



Complete, fold and seal
(see note 2 below)

SURNAME: Liddell

FORENAME(S): Harrison Lewis

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.**

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

OK
Mark agreed

23/01/19

1911

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1.)

i. $\epsilon_x = 15 \times 10^{-6}$
 $\epsilon_y = -18 \times 10^{-6}$
 $\nu = 0.26$

$$E = 169 \times 10^9$$

$$\sigma_1 = \frac{E}{1-\nu^2} (\epsilon_1 + \nu \epsilon_2)$$

$$\sigma_2 = \frac{E}{1-\nu^2} (\epsilon_2 + \nu \epsilon_1)$$

$$\sigma_1 = \frac{169 \times 10^9}{1-0.26^2} (15 \times 10^{-6} + 0.26 \times -18 \times 10^{-6})$$

$$\sigma_1 = 2.357 \times 10^6 \text{ tensile.}$$

$$\sigma_2 = \frac{169 \times 10^9}{1-0.26^2} (-18 \times 10^{-6} + 0.26 \times 15 \times 10^{-6})$$

$$\sigma_2 = -3.22 \times 10^6 \text{ compressive}$$

ii. $\sigma_x = 65 \times 10^6$
 $\sigma_y = 10 \times 10^6$
 $\nu = 0.26$
 $E = 169 \times 10^9$

$$\epsilon_1 = \frac{1}{E} (\sigma_1 - \nu \sigma_2)$$

$$\epsilon_2 = \frac{1}{E} (\sigma_2 - \nu \sigma_1)$$

$$\epsilon_1 = \frac{1}{169 \times 10^9} (65 \times 10^6 - 0.26 \times 10 \times 10^6)$$

$$\epsilon_1 = 369.2 \times 10^{-6}$$

$$\epsilon_2 = \frac{1}{169 \times 10^9} (10 \times 10^6 - 0.26 \times 65 \times 10^6)$$

$$\epsilon_2 = -40.83 \times 10^{-6}$$

2).

$$\epsilon = 2.0 \cdot 0.25 \times 10^{-3}$$

$$P = 20 \times 10^5$$

$$V = 0.3$$

$$E = 163.2 \times 10^9$$

$$i) K = \frac{E}{3(1-2V)}$$

$$K = \frac{163.2 \times 10^9}{3(1-2 \times 0.3)}$$

$$G = \frac{E}{2(1+V)}$$

$$K = 136 \times 10^9$$

$$G = \frac{163 \times 10^9}{2(1+0.3)} = 62.69 \times 10^9$$

$$K = \frac{\sigma}{\epsilon_v}$$

$$136 \times 10^9 = \frac{20 \times 10^5}{\epsilon_v}$$

$$K = \frac{2G(1+V)}{3(1-2V)}$$

$$\epsilon_v = 136 \times 10^9 \times 20 \times 10^5$$

$$\epsilon_v =$$

$$K = \frac{2 \times (62.69 \times 10^9) \times (1+0.3)}{3(1-2 \times 0.3)}$$

$$K = 134.37 \times 10^9$$

$$ii) K = \frac{\sigma}{\epsilon_v}$$

$$\epsilon_v = \frac{\sigma}{K}$$

$$\epsilon_v = \frac{20 \times 10^5}{134.37 \times 10^9} = 31.74 \times 10^{-6}$$

iii) $V_{\text{sphere}} = \frac{4}{3} \pi (0.025 \times 10^{-3})^3$

$V_{\text{sphere}} = 5.89 \times 10^{-5}$

$\epsilon_v = \frac{\delta V}{V}$

$\delta V = \epsilon_v \times V$ ✓

$\delta V = 31.74 \times 10^{-6} \times 5.89 \times 10^{-5}$ ✗

$\delta V = 1.876 \times 10^{-9}$ ✗

iv) ~~Material~~ isotropic material - Same material properties in all directions. ✓

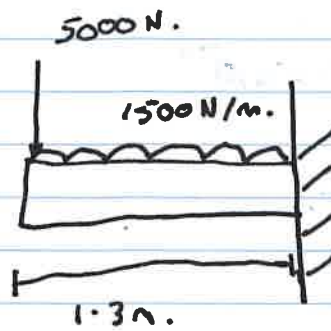
3.)

$$EI = 2.2 \times 10^6$$

$$F = 5000$$

$$W = 1500$$

$$L = 1.3$$



i)

$$\frac{WL^4}{8EI}$$

$$\frac{1500 \times 1.3^4}{8(2.2 \times 10^6)}$$

$$\text{deflection} = \cancel{4.18 \times 10^{-3}} \text{ m}$$

$$0.24 \times 10^{-3} \text{ m}$$

ii)

$$\frac{FL^3}{3EI}$$

$$\frac{5000 \times 1.3^3}{3(2.2 \times 10^6)}$$

$$\text{deflection} = 1.66 \times 10^{-3} \text{ m.}$$

iii)

$$\text{total deflection} = 1.9 \text{ mm.}$$

iv).

$$\frac{3.5 \times 10^{-3}}{2.197} = \frac{F \times 1.3^3}{3(2.2 \times 10^6)}$$

$$\frac{3.5 \times 10^{-3}}{2.197} = \frac{F \times 2.197}{6.6 \times 10^6}$$

$$3.5 \times 10^{-3} = \frac{F \times 1.3^3}{3(2.2 \times 10^6)}$$

$$F = \frac{3.5 \times 10^{-3} \times 3 \times (2.2 \times 10^6)}{1.3^3}$$

$$F = 10514.34 \text{ N.}$$

$$\% \text{ max increase in } F = 5514.34 \text{ N.}$$

4.)

$$d = 0.35.$$

$$L = 0.8 \text{ m.}$$

$$\sigma_c = 0.85$$

$$\sigma_t = 0.95.$$

$$P = 20 \times 10^6.$$

$$\sigma = 110 \times 10^6.$$

$$\sigma_c = \frac{PD}{2t n_c}$$

$$\sigma_t = \frac{PD}{4t n_t}$$

$$t = \frac{2\sigma_c n_c}{PD}$$

$$t = \frac{4\sigma_t n_t}{PD}$$

$$t = \frac{2(110 \times 10^6) \times 0.85}{20 \times 10^5 \times 0.35}$$

$$t = \frac{4(110 \times 10^6) \times 0.95}{20 \times 10^5 \times 0.35}$$

$$t = 267.14 \text{ mm}$$

$$t = 597.14 \text{ mm}$$

$$t_{\text{Min}} = 597.1 \text{ mm.}$$

5.)

$$d_o = 150 \text{ mm } 150 \times 10^{-3}$$

$$d_i = 130 \text{ mm } 130 \times 10^{-3}$$

$$p_i = 80 \times 10^6$$

the inner

boundary conditions.

$$@ r_i = 0.065 - p = -80 \times 10^6$$

$$@ r_o = 0.075 \quad p = 0$$

@ r_o

@ r_i

$$\sigma_r = a - \frac{b}{r^2}$$

$$\sigma_r = a - \frac{b}{r^2}$$

$$0 = a - \frac{b}{0.075^2}$$

$$-80 \times 10^6 = a - \frac{b}{0.065^2}$$

$$\times (0.075^2)$$

$$\times (0.065^2)$$

$$0 = 0.075^2 a - b$$

$$-338 \times 10^3 = 0.065^2 a - b$$

$$338 \times 10^3 = a(0.075^2 - 0.065^2)$$

$$338 \times 10^3 = a \cdot 1.4 \times 10^{-3}$$

$$a = \frac{338 \times 10^3}{1.4 \times 10^{-3}}$$

$$a = 241.42 \times 10^6$$

$$b = ar^2$$

$$b = (241.42 \times 10^6) \times 0.075^2 = 1.36 \times 10^6$$

$$\sigma_R = \frac{a-b}{r^2}$$

$$\sigma_C = \frac{a+b}{r^2}$$

~~$$\sigma_R = \frac{241.42 \times 10^6}{0.065^2} - \frac{1.36 \times 10^6}{0.065^2}$$~~

$$\sigma_C = \frac{a+b}{r^2}$$

$$\sigma_C = \cancel{0.065^2} \frac{241.42 \times 10^6}{0.065^2} + \frac{1.36 \times 10^6}{0.065^2}$$

$$\sigma_{C \text{ inner}} = 262.34 \times 10^6. \quad \times$$

$$\sigma_{C \text{ outer}} = 241.42 \times 10^6 + \frac{1.36 \times 10^6}{0.075^2}$$

$$= 259.55 \times 10^6. \quad \times$$

Question No.

Examiner Only

Arholwr yn unig

hff y Cwestiwn

Question No.

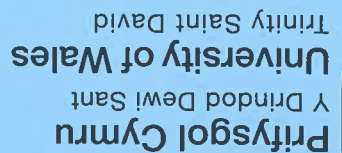
Examiner Only

Question No.

Examiner Onl

Arholwrynnig

if y Cwest!wn



12 Tudalen

1. Rhowch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwng eich enw yn y lle a ddarparwyd ar y dde, plygwch ef a'i seilio 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 sgrïpt annarllenadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.

4. Ysgrifennwch eich atebion mewn inc.

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

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

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

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 Myfyrwr	

[illegible]

(See the other side for English version)

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

CYFENW:

ENW(AU) CYNTAF:

ENW(AU) CYNTAF: