

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.**

1	Student Number	
2	Title of Examination Paper	Engineering Science.
3	Module Code	PCPD04001
4	Date and Time of Examination	15-05-2024 11:00
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

Complete, fold and seal
(see note 2 below)

SURNAME: Williams

FORENAME(S): Matthew

William L
03/06/24

1. Resistors in Series = $R_1 + R_2 + R_3$
 A. Resistors in Parallel = $\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$$\begin{aligned}
 4.3K + 4.8K &= 9.1 \\
 \frac{1}{9.1} + \frac{1}{12} &= 5.17535 \\
 5.17535 + 25 &= 30.17535 \\
 \frac{1}{30.17535} + \frac{1}{12} + \frac{1}{10} &= 4.6195 \\
 4.6195 + 50 &= 54.62K\Omega \\
 &= \underline{54.62K\Omega} \quad \checkmark
 \end{aligned}$$

- B.
 i $\rightarrow$ Total capacitance. $\begin{matrix} -6 & -9 & -12 \\ \mu & n & p \end{matrix}$

$$(22 \times 10^{-9}) + (510 \times 10^{-12}) = 22.51 \times 10^{-9}$$

$$\begin{aligned}
 \frac{1}{22.51 \times 10^{-9}} + \frac{1}{220 \times 10^{-9}} + \frac{1}{47 \times 10^{-6}} &= \cancel{489.90 \times 10^{-6}} \\
 &= \cancel{489.90} \\
 &= 20.41 \times 10^{-9} \\
 &= 20.41nF \quad \checkmark
 \end{aligned}$$

- ii) $Q = CV$

$$\begin{aligned}
 &\overset{489.90nF}{20.41 \times 10^{-9}} \times 24 = 489.90 \times 10^{-9} \\
 &489.90nC \quad \checkmark
 \end{aligned}$$

- iii) $\rightarrow \frac{1}{2}CV^2$

$$\frac{1}{2} \times (20.41 \times 10^{-9}) \times 24^2$$

$$= 5.88 \times 10^{-6} J \rightarrow 5.88\mu J \quad \checkmark$$

20
 20
 40

2. T_1 T_2 T_3 T_4 $115 = 0.115$

i) 2°C 65°C

B	C	W
R	O	O
I	R	O
C	K	D
K		

α	0.115	0.075	0.025
K	0.9	0.04	0.17

$$\frac{A}{\left(\frac{\alpha}{k}\right)\left(\frac{\alpha}{k}\right)\left(\frac{\alpha}{k}\right)} \Delta T$$

$$\frac{1}{\left(\frac{0.115}{0.9}\right) + \left(\frac{0.075}{0.04}\right) + \left(\frac{0.025}{0.17}\right)} \times 63 = 29.30 \text{ W} \quad \checkmark$$

ii) $4.7\text{m} \times 2.3\text{m}$ $\times 63 = 316.80 \text{ W} \quad \checkmark$

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

iii) Corn/wood + Brick/corn.

Corn-wood = $Q = \frac{KA(\Delta T)}{\alpha}$

$$29.30 = \frac{0.17 \times 1 (65 - T_3)}{0.025} \rightarrow \times 0.025$$

$$0.7325 = 0.17 (65 - T_3) \rightarrow \div 0.17$$

$$4.3088 = 65 - T_3 \rightarrow T_3 = \underline{\underline{60.69^\circ}} \quad \checkmark$$

$$\text{Brick corn} \rightarrow 29.30 = \frac{0.04 \times 1 (60.69 - T_2)}{0.075}$$

$$\times 0.075$$

$$2.1975 = 0.04 \times 1 (60.69 - T_2)$$

$$\div 0.04$$

$$54.9375 = 60.69 - T_2$$

$$T_2 = \underline{\underline{5.75^\circ}}$$

Check T_1 .

$$29.30 = \frac{0.9 \times 1 (5.75 - T_1)}{0.115}$$

$$3.3695 = 0.9 (5.75 - T_1)$$

$$3.74 = 5.75 - T_1$$

$$T_1 = \underline{\underline{2.00^\circ}}$$

IV) $\epsilon \sigma A T^4$

$$0.9 \times (56.72 \times 10^{-9}) (\text{Wall Area}) (65^4 - 60.69^4)$$

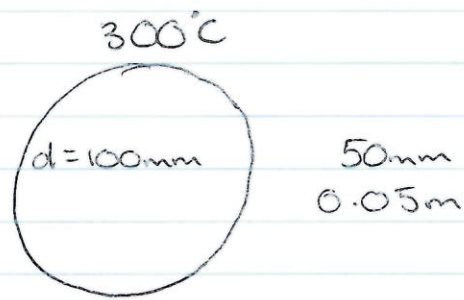
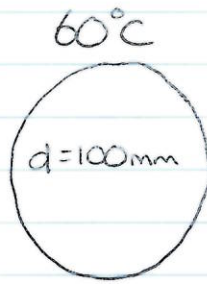
$$= 0.218 \quad \begin{matrix} 65 + 273 & 338 \\ 60.69 + 273 & 333.69 \end{matrix}$$

$$= \underline{\underline{33.34}}$$

15

15

v)



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

$$\epsilon = 0.6$$

$$60 + 273 = 333$$

$$300 + 273 = 573$$

$$\sigma = 56.72 \times 10^{-9}$$

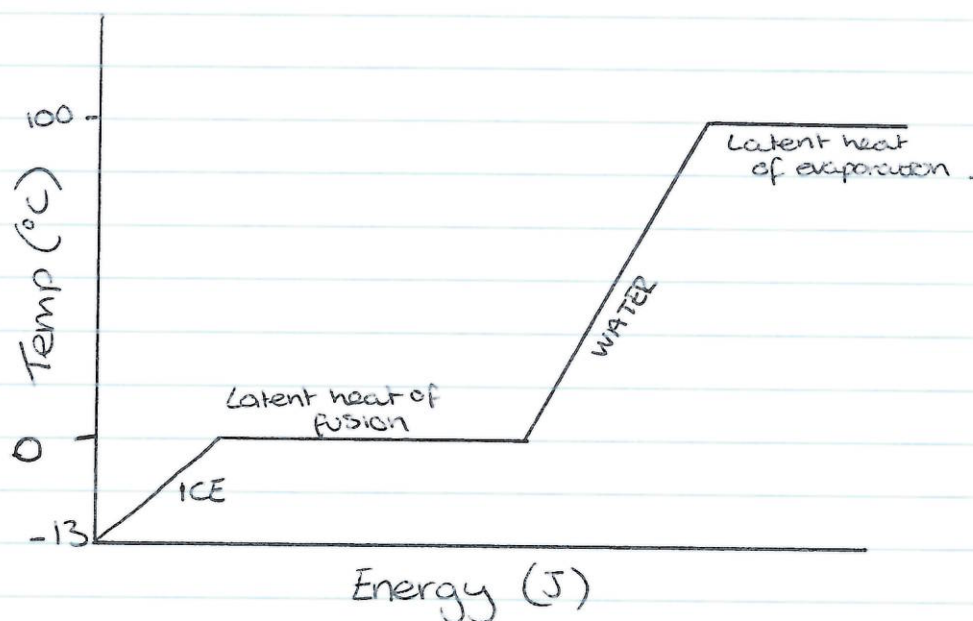
$$0.6 \times (56.72 \times 10^{-9}) \times (4 \times \pi \times 0.05^2) \times (573^4 - 333^4)$$

$$= 102.11 \text{ W}$$

Heat transferring from right to left.

Correct

3. i) 23kg ice -13°C to 100°C 5 mins
300s



heat capacity of ice = 2.14×10^3
 heat capacity of water = 4.2×10^3
 Lat heat fusion = 334×10^3
 lat heat evap = 2.26×10^6

$$U = MC\Delta T$$

$$U = MC$$

$$\begin{aligned} \textcircled{1} \quad & 23 \times (2.14 \times 10^3) \times 13 = 639860 \\ & 23 \times (334 \times 10^3) = 7682000 \\ & 23 \times (4.2 \times 10^3) \times 100 = 9660000 \\ & 23 \times (2.26 \times 10^6) = 51980000 \\ & \quad = 63048060 \text{ J ?} \\ & \quad = 63.05 \text{ MJ} \end{aligned}$$

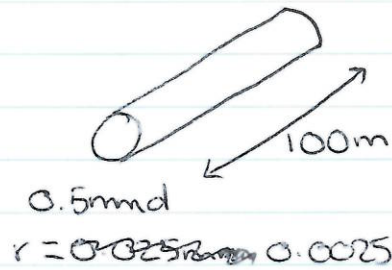
ii) Power = $\frac{\text{Workdone}}{\text{Time}}$

Efficiency = $\frac{\text{Power out}}{\text{Power in}} \times 100$

$$= \frac{63048060}{300} = 210160.2 \text{ W} \rightarrow \frac{210160.2}{(8 \times 10^6)} \times 100 = 2.63\%$$

Method correct. Workdone mistake carries over

4. A.



$$R = 10\Omega$$

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

$$\rho = \frac{RA}{L}$$

$$\rho = \frac{10 \times (\pi \times 0.025^2)}{100} = 196.35 \times 10^{-6}$$

new diameter of 0.3 $\rightarrow r = 0.015\text{m}$

$$R = \frac{(196.35 \times 10^{-6}) \times 100}{(\pi \times 0.025^2)}$$

$$R = 27.78\Omega \quad \checkmark$$

B) 95Ω at 20°C $\uparrow$ to 75°C .

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

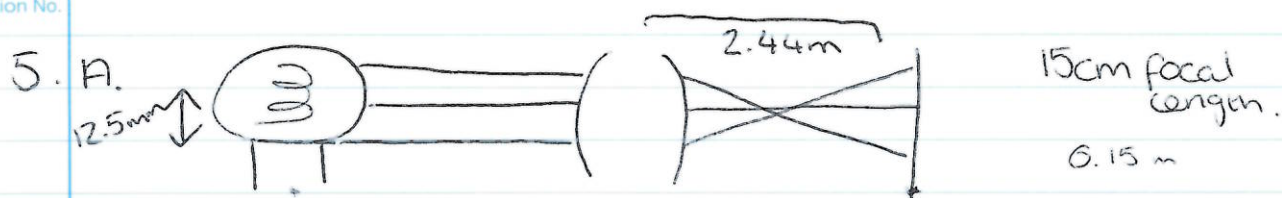
$$R_{\text{new}} = 95 (1 + 0.00369 (75 - 20))$$

$$= 114.28\Omega \quad \checkmark$$

$$115.7\Omega$$

20
18

18
18



Convex - converging = Real image reversed.
(Inverted)

i) distance between lens + bulb for focussed image.

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o} \quad \frac{1}{0.15} = \frac{1}{2.44} + \frac{1}{d_o}$$

$$= 6.2568 \quad \frac{1}{\text{ans}} = 0.1598 \text{ m}$$

$$15.98 \text{ cm} \checkmark$$

ii) The image will be a real image that will be reversed (Inverted). $\checkmark$

iii) length of filament image.

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

$$h_o = 0.012 \text{ m}$$

$$d_i = 2.44 \text{ m}$$

$$d_o = 0.1598 \text{ m}$$

$$\frac{h_i}{0.012} = - \frac{2.44}{0.1598}$$

$$\frac{-2.44}{0.1598} \times 0.012 = -0.1832 \text{ m}$$

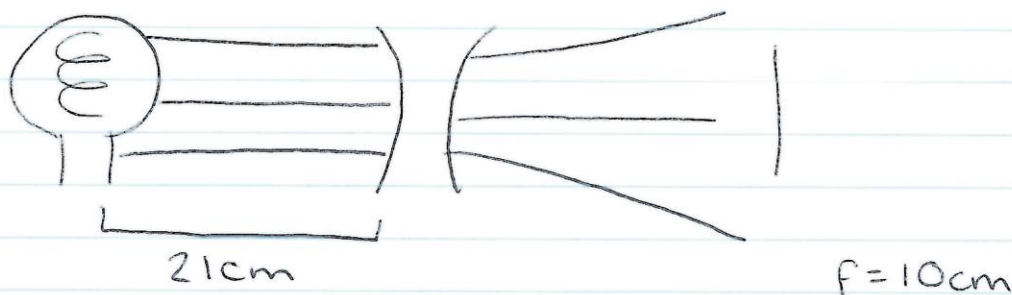
(Reversed)

$$0.18 \text{ m}$$

$$18.32 \text{ cm} -$$

$$19.06 \text{ cm}.$$

B)



- i) The type of image produced is a virtual image that is upright. ✓ → as the screen gets further away the image on the screen will get larger. ✗ *cannot be seen on screen.*

- ii) Position of image. $f = 10\text{cm}$
 $d_o = 21\text{cm}$

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

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

$$0.0523809 = \frac{1}{d_o}$$

$$d_o = \underline{\underline{19.10\text{cm}}} \quad \checkmark$$

- c) incidence angle = 32° refractive index = 1.54

$$\frac{\sin I}{\sin R} = n \quad \frac{\sin(32)}{\sin R} = 1.54$$

$$\frac{1}{1.54} = \frac{\sin R}{\sin(32)}$$

$$\sin(32) \times \frac{1}{1.54} = 0.344$$

$$\sin^{-1}(0.344)$$

$$\sin R = 20.13^\circ \quad \checkmark$$

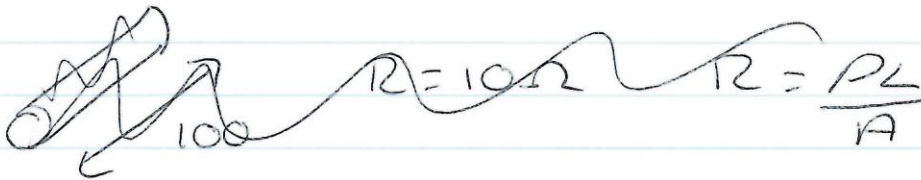
$$D \quad \frac{\sin i}{\sin R} = n$$

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

refractive index
= 0.26 ✓

17.

~~0.5 0.05 0.5 0.05 0.005~~



$$r = 0.0025$$

$$P = \frac{RA}{L}$$

$$P = \frac{10 \times (\pi \times 0.0025^2)}{100}$$

$$= 1.96 \times 10^{-6}$$

new diameter = 0.3 mm $\rightarrow$ $r = 0.0015$ mm

$$R = \frac{(1.96 \times 10^{-6}) \times 100}{(\pi \times 0.0015^2)} = 27.78 \Omega$$