1 **(a** sensitive to box 5 B1
linear to box 3 B1
wide range to box 2 B1 [3]

(b) 2 <u>different</u> metals (need not be named but must be identified as different) M1
volt/millivolt/am/milliammeter/galvanometer/display reading V/mV/A/mA/°C
AND circuit would work A1 [2]
do not allow unlabelled box/meter
ignore hot/cold junction labels

(ii) **1.** metals will not melt/gives p.d. at high temperature/remote sensing
Ignore can withstand/will not be damaged by high temperature B1
2. small heat capacity/mass B1 [2]

2 **(a)** double cup not so hot (to hold) B1
less heat transfer/sensible comment about air gap/more or better insulation
ignore any explanation involving vacuum B1 [2]

(b) starts at (0,80) always above original line and below 80°C, reaches 5 min M1
always descends, straight or concave up, reaches 10 min A1 [2]

(c) two points from:
reduces/stops (energy losses by) convection B1
reduces/stops (energy losses by) evaporation B1
reduces/stops (energy losses by) radiation
explanation of mechanism of heat loss (by convection, evaporation or radiation)
explanation plus something like "which reduces heat losses" scores 2/2 on this part but must do more than restate question [2]

3 **(a** $Q = mc\Delta T$ in any form or $mc\Delta T$ C1
$\Delta T = 50$ C1
$Q = 798\,000$ J A1 [3]

(b) use of E = Pt OR 170×8 OR see 1 360 OR $\times 60$) C1
energy = $(170 \times 8 \times 3\,600) = 4\,896\,000$ J A1 [2]

(c) efficiency = output(energy)/input (energy) OR his **(a)** ÷ his **(b)**
accept power for energy but not wrong/mixed quantities. Accept useful for output, ignore total for input C1
efficiency = 0.16 or 16% ecf from **6(a)** and **6(b)** A1 [2]

(d) source not finite/will not run out ignore can be re-used/replaced
Give for right idea e.g. accept sun always shines B1 [1]

(e) one point from:
doesn't work at night/cloud cover/no sun/variable output
high (initial) cost (of panels)
do not accept too low unless appropriate for a clearly stated context B1 [1]

4 **(a)** Pt OR $1.2 \times 10^4 \times 9$ OR $1.2 \times 10^4 \times (11 - 2)$ C1
(l=) E/m OR $E/0.36$ OR Pt/m OR $Pt/0.36$ C1
3×10^5 J/kg A1

(b) liquid ignore vapour/gas/water A1

(ii) move around more rapidly / faster / more KE
ignore **start to** vibrate etc but accept starts to vibrate faster
move further apart / spreads out (NOT molecules expand) any 2 B1
break free / evaporate / overcome bonds / overcome forces of attraction /escape / change state (accept boils)
convection (current) [6]

5 **(a** 330 J of heat / energy required to change 1 g of ice to water at constant temperature / at melting point / at 0 degrees C B1

(b) (i) (B to C ice is) changing to water / melting / changing to liquid / changing state B1

(D to E water is) changing to steam / vaporising / boiling / changing to gas B1

(ii) Sp. latent of vaporisation of water is greater than sp. latent of fusion of ice B1

(iii) s.h.c. of ice is less than s.h.c. of water B1

more heat required to raise temperature of water
OR rate of temperature rise of water is slower
OR temperature rise of water takes longer B1 [6]

6 **(a (i)** most: gas
least: solid both required B1

(ii) because change of pressure (also) causes volume change (in a gas) B1
NOT 'gas can be compressed'

(b) two from:
expands uniformly (over required range)
remains liquid over required range
expands more than glass / has high expansivity / expansion
has (reasonably) low specific heat capacity.
has low freezing point / lower freezing point than mercury max B2

(ii) make (capillary) tube narrower (and longer) / thinner / smaller diameter B1
make bulb larger (and tube longer) B1
allow 'bore' for tube ignore 'smaller' ignore narrow thermometer

(c) allows fast(er) flow of heat to / from alcohol
OR allows fast response (to temperature change)
OR because glass is a poor conductor / good insulator (so needs to be thin for fast response)
OR heat transfer more efficient / faster
OR glass takes up less heat B1 [7]
ignore reference to sensitivity ignore 'easier'