

Complete, fold and seal
(see note 2 below)

SURNAME: Vaughan

FORENAME(S): Luke

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	PcPo4001
4	Date and Time of Examination	15/05/24
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

William

50% 03/06/74

$$\begin{aligned}
 1) \quad & 4.3 + 4.8 = 9.1 \Omega \\
 & \frac{1}{9.1} + \frac{1}{12} = \frac{1}{R_{eq}} = 5.18 \Omega \\
 & 25 + 5.18 = 30.18 \Omega \\
 & \frac{1}{30.18} + \frac{1}{10} + \frac{1}{12} = \frac{1}{R_{eq}} = 4.62 \Omega \\
 & 50 + 4.62 = 54.62
 \end{aligned}$$

$$54.62 \text{ K}\Omega \checkmark$$

b)

$$i) \quad 22 \text{ n} + 510 \text{ p} = 22.51 \text{ n}$$

$$\frac{1}{22.51 \text{ n}} + \frac{1}{220 \text{ n}} + \frac{1}{47 \text{ n}} = \frac{1}{C_{eq}} = 20.41 \text{ nF}$$

$$20.41 \text{ nF} \checkmark$$

$$ii) \quad \text{Total charge, } Q = CV$$

$$20.41 \times 10^{-9} \times 24 = 489.84 \times 10^{-9}$$

$$489.84 \text{ nC} \checkmark$$

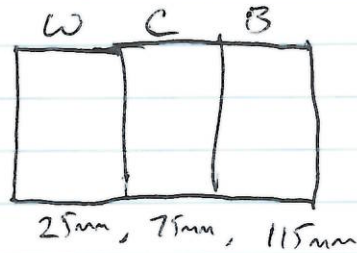
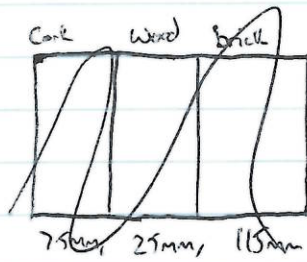
$$iii) \quad \text{Total energy, } \frac{1}{2} CV^2$$

$$\frac{1}{2} \times 20.41 \times 10^{-9} \times 24^2 = 5.88 \times 10^{-6}$$

$$5.88 \mu\text{J} \checkmark$$

20

2)



i) Thermal energy $m c \Delta T = \Delta U$
 $m_{ui} = \Delta U$

$$0.9 \times 115 = 103.5$$

$$0.04 \times 75 = 2.96$$

$$0.17 \times 25 = 4.25$$

$$110.71 \times 63$$

$$\Delta T = 63$$

ii) $4.7 \times 2.3 = 10.81 \text{ m}^3$ ✓ Area correct

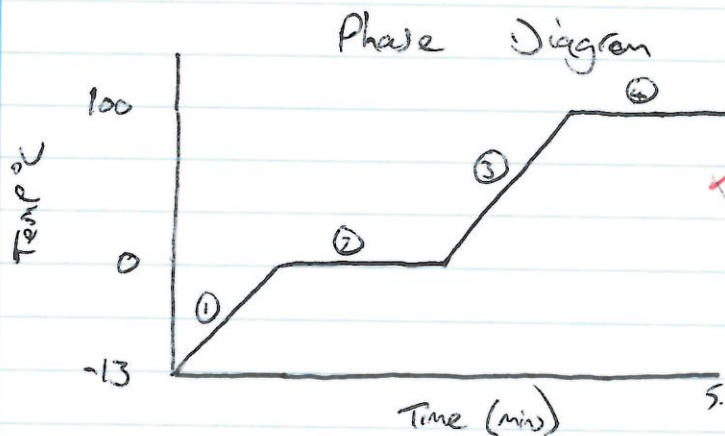
iii) /

iv) /

v) At back

3)

i)



2

$$① \quad 23 \times (2.14 \times 10^3) \times 13 = 639860 \quad \checkmark$$

$$② \quad 23 \times (4.2 \times 10^3) = 96600$$

incorrect
constant
used

$$③ \quad 23 \times (334 \times 10^3) \times 100 = 768200000$$

$$④ \quad 23 \times (2.26 \times 10^6) = 51980000 \quad \checkmark$$

$$820916460 \text{ J}$$

4

$$ii) \quad \frac{W.D}{t} = \frac{820916460}{300} = 2736388.2 \text{ W} \quad \checkmark$$

Correct
with

$$Eff = \frac{2736388.2}{8 \times 10^6} \times 100 = 34.20\% \quad \checkmark$$

your
numbers

4

4)
A) $R = \frac{\rho L}{A}$

$$R = \frac{(\pi \times 0.5) \times 100000}{100} = 15707.96$$

4)

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

$$10 = \frac{\rho \times 100m}{\pi \times 0.5m}$$

0.05

10000

$$10 = \frac{\rho \times 10000}{\pi \times 0.05}$$

$$\rho = 1.571 \times 10^{-4}$$

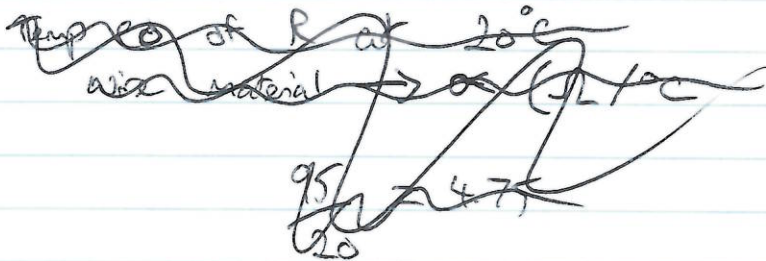
$$1.96 \times 10^{-3} \Omega m$$

$$\text{New Resistance} = \frac{1.571 \times 10^{-4} \times 10000}{\pi \times 0.03} = \underline{16.67 \Omega}$$

$$27.8 \Omega$$

4
B) $R_{\text{new}} = R_{\text{ref}} (1 + \alpha (\Delta T))$

Original 95Ω at 20°C



~~$R_{\text{new}} = 95(1 + 4.75(75 - 20)) = 24913.75 \Omega$~~

Temp Co of R at 20°C
Copper $\rightarrow 0.00396$

$R_{\text{new}} = 95(1 + 0.00396(75 - 20)) = 115.69 \Omega$ ✓

10

5)

A)

i)

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

$$\frac{1}{f} - \frac{1}{d_o} = \frac{1}{d_i} = \frac{1}{ans} = \underline{15.98cm} \quad \checkmark$$

ii) Image being shown will be an inverted image. $\checkmark$

iii)

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

+ Real

$$- \frac{\frac{1}{15.98}}{\frac{1}{244}} = -15.26$$

$$\text{Length} = 15.26 \text{ mm}$$

X
190.6mm

B)

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

$$\frac{1}{10} = \frac{1}{d_i} + \frac{1}{20} =$$

$$\frac{1}{10} - \frac{1}{20} = \frac{1}{d_i} = \frac{1}{19.1 \text{ cm}} \checkmark$$

Image that is being shown will be an inverted image $\times$ Virtual, Upright $\checkmark$

C)

Refractive index

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

Snell's Law

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

$$1.54 \sin 32 = 0.816$$

$$1.54 \sin^{-1} 0.816 = 84.23$$

$$\theta = 84.23^\circ \times 20.13^\circ$$

D)

Refractive index

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

$$\frac{\sin 9}{\sin 37} = \underline{\underline{0.26}}$$

Polymer material Sample refractive index = 0.26 $\checkmark$

2)
v)

$$A = 4\pi r^2 \quad \checkmark$$

$$A = 4\pi \overset{605}{50}^2 = 31415.93 \text{ m}^2 \quad \text{Area should be in m}^2$$

$$Q = \sigma A T^4 \quad \text{We also have an emissivity value}$$

$$= 5.672 \times 10^{-8} \times 31415.93 \times 60 = 0.107$$

$$= 5.672 \times 10^{-8} \times 31415.93 \times 300 = 0.537$$

Temp should be in Kelvin.

Area should be in m²

You have forgotten the emissivity value.