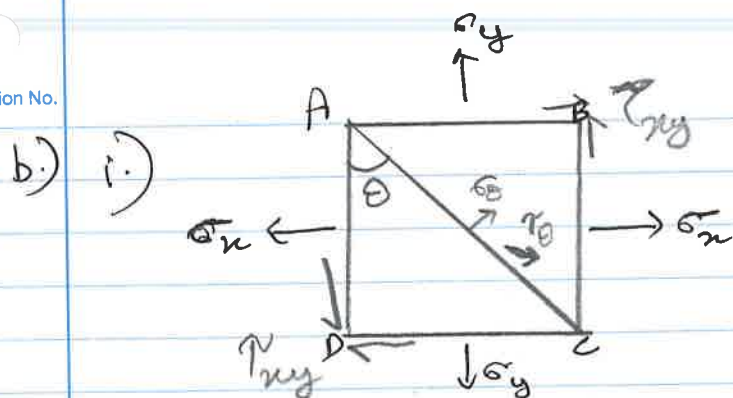
- e.) Observing the hoop stress in spheres and cylinders we can say that the hoop stress in cylinders is 2 times more compared to the hoop stress in spheres,

$$\text{Cylinder } \left(\sigma_H = \frac{P d}{2 t} \right), \text{ sphere } \left(\sigma_H = \frac{P d}{4 t} \right)$$

This means that, fluids can be stored at a higher pressure safely in spherical tanks / containers. (0)

- Q2.) a.) Principal stresses are the stresses experienced at the principal planes (xy). The minimum and maximum principal stresses can be calculated to design a material.

$\sigma_{1,2}$ are the maximum and minimum ^{principal} stresses. ✓ (3)



given, $\sin\theta \cos\theta = \frac{1}{2} \sin 2\theta$, $\sin^2\theta - \cos^2\theta = -\cos 2\theta$

normal stress on a plane inclined at an angle,

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

in $\triangle ACD$,

$$\sin\theta = \frac{\sigma_y}{AC} = \frac{\sigma_y}{\sqrt{\sigma_x^2 + \sigma_y^2}} \quad AC = \sqrt{\sigma_x^2 + \sigma_y^2}$$

$$\cos\theta = \frac{\sigma_x}{\sqrt{\sigma_x^2 + \sigma_y^2}} \quad \text{using } \sin^2\theta - \cos^2\theta = -\cos 2\theta$$

$$\text{but, } \tau_{xy} = \frac{2 \times \sigma_x \times \sigma_y}{(\sigma_x^2 + \sigma_y^2)}$$

$$\text{therefore, } \sigma_\theta = \frac{2 \times \sigma_x \times \sigma_y}{(\sigma_x^2 + \sigma_y^2)} \times \sin 2\theta$$

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

ii.) τ_θ is perpendicular in direction to σ_θ
~~therefore,~~

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

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

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

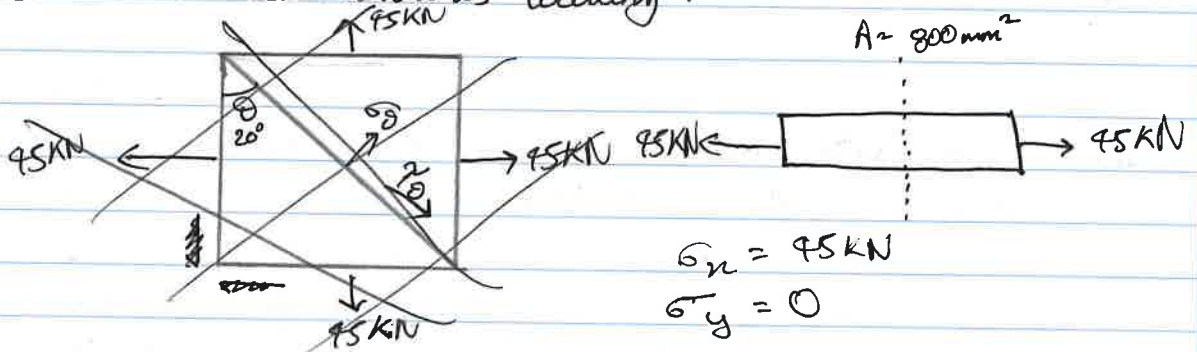
$$\tau_\theta = -\tau_{xy} \times \left(\frac{\sigma_y^2 - \sigma_x^2}{\sigma_x^2 + \sigma_y^2} \right)$$

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

P.T.O.

Page No. 3

2. c) $A = 800 \text{ mm}^2$ (cross-section)
 tensile forces 75 kN
 $\theta = 20^\circ$ inclined towards loading.



the normal stress is given by,

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

$$\sigma_\theta = \frac{1}{2}(75 \times 10^3 \times 0) + \frac{1}{2}(75 \times 10^3 - 0) \cos 2(20)$$

$$\sigma_\theta = 22500 + 17235.9$$

$$\sigma_\theta = 39735.9 \text{ Pa}$$

$$\sigma_\theta = 39.7 \text{ kPa} //$$

the shear stress,

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

$$\tau_\theta = \frac{1}{2}(75 \times 10^3) \sin 2(20)$$

$$\tau_\theta = 14,962.7$$

$$\tau_\theta = 14.96 \text{ kPa}$$

$$\tau_\theta \approx 15 \text{ kPa} //$$

Q(3.) a)

Design Problem

- A design problem relates to the final product.
- A common design problem in FEA is, making the product structurally complex.
- The materials used in initial design idea create engineering limitations.

Analysis Problem

- An analysis problem relates to the research and evaluation of product.
- In analysis the product gets simplified into smaller geometry.
- CAE programs help in choosing material geometry and properties after analysis of FEA models.

b.) Design Problem (Iterative Process)

- A design process begins with an idea.
- Ideas keep evolving over time to get a productive result
- Many design steps have to be considered such as, tolerances, weight, fabrication and most importantly the working principle
- Design changes affect all other departments in engineering
- If a component has to be assembled, the individual pieces have to be designed to create a desired fit meeting all requirements.

Analysis problem (Sequential)

- The CAE softwares help in creating a virtual 3D model which is the first step in any CAE analysis.
- The next steps would include splitting of individual parts for ~~their~~ ~~each~~ individual part analysis.
- Each part is then given fixed geometry, fixed material, dynamic loading conditions to simulate non-destructive tests (NDT)
- The CAE software helps in evaluating a design and it produces values of stress and strain that, help in selecting alternate materials for manufacturing.
- The last step would be to analyse the manufacturing methods and jig/support fixtures for ^{final} assembly.

c.) The design process can be used by theory $\Rightarrow$ S.I.M.P.L.E.

S - Split

I - Interpret

M - Material

P - Physical Properties

L - Loading conditions

E - Evaluate

Split

Divide the number of parts and use a specific requirement for every part. Understand all the components involved to build the final product.

Interpret

Picturise the working conditions of the product and think about easy ways to simplify the product usage.

Material

Choose thicknesses, dimensions and properties of various materials that can be used to simulate in CAE.

Physical Properties

Update the behaviour of material in CAE by defining the shape and form (2D, 3D). Choose best material after analysis.

Loading Conditions

Use dynamic loading situations to understand how the forces are behaving with material. Each degree of freedom can be analysed off a force acting on a body only if its not infinite stress.

Evaluate

The final design process can be evaluated by using simulation analysis and also, prototypes can be manufactured by reducing build time.

The advantage of CAE and design is only in the final evaluation phase in which the CAE engineer understands the material in a virtual environment.

————— X —————

Question No.

Examiner Only

Rhif y Cwestiwn

Arholwr yn unig

Question No.

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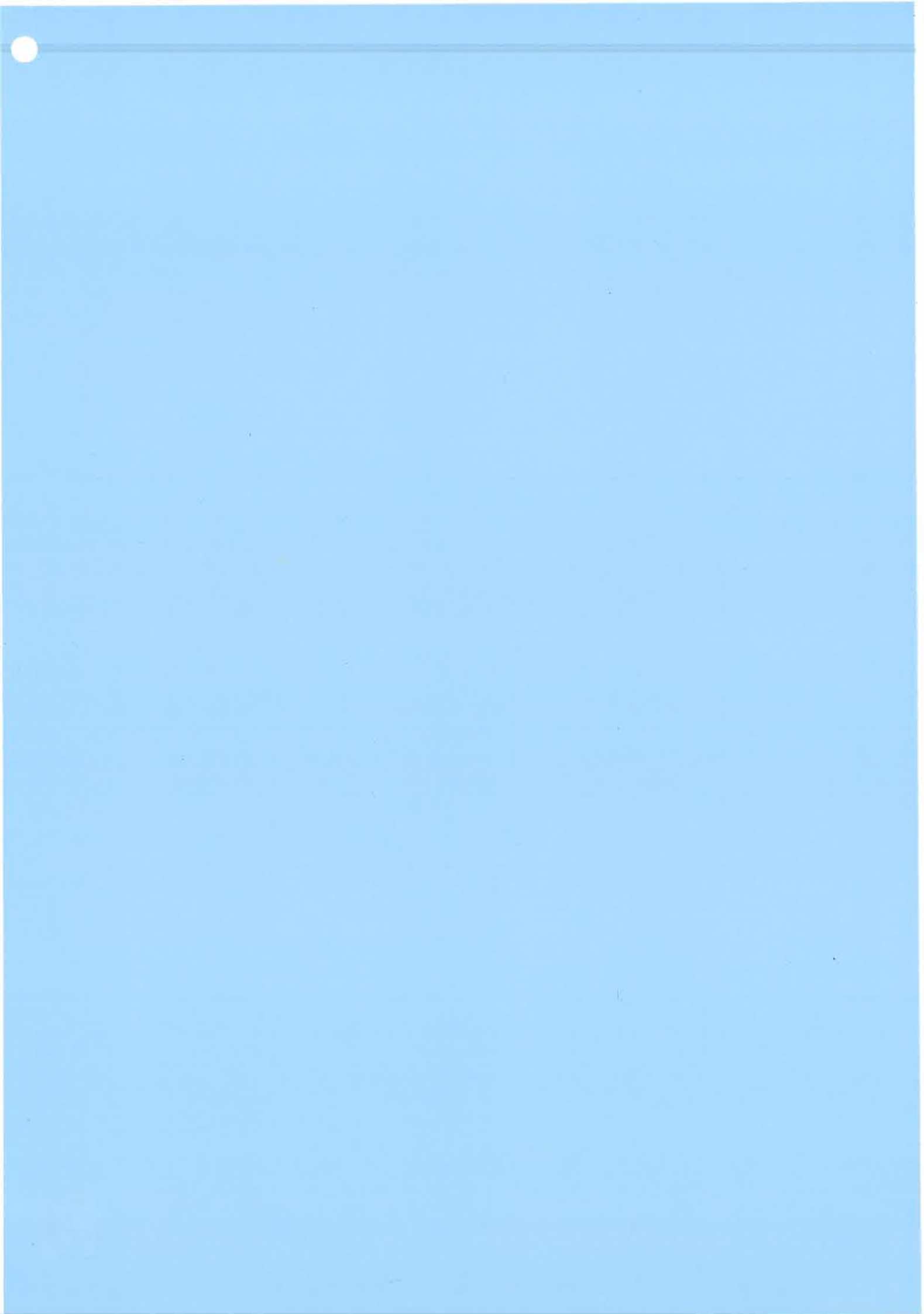
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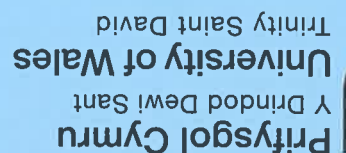
Examiner On

100×10^3

Arholwr yn unig

llyf y Cwestiwn





Cyfarwyddiadau i Ymgeiswyr

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y lle a ddarparwyd ar y dde, plygwch et a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.

3. Rhaid i'r atebion fod mewn llawysgrifen ddarllenadwy. Gall yr Arholwyr naill ai anwybyddu sgrïp annarllenadwy, neu drefnu iddi gael ei threipio a chael yr ymgeisydd i dalu.

4. Ysgriennwch eich atebion mewn inc.

5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.

6. Ni ddylid rhwygo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.

7. Os defnyddir mwy nag un lliftr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwylwlwr/gwylwyr.

8. 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 Myfyriwr	

[illegible]

(See the other side for English version)

CYFENW:

ENW(AU) CYNTAF:

Llenwch, plygwch a seiwch
(gweler nodyn 2 isod)