



Complete, fold and seal
(see note 2 below)

FORENAME(S): Thomas Edward

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.**

[illegible]

William H
03/06/24

Question 1

$$1A. 4.8 + \left(\frac{1}{4.3}\right)^{-1} = 9.1$$

$$25 + \left(\frac{1}{9.1} + \frac{1}{12}\right)^{-1} = 30.175$$

$$\left(\frac{1}{30.175} + \frac{1}{10} + \frac{1}{12}\right)^{-1} = 4.62$$

$$50k + 4.62k = 54.62 k\Omega \checkmark$$

$$1B i) (510 \times 10^{-12}) + (22 \times 10^{-9}) = 2.251 \times 10^{-8}$$

$$\frac{1}{2.251 \times 10^{-8}} + \frac{1}{220 \times 10^{-9}} + \frac{1}{47 \times 10^{-6}} = \text{ans}$$

$$\frac{1}{\text{ans}} = 2.04 \times 10^{-8}$$

$$= 20.4 \times 10^{-9}$$

$$= 20.4 \text{ nF} \checkmark$$

$$1B ii) \text{ Charge} = (20.4 \times 10^{-9}) \times 24V = 4.896 \times 10^{-7}$$

$$= 48.96 \times 10^{-8}$$

$$= 489.6 \times 10^{-9} = 489.6 \text{ nC} \checkmark$$

1 Biii) ~~En~~ Energy = $\frac{1}{2} \times (20.4 \times 10^{-4}) \times 24^2 = 5.8752 \times 10^{-6}$
 $= 5.8752 \mu\text{J}$ ✓

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Question 2

2i) ~~155~~ 115mm = 0.115m = brick 0.4
 75mm = 0.075m = cork 0.04
 25mm = 0.025m = wool 0.17

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

$$65 - 2 = 63$$

$$\frac{1}{\left(\frac{0.115}{0.4}\right) + \left(\frac{0.075}{0.04}\right) + \left(\frac{0.025}{0.17}\right)} \times 63 = 29.305 \text{ watts}$$
 ✓

2ii) $A = 4.7 \times 2.3 = 10.81$

$$\frac{10.81}{\left(\frac{0.115}{0.4}\right) + \left(\frac{0.075}{0.04}\right) + \left(\frac{0.025}{0.17}\right)} \times 63 = 316.78 \text{ watts}$$
 ✓

2iii) T₄

$$316.78 = \frac{0.17 \times 10.81 (65 - T_4)}{0.025}$$
 ✓

$$316.78 \times 0.025 = 7.9195$$

$$\frac{7.9195}{(0.17 \times 10.81)} = \cancel{65 - 63} T_4 \quad 65 - T_4$$

20

$$\Rightarrow 4.3045 = \cancel{65 - T_4} \quad 65 - T_4$$

$$T_4 + 4.3045 = \cancel{65} \quad 65$$

$$T_4 = 65 - 4.3045 = \cancel{60.7} \quad 60.7^\circ\text{C} \quad \checkmark$$

T_3

$$316.78 = \frac{0.04 \times 10.81 (60.7 - T_3)}{0.075}$$

$$\Rightarrow 316.78 \times 0.075 = 23.7585$$

$$\frac{23.7585}{(0.04 \times 10.81)} = 60.7 - T_3 \quad \checkmark$$

$$\cancel{54.55} \quad 54.95 = 60.7 - T_3$$

$$T_3 + 54.95 = 60.7$$

$$T_3 = 60.7 - 54.95 = 5.75^\circ\text{C} \quad \checkmark$$

(iv) missing

Check with $T_4 = 2^\circ\text{C}$

$$2v) \quad \text{at } 100\text{mm} = 0.1\text{m} \div 2 = 0.05$$

$$300 + 273 = 573 \quad \checkmark$$

$$60 + 273 = 333 \quad \checkmark$$

$$0.6 \times (5.672 \times 10^{-8}) \times (4\pi \times 0.05^2) \times (573^4 - 333^4)$$

$$= 1283.12 \text{ W/m}^2 \text{ to the left}$$

$$= 102.11 \text{ W/m}^2 \text{ to the left} \quad \checkmark$$

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14

labelled diagram?

Question No.

Question 3

Examiner Only

$$3i) \quad 23 \times (2.14 \times 10^3) \times 13 = 639,860 \quad \checkmark$$

$$23 \times (334 \times 10^3) = 7,682,000 \quad \checkmark \text{ Units}$$

$$23 \times (4.2 \times 10^3) \times 100 = 9660,000 \quad \checkmark$$

$$23 \times (2.26 \times 10^6) = 51,980,000 \quad \checkmark$$

$$\text{Total} = 69,961,860 \quad \checkmark$$

$$3ii) \quad P = \frac{WD}{T} \quad \text{5 minutes} = 300 \text{ seconds} \quad \checkmark$$

$$e = \frac{P_{out}}{P_{in}}$$

$$\frac{69,961,860}{300} = 233206.2 \quad \checkmark$$

Good.

$$233206.2$$

$$\frac{233206.2}{8 \times 10^6} \times 100 = 2.92\% \quad \checkmark$$

Question 4

$$4i) \quad 0.5 \text{ mm} = 0.0005 \text{ m} \div 2 = 2.5 \times 10^{-4}$$

$$\frac{(\pi \times 2.5 \times 10^{-4})^2}{100} = 1.96 \times 10^{-8} \quad \checkmark \text{ m}^2$$

17

17

17
W

$$\frac{1.46 \times 10^{-8} (100)}{0.3 \text{ mm} = 0.0003 \text{ m} \div 2 = 1.5 \times 10^{-4}}$$

$$0.3 \text{ mm} = 0.0003 \text{ m} \div 2 = 1.5 \times 10^{-4}$$

$$\frac{1.46 \times 10^{-8} (100)}{(\pi \times 1.5 \times 10^{-4})} = 27.73 \Omega \checkmark$$

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4ii) $R_{\text{max}} =$

$$45(1 + 0.00346(75 - 20)) = 115.641 \Omega \checkmark$$

Question 5

5A)i) $F = 15 \text{ cm}$, $d_i = 24.4 \text{ cm} = 244 \text{ mm}$, $h_o = 12.5 \text{ mm} = 1.25 \text{ cm}$

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

$$\frac{1}{15} = \frac{1}{244} + \frac{1}{d_o}$$

$$\frac{1}{d_o} = \frac{1}{15} - \frac{1}{244} = 15.48 \text{ cm}$$

$$\frac{1}{d_o} = \frac{1}{15} - \frac{1}{244} = 15.48 \text{ cm}$$

$$\frac{1}{d_o} = 15.48 \text{ cm} \checkmark$$

5Aii) The image is ~~not~~ real/inverted $\checkmark$

18 WB

$$S_{\text{iii}}) \frac{15.48}{12.5} = 12.784$$

$$\frac{15.48}{244} \times 1.25 = \cancel{0.082 \text{ uns}}, \frac{1}{\cancel{\text{uns}}} \frac{744}{9760}$$

$$\frac{1}{\text{uns}} = 12.22 \text{ cm} \times 19 \text{ cm}$$

SBi) The image will be virtual/upright ✓

SBii) $F = \frac{1}{10}$ $F = 10 \text{ cm}$, $d_o = 21 \text{ cm}$

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

$$\frac{1}{10} = \frac{1}{21} + \frac{1}{d_o}$$

$$\frac{1}{d_o} = \frac{1}{10} - \frac{1}{21} = \text{uns}$$

$$\frac{1}{\text{uns}} = +14.09 \text{ cm} \checkmark$$

SBiii) $\frac{\sin 36^\circ}{1.54} = 0.3816787353 \times$

$$\sin^{-1} \text{uns} = 22.44^\circ \times 20.13^\circ$$

SBiv) $\frac{\sin 4}{\sin 37} = 0.2594 \checkmark$

(28)