



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.**

Complete, fold and seal
(see note 2 below)

SURNAME: Jones

FORENAME(S): George

1	Student Number	P149914
2	Title of Examination Paper	M5X02064 CAE + stress analysis
3	Module Code	M5X02064
4	Date and Time of Examination	12.00 9-5-19
5	Examination Venue	IQ 310
6	Seat Number	GG14
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	20
3	10
4	4
Total	34

(Gweler yr ochr arall am y fersiwn Cymraeg)

(56.7)



Question 1

a) Forces $\uparrow$ = Forces $\downarrow$

$$\begin{aligned}\text{Forces } \uparrow &= P \times A \\ &= P \times d \times L\end{aligned}$$

$$\text{Forces } \downarrow = 2\sigma_H \times L \times t$$

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

$$\begin{aligned}2\sigma_H \times t &= P \times d \\ \sigma_H &= \frac{Pd}{2t}\end{aligned}$$

b) $\sigma_H = 200 \times 10^6$ (200 MPa)
 $d = 3.5$ (3.5 m)
 $t = 0.5 \times 10^{-3}$ (0.5 mm)

i) sealed at sea level? ($P = 101 \times 10^3$) [101 kPa]

$$\sigma_H = \frac{(101 \times 10^3)(3.5)}{(2)(0.5 \times 10^{-3})}$$

$$\sigma_H = 353.5 \times 10^6 \text{ Pa}$$

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

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

$$P = 57.14 \times 10^3 \text{ Pa} [57.14 \text{ kPa}]$$

$$[101 - 57.14 = 43.86] \quad \underline{43.86 \text{ kPa}}$$

table 1 = $\left\{ \begin{array}{l} 37.6 \text{ kPa @ 25,000} \\ 46.6 \text{ kPa @ 20,000} \end{array} \right\}$ Δ altitude per 500 ft = 10

$$46.6 - 37.6 = 9, \quad \underline{9 \text{ kPa per 500 ft}}$$

$$43.8 \text{ kPa} = \text{max}$$

$$37.6 @ 25,000$$

$$43.8 - 37.6 = 6.2$$

$$6.2 \div 0.9 = \frac{6.8}{\cancel{5.5}} , \quad 6 \times 500 = \frac{3000 \text{ ft}}{\cancel{2500 \text{ ft}}}$$

$$25,000 - \cancel{3000 \text{ ft}} = \cancel{22,500 \text{ ft}} \quad (22,000 \text{ ft})$$

ii) if cabin pressurised to 8000ft. [75.3 kPa]

From i) $P = 57.14 \text{ kPa}$ when $\sigma_H = 200 \text{ MPa}$ (max)

$$\cancel{57.14 \text{ kPa}} \quad 75.3 - 57.14 = 18.16 \text{ kPa}$$

Table 1, $14.5 \text{ kPa} @ 45,000 \text{ ft}$ } $\Delta \text{ alt per } (500 \text{ ft}) = 10$
 $18.7 \text{ kPa} @ 40,000 \text{ ft}$ }

$$18.7 - 14.5 = 4.2$$

$$4.2 \div 10 = 0.42 \text{ kPa per } 500 \text{ ft}$$

$$18.16 \text{ kPa} = \text{max}$$

$$14.5 \text{ kPa} @ 45,000 \text{ ft}$$

$$18.16 - 14.5 = 3.66 \text{ kPa}$$

$$3.66 \div 0.42 = 8.71$$

$$8 \times 500 = 4000 \text{ ft.}$$

$$45,000 - 4000 = (41,000 \text{ ft})$$

(3)

c. The advantages of pressurising planes (pressure matching / pressure equalising) or reducing pressure differences for cruising altitudes is to improve fuel economy and to be able to achieve higher cruising altitudes. By reducing the pressure difference between the inside and outside of the cabin, less stress will be applied to the fuselage. ~~For~~ greater velocities can be achieved.

②

d) Forces $\leftarrow$ = Forces $\rightarrow$

$$\text{Forces } \leftarrow = \sigma_H \times \pi \times d \times t$$

$$\text{Forces } \rightarrow = P \times A$$

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

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

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

④

e) Spherical storage tanks are used ~~for~~ storage of oils capable of pressurising (such as petrol) ~~as~~ as hoop stress in spheres are half that of those in cylinders per unit pressure. Proven by the derivations:

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

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

~~In addition, spheres are also used where the fluid being stored has a high specific~~

~~is so~~

Spheres are ~~the chosen~~ the stronger of the two shapes. Cylinders are used in storage systems where there is less capacity in terms of floor space. Cylinders can store a greater amount of fluid per unit area (footprint).

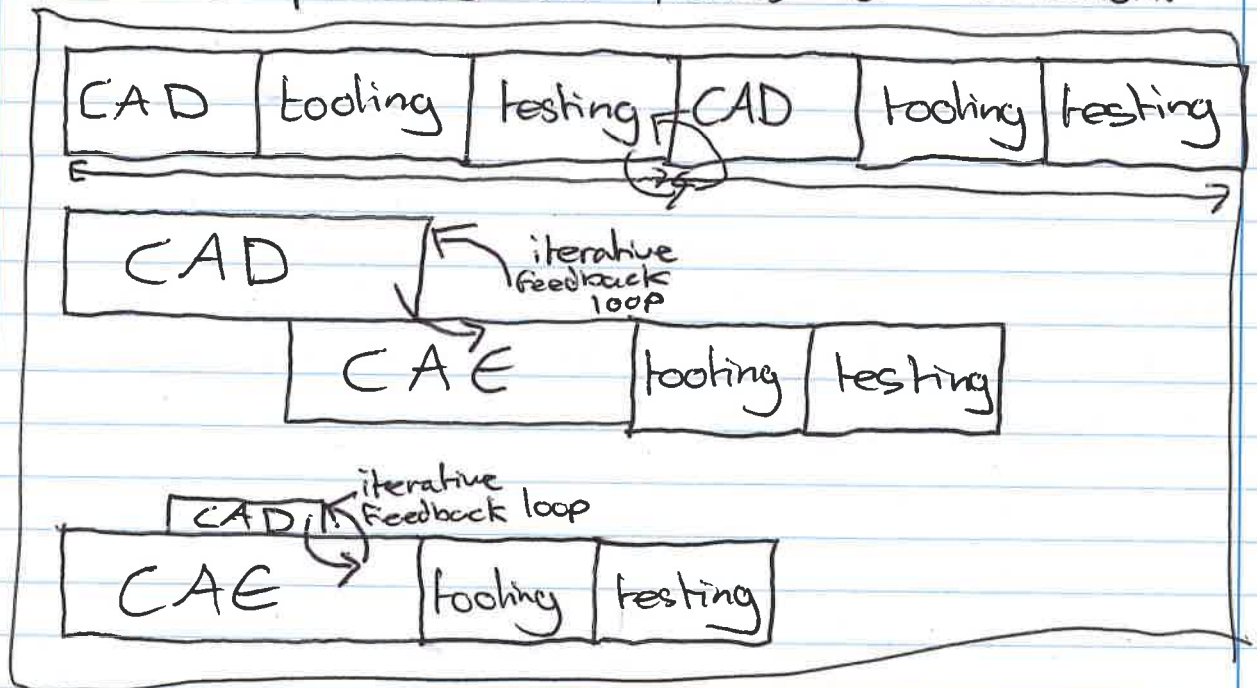
3

Question 3

- a) A design problem carries more freedom than an analysis problem. Design problems are usually considered to have multiple possible outcomes (methods to solve). Many factors can manipulate the final outcome, based on methods used and specific requirements. Design is considered to be an objective process with multiple iterations being produced through the process. Analysis problems have more constraints as the solutions are usually found to be singular. A design problem can be solved using multiple methods with multiple solutions. Analysis problem can be solved by using multiple methods, however, the solutions for each method should be the same (results).
- b) A design problem begins with defining the problem. This is usually given by a set of features/parameters in which the product should include. The geometric, material, functional and manufacturing constraints are typically established before a solution can be worked. From this, information is gathered as to how the solution may already be implemented, then many possible solutions are produced. The typical manner in which these solutions are created is that of an iterative process. Traditional methods include producing basic (conceptual) designs and expanding on these. From this a selection is made to shortlist the possible solutions by experienced engineers. Each method of possible solution is then tested and further improvements to the

3

design can be implemented until a suitable solution is achieved. Computational methods can improve the ~~rate of speed~~ time in which the design process is completed, ~~the~~ the diagram below suggests how a design process is considered iterative, and how using CAE and CAD can improve the ~~iteration~~ iterative process in terms of duration.



Analysis problems are considered to be sequential as there is usually only one outcome (result). An example of a sequential analysis ~~problem~~ process can be observed by the F.E.A based process of S.I.M.P.L.E. This example proves a sequential process:

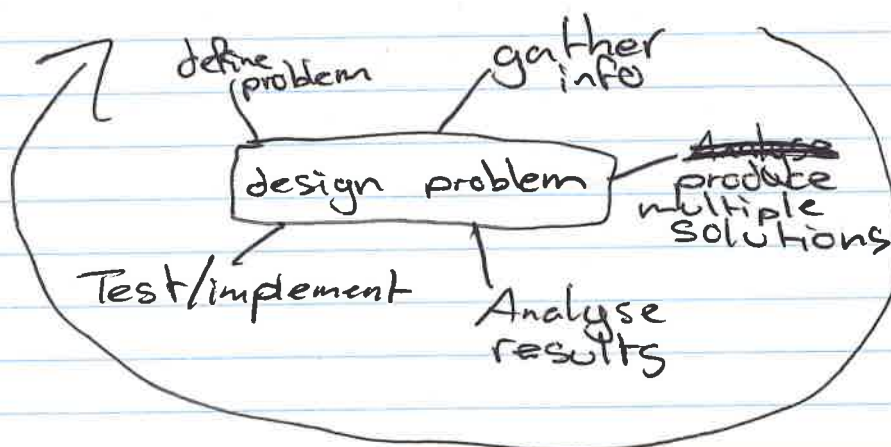
The geometry is first split into finite elements (elements + nodes)

The geometry is then simplified to reduce the time in which a reasonable result can be achieved. The material information is then added, ensuring a match with physical

material being used. This selection also determines whether a linear or non-linear solver is used. Physical properties are then added. IF 1D, 2nd moment of area + polar 2nd moment of area + orientation are specified, IF 2D, thickness is added, paying attention to manufacturing tolerances. IF 3D, the geometry has all relevant information. The way in which the part/face is loaded is considered, with reference to the constraints. Finally the results are produced in a matrix and simultaneous equations are applied. This is a sequential process in which most analysis methods operate. The process is only repeated if details are changed or mistakes are made.

/ (5)

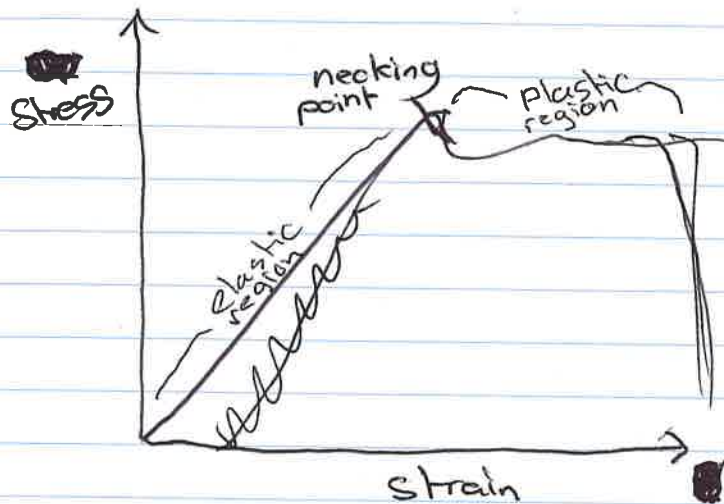
C.



/ (2)

Question 4

a)



gradient based optimisation methods are formed by young's modulus. These methods predict how the design can be improved (lightened) up to the necking point of the material. Material information must be given to perform this type of optimisation and becomes unpredictable when the material is subject to plastic deformation. Thus, these tools operate in the elastic region of the material properties.

X

- b) The major ~~way~~ limitation in gradient based optimisation can be overcome by physical testing of the product. However, this will increase design-to-manufacture time and also increase cost.

c. Topometry - can produce an F.E.A mesh based on given geometry. Can improve geometry/remove material.

Topology - Can improve/create F.E.A mesh based on defined constraints.
Ability to "grow" a mesh to resolve

(4)

Question No.

Examiner Or

Arholwr yn unig

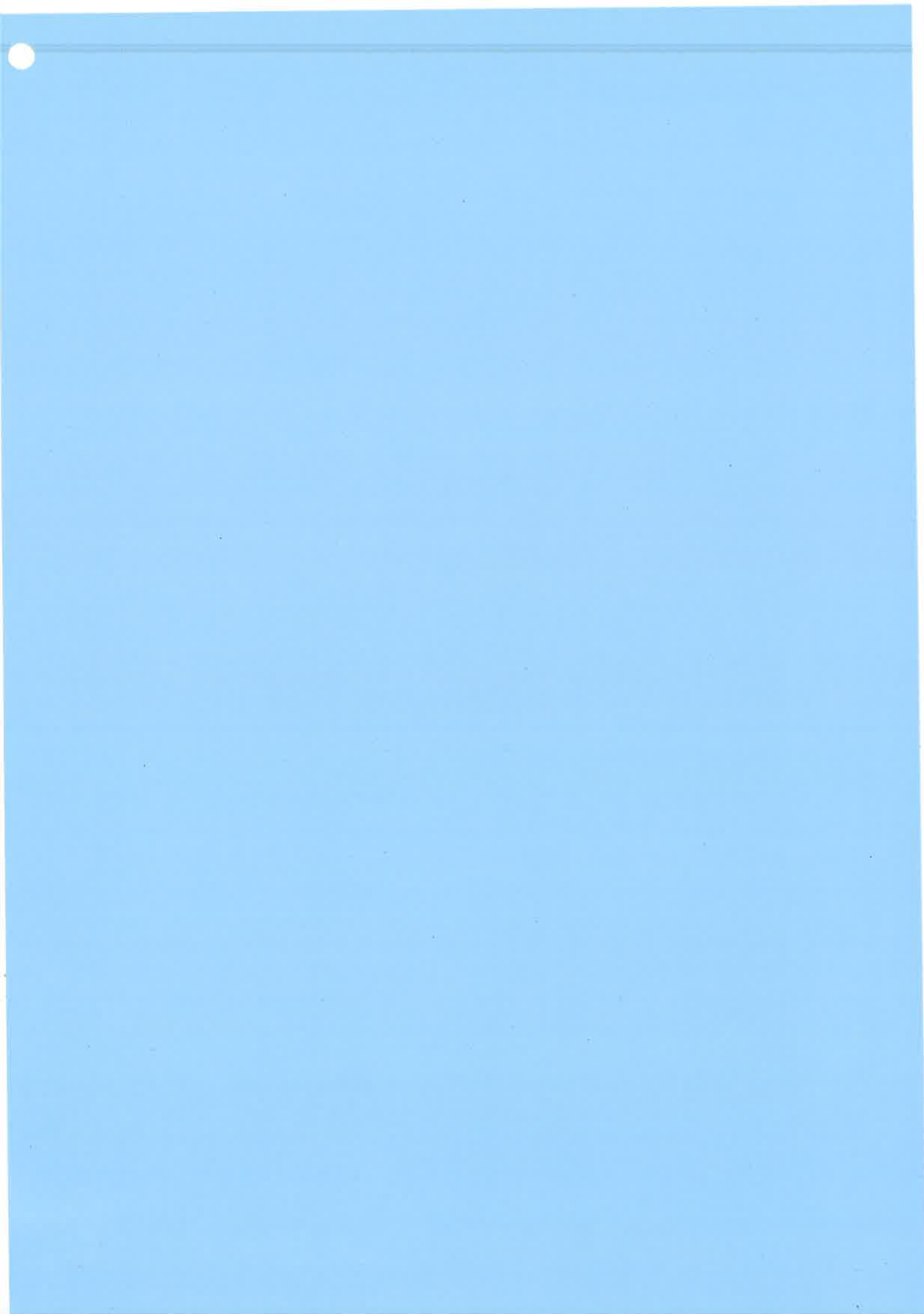
off y Cwestiwn

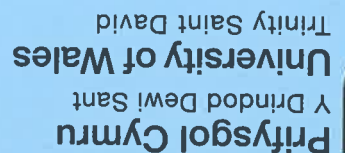
Question No.

Examiner O

Arholwr yn unig

liff y Cwestiwn





12 Tudalen

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 ef a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.

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

4. Ysgriftennwyd eich atebion mewn inc.
5. Dechreuwyd bob ateb ar dudalen newydd. Gwnwyd 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 llyfr, rhwymwyd 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 unrhyw amgylchiad.

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: