**1**

(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]**

**2**

(a) (black) is a good absorber of (infrared) radiation

1

(b) (i) amount of energy required to change (the state of a substance) from solid to liquid (with no change in temperature)

*melt is insufficient*

1

unit mass / 1kg

1

(ii) $5.1 \times 10^6$ (J)

*accept $5 \times 10^6$*

*allow **1** mark for correct substitution ie $E = 15 \times 3.4 \times 10^5$*

**2**

(c) (i) mass of *ice*

*allow volume / weight / amount / quantity of ice*

**1**

(ii) to distribute the salt throughout the ice

**1**

to keep all the ice at the same temperature

**1**

(iii) melting point decreases as the mass of salt is increased

*allow concentration for mass*

*accept negative correlation*

*do **not** accept inversely proportional*

**1**

(d) 60 000 (J)

*accept 60 KJ*

*allow **2** marks for correct substitution ie $E = 500 \times 2.0 \times 60$*

*allow **2** marks for an answer of 1000 **or** 60*

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

*$E = 500 \times 2.0$ **or** $0.50 \times 2.0 \times 60$*

*allow **1** mark for an answer of 1*

**3**

(e) Marks awarded for this answer will be determined by the Quality of Communication (QC) 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)**
There is *an attempt at a description of some advantages or disadvantages.*

**Level 2 (3–4 marks)**
*There is a basic description* of *some advantages* ***and / or*** *disadvantages for some of the methods*

**Level 3 (5–6 marks)**
There is a clear description of the advantages and disadvantages of all the methods.

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

**energy storage**

advantages:

- no fuel costs
- no environmental effects

disadvantages:

- expensive to set up and maintain
- need to dig deep under road
- dependent on (summer) weather
- digging up earth and disrupting habitats

**salt spreading**

advantages:

- easily available
- cheap

disadvantages:

- can damage trees / plants / drinking water / cars
- needs to be cleaned away

**undersoil heating**

advantages:

- not dependent on weather
- can be switched on and off

disadvantages:

- costly
- bad for environment

6

**[18]**

**3**

(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]**

**4**

(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]**

**5** (a) (matt) black is a good <u>emitter</u> 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]**

**6** (a) (i) to check rise in temperature (of other thermometers) was due to the (different wavelengths of) light

*accept as a control / comparison*

*to measure room temperature is insufficient*

**1**

(ii) any **two** from three:

- different colours produce different heating effects / (rises in) temperatures
- red light produces the greatest heating effect / (rise in) temperature

**or**

- violet produces the least heating effect / (rise in) temperature
- all colours produce a greater heating effect than outside the spectrum

*an answer*

*the longer the <u>wavelength</u> the greater the (rise in) temperature*

***or***

*the lower the <u>frequency</u> the greater the (rise in) temperature gains both marks*

**2**

(b) move a thermometer into the infrared region / just beyond the red light

*allow use an infrared camera / infrared sensor*

**1**

the temperature increases beyond 24(°C)

*accept temperature higher than for the red light*

**1**

(c) $v = f \times \lambda$

$9.4 \times 10^{-6}$

*accept $9.375 \times 10^{-6}$ or $9.38 \times 10^{-6}$*

**or**

0.0000094

*accept 0.000009375*

***or** 0.00000938*

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

*ie $3 \times 10^{8} = 3.2 \times 10^{13} \times \lambda$*

**2**

(d) at night the surroundings are cooler

*accept at night the air is colder*

*there is no heat from the Sun is insufficient*

**or**

at night there is a greater temperature difference between people and surroundings

**1**

(so surroundings) emit less infrared (than in daytime)

*accept camera detects a greater contrast*

**or**

gives larger difference in infrared emitted (between people and surroundings)

**1**

**[9]**

**7** (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)

$$efficiency = \frac{useful\ energy\ out\ (\times 100\%)}{total\ energy\ in}$$

*allow 1 mark for correct substitution, ie* $\frac{13.5}{15}$

*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) $E = m \times c \times \theta$

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]**

**8** (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 <u>bad / poor</u> conductor

**or**

air is a good <u>insulator</u>

*accept air is an insulator*

**1**

**[7]**

**9** (a) (i) convection

**1**

(ii) conduction

**1**

(b) (i) 2

**1**

black is the best <u>absorber</u> (of thermal energy / heat)

*accept black is the best emitter (of thermal energy / heat)*

*note that a comparative is needed (eg better or best)*

**1**

(ii) the colour of the metal plates

**1**

(iii) any **one** from:

- more precise / accurate / reliable

  *do **not** accept better reading*

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

- can measure continuously
- take many readings in a small time
- removes (human) reading error

  *accept easier to read*

- can compare / draw graphs automatically
- records data automatically

**1**

(c) (i) radiation

*accept radiates*

*accept infra red (IR) waves*

*do **not** accept heat waves*

**1**

(ii) to reflect (heat away from the fire fighter)

*accept it reflects*

*accept it is a poor absorber (of thermal radiation / heat)*

*do **not** accept deflect / bounce for reflect*

**1**

(d) **N**

*the mark is for the reason which does not score if **M** is chosen*

transfers / absorbs less heat
**or**
gives smallest increase in temperature

*accept will keep fire fighters cooler*

*accept **N** is cooler (after 15 minutes)*

*an answer **N** goes up to 52°C and **M** goes up to 100°C is insufficient*

**1**

**[9]**

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

**A** and **C**

*both required and none other*

**or**

**B** 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**

**[4]**

**11** (a) (i) radiation

*ignore thermal / infrared*

**1**

(ii) black is a better / good absorber (of heat / radiation)

*ignore reference to black being a good emitter*

*black absorbs heat is insufficient*

*do **not** accept black attracts / absorbs the Sun*

*do **not** accept black attracts heat*

**1**

(so) temperature rises faster

*must be an indication of heating up quicker*

**or**

white is a worse / poor absorber (of heat / radiation) (1)

*accept white is a better / good reflector (of heat / radiation)*

(so if white faces) temperature would rise slower (1)

*ignore any reference to light*

**1**

(b) (i) 1.2 (hours) **or** 1 hour 12 minutes

*no tolerance*

**1**

(ii) increases (rapidly at first then increases at a slower rate)

*do **not** accept increases at a steady rate*

**1**

(c) (i) any **two** from:

- (fill with) same mass / volume / amount of water
- same level of (sun)light / sunshine
  *accept same heat / light source*
  *accept same place*
- outside for the same (length of) time
- outside at same time (of day / year)
- initial water temperature
- the side of the bag facing the Sun
  *do **not** accept any factors to do with the construction of plastic bags eg thickness*

**2**

(ii) curved line drawn above given line
*both lines must start from the same point*
*ignore if continues beyond one hour or levels off after 1 hour*
*do **not** accept a straight line*

**1**

**[8]**

**12** (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*

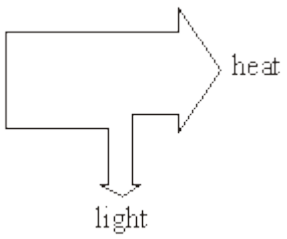
*ignore correct reference to absorption*

**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]**

**13** (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]**

**14** (a) conduction

*do **not** accept conductor*

**1**

(b) the freezer

*both parts needed*

greater <u>temperature</u> 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 <u>into</u> the fridge-freezer

- reduces power consumption of fridge-freezer

  *do **not** accept it is a bad conductor / good insulator*

**2**

**[4]**

**15** (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]**

**16** (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]**

**17** (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]**

**18** (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]**

**19** (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]**

**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) 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 <u>radiates / emits</u> 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]**

**22** absorber

1

reflector

1

emitter

1

**[3]**

**23** (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]**

**24** (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]**