1. (a) conduction  rod / target / anode  
   copper / thickness of rod  
   **good** conductor / increases amount of conduction (of thermal energy)  

   (b) convection  fins  
   large surface area / number of fins / spaces between fins  
   large contact with air / allows air to rise between fins  

   (c) radiation  fins / black surface / end of rod  
   black surface / large surface area  
   good emitter / large radiating surface  ignore absorber
2 (a) **electrical method**
lagged container + lid  
liquid (allow) water  
heater in liquid  
heater connected to electrical supply (seen or stated)  
voltmeter and ammeter appropriately connected (seen)  
thermometer  

5 points 3  
4 points 2  
3 points 1  

OR

**mixtures method**
lagged container  
liquid  
hot solid/hot liquid  
means of heating hot solid / liquid (seen or stated)  
means of weighing hot solid / liquid / use of known mass (seen or stated)  
thermometer  

5 points 3  
4 points 2  
3 points 1  

(iii) **electrical method**
initial & final temps of liquid OR temp rise  
voltmeter reading (however expressed)  
ammeter reading (however expressed)  
heating time  
mass of liquid  

-1 e.e.o.o.  

OR

**mixtures method**
initial and final temps of liquid OR temp rise  
initial and final temps of added solid / liquid OR temp drop  
mass of added solid / liquid  
mass of liquid  
SHC of added solid / liquid  

-1 e.e.o.o  

(b) \[ Q = mc\dot{\theta} \quad \text{in any form} \]
\[ 100.6 - 12 \quad \text{OR} \quad 88.6 \]
\[ 0.8 \times 3900 \times 88.6 \]
\[ 276 \ 432 \ J \]

\[ Q = Wt \quad \text{OR} \quad (t = \text{candidate's (i)}/620) \]
\[ 445.858 \ s \quad \text{ecf (i)} \]
3 (a) energy / heat required to change state / phase / any example of change of state / phase
   with no change in temperature / at a specified temperature OR energy to break bonds between molecules / atoms
   with no change in K.E.

(b) any time or range of time between 1.6 (min) and 14.0 (min) inclusive [no UP]

(c) turns substance to gas / vapour OR causes evaporation OR escape from liquid
   energy to break bonds / separate molecules / overcome intermolecular forces
   Ignore move faster / PE increases

    480 000 J OR 480 kJ

   (ii) (l) = 43 (°C) seen anywhere
    Q = mcθ OR 480000 = m x 1760 x 43 in any form ecf. from (i)
    6.34 kg or 6.3 kg ecf.

4 (a) (i) change in length / distance moved (accept "how much it expands")
    per unit / given temp rise OR equivalent

   (ii) large bulb OR thin / narrow bore / tube / capillary
    NOT thin / narrow thermometer

(b) (i) difference between the highest and lowest temperatures
    ignore reference to fixed points

   (ii) tube (sufficiently) long / not too short
    OR bore wide / not too thin
    OR little / not too much liquid / bulb
    NOT change liquid

(c) (i) idea of equal size divisions / expansion for equal temperature rises
    OR Δl / Δθ constant OR reference to l against θ graph straight line
    ignore 1 division = 1 °C

   (ii) uniform bore OR alcohol / liquid expands uniformly (with temp)

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5  (a) heat/energy to raise/change temperature of 1 kg/1g/unit mass through 1°C/1K (mention of change of state scores zero)  

(b) \[ Q = mc\theta \] (for \( \theta \) accept \( t, T, \Delta \theta, \Delta t, \) or \( \Delta T \))  
\[ 23800 = 0.93 \times c \times (41.3 - 13.1) \]  
907.5 or 907 or 908 or 910 J/(kg °C) or J/(kg K) at least 2 sig. figs  
(for unit in (b) and (c)(i) condone no brackets and extra solidus)  

(c) 1212.9 or 1200 or 1210 or 1213 or 1214 J/(kg °C) or J/(kg K)  

(ii) more energy lost (to surroundings)  
(average) temperature is higher/initial temperature higher/no cooling time allowed/temperature rise is lower/time of heating may be longer/rate of heating may be lower  

(d) insulate block/provide lid/cover with shiny foil  
start & finish same amount below & above room temperature  
get heater up to temperature before inserting  
put oil in gap between heater & block  

[Total: 10]