1. **(a)** In all parts accept by implication reference to X
   e.g. in (i) accept “it covers a greater range of temperature

   (i) X covers greater range of temperature OR (goes to) higher temperature OR greater range expressed numerically

   (ii) liquid in X expands uniformly (with temperature rise)

   (iii) (for the same temperature rise,) the liquid in X expands more

   **(b)** (i) two junctions correctly connected to each other and to meter OR one junction between wires and other junction at connection to meter temperature difference between junctions two wires correctly labelled as made of different materials, accept labels metal A & metal B NOT 3 different metals labelled

   (ii) junction (in liquid) has low mass/small heat capacity/small size temperature of junction reacts quickly/quickly reaches temperature of liquid/heat or cools faster

   [Total: 8]

2. **(a)** Any two from:
   volume (of a liquid/gas); resistance (of a metal); voltage (of a thermocouple); other appropriate examples;

   **(b)** (i) 1 place bulb in ice and water mixture AND mark liquid level
   2 place bulb in steam from boiling water AND mark liquid level
   pure ice OR pure water mentioned in 1 OR at normal atmospheric pressure mentioned in 2

   (ii) 1 liquid expands uniformly (as temperature rises) OR capillary/tube has uniform diameter/cross-sectional area
   2 glass expands much less than the liquid or (also) expands linearly

   [Total: 7]
3  (a) (i) (liquid) has a uniform expansion/expands at a constant rate/expands evenly/expands linearly B1

(ii) any two from:
    - larger bulb/wider/longer bulb
    - more liquid
    - narrower capillary/tube
    - use liquid with greater expansion B2

(iii) thermometer must be longer B1

(b) any 2 from:
    - resistance/conductance of a metal/wire/conductor/thermistor
    - voltage/current of a thermocouple
    - volume/pressure/expansion/contraction of a gas
    - colour of a metal
    - amount of radiation OR frequency OR wavelength of radiation from a metal/furnace
    - colour/arrangement of liquid crystals
    - expansion of a solid/any dimension of a solid
    - bending of a bimetallic strip B2

[Total: 6]

4  (a) (a liquid evaporates) at any temperature/below the boiling point/over a range of temperatures/below 100°C/at different temperatures/not at a fixed temperature B1

(during evaporation) vapour forms at/escapes from the surface of the liquid B1

(without a supply of thermal energy,) evaporation continues/occurs/doesn't stop OR causes liquid to cool/is slower/reduces

(b) (i) \( Q = mL \) OR \( 0.075 \times 2.25 \times 10^6 \) OR \( 1.7 \times 10^5 \) J C1

(ii) \( E = \frac{VIt}{t} \) OR \( 240 \times 0.65 \times (20 \times 60) \) OR \( P = IV \) and \( P = \frac{E}{t} \) OR energy/time C1

OR \( P = 1.9 \times 10^5 \) J A1

(iii) energy is transferred to the surroundings OR in heating the surroundings/air/atmosphere/hot-plate

[Total: 8]
5. (a) (thermal) energy/heat to heat unit mass/1 kg/1 g

by unit temperature/1 °C/1 K

(b) SHC = \( \frac{Q}{m \Delta T} \) in any form or \( \frac{Q}{m \Delta T} \) words, symbols or numbers

\[
\text{SHC} = \frac{8700}{800 \times 12} = 0.91 \text{ J/°C or 910 J/kg °C}
\]

(ii) th. cap. = \( \frac{Q}{\Delta T} \) in any form or \( \frac{Q}{\Delta T} \) or \( m \times \text{SHC} \) words, symbols or numbers

\[
\text{th. cap.} = \frac{8700}{12} \text{ or } 0.906 \times 800 \text{ or } 906 \times 0.8 = 730 \text{ J/°C or 725 J/°C}
\]

(c) lag (cylinder)/wait after heating until temperature stable/at max. value

prevents/reduces heat losses or heat (energy) takes time to flow throughout block throughout 4(c), reward correct alternative physics which answers the question e.g. use greater power to reduce expt time and hence energy lo ignore: repeats or use thermometer with low thermal capacity

[Total: 8]

6. (a) \( m = \) \( Pt/l \ OR \ 460 \times 180 / 2.3 \times 10^6 \ OR \ 82 \ 800 / 2.3 \times 10^6 \)

0.036 kg OR 36 g

(b) (i) any two from:
- (surface) area
- draught
- temperature (of water/room)
- humidity of air

(ii) any two from:
- evaporation at any temperature/below boiling point
- evaporation (only) at the surface
- evaporation influenced by surface area/draught/temperature/humidity (not if given in (b)(i))

[Total: 6]
7  (a)  (i)  A OR left hand thermometer  

(ii)  E AND longest length and smallest range/more length per degree/liquid moves more per degree/increases the most per degree

(b)  any two from:
- narrow bore/tube
- large amount of liquid/mercury/ethanol/alcohol/bulb
- liquid with large expansivity OR ethanol instead of mercury

(c)  80 (°C) OR 80/120 OR 18/120

12 cm

[Total: 6]