Mr Baker's Science-Stuff

Particle Model of Matter

Name: ______________________

Class: ______________________

Date: ______________________

Time: **126 minutes**

Marks: **125 marks**

Comments:

Q1.

People do a number of things to reduce the energy loss from their homes.

(a) Describe **one** thing they may do to cut down the energy loss through:

(i) the roof;

____

(1)

(ii) the outside walls;

____

(1)

(iii) the glass in the windows;

____

(1)

(iv) gaps around the front and back doors.

____

(1)

(b) A house is more difficult to keep warm in cold weather. What other type of weather makes it difficult to keep a house warm?

____

(1)

(Total 5 marks)

Q2.

A student wanted to determine the density of a small piece of rock.

(a) Describe how the student could measure the volume of the piece of rock.

____

____

____

____

____

____

____

____

(4)

(b) The volume of the piece of rock was 18.0 cm^3.

The student measured the mass of the piece of rock as 48.6 g.

Calculate the density of the rock in g/cm^3.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

____

____

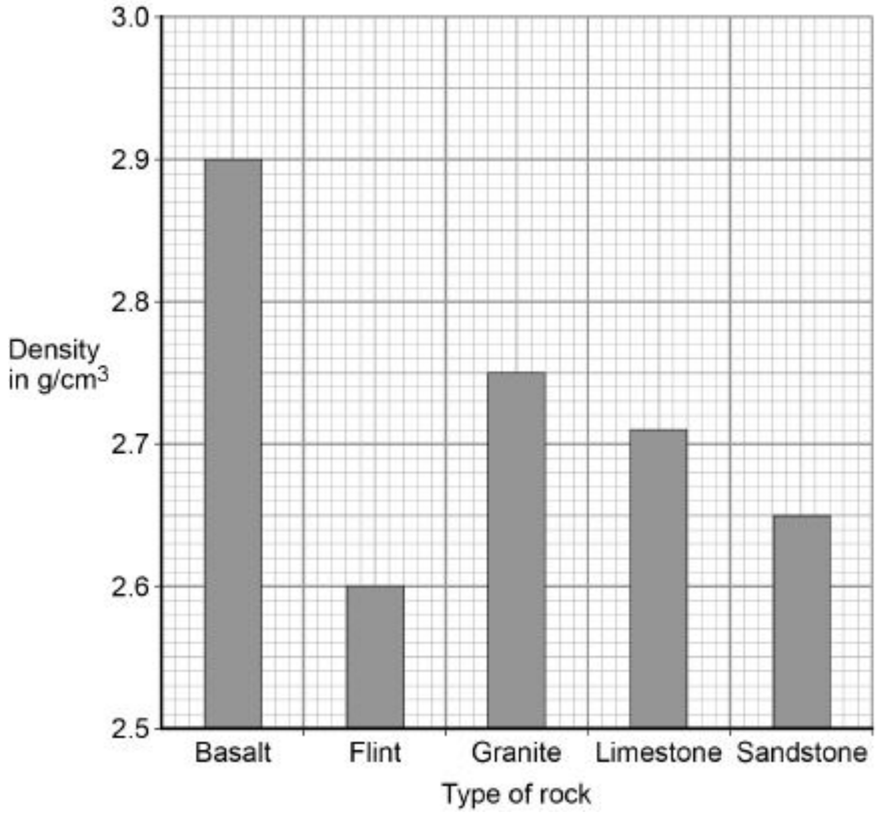
____

____

Density = ____________________ g/cm^3

(2)

The graph below shows the densities of different types of rock.



(c) What is the most likely type of rock that the student had?

Tick **one** box.

Basalt ☐

Flint ☐

Granite ☐

Limestone ☐

Sandstone ☐

(1)

(d) Give **one** source of error that may have occurred when the student measured the volume of the rock.

____

____

(1)

(e) How would the error you described in part **(d)** affect the measured volume of the rock?

____

____

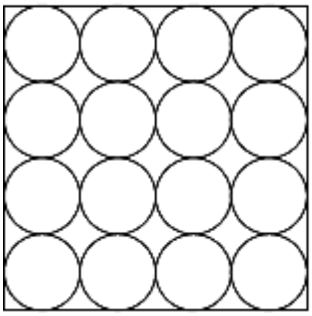
(1)
(Total 9 marks)

Q3.

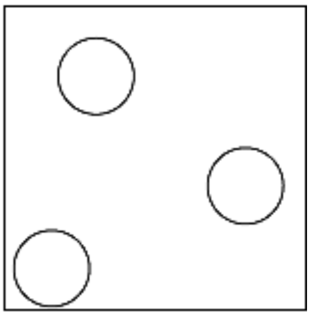
(a) The diagrams show the arrangement of the particles in a solid and in a gas.

Each circle represents one particle.

Solid

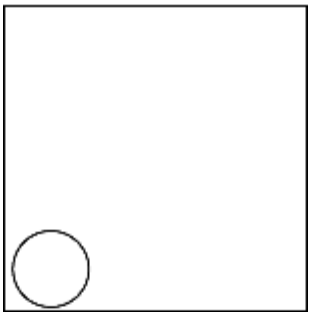


Gas



(i) Complete the diagram below to show the arrangement of the particles in a liquid.

Liquid



(2)

(ii) Explain, in terms of the particles, why gases are easy to compress.

____

____

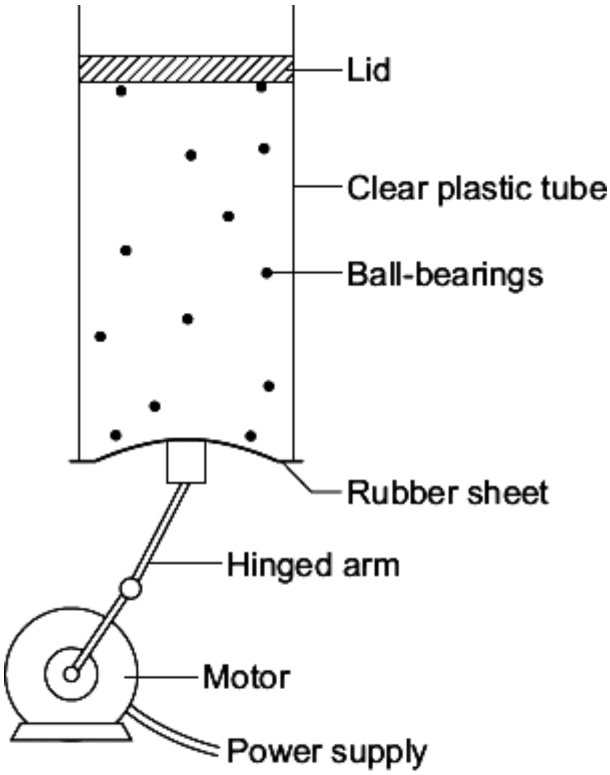
____

____

(2)

(b) The diagram below shows the model that a science teacher used to show her students that there is a link between the temperature of a gas and the speed of the gas particles.

The ball-bearings represent the gas particles. Switching the motor on makes the ball-bearings move around in all directions.



(i) How is the motion of the ball-bearings similar to the motion of the gas particles?

____

____

(1)

(ii) The faster the motor runs, the faster the ball-bearings move. Increasing the speed of the motor is like increasing the temperature of a gas.

Use the model to predict what happens to the speed of the gas particles when the temperature of a gas is increased.

____

____

(1)

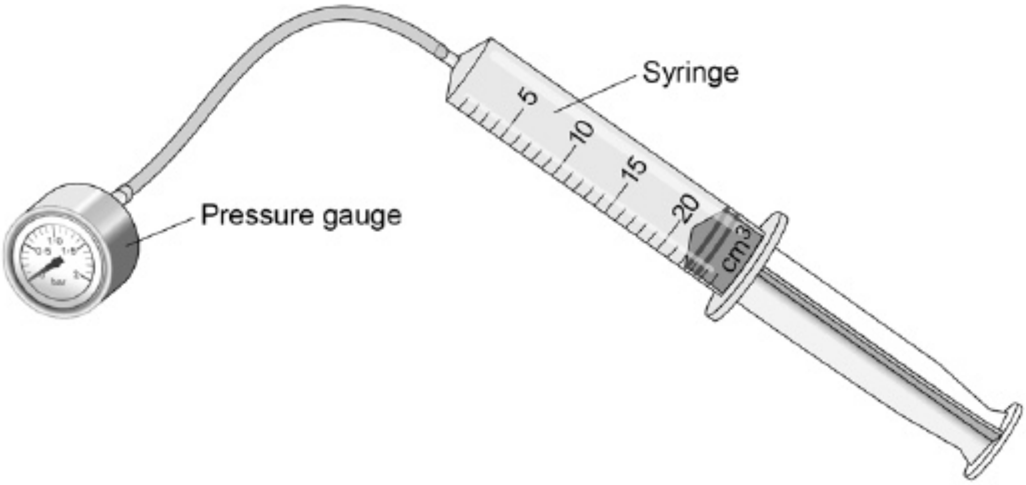
(Total 6 marks)

Q4.

A student investigated how the pressure of a gas varied with the volume of the gas.

The mass and temperature of the gas were constant.

The diagram shows the equipment the student used.



(a) What is the range of the syringe?

Tick **one** box.

0 to 1 cm^3 ☐

0 to 5 cm^3 ☐

0 to 20 cm^3 ☐

0 to 25 cm^3 ☐

(1)

(b) What type of variable was the mass of gas?

Tick **one** box.

Control ☐

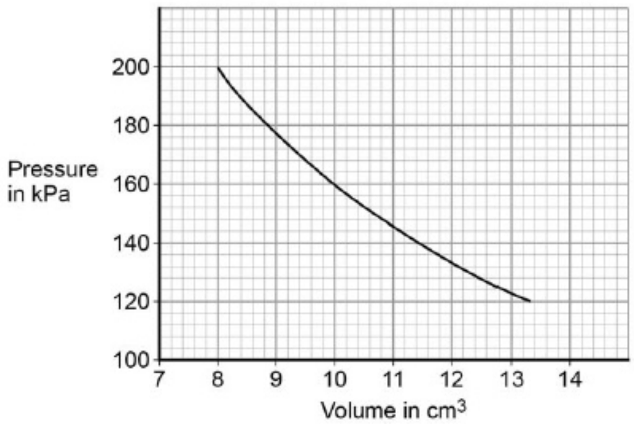
Dependent ☐

Independent ☐

(1)

The student compressed the gas in the syringe and read the pressure from the pressure gauge.

The graph shows the student's results.



(c) The student concluded that when the pressure was multiplied by the corresponding volume the answer was the same.

Use data from the graph to show that the student's conclusion was correct.

____

____

____

____

____

____

(2)

(d) Complete the sentences.

Choose the answers from the box.

Each answer may be used once, more than once or not at all.

decreases	**increases**	**remains the same**

When the gas is compressed, the volume of gas in the syringe ________________ .

So the number of collisions each second between the gas particles inside the syringe and the inside surface of the syringe ____________________ .

This means the force exerted on the inside surface of the container walls ____________________ .

(3)

(Total 7 marks)

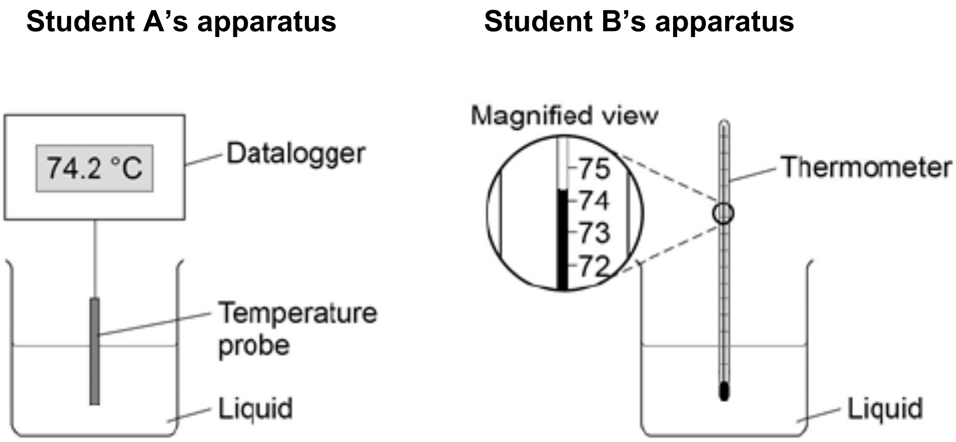
Q5.

Two students investigated the change of state of stearic acid from liquid to solid.

They measured how the temperature of stearic acid changed over 5 minutes as it changed from liquid to solid.

Figure 1 shows the different apparatus the two students used.

Figure 1



(a) Choose **two** advantages of using student **A**'s apparatus.

Tick **two** boxes.

Student **A**'s apparatus made sure the test was fair.	☐
Student **B**'s apparatus only measured categoric variables.	☐
Student **A**'s measurements had a higher resolution.	☐
Student **B** was more likely to misread the temperature.	☐

(2)

(b) Student **B** removed the thermometer from the liquid each time he took a temperature reading.

What type of error would this cause?

Tick **one** box.

A systematic error ☐

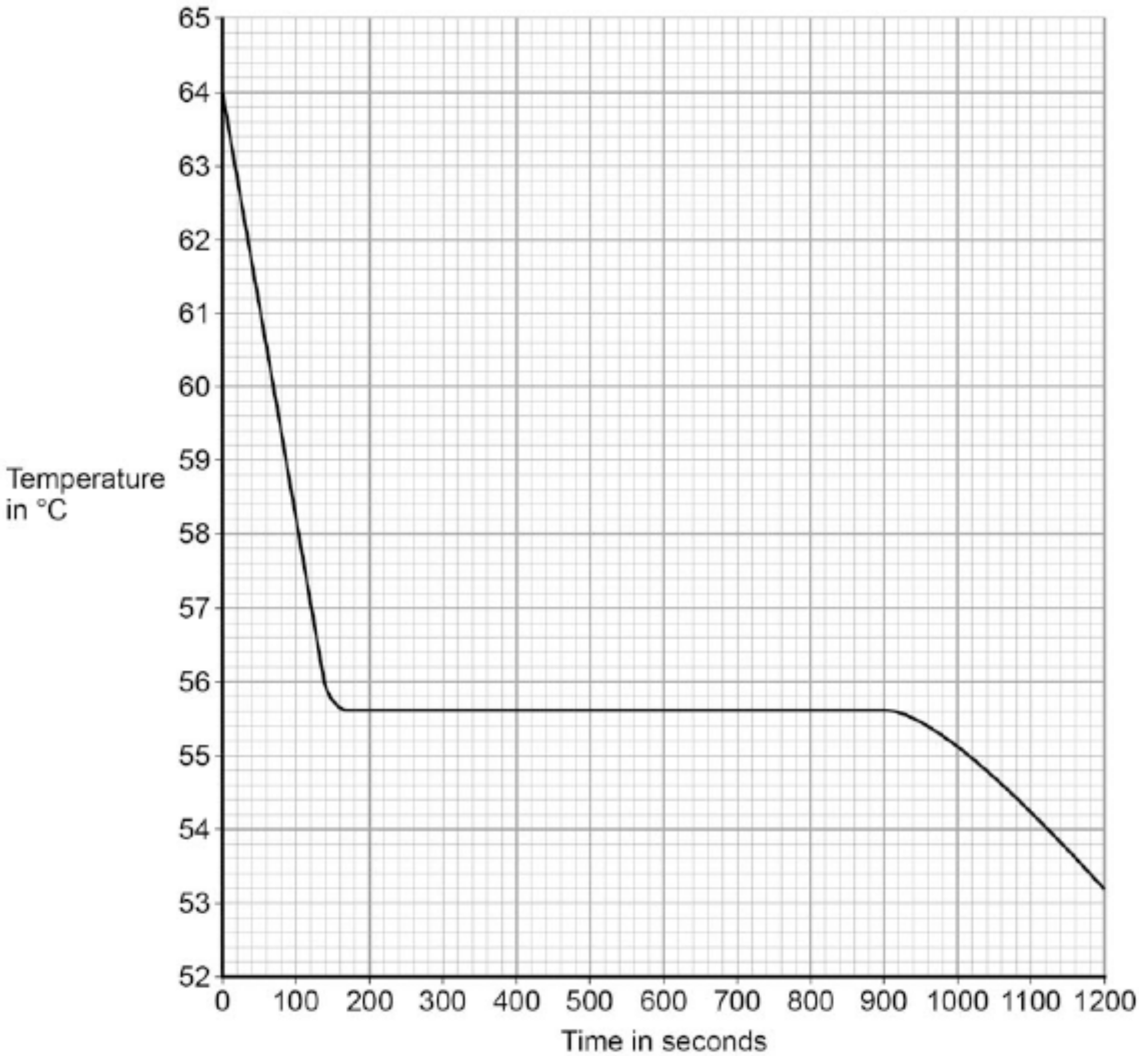
A random error ☐

A zero error ☐

(1)

(c) Student **A**'s results are shown in **Figure 2**.

Figure 2



What was the decrease in temperature between 0 and 160 seconds?

Tick **one** box.

8.2 °C ☐

8.4 °C ☐

53.2 °C ☐

55.6 °C ☐

(1)

(d) Use **Figure 2** to determine the time taken for the stearic acid to change from a liquid to a solid.

Time = ____________ seconds

(1)

(e) Calculate the energy transferred to the surroundings as 0.40 kg of stearic acid changed state from liquid to solid.

The specific latent heat of fusion of stearic acid is 199 000 J / kg.

Use the correct equation from the Physics Equations Sheet.

____

____

____

Energy = ______________________ J

(2)

(f) After 1200 seconds the temperature of the stearic acid continued to decrease.

Explain why.

____

____

____

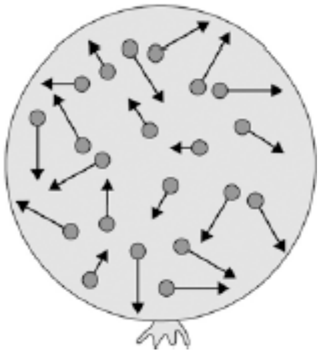
____

(2)

(Total 9 marks)

Q6.

The figure below shows a balloon filled with helium gas.



(a) Describe the movement of the particles of helium gas inside the balloon.

___

___

___

___

(2)

(b) What name is given to the total kinetic energy and potential energy of all the particles of helium gas in the balloon?

Tick **one** box.

External energy ☐

Internal energy ☐

Movement energy ☐

(1)

(c) Write down the equation which links density, mass and volume.

___

(1)

(d) The helium in the balloon has a mass of 0.00254 kg.

The balloon has a volume of 0.0141 m^3.

Calculate the density of helium. Choose the correct unit from the box.

m^3 / kg	**kg / m^3**	**kg m^3**

____

____

____

____

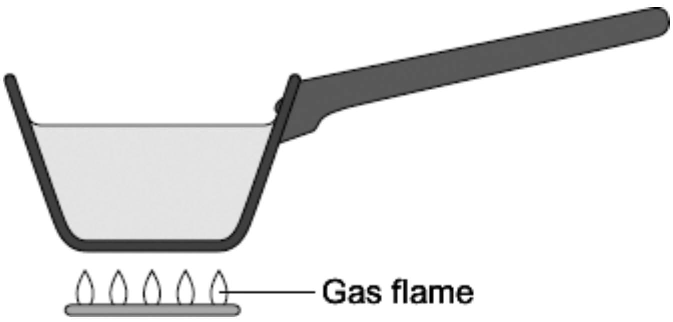
Density = ____________________ Unit __________

(3)

(Total 7 marks)

Q7.

The diagram shows a metal pan being used to heat water.



Energy from the gas flame is transferred through the metal pan by conduction.

Explain the process of conduction through metals.

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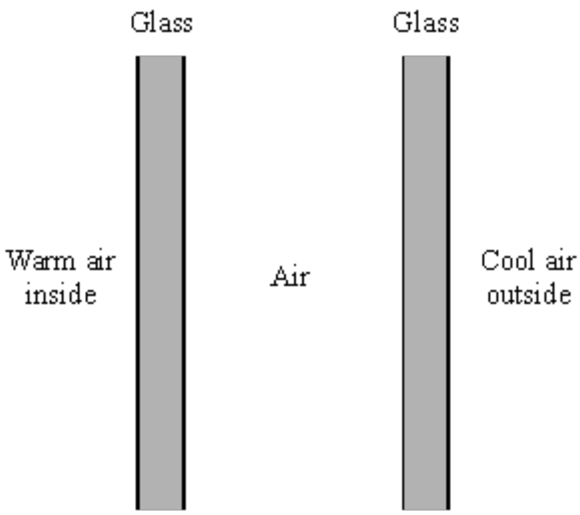
(Total 4 marks)

Q8.

The diagram shows a side view of a double-glazed window.



(a) Use each of the terms in the box to explain how heat is lost from inside a house through the window.

conduction	convection	radiation

____

____

____

____

____

____

(3)

(b) Besides heat, state **one other** form of energy that passes through double-glazed windows.

____

(1)

(c) Explain why plastic foam cavity wall insulation cuts down energy transfer between warm inner walls and cooler outer walls.

____

____

____

____

(2)

(d) When it rains the walls and windows of a house get wet.

Explain how the drying process can increase the cooling of the house.

___

___

___

(2)
(Total 8 marks)

Q9.

Solid, liquid and gas are three different states of matter.

(a) Describe the difference between the solid and gas states, in terms of the arrangement and movement of their particles.

___

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___

___

___

___

___

___

___

___

___

(4)

(b) What is meant by 'specific latent heat of vaporisation'?

___

___

___

___

(2)

(c) While a kettle boils, 0.018 kg of water changes to steam.

Calculate the amount of energy required for this change.

Specific latent heat of vaporisation of water = 2.3×10^6 J / kg.

____

____

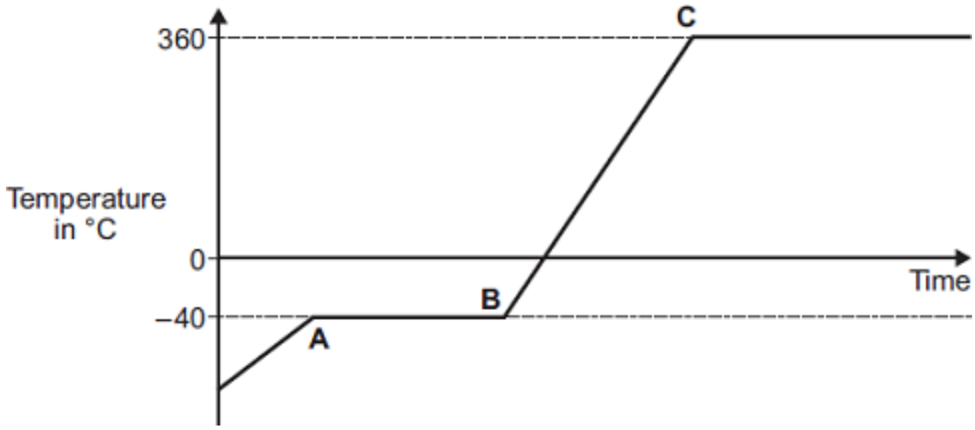
____

Energy required = ____________________ J

(2)

(d) The graph shows how temperature varies with time for a substance as it is heated.

The graph is **not** drawn to scale.



Explain what is happening to the substance in sections **AB** and **BC** of the graph.

Section **AB** ____

____

____

____

____

Section **BC** ____

____

____

____

____

(4)

(Total 12 marks)

Q10.

(a) A company is developing a system which can heat up and melt ice on roads in the winter. This system is called 'energy storage'.

During the summer, the black surface of the road will heat up in the sunshine.

This energy will be stored in a large amount of soil deep under the road surface. Pipes will run through the soil. In winter, cold water entering the pipes will be warmed and brought to the surface to melt ice.

The system could work well because the road surface is black.

Suggest why.

____

____

(1)

(b) (i) What is meant by specific latent heat of fusion?

____

____

____

____

(2)

(ii) Calculate the amount of energy required to melt 15 kg of ice at 0 °C.

Specific latent heat of fusion of ice = 3.4×10^5 J/kg.

____

____

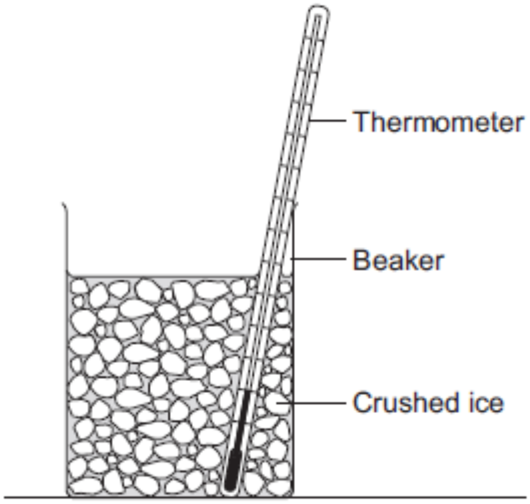
Energy = ____________________ J

(2)

(c) Another way to keep roads clear of ice is to spread salt on them.
When salt is added to ice, the melting point of the ice changes.

A student investigated how the melting point of ice varies with the mass of salt added.

The figure below shows the equipment that she used.



The student added salt to crushed ice and measured the temperature at which the ice melted.

(i) State **one** variable that the student should have controlled.

____

____

(1)

(ii) During the investigation the student stirred the crushed ice.

Suggest **two** reasons why.

Tick (✓) **two** boxes.

	Tick (✓)
To raise the melting point of the ice	
To lower the melting point of the ice	
To distribute the salt throughout the ice	
To keep all the ice at the same temperature	
To reduce energy transfer from the surroundings to the ice	

(2)

(iii) The table below shows the data that the student obtained.

Mass of salt added in grams	0	10	20
Melting point of ice in °C	0	-6	-16

Describe the pattern shown in the table.

____

____

(1)

(d) Undersoil electrical heating systems are used in greenhouses. This system could also be used under a road.

A cable just below the ground carries an electric current. One greenhouse system has a power output of 0.50 kW.

Calculate the energy transferred in 2 minutes.

____

____

____

Energy transferred = ____________________ J

(3)

(e) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

A local council wants to keep a particular section of a road clear of ice in the winter.

Describe the advantages and disadvantages of keeping the road clear of ice using:

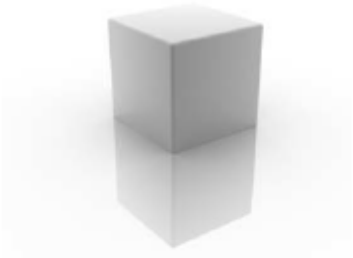
- energy storage
- salt
- undersoil electrical heating.

Extra space

(6)
(Total 18 marks)

Q11.

A student wants to calculate the density of the two objects shown in the figure below.



Metal cube

Small statue

Describe the methods that the student should use to calculate the densities of the two objects.

___

___

___

___

___

___

___

___

___

___

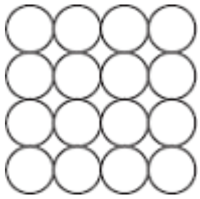
(Total 6 marks)

Q12.

According to kinetic theory, all matter is made up of small particles. The particles are constantly moving.

Diagram 1 shows how the particles may be arranged in a solid.

Diagram 1



(a) One kilogram of a gas has a much larger volume than one kilogram of a solid.

Use kinetic theory to explain why.

____

____

____

____

____

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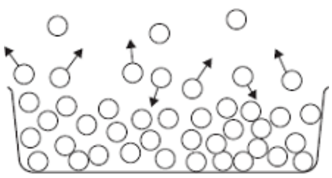
____

____

(4)

(b) **Diagram 2** shows the particles in a liquid. The liquid is evaporating.

Diagram 2



(i) How can you tell from **Diagram 2** that the liquid is evaporating?

____

____

(1)

(ii) The temperature of the liquid in the container decreases as the liquid evaporates.

Use kinetic theory to explain why.

____

____

____

____

____

____

____

____

(3)

(Total 8 marks)

Q13.

The table gives information about some methods of conserving energy in a house.

Conservation method	**Installation cost in £**	**Annual saving on energy bills in £**
Cavity wall insulation	500	60
Hot water tank jacket	10	15
Loft insulation	110	60
Thermostatic radiator valves	75	20

(a) Explain which of the methods in the table is the most cost effective way of saving energy over a 10 year period. To obtain full marks you must support your answer with calculations.

____

____

____

____

(3)

(b) Describe what happens to the energy which is 'wasted' in a house.

___

___

___

___

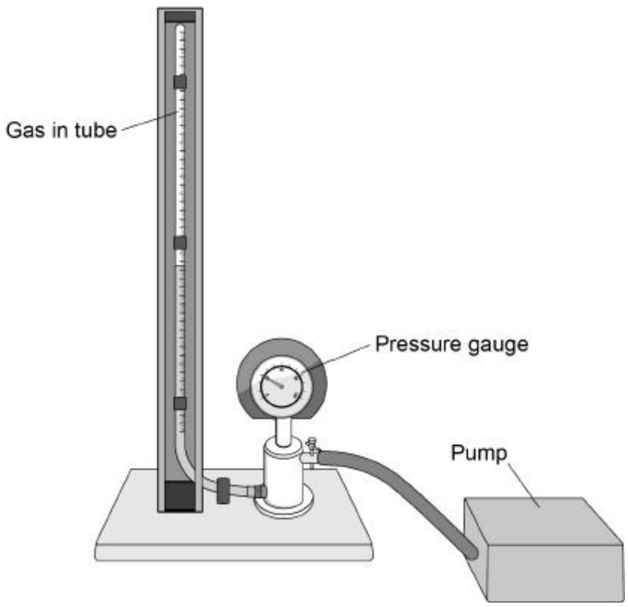
(2)
(Total 5 marks)

Q14.

A student investigated how the pressure exerted by a gas varied with the volume of the gas.

Figure 1 shows the equipment the student used.

Figure 1



A pump was used to compress the gas in a tube. As the volume of the gas decreases, the pressure of the gas increases.

(a) The student only recorded one set of results.

Give **two** reasons why taking repeat readings could provide more accurate data.

1. ___

___

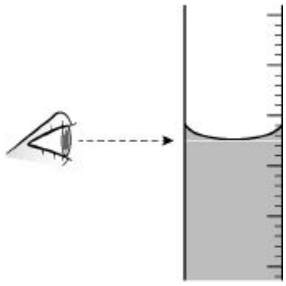
2. ___

___

(2)

(b) **Figure 2** shows the position of the student's eye when taking volume measurements.

Figure 2



Explain what type of error would be caused if the student's eye was **not** in line with the level of the liquid in the tube.

____

____

____

____

(2)

(c) If the gas is compressed too quickly the temperature of the gas increases.

Explain how the temperature increase would affect the pressure exerted by the gas.

____

____

____

____

(2)

(d) One of the student's results is given below.

pressure = 1.6×10^5 Pa
volume = $9.0\ cm^3$

Calculate the volume of the gas when the pressure was 1.8×10^5 Pa.

The temperature of the gas was constant.

____

____

____

Volume = ______________________ cm^3

(3)

(e) **Figure 3** shows a person using a bicycle pump to inflate a tyre.

Figure 3

The internal energy of the air increases as the tyre is inflated.

Explain why.

____

____

____

____

(2)
(Total 11 marks)

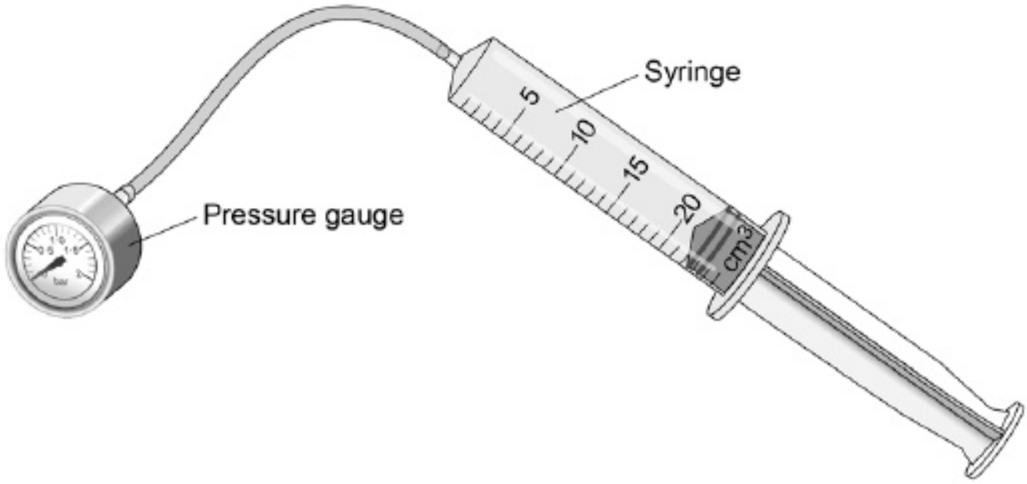
Q15.

A student investigated how the pressure of a gas varied with the volume of the gas.

The mass and temperature of the gas were constant.

Figure 1 shows the equipment the student used.

Figure 1



(a) What is the resolution of the syringe?

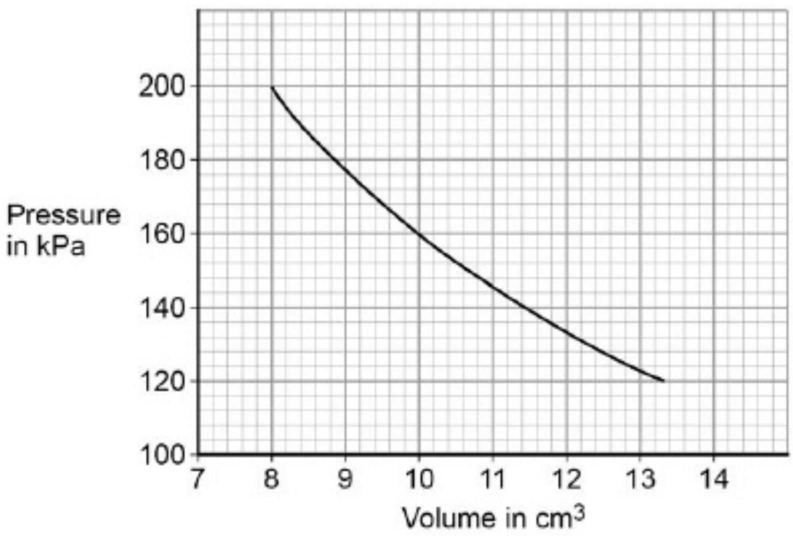
____________________ cm^3

(1)

The student compressed the gas in the syringe and read the pressure from the pressure gauge.

Figure 2 shows the student's results.

Figure 2



(b) What conclusion can the student make from the data in **Figure 2**?

Use data from **Figure 2** in your answer.

Give the reason for your answer.

____

____

____

____

____

____

(3)

(c) Explain why the pressure in the gas increases as the gas is compressed.

___

___

___

___

___

___

___

___

___

___

(4)
(Total 8 marks)

Q1.

(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]

Q2.

(a) **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.

3–4

Level 1: The method would not necessarily lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- part fill a measuring cylinder with water
- measure initial volume
- place object in water
- measure final volume
- volume of object = final volume − initial volume

- fill a displacement / eureka can with water
- water level with spout
- place object in water
- collect displaced water
- measuring cylinder used to determine volume of displaced water

(b) $\text{density} = \dfrac{48.6}{18.0}$ 1

density = 2.70 (g/cm^3) 1

*an answer of 2.70 (g/cm^3) scores **2** marks*

(c) limestone 1

(d) eye position when using measuring cylinder
or
water level in can (at start) not at level of spout
or
not all water displaced by stone is collected in container 1

(e) volume would be lower / higher 1

[9]

Q3.

(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]

Q4.

(a) 0 to 25 cm^3

1

(b) control

1

(c) 2 sets of data recorded from line of best fit to show that the product is the same in both cases (1600)

*allow for **1** mark one set of calculated data for one point on the line of best fit*

2

(d) decreases

1

increases

1

increases

1

[7]

Q5.

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

1

Student B was more likely to misread the temperature

1

(b) a random error

1

(c) 8.4 °C

1

(d) 740 (seconds)

allow answers in the range 730 – 780

1

(e) 0.40 × 199 000

1

79 600 (J)

1

*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

1

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

1

[9]

Q6.

(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 / m^3

1

[7]

Q7.

accept atoms / particles for ions throughout

(a metal has) free <u>electrons</u>

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) <u>electrons</u> 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]

Q8.

(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]

Q9.

(a) **solid**

<u>particles</u> vibrate about fixed positions

1

closely packed

accept regular

1

gas

<u>particles</u> move randomly

accept particles move faster

accept freely for randomly

1

far apart

1

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

1

unit mass / 1 kg

dependent on first marking point

1

(c) 41000 **or** 4.1×10^4 (J)

accept

41400 or 4.14×10^4

correct substitution of

$0.018 \times 2.3 \times 10^6$ *gains* ***1*** *mark*

2

(d) **AB**

changing state from solid to liquid / melting

1

at steady temperature

dependent on first ***AB*** *mark*

1

BC

temperature of liquid rises

1

until it reaches boiling point

dependent on first ***BC*** *mark*

1

[12]

Q10.

(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) 5.1×10^6 (J)

accept 5×10^6

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

2

(c) (i) mass of <u>ice</u>

allow volume / weight / amount / quantity of <u>ice</u>

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]

Q11.

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 $\rho = m / V$

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

[6]

Q12.

(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 <u>mean / average</u> 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]

Q13.

(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]

Q14.

(a) any **two** from:

- calculate a mean
- reduces the effect of random errors
  reduces human error is insufficient
- identify / remove anomalies
  allow to assess the repeatability of the data

2

(b) random error
allow a parallax error
human error is insufficient

1

(because) eye position would not be the same each time (relative to the liquid)
allow systematic error only if it is clear that the student always viewed liquid level from above meniscus (or below)

1

(c) (a temperature increase would) increase the pressure in the tube (even if the volume was constant)

1

(because a higher temperature would mean) higher (average) kinetic energy of molecules / particles

allow higher (average) speed for higher (average) kinetic energy

1

(d) $1.6 \times 10^5 \times 9.0$ (= 1.44×10^6)

1

$1.44 \times 10^6 = 1.8 \times 10^5 \times V$

*allow for **2** marks*

$$V = \frac{1.6 \times 10^5 \times 9.0}{1.8 \times 10^5}$$

1

or

$$V = \frac{1.44 \times 10^6}{1.8 \times 10^5}$$

V = 8.0 (cm^3)

1

*an answer of 8.0 (cm^3) scores **3** marks*

(e) work is done on the air (in the tyre)

1

so the temperature (of the air) increases

allow the (average) kinetic energy of the particles increases

1

[11]

Q15.

(a) 1 (cm^3)

1

(b) pressure is inversely proportional to volume

1

data to prove inversely proportional relationship

eg 8 × 200 = 1600

and 10 × 160 = 1600

*if no other marks score allow for **1** mark: as volume decreases pressure increases*

2

(c) (as the gas is compressed) the volume of gas decreases

1

(so there are) more frequent collisions of gas particles with container walls

1

(and) each particle collision with the wall causes a force

1

(so there is a) greater force on walls

1

[8]

Q1.

The answers to part (a) of this question tended to be very brief, with the single word insulation being a common response. Candidates often failed to note that the rubric asked them to *describe* what could be done, rather than simply to *state.* Strangely, in part (b), many candidates suggested that hot weather would make it difficult to keep a house warm.

Q2.

(a) The stem of the question referred to determining the density of the piece of rock; this was to set the context for the question. This part asked for a way of measuring the volume of the rock, but many students described the whole density experiment. Nevertheless, they were able to gain full marks if they described the volume measurement correctly.

A large number of students described measuring the length, width and height of the rock; no marks were given for this, as a piece of rock would not be a regular shape. Students who described a displacement method were usually able to gain some marks. However, not all descriptions were detailed enough to lead to a valid outcome so were unable to score more than one or two marks. A common statement was 'see how much the water rises' without reference to volume. Another imprecise answer was 'collect the water that overflows', without specifying a suitable vessel to collect it in, or how to measure the volume of the water displaced.

(b) Around 90% of students scored both marks for this calculation. Amongst those who did not score a mark, a fairly common mistake was thinking that the volume of 18.0 cm^3 meant 183.

(c) Limestone was the type of rock whose density was closest in value to the calculated value of 2.7 g/cm^3. Although 90% of students obtained the correct value in the previous question, only 70% chose limestone here. Granite was the most popular incorrect choice.

(d) This mark was only accessible to students who had described a displacement method. Many referred to the student mis-reading the measurement, which did not gain credit.
Just under one fifth of students scored the mark, usually for referring to water not being up to the level of the spout of the eureka can or water splashing out of the measuring cylinder.

(e) This was marked along with the previous question, so the effect on the volume measurement had to tie in with the source of error described. Approximately two thirds of those who scored the mark in the previous question were also able to score the mark here.

Q3.

(a) (i) Students found great difficulty in drawing a representation of a liquid - many of the diagrams looking like the structure of a gas rather than a liquid.

(ii) A poorly answered question, with only the very best students scoring both marks. Many students simply stated that there were fewer particles in a gas.

(b) (i) Students found difficulty in describing the way in which the motion of the ball bearings was similar to that of the gas particles; the difficulty was often with the language rather than the science.

(ii) Some students referred to the ball bearings in the model instead of to the particles in the gas. Some students simply said that the particles moved ‘more’. There were many students who failed to attempt this question.

Q7.

The mechanism of conduction appeared to be only loosely understood by many students. Unfortunately, unclear or incorrect statements such as 'the particles start to vibrate' were often seen. About half of the answers referred to the metal having free electrons, but descriptions of how these played a part in conduction were often hazy, if not wrong.

Q8.

Foundation Tier

Again this was a poorly answered question. In part (a), even those candidates who understood the mechanisms of conduction, convection and radiation failed to apply their knowledge to the situation described in the question.

Most candidates were able to pick up a mark in part (b) for mentioning light or sound. In part (c) very few mentioned trapped air in the cavity wall insulation.

The cooling effect of evaporation in part (d) appears to be little known. Again, those candidates who mentioned evaporation often failed to relate this knowledge to the particular context of the question.

Higher Tier

Although candidates showed good knowledge of the mechanisms of the three transfer processes in part (a), it was poorly answered in the context of the question. Candidates had considerable trouble expressing themselves coherently. Few attained the radiation mark. There may have been some confusion, since pupils are taught that double glazing reduces heat loss but science must be capable of being applied as well as regurgitated. Some candidates thought the diagram showed a window with an air gap open at the top. Many candidates described convection within the room or radiation from a radiator or from the Sun. Some had warm air ‘going’ through the glass.

A pleasing number of candidates answered part (d) well, though many failed to link energy ‘needed’ with evaporation.

Q10.

(a) Three-quarters of students knew why an energy storage system would work if the road surface was black. Many answers stated that ‘black surfaces absorb heat’ rather than ‘absorb heat well’.

(b) (i) A quarter of students gave a correct definition of specific latent heat of fusion. However, many incorrect responses referred to melting rather than a change from solid to liquid.

(ii) Nearly all students correctly calculated the amount of energy required to melt the ice.

(c) (i) Two-thirds of students correctly stated that the variable to be controlled was mass of ice. The remainder stated that the mass of salt had to be controlled.

(ii) Two-thirds of students correctly ticked two boxes with suggestions as to why the student stirred the crushed ice.

(iii) Nearly all students could correctly describe the pattern of how mass of salt added to some crushed ice affected the melting point of the ice.

(d) Just under half of students scored full marks for a calculation of energy transferred given values of power and time in non-SI units. Conversion from: kW to W; and minutes to seconds, was required. The spread of marks demonstrated this, with a third of students dropping one mark.

(e) The Quality of Communication question brought together the elements of the entire question and asked for advantages and disadvantages of using energy storage, salt and undersoil heating for keeping a road free from ice in the winter. Most students used the available space and many used additional pages.

Three-quarters of students scored four marks or more. Some excellent work was seen, but many students wasted time by repeating much of what was in the question. Also they ended a very good account with an unnecessary summary. Some very well written work only addressed either an advantage or a disadvantage of each system.

Q12.

(a) Whilst many answers referred to the arrangement of particles in solids and gases, fewer responses referred to the forces between the particles.

(b) (i) Just under half of the students answered correctly in terms of particles leaving the container / liquid. Other answers seen just referred to the particles ‘rising.’

(ii) Many answers referred to particles needing energy to escape, but often just stated ‘gaining energy’, without specifying that they had more energy than the particles that remained. Very few students gained the second marking point because they did not refer to “mean / average” energy. A fair number of students gained the third mark by linking a decrease in energy to the decrease in temperature.

Q13.

(a) This part was well answered. Most candidates were able to identify loft insulation as the most effective method and provided calculations supporting this conclusion.

(b) A surprising number made no reference to heat/thermal energy in their responses.

Q14.

(a) 64% of students scored 2 marks for this question. Some students scored both marking points in the first two answer lines. As long as their answer wasn’t followed by an incorrect answer in the second set of answer lines, this was ok. Calculate means and identify anomalies were commonly seen correct answers. Improve accuracy was insufficient.

(b) Only 3% of students scored 2 marks, with 15% of students scoring 1 mark. Lots of students stated human error, which is always insufficient for a description of the error type. A number of students stated parallax error, which was worth a mark.

(c) 49% of students scored 2 marks, while 42% of students scored 1 mark. Many students related higher E_k or higher speed to higher pressure. Some students only discussed collision frequency instead of pressure, scoring only 1 mark if they said the particles' speed increased.

(d) 60% of students scored 3 marks. The most common mistake was to wrongly calculate the constant, which prevented any further marks from scoring.

(e) 5% of students scored 2 marks, while 34% scored 1 mark. Students more often scored a mark for increased kinetic energy of particles. Increased kinetic energy of the air was insufficient. Most students thought that the internal energy increased because there are more air particles in total. The question was deliberately worded so that the increase in mass of air was not the focus of the question. The internal energy of the air increased because of the work done on the air, which raised the temperature of the air.