1 **(a** mass of block m B1
initial temperature θ_1 and final temperature θ_2 B1
time of heating t B1
voltage / p.d. V AND current I B1

(b) (c =) $VIt \div [m\,(\theta_2 - \theta_1)]$
OR $Pt \div [m\,(\theta_2 - \theta_1)]$ **OR** $E \div [m\,(\theta_2 - \theta_1)]$ as appropriate to symbols defined in **(a)**
numerator correct B1
denominator correct B1

(c) (more) thermal energy / heat lost (to surroundings) so temperature rise is less
OR more thermal energy / heat input required for same temperature rise B1

[Total: 7]

2 **(a (i) 1.** range M1

2. correct link between stem length and range/top temperature/expansion A1

(ii) 1. sensitivity M1

2. correct link between capilliary diameter and sensitivity/movement of thread A1

(b) (i) (coloured) alcohol (note: no mark for this point, but must be present for subsequent marks to be awarded) M0

(ii) any two from:
- water will freeze / alcohol doesn't freeze
- coloured alcohol (clearly) visible
- alcohol has even expansion / water has uneven expansion
- alcohol expands more / water expands less
- alcohol has lower SHC/thermal capacity
- alcohol does not stick to glass B2

[Total: 6]

3 **(a** (Q/E =) Pt **or** 2400 × 50 — C1
1.2×10^5 (J) — C1
(c =) $Q/m\Delta T$ **or** $1.2 \times 10^5/(1.5 \times 32)$ (condone $2400/(1.5 \times 32)$)
(allow e.c.f. from candidate's $Q = 1.2 \times 10^5$) — C
2.5×10^3 J/(kg °C) **or** 2.5 J/(g °C) (condone missing brackets)
(allow e.c.f. from candidate's $Q = 1.2 \times 10^5$) — A [4]

(b) (student's value) too large **and** heat lost to surroundings/kettle/evaporation — B1 [1]

[Total: 5]

4 **(a (i)** e.g. freezing, solidification, condensation
OR example e.g. water to ice, steam to water, gas to solid — B1

(ii) No change — B1

(b) Heat/energy required to change temperature of the body — B1
by 1 °C / 1 K / 1 unit / 1 deg — B1
OR
mass (of body) × specific heat capacity — (B2)

(c) (i) $Q = mc\theta$ OR in words OR 250 × 4.2 × 20 — C1
= 21000 J — A1

(ii) 21000 J OR same as **(c)(i)** — B1

(iii) $Q = mL$ OR $m = Q/L$ OR either in words
OR 21000 = m × 330 OR m = 21000/330 — C1
= 63.6 g at least 2 s.f. — A1

[Total: 9]

5 **(a (i)** Glass / flask receives heat / rises in temperature B1
Glass / flask expands B1

(ii) Heat flows through glass to water OR Water receives heat / thermal energy from / conducted by glass OR Water temperature rises OR Water molecules move faster / gain K.E. B1
Water expands / Water molecules move further apart B1

(iii) Glass / solid expands less OR water / liquid expands more B1

(b) Use a bigger flask OR a narrower tube
OR Use a solid and a liquid that expand more B1

[Total: 6]

6 **(a** Heat required to change state of / melt 1 kg / 1 g / unit mass of solid (with no change of temperature) B1

Allow specific example e.g. ice to water
NOT liquid to gas

(b) d = m/V in any form OR (m =) V × d C1
OR (m =) 0.25 × 0.012 × 920
= 2.76 kg at least 2 significant figures. *Unit penalty applies A1

(ii) 60% of 250 = 150 (W/m^2) OR 250 × 0.25 = 62.5 (J) C1
Heat absorbed in 1 s = 150 × 0.25 = 37.5 (J)
OR 60 % of 62.5 = 37.5 J OR J/s OR W *Unit penalty applies A1

Allow J/s or W because in one second.

(iii) Q = mL OR m = Q/L OR m = 37.5 / 3.3 × 10^5 ecf from **(b)(ii)** C1
m = 0.0001136 (kg) (in 1 s) C1
Time taken = 2.76/0.000114 = 24300 s at least 2 significant figures. *Unit penalty applies A1
OR
P = Q/t OR t = Q/P OR t = mL/P (C1)
t = 2.76 × 3.3 × 10^5 / 37.5 (C1)
= 24300 s *Unit penalty applies (A1) **[8]**

***Apply unit penalty once onl

7 **(a** Faster / more energetic molecules escape / evaporate (from surface) B1
Molecules left (in liquid) have lower average speed / energy so temperature is lower B1
OR
(Latent) heat needed to evaporate / leave the surface (B1)
comes from remaining liquid (B1)

(b) (i) Dull surface is <u>better</u> radiator / radiates <u>faster</u>
OR Shiny surface is <u>poorer</u> radiator / radiates <u>slower</u> B1

(ii) C <u>hotter</u> (than A) OR A <u>cooler</u> (than C) (so evaporates at a <u>faster</u> rate in C) B1

(iii) Less liquid in D OR more liquid in A B1

(iv) E has <u>greater</u> (surface) area / more open to air / is <u>shallower</u> B1
<u>greater</u> rate of loss of heat by evaporation / convection / conduction / radiation B1 **[7]**