Mark schemes

(a) Student A's measurements had a higher resolution

Student B was more likely to misread the temperature

(b) a random error

(c) 8.4 °C

(d) 740 (seconds)

allow answers in the range 730 – 780

(e) 0.40 \times 199 000

79 600 (J)

accept 79 600 (J) with no working shown for 2 marks

(f) stearic acid has a higher temperature than the surroundings

accept stearic acid is hotter than the surroundings

temperature will decrease until stearic acid is the same as the room temperature / surroundings

[9]

2

(a) range of speeds

moving in different directions

accept random motion

(b) internal energy

(c) density = mass / volume

(d) 0.00254 / 0.0141

0.18
accept 0.18 with no working shown for the 2 calculation marks

\[ \text{kg / m}^3 \]

Level 3 (5–6 marks):
Clear and coherent description of both methods including equation needed to calculate density. Steps are logically ordered and could be followed by someone else to obtain valid results.

Level 2 (3–4 marks):
Clear description of one method to measure density or partial description of both methods. Steps may not be logically ordered.

Level 1 (1–2 marks):
Basic description of measurements needed with no indication of how to use them.

0 marks:
No relevant content.

Indicative content

For both:
• measure mass using a balance
• calculate density using \( \rho = \frac{m}{V} \)

Metal cube:
• measure length of cube’s sides using a ruler
• calculate volume

Small statue:
• immerse in water
• measure volume / mass of water displaced
• volume of water displaced = volume of small statue
(a) dependent

(b) (probe) C
   allow 103.2

largest difference between reading and actual temperature
   reason only scores if C chosen
   accept larger
   it is 3.2 greater is insufficient
   comparing C with only one other probe is insufficient

(c) (i) 12°C
   accept a value between 12.0 and 12.2 inclusive

(ii) 140 (seconds)
   accept an answer between 130 and 150 inclusive

   temperature starts to rise
   only scores if time mark awarded
   accept the temperature was lowest (at this time)

(iii) increase
   accept faster (rate)

(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 × θ
   or
   \[
   \frac{46200}{0.5 \times 4200} = θ
   \]

(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
(a) surface area or duration of experiment
accept shape of beaker
size of beaker is insufficient

(b) any two from:
- takes readings automatically
  ignore easier or takes readings for you
- takes readings more frequently
- reduces / no instrument reading error
  ignore human error
- higher resolution
  allow better resolution
- don't need to remove probe to take reading
- more accurate

(c) (i) 0.07 (°C/s)
allow 1 mark for obtaining a temperature drop of 7 (°C)
allow 1 mark for an answer between 0.068 and 0.069 (°C/s)

(ii) rate of temperature change is greater at the start
accept rate of evaporation is greater at the start
or rate of temperature change decreases
allow rate of evaporation decreases
allow temperature decreases faster at the start

(iii) A
reason only scores if A is chosen
lower temperature decrease (over 200 seconds)
accept lower gradient

(iv) no effect (as rate of evaporation is unchanged)
allow larger temperature change (per second as mass of liquid is lower)
(d) particles with more energy
   accpet particles with higher speeds

leave the (surface of the) liquid

(which) reduces the average (kinetic) energy (of the remaining particles)
   allow reference to the total energy of the liquid reducing

(a) solid
   particles vibrate about fixed positions

   closely packed
      accept regular

   gas
   particles move randomly
      accept particles move faster
      accept freely for randomly

   far apart

(b) amount of energy required to change the state of a substance from liquid to gas (vapour)

   unit mass / 1 kg
      dependent on first marking point

(c) 41000 or 4.1 \times 10^4 (J)

   accept
   41400 or 4.14 \times 10^4
   correct substitution of
   0.018 \times 2.3 \times 10^6 gains 1 mark

(d) AB
   changing state from solid to liquid / melting

   at steady temperature
      dependent on first AB mark
temperature of liquid rises

until it reaches boiling point

*dependent on first BC mark*

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

(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*

unit mass / 1kg

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

*accept $5 \times 10^6$*

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

(c) (i) mass of *ice*

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

(ii) to distribute the salt throughout the ice

*to keep all the ice at the same temperature*

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

*allow concentration for mass*

*accept negative correlation*

*do not accept inversely proportional*

(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*
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:
(a) solid

(b) decreased

(c) (i) A reason only scores if A chosen
    uses least / less energy (in 1 year)
    a comparison is required
    accept uses least power
    accept uses least kWh

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

    (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
(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

(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

(iii) concrete

reason only scores if concrete chosen

(heater on for) longest / longer time

a long time or quoting a time is insufficient

do not accept it is the highest bar

(iv) 4500 (J)

allow 1 mark for correct substitution ie

2 × 450 × 5 provided no subsequent step shown

(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.
(iv) 2 (minutes)

(a) infrared / IR

\textit{correct answer only}

(b) any two from:

- increase the power / watts
  \textit{allow increase the temperature of the oven or make the oven hotter}
- decrease the speed
  \textit{allow leave the biscuits in for longer}
- put biscuits through again
  \textit{increase radiation is insufficient}
  \textit{ignore changes to the design of the oven}

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

\textit{Ignore bounce for reflect}

\textit{surface is a (good) reflector of light does not score}

\textit{surface is a (good) reflector of light and infrared / heat does score}

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

(so) increases the energy reaching the biscuits

\textit{allow reduces energy loss or makes oven more efficient}

\textit{do not accept no energy losses}

\textit{keeps oven hotter is insufficient}