**M1.**          (a)     (i)      (insulate it) with **fibre** glass **or** foam  
**or** felt **or** polystyrene beads **or**rockwool **or** (aluminium) foil

*an example must be included*

*do not credit loft insulation*

**1**

(ii)     fill the cavity with fibre glass **or** foam  
**or** mineral wool **or** polystyrene **or**named liner inside wall **or** making  
walls thicker

*an example must be included*

*do not credit cavity wall insulation*

**1**

(iii)     double glaze **or** draw the curtains **or**blinds **or** thicker glass **or** secondary  
glazing described

*do not credit fit smaller windows*

**1**

(iv)    put in draught excluder (or described)  
**or** strip **or** description of filling gaps  
**or** seal gaps **or** double glazed doors  
**or** build porch **or** curtains inside door  
**or** mat under door

*do not credit just carpet*

*accept buy new doors  
accept premise that gap is between frame and wall as well as between frame and door*

**1**

(b)     windy **or** stormy **or** wet **or** snow **or**rain **or** sleet **or** hail **or** fog **or** mist

*do not credit frosty*

**1**

**[5]**

**M2.**          (a)     (i)      7pm

*accept 19.00 / 1900*

**1**

(ii)     8pm

*accept 20.00 / 2000*

**1**

temperature drops more slowly

*accept heat for temperature accept line is less steep*

**1**

(b)     insulator

**1**

conduction \*

**1**

convection \*

*\* answers can be either way around*

**1**

(c)     (i)      4 (years)

**1**

(ii)     it is the cheapest / cheaper / cheap

*do* ***not*** *accept answers in terms of heat rising or DIY*

**1**

has the shortest / shorter payback time

*do* ***not*** *accept short payback time*

**1**

**[9]**

**M3.** (a)     because black is a good absorber of radiation

**1**

there will be a faster transfer of energy

*allow the temperature of the water rises faster*

**1**

(b)     16 800 000

*allow* ***1*** *mark for substitution into correct equation  
ie 100 × 4200 × 40*

**2**

(c)     7 allow

*ecf from part (b)*

**1**

(d)     Marks awarded for this answer will be determined by the  
Quality of Written Communication (QWC) as well as the  
standard of the scientific response.

No relevant content.

**0 marks**

There is a brief description of the advantages and disadvantages  
of using solar energy to heat the water rather than using an  
electric immersion heater, including either advantages or  
disadvantages from the **examples** below.

**Level 1 (1-2 marks)**

There is a description of some of the advantages **and**disadvantages of using solar energy to heat the water  
rather than using an electric immersion heater, with at  
least **one** advantage and **one** disadvantage from the  
**examples** below.

**Level 2 (3-4 marks)**

There is a clear, balanced and detailed description of the  
advantages **and** disadvantages of using solar energy to  
heat the water rather than using an electric immersion  
heater, with a minimum of **two** advantages and **two**disadvantages from the **examples** below.

**Level 3 (5-6 marks)**

**examples of the points made in the response**

**advantages**

*accept specific examples of polluting gases*

•        a renewable energy source

•        energy is free

•        does not pollute the atmosphere

•        no fuel is burnt

•        energy can be stored (in the water)

**disadvantages**

*accept unreliable energy source*

•        only available in daylight hours

•        availability fluctuates

•        insufficient hours of sunlight in some countries

•        average low intensity in some countries

**[11]**

**M4.**          (a)     insulation

*allow example e.g fibreglass*

**1**

double glazing

*allow curtains*

**1**

draught excluder

*allow double glazing / close fitting door*

*allow turning down thermostat once only / turn down the heating*

**1**

(b)     transfers more useful energy

*allow converts more energy into light / less into heat / less energy wasted*

**1**

**[4]**

**M5.**          (a)     (i)      20

**1**

(ii)     convection

**1**

(iii)     fit draughtproof strips

**1**

*accept lay carpet  
accept fit curtains  
accept close doors / windows / curtains  
accept any reasonable suggestion for reducing a draught  
‘double glazing’ alone is insufficient*

(b)     air is (a good) insulator

**1**

**or** air is a poor conductor

*accept air cavity / ‘it’ for air*

reducing heat transfer by conduction

*accept stops for reduces  
ignore convection  
do* ***not*** *accept radiation  
do* ***not*** *accept answers in terms of heat being trapped*

**1**

(c)     (i)      most cost effective

*accept it is cheaper or lowest cost  
accept shortest payback time  
accept in terms of reducing heat loss by the largest amount  
do* ***not*** *accept it is easier  
ignore most heat is lost through the roof*

**1**

 (ii)    4

**1**

**[7]**

**M6.**(a)     (i)      any **two** from:

•        mass (of block)

*accept weight for mass*

•        starting temperature

•        final / increase in temperature

*temperature is insufficient*

•        voltage / p.d.

*same power supply insufficient*

•        power (supplied to each block)

•        type / thickness of insulation

*same insulation insufficient*

**2**

(ii)     one of variables is categoric  
**or**(type of) material is categoric

*accept the data is categoric*

*accept a description of categoric*

*do* ***not*** *accept temp rise is categoric*

**1**

(iii)    concrete

*reason only scores if concrete chosen*

**1**

(heater on for) longest / longer time

*a long time or quoting a time is insufficient*

*do* ***not*** *accept it is the highest bar*

**1**

(iv)    4500 (J)

*allow* ***1*** *mark for correct substitution ie*

*2  ×  450  ×  5 provided no subsequent step shown*

**2**

(b)     (i)      point at 10 minutes identified

**1**

(ii)     line through all points except anomalous

*line must go from at least first to last point*

**1**

(iii)    20 (°C)

*if 20°C is given, award the mark.*

*If an answer other than 20°C is given, look at the graph. If the graph shows a correct extrapolation of the candidate’s best-fit line and the intercept value has been correctly stated, allow 1 mark.*

**1**

(iv)    2 (minutes)

**1**

**[11]**

**M7.**(a)     20 790 (J)

*an answer of 21 000 (J) (2 s.f.) gains* ***2*** *marks*

*allow* ***1*** *mark for correct  
substitution:  
ie E = 0.33 × 4200 × 15 provided no subsequent step shown*

**2**

(b)     temperature

**1**

(c)     (top pan) balance

*accept scales*

*do* ***not*** *accept a scale  
do* ***not*** *accept weighing scales  
do* ***not*** *accept newtonmeter  
do* ***not*** *accept spring balance*

**1**

(d)     dark / black / (dark) grey

**1**

convection

*correct order only*

**1**

(e)     (i)      created

*accept made*

**1**

(ii)     increases

**1**

**[8]**

**M8.**          *accept atoms / particles for ions throughout*

(a metal has) free electrons

*accept mobile for free*

**1**

(kinetic) energy of (free) electrons increases

*accept energy of ions increases*

*accept ions vibrate with a bigger amplitude*

*accept ions vibrate more*

*do* ***not*** *accept electrons vibrate more*

**1**

(free) electrons move faster

**1**

**or**

electrons move through metal

*accept electrons collide with other electrons / ions*

(so) electrons transfer energy to other electrons / ions

*accept ions transfer energy to neighbouring ions*

**1**

**[4]**

**M9.**         (a)      (i)      The volume of boiling water.

**1**

(ii)     any **one** from:

•    (more) precise

*do* ***not*** *accept better (reading)*

•    accurate

•    reliable

*do* ***not*** *accept thermometer is unreliable*

•    removes human / reading error

*accept easier to read  
accept take temperature more frequently*

**1**

(b)     **B**

*marks are for the explanation*

temperature falls faster

*this mark point cannot score if* ***A*** *chosen*

**1**

because black is a better / good emitter

*ignore reference to better absorber  
accept for both marks an answer in terms of why* ***A*** *is the white can*

**1**

(c)     (i)      faster than

**1**

(ii)     darker / black surfaces absorb heat faster

*accept black is a better / good absorber*

*dark surfaces attract heat negates this mark*

**1**

(iii)     air is a bad / poor conductor**or**air is a good insulator

*accept air is an insulator*

**1**

**[7]**

**M10.**         (a)      (i)     conduction

**1**

(ii)     free / mobile electrons gain (kinetic) energy

*accept free / mobile electrons move faster*

**1**

free electrons collide with other (free) electrons / ions / atoms / particles

*an answer in terms of atoms / particles gaining (kinetic) energy (and) colliding with / vibrating and passing energy to other atoms / particles gains* ***1*** *mark only*

*answers in terms of heat particles negate*

**1**

(iii)    convection

**1**

(b)     (i)*this mark only scores if a correct pair is chosen* ***and*** *a          correct reason given*

**A** and **C**

*both required and none other*

**orB** and **D**

*both required and none other*

only one (independent) variable**or**different shapes but the same colour

*accept only the shape changes*

**1**

(ii)     **B** radiates heat faster

*converse answer in terms of* ***A*** *gains full marks*

**1**

**or**B is a better emitter (of heat)

but B has a smaller (surface) area**or**B has a smaller (surface) area: volume ratio

*allow* ***2*** *marks for both lose the same quantity / amount of heat in the same time*

***or*** *both have same rate of heat loss*

*allow* ***1*** *mark for both lose the same quantity / amount of heat*

**1**

(iii)    any **one** from:

•    transfer a lot of heat (too rapidly)

•    water temperature drops too rapidly

*accept (significantly) more heat will be lost from the first radiator*

•    water too cold for the next radiator

*mention of absorption of heat negates mark*

**1**

**[8]**

**M11.**          (a)     (i)      25 (%)

*do* ***not*** *accept ¼*

**1**

(ii)     increases

**1**

(b)     tick () in top and bottom box

*both required*

**1**

(c)     SHINY surfaces are good reflectors of infra-red radiation

*accept white for shiny*

**or** black surfaces are POOR reflectors of infra-red radiation

*accept bad for poor  
accept insertion of ‘not’ before ‘good’ in statement*

**or** black surfaces are good EMITTERS of infra-red radiation

**or** black surfaces are good ABSORBERS of infra red radiation

**1**

**[4]**

-

**M12.**          (i)      D, C **or** B, in either order, then A

*tick or cross on the A*

**1**

(ii)      matt absorbs energy (better than shiny)

*the converse arguments are acceptable*

**1**

          black absorbs energy (better than white)

**1**

**[3]**

**M13.**(a)     energy required to raise the temperature of a substance by 1 °C

*accept heat for energy*

**1**

unit mass / 1 kg

**1**

(b)     (i)      7 140 000 (J)

*allow 2 marks for a correct substitution, ie*

*E = 20 × 420 × 850*

*provided no subsequent step*

*850 gains* ***1*** *mark if no other mark awarded*

**3**

(ii)     particles in the air have more (kinetic) energy than the particles in the steel

*allow particles in the air have a greater speed.*

**1**

**steel**

particles vibrate (about fixed positions)

**1**

**air**

particles move freely

**1**

(ii)     the most energetic particles

*accept molecules for particles throughout*

*accept the fastest particles*

**1**

have enough energy to escape from (the surface of) the water

**1**

therefore the mean energy of the remaining particles decreases

*accept speed for energy*

**1**

as energy decreased, temperature has decreased

**1**

**[12]**

**M14.**(a)     dark matt

**1**

light shiny

**1**

(b)     B      A      C

**1**

biggest temperature difference (80 °C)

*dependent on first mark*

**1**

(c)     (i)       (the can that is) dark matt

**1**

best absorber (of infrared radiation)

**1**

(ii)     any **three** from:

•        same area / shape of can

•        surrounding temperature is the same for all cans

•        same surface underneath cans

•        same position in the room

**3**

(d)     fox A

smaller ears

**1**

thicker fur

**1**

these minimise energy transfer

*dependent on first 2 marks*

**1**

**[12]**

**M15.**          (a)     (heat) is conducted through the glass

*the answers must be within the context of the question*

**1**

          (heat) passes through glass and air by radiation

*both glass and air required*

**1**

          (heat) crosses the air gap by convection

*mention of conduction through air is neutral*

**1**

(b)     any **one** from

          light

*accept sunlight*

gamma rays

X-rays

radio

*accept sound* ***or*** *ir* ***or*** *microwaves* ***or*** *electromagnet waves*

**1**

(c)     any **two** from

          cuts down convection currents

*accept stops air moving*

air pockets trap air (from moving)

*accept has air pockets  
do not accept stops heat moving* ***or*** *traps heat*

foam is a poor conductor

*air in the foam is a good insulator*

*accept air is a good insulator in air pockets for both marks*

**2**

(d)     evaporation (of the water)

*do not accept rain is cold*

**1**

takes energy from the house

*accept takes heat away* ***or*** *higher energy molecules leave first*

**1**

**[8]**