

Mark schemes

1

(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]**2**

(a) (i) 2.1

correct answer only

1

(ii) 3.15

or

their (a)(i) \times 1.5 correctly calculated

allow 1 mark for correct substitution

ie 2.1×1.5

or

their (a)(i) \times 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]

3

(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*

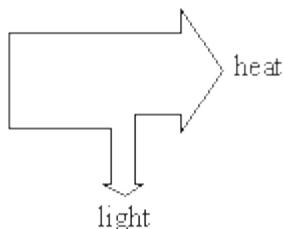
2

- (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]

4

- (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]**5**

(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]

6

- (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]

7

- (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 $\frac{1}{4}$ of the total energy loss ie 150 / 600 2
- (ii) £142.50
allow ecf 50 % of their (a)(i) $\times 1.5$ ie their (a)(i) $\times 0.75$ 1

(b) transferred to surroundings / atmosphere

or becomes spread out

1

[4]

8

(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]

9

- (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]

10

- (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]**11**

(a) four calculations correctly shown

$$200 \times 10 - 1800 = \text{£}200$$

$$100 \times 10 - 2400 = -\text{£}1400$$

$$50 \times 10 - 600 = -\text{£}100$$

$$20 \times 10 - 75 = 125$$

*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 $\times 10$ 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]

12

- (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]

13

- (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]

14

(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]

- 15** (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]

- 16** (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 1 mark

1

[5]**17**

- (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]

18

- (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
- convection 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 [7]
- 19** (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]

| | | | |
|-----------|---------|--|-------------|
| 20 | (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] |

| | | | |
|-----------|---------|---|---|
| 21 | (a) (i) | hot water rises (not heat) <i>for 1 mark</i> due to convection currents or water expands/becomes less dense on heating or less dense water rises <i>any for 1 mark</i> | 2 |
| | (ii) | inside hotter (than outside) <i>for 1 mark</i> | 1 |
| | (iii) | (heat transfer by) conduction <i>for 1 mark</i> | 1 |
| | (iv) | surround/cover/insulate tank with poor conductor or named insulator <i>for 1 mark each</i> | 2 |

- (b) (i) air is an insulator/poor conductor
for 1 mark
- (ii) convection stopped foam is an insulator/poor conductor
for 1 mark each

1

2

[9]**22**

- (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]**23**

- (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 heatedthe warmer/less dense liquid/gas **then rises** through the colder/denser liquid/gasthe **colder/denser liquid/gas falls** to replace the liquid/gas which has risen, and in turn becomes heated*for 1 mark each*

4

[5]**24**

..... conduction

..... convection

..... insulation

..... radiation

*for 1 mark each***[4]**

25

- (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]

26

- (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]

27

(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]

28

(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]**29**

- (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]**30**

- (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]

31

- (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]

32

- (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]