1 **(a** three valid features listed without explanation [1]

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 owtte

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 [1]
$mc\theta$ OR 250 × 4200 × candidate's temperature difference [1]
2.31×10^7 (J) e.c.f. from previous line [1]
9.24×10^7 J OR e.c.f. from previous line × 4 correctly evaluated [1]
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: [1]
note: if no explanation, this mark is not awarded even if more than three reasons are given

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 B1

(ii) surface/silver (of walls) is good reflector/poor absorber (of radiation) B1
surface/silver (of walls) is poor emitter (of radiation) B1

(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 M1 B1

made of insulator OR example of insulator to reduce/prevent (loss of heat by) convection/radiation/evaporation OR to prevent steam/hot air leaving B1

[Total 6]

3 **(a) (i)** heated air / warm air rises / moves up (not sideways) B1

(ii) air (between plate and hands) is a poor conductor / does not conduct B1

(b) left hand / palm (facing matt black side gets hotter)
OR hand facing matt black side (gets hotter) B1
matt black side is a better emitter / radiator (of heat than shiny side) B1

(c) conduction takes place B1
copper a good conductor / conduction is rapid / heat flows to equalise temperature B1

[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 (M1)
reduce, ignore prevent, conduction (to bench) (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)	B1	[1]
		(ii)	(at hot end) molecules vibrate (more) **or** electrons identified as mechanism of conduction	B1	
			molecules collide with their neighbours **or** electrons move faster/have more energy	B1	
			energy/vibration passed on **or** electrons pass on energy/reach far end/free to move	B1	[3]
	(b)		determine mass of spoon (condone weigh provided word mass is used in answer)	B1	
			immerse spoon in water/liquid	B1	
			determine increase in volume/overflow	B1	
			$\rho = m/V$ **or** density = mass/volume	B1	[4]
					[Total: 8]
6	**(a)**	**(i)**	current		
		(ii)	p.d. OR potential difference OR voltage	B1	
			Both required		
	(b)		$R = R_1 + R_2$ OR 1.2 + 3.6 OR 4.8 (k Ω)	C	
			$I = 9.0 / 4.8 = 1.875$ (mA) OR $9.0/4800 = 1.875 \times 10^{3}$ (**A**)		
			Voltmeter reading = 6.75 V *Unit penalty applies	A1	
			OR		
			Voltmeter reading = $[R_1 / (R_1 + R_2)]$ V	(C1)	
			$= [3.6 / (1.2 + 3.6)] \times 9.0$	(C1)	
			= 6.75 V *Unit penalty applies	(A1)	
	(c)		(In fire) temperature of thermistor rises and its resistance falls	B1	
			Current (through thermistor and relay coil) rises / flows	B1	
			OR voltage / p.d. across / of relay coil rises		
			Magnetic field of relay closes switch (and bell rings)	B1	**[7]**
			***Apply unit penalty once onl		