(a) three valid features listed without explanation

any three features explained from:

- copper/metal is a good conductor (of heat)
  NOT of electricity
- black is good absorber/bad reflector
  ignore emitter
- insulating material will reduce heat lost/conducted away (from pipes/sheet)
  NOT prevents heat loss overall
- glass/trapping of air reduces/prevents convection/warm air being blown away
- glass produces greenhouse effect/reference to far and near I.R.  [max 3]

(b) 38 – 16 OR 22

- $mc\theta$ OR $250 \times 4200 \times$ candidate’s temperature difference
- $2.31 \times 10^7$ (J) e.c.f. from previous line
- $9.24 \times 10^7$ J OR e.c.f. from previous line $\times 4$ correctly evaluated
- no unit penalty if J seen anywhere in (b) clearly applied to an energy

(c) valid explanation relating to at least one of the reasons below:

- any three reasons from:
  - which direction roof faces
  - estimate output of panels
  - household needs / whether household will use all hot water
  - cost of panel / installation
  - time to recoup cost
  - whether roof is shaded
  - relevant environmental consideration (e.g. not using wood or other fuel to heat water)  [max 3]

(d) nuclei join together, accept hydrogen for nuclei

- to produce a different element / helium (and energy)  [2]
2  (a)  (i)  mention of vacuum OR glass is a poor conductor OR vacuum/gap between walls has no molecules/atoms/particles  
(ii)  surface/silver (of walls) is good reflector/poor absorber (of radiation)  
surface/silver (of walls) is poor emitter (of radiation)  

(b)  add a stopper/lid/bung/cover/top to reduce/prevent (loss of heat by) convection/conduction/radiation/evaporation OR to prevent steam/hot vapour leaving made of insulator OR example of insulator to reduce/prevent (loss of heat by) convection/radiation/evaporation OR to prevent steam/hot air leaving  

[Total 6]

3  (a)  (i)  heated air/warm air rises/moves up (not sideways)  
(ii)  air (between plate and hands) is a poor conductor/does not conduct  

(b)  left hand/palm (facing matt black side gets hotter)  
OR  hand facing matt black side (gets hotter)  
matt black side is a better emitter/radiator (of heat than shiny side)  

(c)  conduction takes place  
copper a good conductor/conduction is rapid/heat flows to equalise temperature  

[Total: 6]
4 (a) black can/B loses heat energy quicker/cools faster
   OR polished can loses heat energy slower/cools slower      M1
   black radiates/emits more OR polished radiates/emits less
   ignore anything about absorption                          A1  [2]

(b) any four from:                                             B4
   viable experiment e.g. pour in water and measure temperature
   ignore methods with external thermometers (for this point only)
   pour (hot) water into both cans to same level/same amount
   place thermometers in same position relative to each can/detail relating to
   stirring
   thermometers not touching the metal of can
   observe change of temperature
   correct detail of timing
   repeat readings                                            [4]

(ii) use tiles as lids                                       M1
    reduce convection/evaporation (to room)                   A1
    OR alternative method
    put tiles under cans
    reduce, ignore prevent, conduction (to bench)            (M1)
    (A1)
    for both methods, ignore other modes of heat transfer, ignore place tiles
    around can                                               [2]

(c) black can/B                                             M
    black absorbs (radiation) better, ignore anything about emission    A1  [2]

[Total: 10]
5  (a)  (i) (metals/they are) (good) conductors (of heat)  
    (ii) (at hot end) molecules vibrate (more)  
        or electrons identified as mechanism of conduction  
        molecules collide with their neighbours  
        or electrons move faster/have more energy  
        energy/vibration passed on  
        or electrons pass on energy/reach far end/free to move

(b) determine mass of spoon (condone weigh provided word mass is used in answer)  
    immerse spoon in water/liquid  
    determine increase in volume/overflow  
    \( \rho = \frac{m}{V} \) or density = mass/volume

[Total: 8]

6  (a)  (i) current
    (ii) p.d. OR potential difference OR voltage  
        Both required

(b)  \( R = R_1 + R_2 \) OR 1.2 + 3.6 OR 4.8 (k \( \Omega \))  
    \( I = \frac{9.0}{4.8} = 1.875 \) (mA) OR \( \frac{9.0}{4800} = 1.875 \times 10^{-3} \) (A)  
    Voltmeter reading = 6.75 V *Unit penalty applies  
    OR  
    Voltmeter reading = \( \frac{R_1}{R_1 + R_2} \) V  
    = \( \frac{3.6}{1.2 + 3.6} \) \times 9.0  
    = 6.75 V *Unit penalty applies

(c)  (In fire) temperature of thermistor rises and its resistance falls  
    Current (through thermistor and relay coil) rises / flows  
    OR voltage / p.d. across / of relay coil rises  
    Magnetic field of relay closes switch (and bell rings)

*Apply unit penalty once onl