**Mark schemes**

Q1.

(a) range of speeds

1

moving in different directions

accept random motion

1

(b) internal energy

1

(c) density = mass / volume

1

(d) 0.00254 / 0.0141

1

0.18

1

accept 0.18 with no working shown for the 2 calculation marks

kg / m3

1

[7]

Q2.

(a) decreased

correct order only

1

decreased

1

increased

1

(b) (i) A

reason only scores if A chosen

1

uses least / less energy (in 1 year)

a comparison is required

accept uses least power

accept uses least kWh

1

(ii) greater the volume the greater the energy it uses (in 1 year)

1

(iii) a very small number sampled

accept only tested 3

accept insufficient evidence / data

allow not all fridges have the same efficiency or a correct description implying different efficiencies

only tested each fridge once is insufficient

there are lots of different makes is insufficient

1

[7]

Q3.

(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]

Q4.

(a) infrared / IR

correct answer only

1

(b) any two from:

• increase the power / watts

allow increase the temperature of the oven or make the oven hotter

• decrease the speed

allow leave the biscuits in for longer

• put biscuits through again

increase radiation is insufficient

ignore changes to the design of the oven

2

(c) (inside) surface is a (good) reflector or poor absorber (of IR)

Ignore bounce for reflect

surface is a (good) reflector of light does not score

surface is a (good) reflector of light and infrared / heat does score

1

(and) outside surface is poor emitter (of IR)

1

(so) increases the energy reaching the biscuits

allow reduces energy loss or makes oven more efficient

do not accept no energy losses

keeps oven hotter is insufficient

1

[6]

Q5.

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a ‘best-fit’ approach to the marking.

0 marks

No relevant content.

Level 1 (1–2 marks)

Considers either solid or gas and describes at least one aspect of the particles.

or

Considers both solids and gases and describes an aspect of each.

Level 2 (3–4 marks)

Considers both solids and gases and describes aspects of the particles.

or

Considers one state and describes aspects of the particles and explains at least one of the properties.

or

Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

Level 3 (5–6 marks)

Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

examples of the points made in the response

extra information

Solids

• (particles) close together

• (so) no room for particles to move closer (so hard to compress)

• vibrate about fixed point

• strong forces of attraction (at a distance)

• the forces become repulsive if the particles get closer

• particles strongly held together / not free to move around (shape is fixed)

any explanation of a property must match with the given aspect(s) of the particles.

Gases

• (particles) far apart

• space between particles (so easy to compress)

• move randomly

• negligible / no forces of attraction

• spread out in all directions (to fill the container)

[6]

Q6.

(a) air near freezer compartment is cooled or loses energy

accept air at the top is cold

1

cool air is (more) dense or particles close(r) together (than warmer air)

do not allow the particles get smaller / condense

1

so (cooler) air falls

1

air (at bottom) is displaced / moves upwards / rises

do not allow heat rises

accept warm air (at the bottom) rises

1

(b) if volume is doubled, energy use is not doubled

or

volume ÷ energy not a constant ratio

1

correct reference to data, eg 500 is 2×250 but 630 not 2×300

1

(c) accept suitable examples, eg

advantage:

• reduces emissions into atmosphere

• lower input power or uses less energy or wastes less energy

• costs less to run

cost of buying or installing new fridge is insufficient

ignore reference to size of fridge

1

disadvantage:

• land fill

• energy waste in production

• cost or difficulty of disposal

• transport costs

1

[8]

Q7.

(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]

Q8.

(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]

Q9.

(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]

Q10.

(a) any two from:

• water evaporates

accept steam / water vapour for water molecules

accept water turns to steam

• water molecules / particles go into the air

• mirror (surface) is cooler than (damp) air

accept the mirror / surface / glass is cold

• water molecules / particles that hit the mirror lose energy

accept water molecules / particles that hit the mirror cool down

• cooler air cannot hold as many water molecules / particles

2

(causes) condensation (on the mirror)

accept steam changes back to water (on the mirror)

or

particles move closer together

1

(b) mirror (surface) is warm

mirror is heated is insufficient

1

(rate of) condensation reduced

accept no condensation (happens)

1

[5]

Q11.

(a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

0 marks

No relevant content.

Level 1(1-2 marks)

There is a basic explanation of one feature

or

a simple statement relating reduction in energy transfer to one feature.

Level 2(3-4 marks)

There is a clear explanation of one feature

or

a simple statement relating reduction in energy transfer to two features.

Level 3(5-6 marks)

There is a detailed explanation of at least two features

or

a simple statement relating reduction in energy transfer to all four features.

Examples of the points made in response

extra information

accept throughout:

heat for energy

loss for transfer

plastic cap:

• plastic is a poor conductor

accept insulator for poor conductor

• stops convection currents forming at the top of the flask so stopping energy transfer by convection

• molecules / particles evaporating from the (hot) liquid cannot move into the (surrounding) air so stops energy transfer by evaporation

• plastic cap reduces / stops energy transfer by conduction / convection / evaporation

glass container:

• glass is a poor conductor so reducing energy transfer by conduction

• glass reduces / stops energy transfer by conduction

vacuum:

• both conduction and convection require a medium / particles

• so stops energy transfer between the two walls by conduction and convection

• vacuum stops energy transfer by conduction / convection

silvered surfaces:

• silvered surfaces reflect infrared radiation

accept heat for infrared

• silvered surfaces are poor emitters of infrared radiation

• infrared radiation (partly) reflected back (towards hot liquid)

• silvered surfaces reduce / stop energy transfer by radiation

6

(b) (the ears have a) small surface area

ears are small is insufficient

1

so reducing energy radiated / transferred (from the fox)

accept heat lost for energy radiated

do not accept stops heat loss

1

[8]

Q12.

(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]

Q13.

(a) (i) Z

1

(ii) X

1

(b) (i) moving randomly

1

(ii) stronger than

1

(c) (i) evaporation

1

(ii) any one from:

• becomes windy

• temperature increases

accept (becomes) sunny

“the sun” alone is insufficient

• less humid

1

[6]

Q14.

(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]

Q15.

(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]

Q16.

(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]

Q17.

(a) there are strong forces (of attraction) between the particles in a solid

accept molecules / atoms for particles throughout

accept bonds for forces

1

(holding) the particles close together

particles in a solid are less spread out is insufficient

1

or

(holding) the particles in a fixed pattern / positions

but in a gas the forces between the particles are negligible

accept very small / zero for negligible

accept bonds for forces

1

so the particles spread out (to fill their container)

accept particles are not close together

gas particles are not in a fixed position is insufficient

1

(b) (i) particles are (shown) leaving (the liquid / container)

accept molecules / atoms for particles throughout

accept particles are escaping

particles are getting further apart is insufficient

1

(ii) accept molecules / atoms for particles throughout

 accept speed / velocity for energy throughout

particles with most energy leave the (surface of the) liquid

accept fastest particles leave the liquid

1

so the mean / average energy of the remaining particles goes down

1

and the lower the average energy (of the particles) the lower the temperature (of the liquid)

1

[8]

Q18.

(a) conduction

1

(b) (i) any one from:

• starting temperature (of cold water)

temperature is insufficient

• pipe length

accept size of pipe

• pipe diameter

• pipe (wall) thickness

• volume of cold water

accept amount for volume

• temperature of hot water (in)

• time

1

(ii) copper

1

greatest temperature change

only scores if copper chosen

accept heat for temperature

accept heated water the fastest

accept it was hottest (after 10 minutes)

accept it is the best / a good conductor

1

(c) the pipe has a larger (surface) area

accept pipe is longer

1

(so) hot / dirty water (inside pipe) is in contact with cold / clean water (outside pipe) for longer

1

[6]

Q19.

(a) (i) random distribution of circles in the box with at least 50 % of circles touching

1

random distribution of circles occupies more than 50 % of the space

judged by eye

1

(ii) (large) gaps between particles

accept particles do not touch

accept particles are spread out

1

(so) easy to push particles closer (together)

or

forces between particles are negligible / none

an answer in terms of number of particles is insufficient

1

(b) (i) (both are) random

accept a correct description of random eg unpredictable or move around freely or in all directions

they take up all the space is insufficient

they are spread out is insufficient

they move in straight lines is insufficient

1

(ii) (speed also) increases

1

[6]

Q20.

(a) B

no mark for B - marks are for the explanation

first two mark points can score even if A is chosen

draught increases (the rate of) evaporation

accept more evaporation happens

accept draught removes (evaporated) particles faster

do not accept answers in terms of particles gaining energy from the fan / draught

1

evaporation has a cooling effect

accept (average) kinetic energy of (remaining) particles decreases

1

so temperature will fall faster / further

1

(b) larger surface area

1

increasing the (rate of) evaporation

accept more / faster evaporation

accept easier for particles to evaporate

or

for water to evaporate from

accept more particles can evaporate

accept water / particles which have evaporated are trapped

(in the bag)

answers in terms of exposure to the Sun are insufficient

1

[5]

Q21.

(a) E = P × t

91 (p)

an answer £0.91 gains 3 marks

an answer 0.91 gains 2 marks

allow 2 marks for energy transferred = 18.2 (kWh)

or

substitution into 2 equations combined, ie 2.6 × 7 × 5

allow 1 mark for correct substitution into E = P × t, ie E = 2.6 × 7

or

allow 1 mark for multiplying and correctly calculating an incorrect energy transfer value by 5

3

(b) answers should be in terms of supply exceeding demand

accept there is a surplus / excess of electricity (at night)

1

(c) reduce (rate of) energy transfer (from ceramic bricks)

accept heat for energy

do not accept no energy / heat escapes

do not accept answers in terms of lost / losing heat if this implies heat is wasted energy

1

so keeping the (ceramic) bricks hot for longer

accept increase time that energy is transferred to the room

accept keep room warm for longer

or

to stop the casing getting too hot

accept so you do not get burnt (on the casing)

1

(d) E = m × c × θ

120

allow 1 mark for correct substitution

ie 9 000 000 = m × 750 × 100

2

[8]

Q22.

(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]

Q23.

(a) any two from:

• black is a good emitter of (infrared radiation)

accept heat for radiation

ignore reference to absorbing radiation

• large surface (area)

• matt surfaces are better emitters (than shiny surfaces)

accept matt surfaces are good emitters

ignore reference to good conductor

2

(b) 90% or 0.9(0)

allow 1 mark for correct substitution, ie

provided no subsequent step shown

an answer of 90 scores 1 mark

an answer of 90 / 0.90 with a unit scores 1 mark

2

(c) (producing) light

allow (producing) sound

1

(d) any two from:

• wood is renewable

accept wood grows again / quickly

accept wood can be replanted

• (using wood) conserves fossil fuels

accept doesn’t use fossil fuels

• wood is carbon neutral

accept a description

cheaper / saves money is insufficient

2

(e) E = m × c × θ

2 550 000

allow 1 mark for correct substitution

ie 100 × 510 × 50

provided no subsequent step shown

answers of 1 020 000, 3 570 000 gain 1 mark

2

joules /J

accept kJ / MJ

do not accept j

for full credit the unit and numerical answer must be consistent

1

[10]

Q24.

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]

Q25.

(a) any two from:

• (air) particles / molecules / atoms gain energy

• (air) particles / molecules / atoms move faster

do not accept move more

do not accept move with a bigger amplitude / vibrate more

• (air) particles / molecules / atoms move apart

• air expands

ignore particles expand

• air becomes less dense

ignore particles become less dense

• warm / hot air / gases / particles rise

do not accept heat rises

answers in terms of heat particles negates any of the mark points that includes particles

2

(b) (i) any two from

• free / mobile electrons gain (kinetic) energy

accept free / mobile electrons move faster

accept vibrate faster for gain energy

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

• atoms / ions / particles collide with other atoms / ions / particles

answers in terms of heat particles negates this mark point

2

(ii) (faster) energy / heat transfer to room(s) / house

accept room(s) / house gets warm(er)

accept lounge / bedroom / loft for rooms

1

[5]

Q26.

(a) (i) radiation

1

(ii) traps (small pockets of) air

do not accept it’s an insulator

do not accept reduces conduction and / or convection

do not allow it doesn’t allow heat to escape

1

(b) (i) bigger temperature difference (between the water and surroundings)

at the start (than at the end)

do not accept water is hotter

1

(ii) starting temperature (of the water)

accept thickness of fleece

do not accept same amount of fleece

do not accept thermometer / can

do not accept time is the same

1

(iii) 18 (°C)

correct answer only

1

(iv) M

1

smallest temperature drop (after 20 mins)

cannot score if M is not chosen

accept it’s the best insulator

accept smallest loss in heat

accept keeps heat / warmth in for longer

1

[7]

Q27.

(a) conduction

1

(b) (i) any one from:

• starting temperature (of cold water)

temperature is insufficient

• pipe length

accept size of pipe

• pipe diameter

• pipe (wall) thickness

• volume of cold water

accept amount for volume

• temperature of hot water (in)

• time

1

(ii) (type of) material is categoric

accept one variable is categoric

accept variable(s) are categoric

accept it is categoric

accept variable(s) are not continuous

descriptions of variables ie names and numbers is insufficient

1

(iii) copper

1

greatest temperature change

only scores if copper chosen

accept heat for temperature

accept heated water the fastest

accept it was hottest (after 10 minutes)

accept it is the best / a good conductor

1

(c) larger (surface) area

accept the pipe is longer

accept hot (dirty) water (inside pipe) is in contact with the cold water (outside pipe) for a longer time

he pipe is a spiral is insufficient

1

[6]

Q28.

(a) (i) 2.1

correct answer only

1

(ii) 3.15

or

their (a)(i) × 1.5 correctly calculated

allow 1 mark for correct substitution

ie 2.1 × 1.5

or

their (a)(i) × 1.5

2

kilowatt-hour

accept kWh

or

a substitution 2100 × 5400 scores 1 mark

2100 × 5400 incorrectly calculated with answer in joules scores 2 marks

an answer of 11 340 000 scores 2 marks

an answer of 11 340 000 J scores 3 marks

1

(iii) most (input) energy is usefully transformed

accept does not waste a lot of energy

accept most of the output / energy is useful

do not accept it does not waste energy

1

(b) the room is losing energy / heat

1

at the same rate as the heater supplies it

this mark only scores if the first is scored

do not accept heater reaches same temperature as room / surroundings

rate of heat gain = rate of heat loss scores both marks

1

[7]

Q29.

(a) (i) silvered surfaces

more than the correct number of ticks in a row negates the mark

 radiation

2

 plastic cap

 conduction, convection (both required)

 conduction convection radiation

vacuum

silvered surfaces (1)

plastic cap (1)

(ii)

any mention of air or any other substance in a vacuum scores zero

 because there are no particles in a vacuum

accept atoms / molecules for particles

accept vacuum is empty space

accept there is nothing in a vacuum

accept there is no air / gas in the vacuum

 conduction and convection need particles / medium

need reference to both conduction and convection

accept correct descriptions

2

(b) (i) less heat lost (to air above the heater)

do not accept no heat lost

 light shiny surfaces are poor emitters (of radiation)

accept radiators for emitters

references to reflection are neutral

 or dull, matt surfaces are good emitters (of radiation)

do not credit answers which infer reflection from the underside of the hood

ignore correct reference to absorption

2

(ii) correct diagram drawn with one output arrow narrower

than the other

ignore input

 arrows correctly labelled with energy form

eg

flow charts score zero

2

(iii) energy cannot be destroyed

accept (principle of) conservation of energy

do not accept because energy cannot be lost without clarification

1

[9]

Q30.

(a) the bigger the surface area, the faster the water cools down / temperature falls

answers must imply rate

accept heat for temperature provided rate is implied

do not accept cools down more unless qualified

1

(b) any two from:

 the ears:

• have large surface / area

not just has large ears

• radiate heat

accept loses heat, but does not score

if the reason given for heat loss is wrong

• keep blood cooler

2

(c) (i) radiation

1

(ii) conduction

1

[5]

Q31.

(a) conduction

do not accept conductor

1

(b) the freezer

both parts needed

 greater temperature difference (between freezer and room)

do not accept because it is the coldest

1

(c) any two from:

• poor absorber of heat / radiation

accept does not absorb heat poor emitter of heat / radiation is neutral

• reflects heat / radiation (from room away from fridge-freezer)

• reduces heat transfer into the fridge-freezer

• reduces power consumption of fridge-freezer

do not accept it is a bad conductor / good insulator

2

[4]

Q32.

(a) (i) makes it warmer / raises the temperature

accept produces convection (current)

accept makes it less dense

1

(ii) reduced or slows down

1

(b) (i) electrical energy (to run the pump) must be paid for

accept electricity for electrical energy

accept electricity is needed for the pump

accept it uses electricity

accept because of the pump

1

(ii) more useful (heat) energy is transferred into the house than the energy

used to operate the pump

 or reduced cost of heating the house is greater than the cost of running the (electrical) pump

 or costs little to run compared to the savings made

accept for 1 mark

reduces energy bills

or reduced fuel costs / heating costs owtte

do not accept it’s cheap

2

[5]

Q33.

(a) (i) as a source of thermal radiation

accept heat for thermal radiation

accept to act as the Sun

do not accept sunlight alone

1

(ii) any one from:

• volume of water

accept amount for volume

• distance between lamp and boiling tube

• initial / starting temperature of water

• same room temperature

do not accept time or same insulation material

1

(iii) any one from:

• greater sensitivity / precision

 do not accept more reliable (negates mark)

• could link to a computer for (automatic) data analysis

• could take more frequent readings

• reduces instrument reading error

 accept more accurate

 do not accept easier to use on its own

1

(b) (i) acts as a control

accept to be able to make a comparison

accept to see the difference

do not accept ‘to make it a fair test’ OWTTE on its own

1

(ii) (plastic) foam and aluminium foil

1

(iii) (aluminium) foil is a poor absorber of thermal radiation

accept heat / infra red for thermal radiation

1

or (aluminium) foil is a (good) reflector of thermal radiation

do not accept ‘reflects sunlight’ on its own

 (plastic) foam traps air which is a (good) insulator

accept (plastic) foam is a poor conductor / (good) insulator

do not accept ‘the material’ is a good insulator / poor conductor

1

(c) particles vibrate with a bigger / stronger amplitude / faster / with more

(kinetic) energy

accept particles vibrate more

do not accept start to vibrate only

1

energy transferred by collisions with other particles

do not accept answers in terms of

free/mobile electrons

1

[9]

Q34.

(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]

Q35.

(a) the outside colour of the cans

1

(b) (i) 18 (°C) or 88 to 70

ignore negative sign

1

(ii) 8 (°C) or 70 to 62

ignore negative sign

1

(c) greater temperature difference between water and surroundings (at start)

must mention temperature difference

ignore just water hotter

accept energy used to heat cans initially

1

(d) black

1

temperature falls the fastest (in L)

accept (can L) loses more heat / cools quicker

accept heat for temperature

1

black is a good / the best / better emitter (of heat / radiation)

accept converse

ignore black is best absorber

1

[7]

Q36.

(a) ions / electrons gain (kinetic) energy

accept atom / particles / molecules for ion

accept ions vibrate faster

accept ions vibrate with a bigger amplitude

accept ions vibrate more

do not accept ions move faster

1

 (free) electrons transfer energy by collision with ions

or energy transferred by collisions between vibrating ions

1

(b) move faster or take up more space

do not accept start to move / vibrate

1

 (warmer) water expands or becomes less dense (than cooler water)

do not accept answers in terms of particles expanding

1

 warm water rises (through colder water) or colder water falls to take its place

1

(c) transfer of energy by waves / infrared (radiation)

accept rays for waves

do not accept transfer of energy by electromagnetic waves

ignore reference to heat

1

[6]

Q37.

(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]

Q38.

(a) (i) vacuum

do not allow stopper

1

(ii) (absence of particles) means no (transfer of energy between)

particles for conduction

accept particles or atoms or molecules or electrons

1

 no movement of molecules for (transfer of energy by) convection

accept particles/atoms/electrons

if answer to (a)(i) is correct: then in (a)(ii) have stated

‘conduction and convection both need a medium/particles/materials’ = 2 marks

(If medium is specified, it must be correct, conduction can be solid, liquid or gas, convection must be liquid or gas)

if answer to (a)(i) is incorrect then in (a)(ii) have stated ‘conduction and convection both need a medium...’= 1 mark, unless further qualified by stating about absence of particles, in which case get a second mark.

1

(b) (i) silvered surface

accept silver surface

1

(ii) silvered is a bad emitter/radiator

1

 surface reflects heat/energy/radiation (at inner and outer surface)

or is a bad absorber (of energy)

accept bounces off

1

[6]

Q39.

(i) conduction, convection

answer can be in either order

1

(ii) traps (lots of) air

do not accept heat is trapped in the fibre

1

 air is a (good) insulator or poor conductor

1

[3]

Q40.

(i) radiation or infra red

do not accept rays

do not accept waves

accept electromagnetic waves

1

(ii) good absorber (of heat) to absorb heat (or infrared)

do not accept ‘attract’ or ‘capture’ or soak

1

(iii) reduce heat loss (from the panel)

accept (good) (heat) insulator

accept stop or reduce conduction

accept stop or reduce convection

accept traps heat

accept keeps water hot

1

(iv) to reflect (back into the panel) heat or infrared or Sun’s energy

do not accept ‘bouncing’

do not accept reflect Sun

do not accept reflect sunlight or sun’s rays

1

 radiated or given out by the (black) pipe

accept back to pipe

accept reduce heat loss for 1 mark

accept reduce heat loss by radiation for 2 marks

accept stop heat loss by radiation for I mark

1

[5]

Q41.

(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]

Q42.

(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]

Q43.

(a) plastic/glass walls; vacuum; insulating top

any two for 1 mark each

2

(b) silvering/shiny on either wall

for 1 mark

1

[3]

Q44.

(a) (i) Carries heat up (as convection current)

1

(ii) (1) By conduction or from molecule to molecule

(2) By radiation or as IR

2

(iii) Use shiny surface (inside or outside) or small area

1

(b) (i) Rise more quickly

1

(ii) Dull surface good absorber

(accept “attract” = “absorb” if context correct,

then penalise spg mark.

Shiny surface poor absorber

2

(c) (i) Fall more quickly

1

(ii) Dull surface good emitter

Shiny surface poor emitter

2

[10]

Q45.

(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]

Q46.

(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]

Q47.

(i) currents of moving liquids/gases/fluids carrying/transferring energy

(can name fluid)

1

(ii) liquids/gases expand when their temperature rises/when they are heated

 the density of the heated liquid/gas is then less than that of the

colder liquid/gas which has not been heated

 the warmer/less dense liquid/gas then rises through the colder/denser liquid/gas

 the colder/denser liquid/gas falls to replace the liquid/gas which has risen,

and in turn becomes heated

for 1 mark each

4

[5]

Q48.

…….. conduction

…….. convection

…….. insulation

…….. radiation

for 1 mark each

[4]

Q49.

(a) convection

air is heated by the burner / particles gain energy

air expands / particles move about more / particles move faster

air becomes less dense / particles are more spread out

air rises / particles rise - not heat rises

air from C moves into the heater / particles from C move into the heater to

replace it / them

any four for 1 mark each

4

(b) (i) radiation

for one mark

1

(ii) black surface radiates / emits well

(allow absorbs and emits well) (allow comparison with shiny / white surfaces)

 large surface area needed

high temperature (of the lumps)

any one for 1 mark

1

[6]

Q50.

(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]

Q51.

(a) (i) conduction

1

convection

they may be in either order

1

(ii) radiation

1

(iii) evaporation

1

convection

they may be in either order

1

(iv) convection

1

(v) conduction

1

(b) in the middle above halfway up (above line joining top of spacers)

below the surface of the liquid

1

(c) by particles vibrating more

particles shake more or move more

do not credit they start vibrating

1

they pass on the energy or vibrations

do not credit heat

1

[10]

Q52.

(a) (i) the outlet mark

hot water rises or floats up

do not accept heat rises

the inlet mark

1

 cold water replacing any drawn off comes in at the bottom and does not mix

with hot or cool the hot water

do not accept descriptions of a convection current

1

(ii) only heats top (of tank) or a small volume

credit heats less water

1

 no mixing occurs with cold because hot water is less dense or water is a poor conductor

no mixing because cold water is more dense

1

(b) radiation (losses from tank)

do not accept reflection of heat

1

lower from light or white or shiny surfaces

credit they are poor radiators for both marks

1

[6]

Q53.

(a) radiates

absorbs / conducts

reflects

for 1 mark each

3

(b) C make sure the lamp is the same distance from both tubes

B switch on the lamp

A switch off the lamp

E wait for the temperature to stop rising

D read the thermometers

for 1 mark each

5

[8]