P3 - Test 1
PARTICLE MODEL OF MATTER

GCSE
AQA
PHYSICS

Materials
For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions
- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information
- The marks for the questions are shown in brackets
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](image)

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

Tick **two** boxes.

- Student A’s apparatus made sure the test was fair.
- Student A’s measurements had a higher resolution.
(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

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

Figure 2

![Temperature vs. Time Graph](https://www.examqa.com/graph.png)
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

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

Time = ......................... seconds

(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

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

Explain why.

(Total 9 marks)
The figure below shows a balloon filled with helium gas.

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

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(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.

<table>
<thead>
<tr>
<th>m$^3$ / kg</th>
<th>kg / m$^3$</th>
<th>kg m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Density = .................................... Unit ..................

(3)
(Total 7 marks)
A student wants to calculate the density of the two objects shown in the figure below.

**Metal cube**

© Whitehoune/iStock/Thinkstock

**Small statue**

© Marc Dietrich/Hemera/Thinkstock

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

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(Total 6 marks)
A student investigated the cooling effect of evaporation.

She used the equipment (datalogger and probe) shown in Figure 1 to measure how the temperature of a liquid changed as the liquid evaporated.

![Figure 1](image)

(a) Which type of variable was the temperature in this investigation?

Tick (✔) one box.

<table>
<thead>
<tr>
<th>Tick (✔)</th>
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</thead>
<tbody>
<tr>
<td>control</td>
</tr>
<tr>
<td>dependent</td>
</tr>
<tr>
<td>independent</td>
</tr>
</tbody>
</table>

(b) Before the investigation started, the student checked the accuracy of three different temperature probes. The student put the probes in a beaker of boiling water that had a temperature of 100.0 °C.

The readings from the three temperature probes are shown in Figure 2.

![Figure 2](image)
Which one of the temperature probes, A, B or C, was least accurate?

Write the correct answer in the box.

Give a reason for your answer.

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(2)
(c) **Figure 3** shows how the temperature recorded changed during the investigation.

![Figure 3](image)

(i) Use **Figure 3** to determine the lowest temperature recorded as the liquid evaporated.

Temperature = ........... °C

(ii) Use **Figure 3** to determine how long it took for all the liquid to evaporate. Give a reason for your answer.

Time = .............. seconds

Reason: ....................................................................................................
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(iii) How would increasing the starting temperature of the liquid above 20 °C affect the rate of evaporation of the liquid?

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(Total 7 marks)
A new design for a kettle is made from two layers of plastic separated by a vacuum. After the water in the kettle has boiled, the water stays hot for at least 2 hours.

The new kettle is shown below.

(a) The energy transferred from the water in the kettle to the surroundings in 2 hours is 46 200 J.

The mass of water in the kettle is 0.50 kg.

The specific heat capacity of water is 4200 J/kg °C.

The initial temperature of the water is 100 °C.

Calculate the temperature of the water in the kettle after 2 hours.

Temperature after 2 hours = ................. °C

(b) Calculate the average power output from the water in the kettle to the surroundings in 2 hours.

Average power output = ...................... W

(Total 5 marks)
A student investigated the cooling effect of evaporation. She used the equipment in Figure 1 to measure how the temperature of three different liquids changed as the liquids evaporated.

**Figure 1**

![Figure 1](image)

(a) The temperature and volume of each liquid was the same at the start of the investigation. State one further control variable in this investigation.

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(1)

(b) Give two advantages of using dataloggers and temperature probes compared to using the thermometer shown in Figure 2.

**Figure 2**

![Figure 2](image)

1. ........................................................................................................................................
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2. ........................................................................................................................................
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(2)
(c) The student's results are shown in Figure 3.

Figure 3

(i) Calculate the average rate of temperature decrease of liquid C between 0 and 100 seconds.

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Average rate of temperature decrease = ...................... °C / s (2)

(ii) Give one conclusion that can be made about the rate of temperature decrease of all three liquids from the results in Figure 3.

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(1)

(iii) Which liquid had the lowest rate of evaporation? Give a reason for your answer.

Liquid ........................................................................................................................................

Reason ........................................................................................................................................

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(1)
(iv) A second student did the same investigation but using a smaller volume of liquid than the first student.

All other variables were kept the same.

What effect would this have on the results of the second student’s investigation?

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(1)

(d) Explain how the evaporation of a liquid causes the temperature of the remaining liquid to decrease.

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(3)

(Total 11 marks)
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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(b) What is meant by ‘specific latent heat of vaporisation’?

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(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 = $2.3 \times 10^6$ J / kg.

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Energy required = .................................... J
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**

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**Section BC**

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(4)
(Total 12 marks)
(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.

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(1)

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

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(2)

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

Specific latent heat of fusion of ice = \(3.4 \times 10^5\) J/kg.

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Energy = ...................................... J

(2)
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.

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

Suggest two reasons why.

Tick (✓) two boxes.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To raise the melting point of the ice</td>
<td></td>
</tr>
<tr>
<td>To lower the melting point of the ice</td>
<td></td>
</tr>
<tr>
<td>To distribute the salt throughout the ice</td>
<td></td>
</tr>
<tr>
<td>To keep all the ice at the same temperature</td>
<td></td>
</tr>
<tr>
<td>To reduce energy transfer from the surroundings to the ice</td>
<td></td>
</tr>
</tbody>
</table>

(2)
(iii) The table below shows the data that the student obtained.

<table>
<thead>
<tr>
<th>Mass of salt added in grams</th>
<th>0</th>
<th>10</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting point of ice in °C</td>
<td>0</td>
<td>-6</td>
<td>-16</td>
</tr>
</tbody>
</table>

Describe the pattern shown in the table.

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(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.

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Energy transferred = ...................................... J

(3)
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

Extra space

(6) (Total 18 marks)
Energy can be transferred through some materials by convection.

(a) Use the correct answer from the box to complete the sentence.

<table>
<thead>
<tr>
<th>gas</th>
<th>liquid</th>
<th>solid</th>
</tr>
</thead>
</table>

Energy cannot be transferred by convection through a ............................................. .

(b) The figure below shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is –5 °C.

Use the correct answer from the box to complete each sentence.

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

<table>
<thead>
<tr>
<th>decreased</th>
<th>unchanged</th>
<th>increased</th>
</tr>
</thead>
</table>

When the air near the freezer compartment is cooled, the energy of the air particles is ............................................. .

The spaces between the air particles are ............................................. .

The density of the air is ............................................. .
(c) The table below shows some information about three fridges, A, B and C.

The efficiency of each fridge is the same.

<table>
<thead>
<tr>
<th>Fridge</th>
<th>Volume in litres</th>
<th>Energy used in one year in kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>232</td>
<td>292</td>
</tr>
<tr>
<td>B</td>
<td>382</td>
<td>409</td>
</tr>
<tr>
<td>C</td>
<td>622</td>
<td>524</td>
</tr>
</tbody>
</table>

(i) Which fridge, A, B or C, would cost the least to use for 1 year?  
Give one reason for your answer.
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(ii) A householder looks at the data in the table above.

What should she conclude about the pattern linking the volume of the fridge and the energy it uses in one year?
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(iii) The householder could not be certain that her conclusion is correct for all fridges.

Suggest one reason why not.
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(Total 8 marks)
A student used the apparatus in Figure 1 to compare the energy needed to heat blocks of different materials.

Each block had the same mass.

Each block had holes for the thermometer and the immersion heater.

Each block had a starting temperature of 20 °C.

The student measured the time taken to increase the temperature of each material by 5 °C.

(a) (i) State two variables the student controlled.

1 ............................................................................................................

2 ............................................................................................................

(2)
Figure 2 shows the student’s results.

(ii) Why was a bar chart drawn rather than a line graph?
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(1)

(iii) Which material was supplied with the most energy?
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Give the reason for your answer.
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(2)
(iv) The iron block had a mass of 2 kg.

Calculate the energy transferred by the heater to increase the temperature of the iron block by 5 °C.

The specific heat capacity of iron is 450 J / kg °C.

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Energy transferred = ................................................................. J

(2)

(b) The student used the same apparatus to heat a 1 kg block of aluminium.

He recorded the temperature of the block as it was heated from room temperature.

The results are shown in Figure 3.

![Figure 3](image)

(i) One of the student’s results is anomalous.

Draw a ring around the anomalous result.

(ii) Draw the line of best fit for the points plotted in Figure 3.

(iii) What was the temperature of the room?

Temperature = ............................................. °C

(1)

(1)

(1)
(iv) What was the interval of the time values used by the student?

Interval = ........................................ minutes

(Total 11 marks)

Figure 1 shows one way that biscuit manufacturers cook large quantities of biscuits.

The uncooked biscuits are placed on a moving metal grid.

The biscuits pass between two hot electrical heating elements inside an oven.

The biscuits turn brown as they cook.

Figure 1

![Diagram of biscuit cooking](https://example.com/diagram)

The oven has two control knobs, as shown in Figure 2.

Figure 2

<table>
<thead>
<tr>
<th>Power</th>
<th>Speed of moving metal grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Slow</td>
</tr>
<tr>
<td>3500 watts</td>
<td>Fast</td>
</tr>
</tbody>
</table>

(a) Which type of electromagnetic radiation makes the biscuits turn brown?

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(b) Suggest two ways of cooking the biscuits in this oven, to make them turn browner.

1 ...........................................................................................................................................................................

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2 ...........................................................................................................................................................................

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(c) The inside and outside surfaces of the oven are light-coloured and shiny.
Explain why.

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(3) (Total 6 marks)