**Mark schemes**

Q1.

(a) 78 (°C)

allow 2 marks for correct temperature change ie 22 °C

allow 1 mark for correct substitution

ie 46 200 = 0.5 × 4200 x θ

or

3

(b) 6.4 (W)

allow 2 marks for an answer that rounds to 6.4

allow 1 mark for correct substitution

ie 46 200 = P × 7200

an answer of 23 000 or 23 100 or 385 gains 1 mark

2

[5]

Q2.

(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]

Q3.

(a) conduction

1

(b) 35 000

1

(c) 500

their (b) = 2 x c x 35 correctly calculated scores 2 marks

allow 1 mark for correct substitution,

ie 35000 = 2 x c x 35

or

their (b) = 2 x c x 35

2

J / kg°C

1

(d) energy lost to surroundings

or

energy needed to warm heater

accept there is no insulation (on the copper block)

do not accept answers in terms of human error or poor results or defective equipment

1

[6]

Q4.

(a) (i) 70

accept ± half a square

(69.8 to 70.2)

1

(ii) 15

accept 14.6 to 15.4 for 2 marks

allow for 1 mark 70 − 55

ecf from (b)(i) ± half a square

2

(iii) C

1

biggest drop in temperature during a given time

accept it has the steepest gradient this is a dependent

1

(iv) starting at 70 °C and below graph for C

must be a curve up to at least 8 minutes

1

(v) because 20 °C is room temperature

accept same temperature as surroundings

1

(b) (i) 6720

correct answer with or without working gains 3 marks

6 720 000 gains 2 marks

correct substitution of E = 0.2 × 4200 × 8 gains 2 marks

correct substitution of E = 200 × 4200 × 8 gains 1 mark

3

(ii) the fastest particles have enough energy

accept molecules for particles

1

to escape from the surface of the water

1

therefore the mean energy of the remaining particles decreases

accept speed for energy

1

the lower the mean energy of particles the lower the temperature (of the water)

accept speed for energy

1

[14]

Q5.

(a) (i) temperature (increase) and time switched on are directly proportional

accept the idea of equal increases in time giving equal increases in temperature

answers such as:

• as time increases, temperature increases

• positive correlation

• linear relationship

• temperature and time are proportional

score 1 mark

2

(ii) any one from:

“it” refers to the metal block

• energy transfer (from the block) to the surroundings

accept lost for transfer

accept air for surroundings

• (some) energy used to warm the heater / thermometer (itself)

accept takes time for heater to warm up

• (metal) block is not insulated

1

(iii) 15 000

allow 1 mark for correct substitution, ie 50 × 300 provided no subsequent step shown

2

(b) lead

reason only scores if lead is chosen

1

needs least energy to raise temperature by 1°C

accept needs less energy to heat it (by the same amount)

lowest specific heat capacity is insufficient

1

[7]

Q6.

(a) conduction

1

(b) (i) there is a bigger temperature difference between the water and the surrounding air

accept the water is hottest / hotter

1

so the transfer of energy (from hot water) is faster

accept heat for energy

ignore temperature falls the fastest

1

(ii) 120

allow 1 mark for converting kJ to J correctly, ie 4 032 000

or

correctly calculating temperature fall as 8°C

or

allow 2 marks for correct substitution, ie 4 032 000 = m × 4200 × 8

answers of 0.12, 19.2 or 16.6 gain 2 marks

answers of 0.019 or 0.017 gain 1 mark

3

(iii) water stays hot for longer

1

so heater is on for less time

accept so less energy needed to heat water

1

so cost of the jacket is soon recovered from) lower energy costs / bills

accept short payback time

1

[9]

Q7.

(a) to reflect (the infrared)

accept (shiny surfaces) are good reflectors

ignore reference to incorrect type of wave

1

(b) black

1

best absorber (of infrared)

answer should be comparative

black absorbs (infrared) is insufficient

accept good absorber (of infrared)

ignore reference to emitter

ignore attracts heat

ignore reference to conduction

1

(c) to reduce energy loss

accept to stop energy loss

accept heat for energy

accept to stop / reduce convection

or

so temperature of water increases faster

accept to heat water faster

accept cooks food faster

or

reduces loss of water (by evaporation)

1

(d) 672 000

allow 1 mark for correct substitution, ie 2 × 4200 × 80 provided no subsequent step shown

2

[6]

Q8.

(a) (i) 5(.0)

1

(ii) 35 or their (a)(i) × 7 correctly calculated

allow 1 mark for correct substitution, ie 5 or their (a)(i) × 7 provided no subsequent step shown

2

(iii) 525(p)

or

(£) 5.25

or

their (a)(ii) × 15 correctly calculated

if unit p or £ given they must be consistent with the numerical answer

1

(iv) decreases

1

temperature difference (between inside and outside) decreases

accept gradient (of line) decreases

do not accept temperature (inside) decreases

do not accept graph goes down

1

(b) air (bubbles are) trapped (in the foam)

do not accept air traps heat

foam has air pockets is insufficient

1

(and so the) air cannot circulate / move / form convection current

air is a good insulator is insufficient

no convection current is insufficient

answers in terms of warm air from the room being trapped are incorrect and score no marks

1

[8]

Q9.

(a) (matt) black is a good emitter of infrared / radiation

accept heat for infrared / radiation

ignore reference to good absorber

attracts heat negates this marking point

1

to give maximum (rate of) energy transfer (to surroundings)

accept temperature (of coolant) falls fast(er)

accept black emits more radiation for 1 mark

black emits most radiation / black is the best emitter of radiation for 2 marks

1

(b) the fins increase the surface area

accept heat for energy

1

so increasing the (rate of) energy transfer

or

so more fins greater (rate of) energy transfer

1

(c) 114 000

allow 1 mark for correct temperature change, ie 15 (°C)

or

allow 2 marks for correct substitution, ie 2 × 3 800 × 15

answers of 851 200 or 737 200 gain 2 marks

or

substitution 2 × 3800 × 112 or 2 × 3800 × 97 gains 1 mark

an answer of 114 kJ gains 3 marks

3

(d) increases the efficiency

1

less (input) energy is wasted

accept some of the energy that would have been wasted is (usefully) used

or

more (input) energy is usefully used

accept heat for energy

1

[9]

Q10.

(a) (i) conduction

1

convection

1

correct order only

(ii) to keep the ceramic bricks hot for a longer time

1

(b) (i) E = P × t

18.2

allow 1 mark for correct substitution ie 2.6 × 7 provided that no subsequent step is shown

2

(ii) 91 (p)

or their (b)(i) × 5 correctly calculated

accept £0.91

do not accept 0.91 without £ sign

1

(c) E = m × c × θ

2 250 000

allow 1 mark for correct substitution ie 120 × 750 × 25 provided that no subsequent step is shown

answers 2250 kJ or 2.25 MJ gain both marks

2

[8]

Q11.

(a) (i) conduction

1

(ii) atoms gain (kinetic) energy

accept particles / molecules for atoms

do not accept electrons for atoms

or

atoms vibrate with a bigger amplitude

accept vibrate faster / more

do not accept start to vibrate

or

atoms collide with neighbouring atoms

1

transferring energy to (neighbouring / other) atoms

do not accept heat for energy

or

making these other atoms vibrate with a bigger amplitude

accept faster / more for bigger amplitude

mention of (free) electrons moving and passing on energy negates this mark

1

(b) (i) 5 (°C) to 25 (°C)

either order

1

(ii) a correct example of doubling temperature difference doubling heat transfer

eg going from 5 to 10 (°C) difference doubles heat transfer from 30 to 60 (J/s)

accept for heat transfer number of joules / it

allow 1 mark for correctly reading 1 set of data eg at 5 °C the heat transfer is 30

or

for every 5°C increase in temperature difference heat transfer increases by 30 (J/s)

no credit for stating they are directly proportional

2

(iii) 1800

allow 1 mark for obtaining heat transfer value = 120

2

(c) payback time calculated as 33 years

calculations must be correct to score the first mark point

explanations must relate to it not being cost effective

1

this is greater than lifetime of windows

or

total savings (over 30 years) = £4800 (1)

this is less than cost of windows (1)

or

= 176 (1)

this is more than the yearly savings (1)

1

[10]

Q12.

(a) (i) 2(.0)

accept 2000 W or 2000 watt(s)

accept answer given in table

do not accept 2000

1

(ii) 4.5

allow 1 mark for correct substitution

ie 1.5 × 3

allow 1 mark for the answers 1.5 or 6(.0)

2

(iii) 54

or

their (a)(ii) × 12 correctly calculated

allow 1 mark for correct substitution

ie 4.5 × 12

or

their (a)(ii) × 12

allow 1 mark if correct answer is given in pounds eg £54

2

(b) (i) 6 pm

1

temperature starts to rise faster

only scores if 6 pm given

or

graph (line) is steeper / steepest

it refers to graph gradient or temperature

accept answers in terms of relative temperature rise

eg 5 to 6 pm 2 °C rise, 6 to 7 pm 6 °C rise

accept temperature rises sharply / rapidly / quickly

do not accept temperature starts to rise

1

(ii) middle box ticked

1

[8]

Q13.

(a) (i) walls

accept sides (of house)

1

(ii) fit double glazing

or

close / fit curtains / fit shutters

accept close windows

accept keep house at a lower temperature

accept fit (foam) draft excluders around the windows / in the jams

accept put plastic (film) across the windows

do not accept fit thicker glass

1

(b) (i) cavity (wall insulation)

accept the middle one

1

(ii) fit hot water jacket and draught-proofing

both required

1

(together) saves most money

only scores if first mark scores

accept saves more than fitting (energy efficient) light bulbs

accept saves £40

accept gives the shortest payback time

an answer fit energy efficient light bulbs (on its own) gains 1 mark only

1

[5]

Q14.

(a) (i) £190

nb mention idea of cost per J in £ will come to an approx figure full credit given

allow 1 mark for showing that the energy loss through the roof is ¼ of the total energy loss ie 150 / 600

2

(ii) £142.50

allow ecf 50 % of their (a)(i) × 1.5 ie their (a)(i) × 0.75

1

(b) transferred to surroundings / atmosphere

or becomes spread out

1

[4]

Q15.

(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]

Q16.

(a) four calculations correctly shown

200 × 10 – 1800 = £200

100 × 10 – 2400 = –£1400

50 × 10 – 600 = –£100

20 × 10 – 75 = 125

accept four final answers only or obvious rejection of solar water heater and underfloor heating, with other two calculations completed any 1 complete calculation correctly

shown or showing each saving × 10 of all four calculations = 1 mark answers in terms of savings as a percentage of installation cost may score savings mark only

2

hot water boiler

correct answers only

1

(b) less electricity / energy to be generated / needed from power stations

accept less demand

1

reduction in (fossil) fuels being burnt

accept correctly named fuel

accept answer in terms of:

fewer light bulbs required because they last longer (1 mark)

less energy used / fuels burnt in production / transport etc. (1 mark)

ignore reference to CO2 or global warming

ignore reference to conservation of energy

1

[5]

Q17.

(a) 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

(b) (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

[4]

Q18.

(a) (i) convection current correctly shown

with arrows extending to above

insulation label line

circulation must show water rising in the left half of the tank accept continuous or broken arrows must be at least one arrow up and one arrow down

allow 1 mark for correct diagram which does not extend high enough

2

(ii) it expands or it gets less dense

do not allow hot water rises

do not accept explanation in terms of molecules expanding or changing density

do not accept lighter or heavier

1

more dense water falls

allow cold water falls if qualified with a suitable reason

1

(b) (i) reflects heat back into the room or where it came from

accept infrared or radiation or energy for heat

accept bounce for reflect if in correct context

1

(ii) air is a (good) insulator or poor conductor or air stops conduction

do not accept plastic foam is a good insulator or bad conductor

1

air is trapped

1

convection loss reduced or stopped

1

(c) two out of the following three:

any answer which gains credit must contain a comparison

rate of evaporation decreases

accept less sweat can evaporate or evaporation is more difficult

less heat energy removed from the body

higher humidity the less water vapour can be absorbed (into the air)

accept sweat for water vapour

do not credit description of high humidity

accept a correct answer in terms of dynamic equilibrium

2

[10]

Q19.

(a) (i) any one from:

water to the mug

water to the air

mug to the air

mug to the table

both required

direction of transfer must be correct

1

(ii) when temperatures are the same

accept a specific example eg when the temperature of the water and mug are the same

accept radiant heat transfer will never stop

1

(b) wood

1

(c) (i) conduction

accept convection if not given as 3rd answer

1

insulator

1

(ii) any one from:

do not accept any rebuilding of house

double glazing

loft insulation

accept roof for loft

1

carpets

(cavity) wall insulation

do not accept closing doors and windows

draft excluders

foil behind radiators

accept blocking chimney

paint inside walls white

[6]

Q20.

(a) (i) hot water rises (not heat)

for 1 mark

due to convection currents

or water expands/becomes less dense on heating

or less dense water rises

any for 1 mark

2

(ii) inside hotter (than outside)

for 1 mark

1

(iii) (heat transfer by) conduction

for 1 mark

1

(iv) surround/cover/insulate tank with poor conductor or named insulator

for 1 mark each

2

(b) (i) air is an insulator/poor conductor

for 1 mark

1

(ii) convection stopped foam is an insulator/poor conductor

for 1 mark each

2

[9]

Q21.

(a) (i) £150

gets 2

Else 1000 – (250 + 350 + 100 + 150) or 1000 – 850

gets 1

2

(ii) (Named) floor covering

OR Insulation under floor

for 1 mark

1

(b) (i) Draught proof doors or fibre glass in loft or in cavity

For draught proofing

gains 1 mark

Very low cost/easy to install

Repays for itself quickly/cost recuperated quickly

Reasonable energy saving

any 2 for 1 mark each

For loft insulation

Second lowest installation cost/easy to install

Reasonable large energy savings for this cost

Reasonable payback time

gains 1 mark

For foam filled cavity

Biggest energy/cash saving

Cost effective

any 2 for 1 mark each

3

(ii) Double glazing

gains 1 mark

Costs most

Saves least energy

Least cost effective

any 2 for 1 mark each

3

[9]

Q22.

(a) loft insulation

1

energy saved in 10 years £600

1

net saving (600 – 110) £490

1

OR

hot water jacket

1

energy saved in 10 years £140

1

This is the highest percentage saving on cost

1

(b) transferred to environment / surroundings

1

as heat / thermal energy

1

[5]

Q23.

(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]

Q24.

(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]

Q25.

(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]