

Complete, fold and seal
(see note 2 below)

FORENAME(S): Nogus

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.**

1	Student Number	
2	Title of Examination Paper	Engineering Science
3	Module Code	PCPD4001
4	Date and Time of Examination	15/5/24 11:00
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

10
8
19
2
8

William A
03/06/74

47510

1

$$a) \frac{1}{4.3 \times 10^3} + 4.8 \times 10^3 = 4.8 \times 10^3$$

$$\left(\frac{1}{4.8 \times 10^3} + \frac{1}{12 \times 10^3} \right)^{-1} = 3.43 \times 10^3$$

$$3.43 \times 10^3 + 25 \times 10^3 = 28.43 \times 10^3$$

$$\left(\frac{1}{28.43 \times 10^3} + \frac{1}{10 \times 10^3} + \frac{1}{12 \times 10^3} \right)^{-1} = 4.58 \times 10^3$$

$$4.58 \times 10^3 + 50 \times 10^3 = \underline{54.58 \times 10^3} \quad \times$$

54.62 k Ω

b)

$$i) \quad 22 \mu F \quad 22 \times 10^{-9} + 510 \times 10^{-12}$$

$$= 2.251 \times 10^{-8}$$

$$ii) \left(\frac{1}{2.251 \times 10^{-8}} + \frac{1}{220 \times 10^{-9}} + \frac{1}{47 \times 10^{-6}} \right)^{-1} = 2.04 \times 10^{-8} \\ = 20.4 \text{ nF} \quad \checkmark$$

$$\text{Charge} = \text{Capacitance} \times \text{volts}$$

$$\text{Energy} = \frac{1}{2} \times \text{Capacitance} \times \text{volts}^2$$

$$iii) \text{ Charge} = 2.04 \times 10^{-8} \times 24 = 4.896 \times 10^{-7} \\ = 489.6 \text{ nC} \quad \checkmark$$

$$iii) \text{ Energy} = \frac{1}{2} \times 2.04 \times 10^{-8} \times 24^2 = 5.86 \times 10^{-6} \\ = 5.86 \mu\text{J} \quad \checkmark$$

10
10
- 10

2)

1)

	T_1	T_2	T_3	
2				T_4 65
	Brick	Cork	Wood	
x	115mm	75mm	25mm	
K	0.9	0.04	0.17	

$$Q = \frac{A}{\left(\frac{x_1}{K_1}\right) + \left(\frac{x_2}{K_2}\right) + \left(\frac{x_3}{K_3}\right)}$$

$$Q = \frac{1}{\left(\frac{0.115}{0.9}\right) + \left(\frac{0.075}{0.04}\right) + \left(\frac{0.025}{0.17}\right)}$$

 ΔT

①

$$Q = 2.48 \text{ units}$$

$$ii) Q = \frac{4.7 \times 2.3}{\left(\frac{0.115}{0.9}\right) + \left(\frac{0.075}{0.04}\right) + \left(\frac{0.025}{0.17}\right)} = 26.79 \text{ units}$$

You have forgotten
temp difference

$$iii) Q = \frac{kA(T_1 - T_2)}{x}$$

$$T_2 = \frac{Q}{kA} (T_1 - T_2)$$

$$2.48 = \frac{0.9 \times 115}{0.115} (T_1 - T_2)$$

Go from hot to
cold

①

② WB

$$2.48 = \frac{0.9 \times \frac{1}{2} (2 - T_2)}{0.115}$$

$$\begin{aligned} 2.48 \times 0.115 &= 0.9 \times \frac{1}{2} (2 - T_2) \\ &= 0.2852 = 0.9 (2 - T_2) \\ \frac{0.2852}{0.9} &= 2 - T_2 \end{aligned}$$

$$0.3168 = 2 - T_2$$

$$T_2 = 2 - 0.3168 = 1.68$$

$$T_3 = \frac{Q = KA(T_2 - T_3)}{x}$$

$$2.48 = \frac{0.044 \times 1 (1.68 - T_3)}{0.075}$$

$$\begin{aligned} 2.48 \times 0.075 &= 0.044 (1.68 - T_3) \\ 0.186 &= 0.04 (1.68 - T_3) \end{aligned}$$

$$\frac{0.186}{0.04} = 1.68 - T_3$$

$$4.65 = 1.68 - T_3 \quad \Rightarrow \quad T_3 = 1.68 - 4.65$$

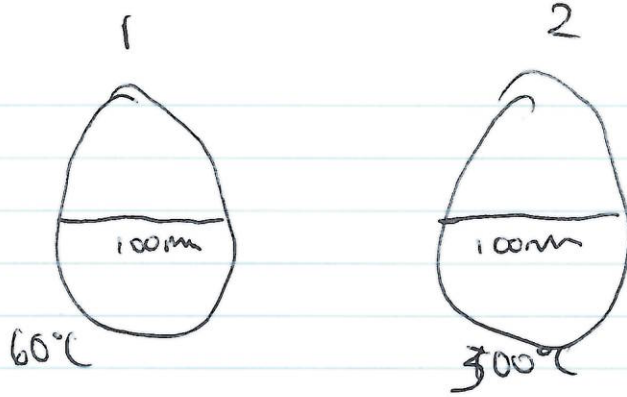
$$T_3 = -2.97 \quad 2-65$$

$$in \quad Q = \frac{KA}{\left(\frac{x}{k}\right)} \Delta T = \left(\frac{1}{\left(\frac{0.075}{0.9}\right)}\right) \times (-2.97 \times 65)$$

$$= -2446.92$$

(iv) Missing = at the end M ①

V)



$$\epsilon = 0.6$$

Grey body = 56.7×10^{-9}

Area = $4 \times \pi \times 0.1^2 = 0.1256 \text{ m}^2$

This should be radius not diameter

$$Q = \epsilon \sigma A T^4$$

$$1) = 0.6 \times 56.7 \times 10^{-9} \times 0.126 \times 60^4$$

$$= 55.55 \times 10^{-3} \text{ } ^\circ\text{C}$$

Temp needs to be in Kelvin

$$2) = 0.6 \times 56.7 \times 10^{-9} \times 0.126 \times 300^4$$

$$= 34.72 \text{ } ^\circ\text{C}$$

incorrect unit

Method correct.

Heat Transfer Left

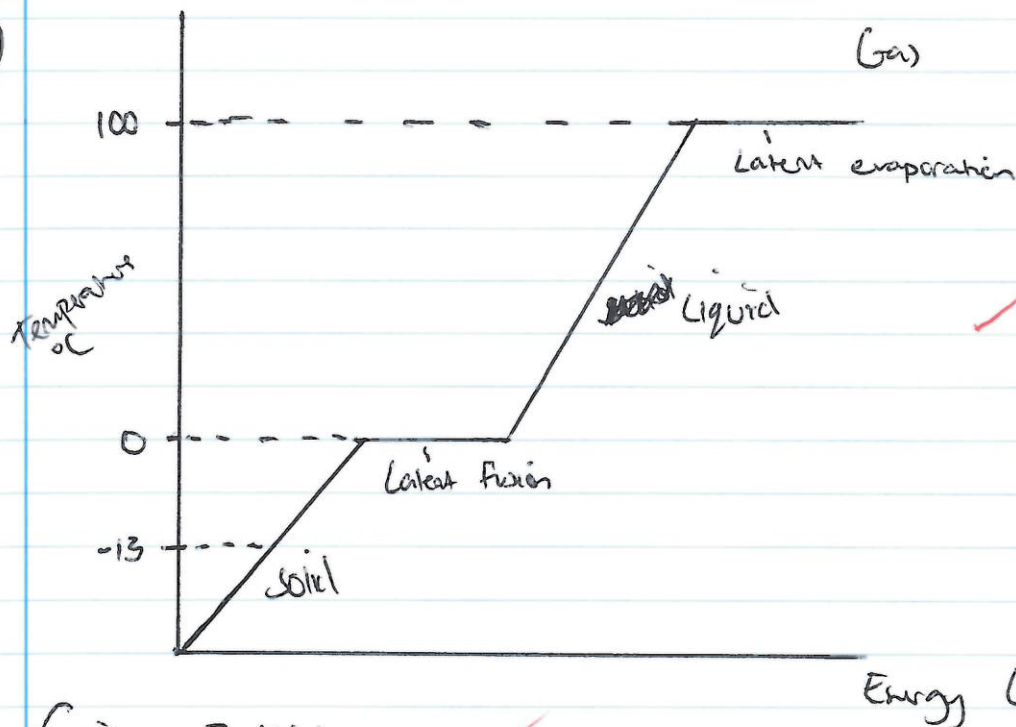
from 2 to 1

4

4

us

3)



$$\begin{aligned}
 C_{ice} &= 2.14 \text{ kJ} \\
 C_{water} &= 4.2 \text{ kJ} \\
 \text{Latent fusion} &= 334 \text{ kJ} \\
 \text{Latent evap} &= 2.26 \text{ MJ}
 \end{aligned}$$

Energy (J)

$$\begin{aligned}
 \text{mass} &= 23 \text{ kg} \\
 \text{Time} &= 300 \text{ secs}
 \end{aligned}$$

$$\begin{aligned}
 \text{MC}\Delta T &= 23 \times 2.14 \times 10^3 \times (-13 \text{ to } 0) = 639860 \text{ J} \\
 \text{MU} &= 23 \times 334 \times 10^3 = 7668200 \text{ J} \\
 \text{MC}\Delta T &= 23 \times 4.2 \times 10^3 (0 \text{ to } 100) = 9660000 \text{ J} \\
 \text{MU} &= 23 \times 2.26 \times 10^6 = 51980000 \text{ J} \\
 \text{Total} &= 69961860 \\
 &= 69.96 \text{ MJ}
 \end{aligned}$$

$$\text{Work done} = \frac{\text{power}}{\text{time}}$$

$$= \frac{69.96 \times 10^6}{300} = 233200 = 233.2 \text{ kJ}$$

$$\text{Efficiency} = \frac{\text{power out}}{\text{power in}} = \frac{233.2 \times 10^3}{8 \times 10^6} \times 100$$

$$= \frac{233.2 \times 10^3}{8 \times 10^6} \times 100 = 2.915\%$$

4

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

$$R = 5 \times 10^{-3} \text{ m} \quad \text{length} = 100 \text{ m} \quad \text{Resistance} = 10 \Omega$$

$$R = \frac{(10 \times 100)}{5 \times 10^{-3} \times 4 \times 10^{-3}} = 15.91 \times 10^3$$

$$b) \quad \rho = \frac{A \times R}{L} \quad \rho = \frac{4 \times 10^{-3} \times 15.91 \times 10^3}{100}$$

$$= 0.6 \times 10$$

$$\times 27.8 \Omega$$

$$b) \quad R_{\text{new}} = R_{\text{ref}} \cdot (1 + \alpha (\Delta T))$$

$$\alpha_{\text{copper}} = 0.00396 \text{ } ^\circ\text{C}^{-1} \quad \Delta T = 20 - 75$$

$$(1 + 0.00396 (20 - 75)) = 55$$

$$= 1.22 \Omega$$

$$\times 115.7 \Omega$$

15

5)

a) Lens 15cm

Length 12.5mm = 1.25cm

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

$$= \frac{1}{15} + \frac{1}{1.25} = \frac{1}{d_o} = 1.15 \quad \times \quad 160\text{mm} \quad 1$$

A is Convex - Real ✓ / ~~inverted~~ DivergingB is Concave - Virtual ✓ / ~~inverted~~

$$a_{iii}) m = \frac{h_i}{h_o} = \frac{d_i}{d_o}$$

$$m = \frac{h_i}{15} = \frac{15}{1.25} \quad m = \quad \times \quad 190.6\text{mm} \quad 1$$

$$C) \text{ incidence} = 32^\circ \quad n_{\text{air}} = 1.54$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$= 1.54 \sin 32 = 0.82 \quad \sin^{-1} 0.82$$

$$= 54.69^\circ \quad \times \quad 20.13^\circ \quad 1$$

3
SM

$$D) \frac{\sin I}{\sin R} = n$$

$$\frac{\sin(9)}{\sin(37)} = 0.26 \quad \checkmark$$

10

5

2

iv)

$$Q = \sigma A T^4$$

$$\epsilon = 0.9$$

$$Q = \epsilon \sigma A T^4 \quad \checkmark$$

$$Q = 0.9 \times 56.7 \times 10^{-9} \times 1 \times 1.68^4$$

$$= 3.32 \times 10^{-6} \times 4.07 \times 10^{-7}$$

Area of wall
is 10.8 m^2

and its temp
is 2

⑥
- W