

12 Pages

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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.
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5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
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1	Student Number	2117891
2	Title of Examination Paper	ENGINEERING SCIENCE
3	Module Code	PCB04001
4	Date and Time of Examination	12.00 PM 11/05/2022
5	Examination Venue	PemBS
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

SURNAME: WILLIAMS

FORENAME(S): TRISTAN

HOLT

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Resistors in parallel

$$R = R_1 + R_2 + R_3$$

Resistors in series

$$R_T = \frac{1}{\frac{1}{25} + \frac{1}{16} + \frac{1}{15}}$$

$$= 9.756097561 \text{ k}\Omega$$

$$= 24.75609756 \text{ k}\Omega$$

$$\frac{1}{R_T} = \left(\frac{1}{12} + \frac{1}{24.75609756} \right) + \frac{1}{15+10}$$

5

$$R_T = 33.082 \Omega$$

Equivalent Resistance = 33.082 Ω 3dp

$$\text{bi)} C_T = C_1 + C_2 + C_3 \text{ in Parallel}$$

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \text{ in series}$$

$$\frac{1}{C_T} \text{ Parallel} = 15 \times 10^{-9} + 80 \times 10^{-9}$$

$$= 9.5 \times 10^{-8}$$

$$\frac{1}{C_T} = \frac{1}{9.5 \times 10^{-8}} + \frac{1}{220 \times 10^{-9}} + \frac{1}{35 \times 10^{-12}}$$

$$C_T = 3.498 \times 10^{-11}$$

5

Total equivalent capacitance = 34.981 pF to 3dp.

$$\text{bi)} Q = CV$$

$$Q = 3.498 \times 10^{-11} \times 12$$

$$Q = 4.1976 \times 10^{-10}$$

$$Q = 419.76 \text{ pC}$$

5

$$\text{iii)} E = \frac{CV^2}{2}$$

$$E = \frac{4.1976 \times 10^{-10} \times (12^2)}{2}$$

$$E = 30.22272 \times 10^{-9} \text{ J}$$

0

$$2a) R = \frac{\rho L}{A}$$

$$24 = \frac{\rho L}{A} \quad A = \pi r^2$$

$$= \pi \times (0.25 \times 10^{-3})^2$$

$$A = 1.963$$

$$R = \frac{\rho L}{A}$$

$$L = 6.2 \text{ m}$$

$$r = 0.00025$$

$$A = \pi r^2$$

$$A = \pi \times 0.00025^2$$

$$A = 1.963 \times 10^{-7} \text{ m}^2$$

$$24 = \frac{\rho \times 6.2}{1.963 \times 10^{-7}}$$

$$\rho = \frac{6.2}{1.963 \times 10^{-7} \times 24} \quad 6.2 \times 24 \times (1.963 \times 10^{-7})$$

$$\rho = 1.316 \times 10^6 \quad 2.92392 \times 10^{-5}$$

$$\text{New length} = 5 \times 6.2 = 31$$

$$\text{New area radius} = 0.5$$

$$\text{New area} = \pi \times 0.5^2 = 7.854 \times 10^{-7}$$

$$R = \frac{\rho L}{A}$$

$$R = \frac{(1.316 \times 10^6 \times 31)}{7.854 \times 10^{-7}} \quad \frac{(2.92392 \times 10^{-5} \times 31)}{7.854 \times 10^{-7}}$$

$$R = 1154.08 \Omega$$

$$2b \ R = 100$$

$$T = 0$$

$$T_2 = 40$$

$$\alpha = 0.00392$$

10

$$\begin{aligned} R &= 100 (1 + (0.00392 \times 40)) \\ &= 100 \times 1.1568 \\ &= 115.68 \Omega \end{aligned}$$

$$3a \ h_o = 7 \text{ cm}$$

$$d_o = 20 \text{ cm}$$

$$f = 40 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{40} = \frac{1}{20} + \frac{1}{d_i}$$

$$\frac{1}{d_i} = \frac{1}{40} - \frac{1}{20}$$

$$d_i = -40 \text{ cm}$$

$$B \ \frac{h_i}{h_o} = - \frac{d_i}{d_o}$$

$$\frac{h_i}{7} = - \frac{40}{20}$$

$$h_i = 7 \times \left(- \frac{40}{20} \right)$$

$$h_i = 14 \text{ cm}$$

10

5

✓

(40/40)

?

x 3

(8)

Ritly Cwestiwn

: 8/12

$$3b \quad h_o = 5$$

$$d_o = 30.5$$

$$f = -15.2$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{-15.2} = \frac{1}{30.5} + \frac{1}{d_i}$$

$$\frac{1}{d_i} = \frac{1}{-15.2} - \frac{1}{30.5}$$

$$d_i = -10.14 \text{ cms}$$

10

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$\frac{h_i}{5} = -\frac{-10.14}{30.5}$$

$$h_i = 5 \times \left(\frac{10.14}{30.5} \right)$$

$$= 1.66 \text{ cms}$$

4a) $d_o = 18 \text{ cm}$
 $f = 38 \text{ cm}$

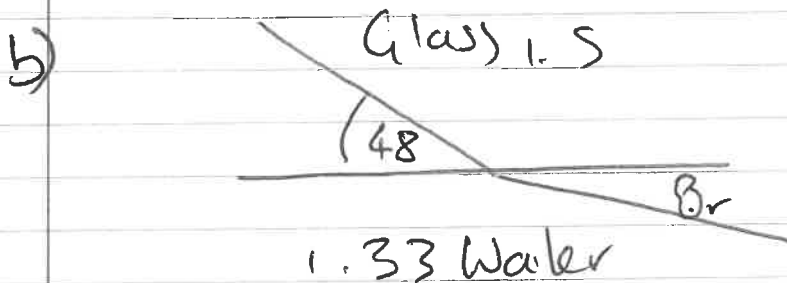
$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{38} = \frac{1}{18} + \frac{1}{d_i}$$

$$\frac{1}{d_i} = \frac{1}{38} - \frac{1}{18}$$

$$d_i = -34.2 \text{ cm}$$

Image is virtual



$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$1.5 \sin 48 = 1.33 \sin \theta_r$$

$$\theta_r = \sin^{-1} \left(\frac{1.5 \sin(48)}{1.33} \right)$$

$$= 56.94^\circ \text{ 2d.p.}$$

5

10

4c $h_o = 4 \text{ cms}$
 $d_o = 25 \text{ cms}$
 $f = -35 \text{ cms}$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{-35} = \frac{1}{25} + \frac{1}{d_i}$$

$$\frac{1}{d_i} = \frac{1}{-35} - \frac{1}{25}$$

$$d_i = -87.5 \text{ cms}$$

$$\frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

$$\frac{h_i}{4} = \frac{-(-87.5)}{25}$$

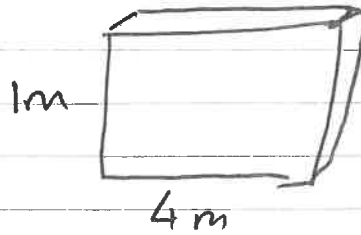
$$h_i = 4 \left(\frac{87.5}{25} \right)$$

$$h_i = 14 \text{ cms}$$

Image height = 14 cms.

$$B \quad L = 1m$$

$$h = 4m$$



$$R = \frac{\rho L}{A}$$

$$\text{Refractory brick } R = \frac{1.6 \times 120 \times 10^{-3}}{4}$$

$$= 0.048$$

C

$$\text{Insulating firebrick } R = \frac{0.3 \times 180 \times 10^{-3}}{4}$$

$$= 0.0135$$

$$\text{Plaster } R = \frac{0.14 \times 20 \times 10^{-3}}{4}$$

$$= 7.7 \times 10^{-3}$$

$$R = 0.0692$$

R