



Complete, fold and seal
(see note 2 below)

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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]

20 ✓
10 ✓
20 ✓
20 ✓
0 ✓

70
12

1.

a) Resistance r :

$$\frac{1}{16} + \frac{1}{25} = 0.1025 \quad \frac{1}{0.1025} = 9.756 \Omega$$

$$15 + 9.756 = 24.756 \Omega$$

$$\frac{1}{24.756} + \frac{1}{20} + \frac{1}{12} = 0.174 \quad \frac{1}{0.174} = 5.756 \Omega$$

$$5.756 + 10 + 15 = \underline{\underline{30.756 \Omega}}$$

b)

i) Capacitance r :

$$15 \times 10^{-9} + 80 \times 10^{-9} = 95 \text{ nF}$$

$$\frac{1}{95 \times 10^{-9}} + \frac{1}{35 \times 10^{-12}} + \frac{1}{220 \times 10^{-9}} = 2.863 \times 10^{10}$$

$$\frac{1}{2.863 \times 10^{10}} = 34.93 \times 10^{-12} \text{ F} \approx \underline{\underline{34.93 \text{ pF}}}$$

ii) ~~charge = voltage~~

$$Q = CV$$

$$= (34.93 \times 10^{-12}) \times 12 = 419.11 \times 10^{-12} \text{ C} \approx \underline{\underline{419.11 \text{ pC}}}$$

$$\text{iii) } E = \frac{CV^2}{2} = \frac{34.93 \times 10^{-12} \times 12^2}{2} = 2.52 \times 10^{-9} \text{ J} \approx \underline{\underline{2.52 \text{ nJ}}}$$

2.

a) $\phi = 0.25 \text{ mm}$

$L = 6.2 \text{ m}$

$R = 24 \Omega$

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

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

~~$24 = \frac{P \times 6.2}{\pi \times (0.25 \times 10^{-3})^2}$~~

$A = \frac{\pi D^2}{4} = 0.397 \text{ mm}^2$

$24 = \frac{P \times 6.2}{0.397 \times 10^{-3}}$

$P = 24 \times 15617.13 = 374811.08$

$R = 374811.08 \times \frac{L}{A}$

$L_2 = 5 \times 6.2 = 31 \text{ m}$

$\phi_2 = 0.5 \text{ mm}$

$A_2 = \frac{\pi \times (1 \times 10^{-3})^2}{4} = 0.785 \times 10^{-3} \text{ mm}^2$

$R = 374811.08 \times \frac{31}{0.785 \times 10^{-3}}$

=

b) $R = R_0 (1 + \alpha \theta)$

$$R_0 = 100 \Omega$$

$$\alpha = 0.00392 / ^\circ\text{C}$$

$$\theta = 40^\circ\text{C}$$

$$R = 100 \times (1 + 0.00392 \times 40)$$

$$R = \underline{\underline{115.68 \Omega}}$$

10

3.

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

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

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

$$\frac{1}{20} - \frac{1}{40} = \frac{1}{d_i} = 0.025$$

$$\frac{1}{0.025} = \underline{\underline{40 \text{ cm}}}$$

5

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

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

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

$$h_i = \underline{\underline{-7 \text{ cm}}}$$

5

b) $h_o = 5 \text{ cm}$

$$d_o = 30.5$$

$$F = -15.2$$

$$\frac{1}{-15.2} - \frac{1}{30.5} = \frac{1}{d_i} = \underline{\underline{-10.14 \text{ cm}}}$$

5

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o} \quad \frac{h_i}{5} = -\frac{-10.14}{30.5}$$

$$h_i = 5 \times \left(-\frac{-10.14}{30.5}\right) = \underline{\underline{1.66 \text{ cm}}}$$

5

4.

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

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

$$\frac{1}{d_i} = \frac{1}{38} - \frac{1}{18} = -0.029$$

$$\frac{1}{-0.029} = \underline{-34.2 \text{ cm}} \quad \checkmark \quad \underline{\text{Image is real.}}$$

5

b) $\theta_i = 48^\circ$

$$n_i = 1.50$$

$$n_r = 1.33$$

$$\theta_r = ?$$

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

$$1.50 \times \sin 48 = 1.33 \sin \theta_r$$

$$\sin \theta_r = \frac{1.50 \times \sin 48}{1.33} = 0.838$$

$$\sin^{-1}(0.838) = \underline{56.94^\circ}$$

10

c) $h_i = ?$

$$h_o = 4 \text{ cm}$$

$$f = -35 \text{ cm}$$

$$d_o = 25 \text{ cm}$$

$$d_i = ?$$

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

$$\frac{1}{-35} - \frac{1}{25} = -0.069$$

$$\frac{1}{-0.069} = \underline{-14.58 \text{ cm}}$$



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

$$\frac{h_i}{4} = -\frac{-14.58}{25}$$

5

$$h_i = 4 \times \left(\frac{-14.5}{25} \right)$$

$$h_i = 4 \times 0.583$$

$$= \underline{\underline{2.33 \text{ cm}}}$$

5.

$$A = 1 \times 4 = 4 \text{ m}^2$$

$$R_B = 120 \times 10^{-3} \text{ m}$$

$$I_{FB} = 180 \times 10^{-3} \text{ m}$$

$$P = 220 \times 10^{-3} \text{ m}$$

$$I_T = 1100^\circ \text{C}$$

$$O_P = 50^\circ \text{C}$$

$$C_{VB} = 1.6 \text{ W/m}$$

$$I_{FB} = 0.3 \text{ W/m}$$

$$P = 0.14 \text{ W/m}$$

a) Resistance

Question No.

2.

$$a) \varnothing = 0.25 \text{ mm}$$

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

$$R = 24 \Omega$$

$$P = ?$$

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

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

$$A = \frac{\pi r^2}{4}$$

$$= \frac{\pi (0.00025)^2}{4}$$

$$= 1.96 \times 10^{-7} \text{ mm}^2$$

$$24 = \frac{P}{A} = \frac{P}{1.96 \times 10^{-7}}$$

$$A = \frac{\pi D^2}{4} = \frac{\pi (0.5 \times 10^{-3})^2}{4}$$

$$= 0.393 \times 10^{-3} \text{ mm}^2$$

$$\frac{L}{A} = \frac{6.2}{0.393 \times 10^{-3}} = 15788.17$$

$$P = \frac{24}{15788.17} = 1.52 \times 10^{-3}$$

$$L_2 = 5 \times 6.2 = 31 \text{ m}$$

$$\varnothing_2 = 0.25 \times 2 = 0.5 \text{ mm}$$

$$P = 1.52 \times 10^{-3}$$

$$R = 1.52 \times 10^{-3} \times \frac{31}{0.5 \times 10^{-3}} = \underline{\underline{94.25 \Omega}}$$