



**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 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	1702453
2	Title of Examination Paper	CAE + Stress Analysis
3	Module Code	M5X02064
4	Date and Time of Examination	12:00 ~~09~~ 09/05/19
5	Examination Venue	1Q 316
6	Seat Number	G04 2
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	20
2	16
3	11
Total	47

(Gweler yr ochr arall am y fersiwn Cymraeg)

78.3%

1)
a)

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

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

$$F = PA$$

$$= PdL$$

$$F = \sigma A$$

$$= \sigma_H 2tL$$

$$PdL = \sigma_H 2tL$$

$$Pd = \sigma_H 2t$$

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

/ (4)

b)
i)

$$\sigma_H = 200 \times 10^6 \text{ Pa} \quad d = 3.5 \text{ m} \quad t = 0.5 \times 10^{-3} \text{ m}$$

$$P = \rho g h$$

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

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

$$= 57143 \text{ Pa}$$

$$= 57 \text{ kPa}$$

$$P @ \text{sea level} = 101 \text{ (from table)}$$

$$101 - 57 = 44 \text{ kPa}$$

$$\text{from table @ } 44 \text{ kPa} \quad h = 20000 \text{ feet}$$

$$\text{ii) } P @ 8000 \text{ ft} = 75.3 \text{ kPa (from table)}$$

$$~~75.3 = 25.7 \text{ kPa}~~ \quad 75.3 - 57 = 18.3 \text{ kPa}$$

$$~~\text{from table @ } 25.7 \text{ kPa} \quad h = 35000 \text{ feet}~~$$

$$\text{from table @ } 18.3 \text{ kPa} \quad h = 40000 \text{ feet}$$

(3)

- c) The advantage of pressurizing plane cabins means that a plane can fly at higher altitudes with ~~no effect~~ than if it wasn't pressurized. This means the plane will fly more efficient. ✓

(2)

d)

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

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

$$F = PA$$

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

$$F = \sigma A$$

$$= \sigma_H \pi d t$$

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

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

$$\sigma_H = \frac{Pd}{4t}$$

(4)

- e) Storing in cylinders is cheaper and easier as it has a smaller footprint. However, if storing in spheres means the fluid can be pressurized twice as much as in cylinders as the hoop stress is half as big. ✓

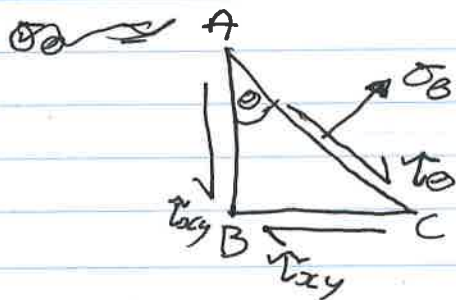
(3)

2) a)

Principle stress is the stress where the integral of the stress is found and its the where, the amount of stress experienced is calculated.

The principle ~~stress~~ plane is the plane in which the principle stress is calculated to be acting.

(2)

b)
i)

$$\sin \theta = \frac{BC}{AC}$$

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

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

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

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

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

$$\begin{aligned} \sigma_{\theta} &= \frac{1}{2} \sin 2\theta \tau_{xy} + \frac{1}{2} \sin 2\theta \tau_{xy} \\ &= \sin 2\theta \tau_{xy} \end{aligned}$$

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

(4)

b) ii)

$$AC \tau_0 + AB \cos \theta \tau_{xy} = BC \sin \theta \tau_{xy}$$

$$\tau_0 + \frac{AB}{AC} \cos \theta \tau_{xy} = \frac{BC}{AC} \sin \theta \tau_{xy}$$

using $\frac{AB}{AC} = \cos \theta$ and $\frac{BC}{AC} = \sin \theta$

$$\tau_0 + \cos \theta \cos \theta \tau_{xy} = \sin \theta \sin \theta \tau_{xy}$$

$$\tau_0 + \tau_{xy} \cos^2 \theta = \tau_{xy} \sin^2 \theta$$

$$\begin{aligned} \tau_0 &= \tau_{xy} \sin^2 \theta - \tau_{xy} \cos^2 \theta \\ &= \tau_{xy} (\sin^2 \theta - \cos^2 \theta) \\ &= -\tau_{xy} \cos 2\theta \end{aligned}$$

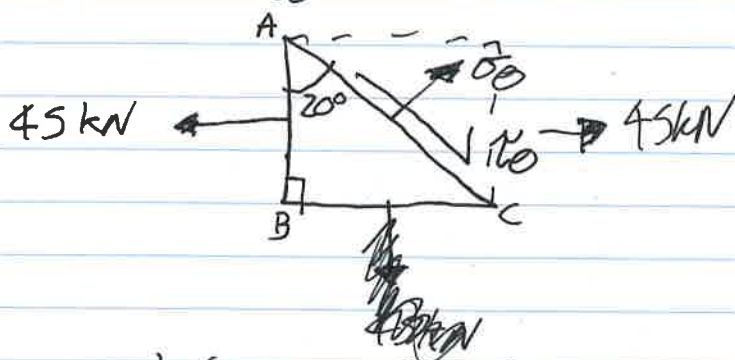
Using $\sin^2 \theta - \cos^2 \theta = -\cos 2\theta$

$$\tau_0 = \tau_{xy} (-\cos 2\theta)$$

$$\tau_0 = -\tau_{xy} \cos 2\theta$$

c) $A = 800 \text{ mm}^2$ Tensile force $= 45 \times 10^3 \text{ N}$ each end

$\sigma_\theta = ?$ $\tau_\theta = ?$ when $\theta = 20^\circ$



$$\begin{aligned} \sigma_\theta &= \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y) \cos 2\theta \\ &= \frac{1}{2}(45 \times 10^3 \times \frac{\sqrt{2}}{30} + 45 \times 10^3 \times \frac{\sqrt{2}}{30}) + \frac{1}{2}(45 \times 10^3 \times \frac{\sqrt{2}}{30} - 45 \times 10^3 \times \frac{\sqrt{2}}{30}) \cos(2 \times 20) \\ &= \frac{1}{2}(2(1272.74)) \end{aligned}$$

$$AB \times BC = 800 \times 1000^{-2}$$

$$(\tan 20) AB = BC$$

$$AB \times AB \tan 20 = 800 \times 1000^{-2}$$

$$AB^2 = \frac{800 \times 1000^{-2}}{\tan 20}$$

$$AB^2 = 2.197 \dots$$

$$AB \approx 0.047$$

$$BC \approx 0.017$$

~~$$\sigma_x = AB \times 45 \text{ kN} \quad \sigma_y = BC \times 45 \text{ kN}$$~~

$$\sigma = \frac{F}{A} \quad \sigma_x = \frac{(45 \times 10^3)}{800 \times 1000^{-2}} \quad \sigma_y = 0$$

$$\sigma_x = (56.25 \times 10^6 \text{ N/m}^2) \times 2$$

$$\sigma_x = 112.5 \times 10^6 \text{ N/m}^2$$

$$\sigma_\theta = \frac{1}{2} (112.5 \times 10^6) + \frac{1}{2} (112.5 \times 10^6) \cos(2 \times 20)$$

$$= 56.25 \times 10^6 (1 + \cos 40)$$

$$\sigma_\theta = 99.3 \text{ MN/m}^2$$

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

$$= \frac{1}{2} (112.5 \times 10^6) \sin(2 \times 20)$$

$$= 36.16 \text{ MN/m}^2$$

3) a)

A Design problem is one with multiple solutions this is because there isn't a defined result.

A Design problem ~~is~~ ^{needs} more of an iterative ~~pattern~~ approach to solve.

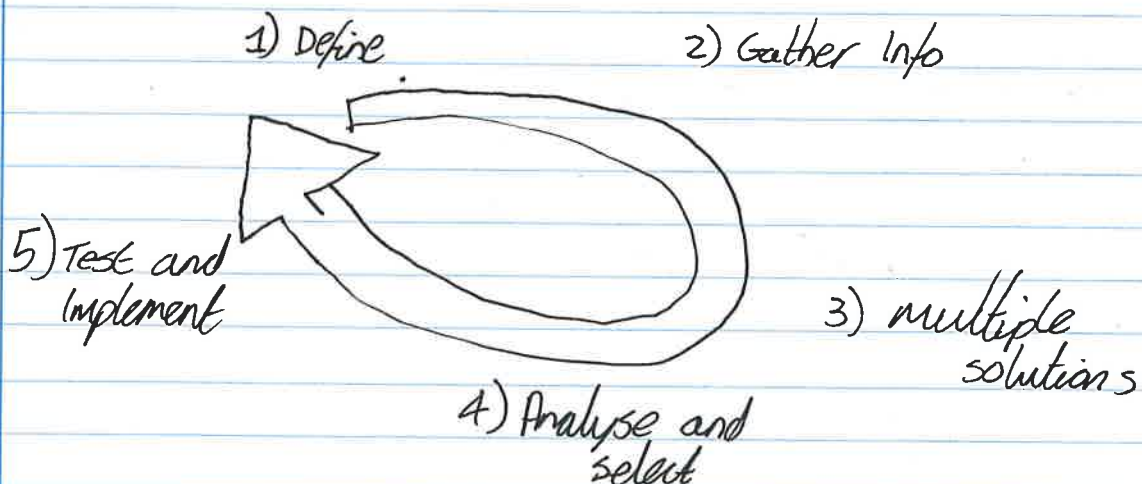
A analysis problem has only one solution as it is well defined

b)

~~Be~~ A design problem is iterative because as the problem is set out the process to solve means you carry out the steps to get to a solution then repeat the solution back through the process to verify and improve the design. This is repeated until no change occurs between two or more iterations.

An analysis problem is sequential as the process to carry out the problem needs each step to be completed before moving on and there is no benefit in redoing any old steps.

c) Design process



1) To begin a definition of the problem needs to be specified.
This allows a clear outset for the problem

2) Gather Information to assess what other solutions are out there, materials and other specification that needs to be met.

3) Design multiple solutions to the problem so the best solution can be used

4) Assess and analyse the solutions and select the best one.

5) Test the design solution using prototypes, and then implement the solution into the problem.

(3)

The process is an iterative function which has multiple steps to reach the goal. However, it can be very time consuming.

5) Split the problem up into finite elements

I) Interpret the geometry and make assumptions and ignore some details

M) material - Select and input a material.

P) Physical Properties - ensure the Properties are correct for other 10, 20 etc

L) Loading - Add the loadings

E) Evaluate the results and interpret them to select a solution.

X

Question No.

Examiner Or

Arholwr yn unig

y Cwestiwn

Question No.

Examiner O

Arholwr yn unig

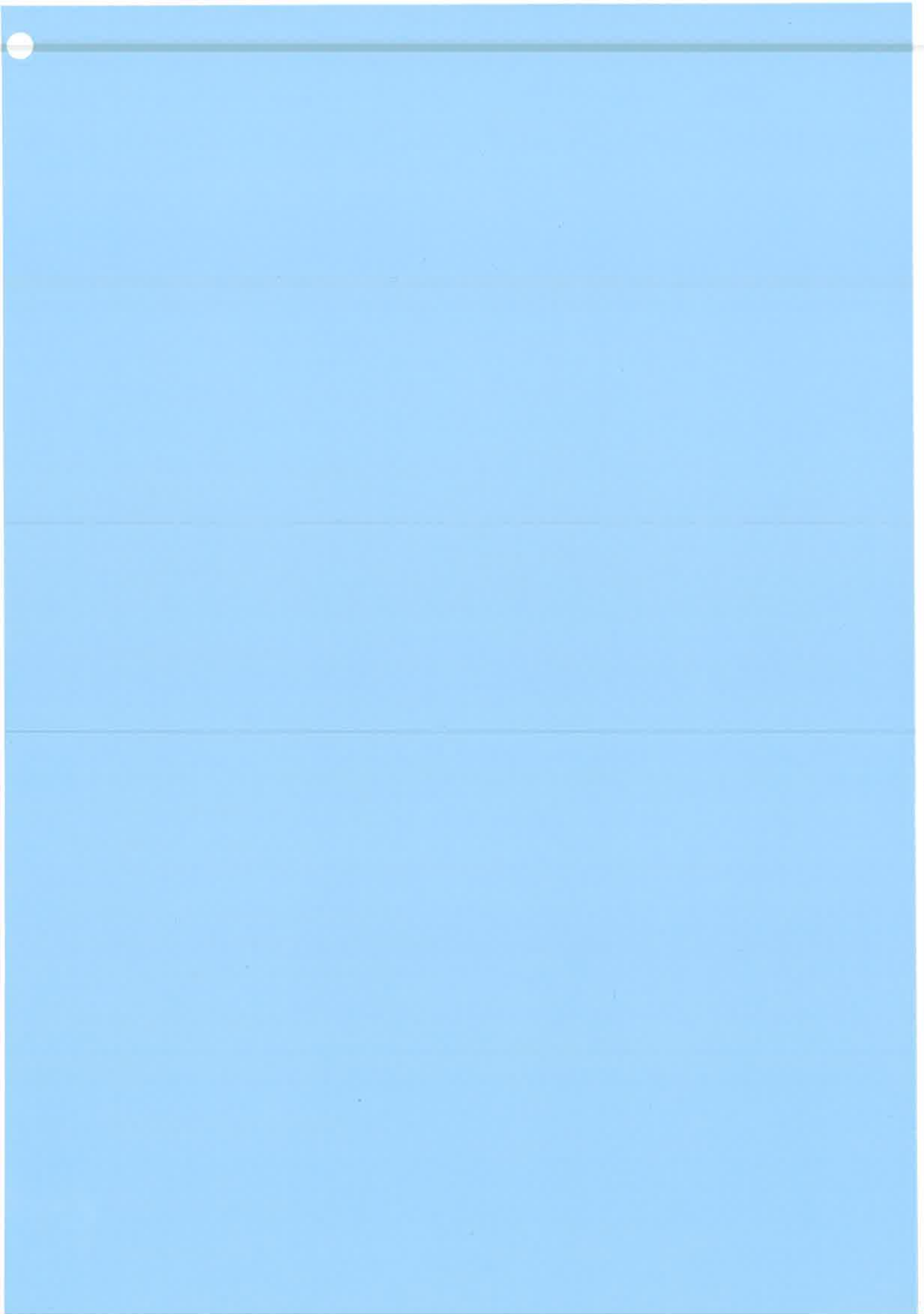
ff y Cwestiwn

Question No.

Examiner O

Arholwr yn unig

y Cwestiwn



Cyfarwyddiadau i Ymgeiswyr

12 Tudalen

2. Rhwch eich enw yn lle a ddarparwyd ar y dde, plygchw ef a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) !

3. Rhaid i'r atebion fod mewn llawysgrifen ddarllenadwy. Gall yr Arholwyr nall ai anwybyddu sgrïp't annarllenedadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.

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

[illegible]

(See the other side for English version)

Llenwch, plygwh a seliwh
(gweler nodyn 2 isod)

CYFENN:

ENW(AU) CYNTAF: