Particle Model part 4 AQA Triple Physics

Name:

Class:

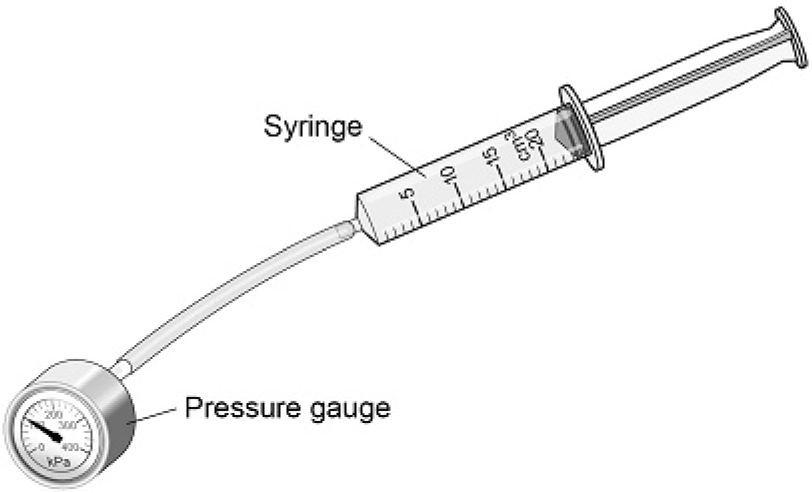
Date:

Time: **65 minutes**

Marks: **63 marks**

Comments:

1. A student used the equipment in the image below to investigate how the pressure of a gas varies with the volume of the gas.



The syringe is filled with air.

The table below shows the results.

Volume in cm^3	Pressure in kPa
24	100
20	120
12	200
10	240

(a) Describe how the student could use the equipment in the image above to obtain the data shown in the table.

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(4)

(b) Describe what happens to the pressure of the air when the volume of the air is halved.

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(2)

(c) The temperature of the air in the syringe remained constant during the student's investigation.

Which **two** properties of the air particles would change if the temperature increased?

Tick (✓) **two** boxes.

kinetic energy ☐

mass ☐

shape ☐

speed ☐

volume ☐

(2)
(Total 8 marks)

2. A student heated water in an electric kettle.

(a) Water has a high specific heat capacity.

Complete the sentence.

Choose answers from the box.

°C	**J**	**kg**	**s**	**W**

The specific heat capacity of a substance is the energy needed to raise the

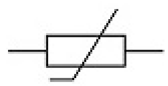
temperature of 1 ___________ of the substance by 1 ___________.

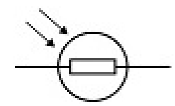
(2)

(b) The kettle circuit contains a thermistor which is used to switch the kettle off when the water reaches 100 °C.

What is the correct symbol for a thermistor?

Tick (✓) **one** box.





(1)

(c) The resistance of the heating element in the kettle is 15 Ω.

The current in the heating element is 12 A.

Calculate the power of the heating element.

Use the equation:

$$\text{power} = (\text{current})^2 \times \text{resistance}$$

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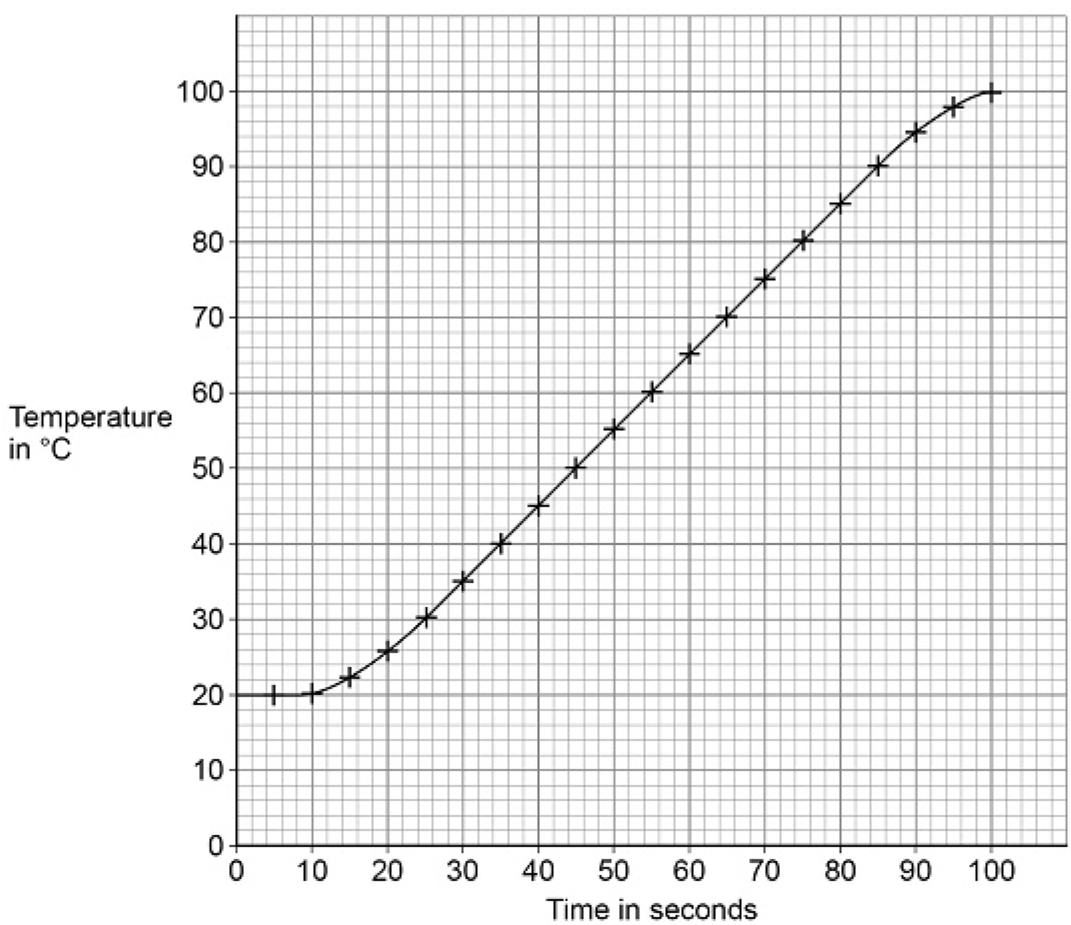
Power = ________________ W

(2)

The student investigated how quickly the kettle could increase the temperature of 0.50 kg of water.

The graph below shows the results of the investigation.



(d) The temperature of the water did **not** start to increase until 10 seconds after the kettle was switched on.

What is the reason for this?

Tick (✓) **one** box.

Energy is transferred from the surroundings to the kettle.	☐
The charge flows slowly through the kettle circuit.	☐
The heating element in the kettle takes time to heat up.	☐
The power output of the kettle increases slowly.	☐

(1)

(e) Describe a method the student could have used to obtain the results shown in the graph.

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(6)

(f) The mass of water in the kettle was 0.50 kg.

The temperature of the water increased from 20 °C to 100 °C.

specific heat capacity of water = 4200 J/kg/°C

Calculate the energy transferred to the water.

Use the Physics Equations Sheet.

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Energy = ________________ J

(3)

(g) The water in the kettle boiled for a short time before the kettle switched off.

During this time 5.0 g of water changed to steam.

specific latent heat of vaporisation of water = 2 260 000 J/kg

Calculate the energy transferred to change the water to steam.

Use the Physics Equations Sheet.

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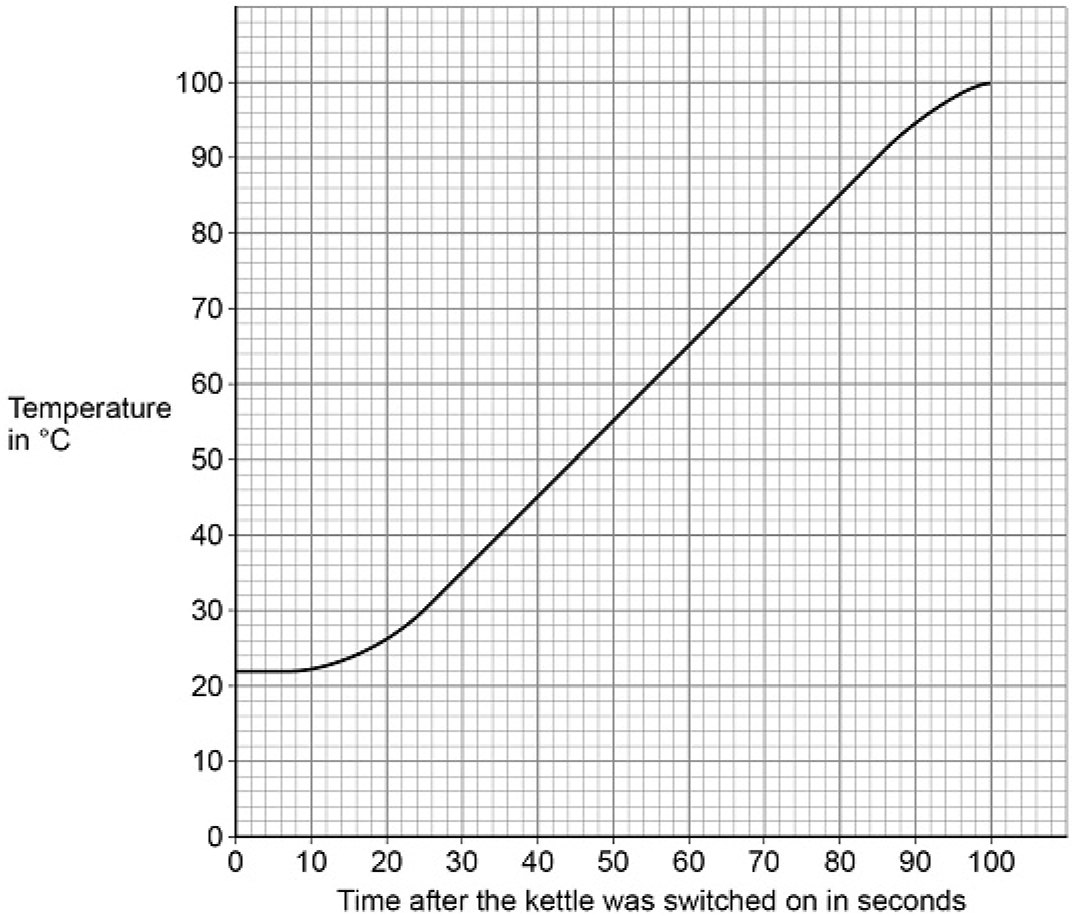
Energy = ________________ J

(3)

(Total 18 marks)

3. An electric kettle was switched on.

The graph below shows how the temperature of the water inside the kettle changed.



(a) When the kettle was switched on the temperature of the water did **not** immediately start to increase.

Suggest **one** reason why.

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(1)

(b) The energy transferred to the water in 100 seconds was 155 000 J.

specific heat capacity of water = 4200 J/kg °C

Determine the mass of water in the kettle.

Use the graph above.

Give your answer to 2 significant figures.

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Mass of water (2 significant figures) = ________________ kg

(5)

(c) The straight section of the line in above graph can be used to calculate the useful power output of the kettle.

Explain how.

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(3)

(Total 9 marks)

4. The photograph below shows a balloon filled with helium gas.

(a) Which statements describe the movement of the gas particles in the balloon?

Tick (✓) **two** boxes.

The particles all move in a predictable way.	☐
The particles move at the same speed.	☐
The particles move in circular paths.	☐
The particles move in random directions.	☐
The particles move with a range of speeds.	☐
The particles vibrate about fixed positions.	☐

(2)

(b) The pressure of the helium in the balloon is 100 000 Pa.

The volume of the balloon is 0.030 m^3.

The balloon is compressed at a constant temperature causing the volume to decrease to 0.025 m^3.

No helium leaves the balloon.

Calculate the new pressure in the balloon.

New pressure = ________________ Pa

(4)

(c) The temperature of the helium in the balloon was increased.

The mass and volume of helium in the balloon remained constant.

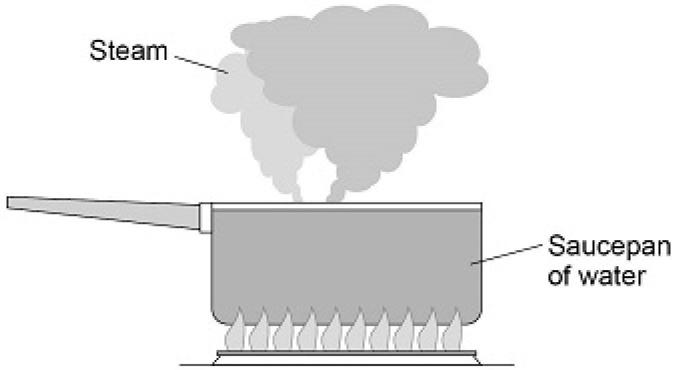
Explain why the pressure exerted by the helium inside the balloon would increase.

(4)

(Total 10 marks)

5. **Figure 1** shows water being heated. Eventually the water changed into steam.

Figure 1



(a) Complete the sentences.

Choose answers from the box.

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

greater than	**less than**	**the same as**

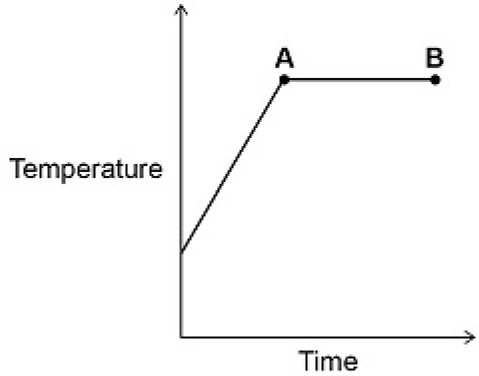
The distance between the particles in steam is ____________________________ the distance between the particles in liquid water.

The density of steam is ____________________________ the density of liquid water.

(2)

Figure 2 shows how the temperature of the water varied with time.

Figure 2



(b) What is the name of the process that is taking place between points **A** and **B**?

Give a reason for your answer.

Process ____

Reason ____

____

(2)

(c) A mass of 0.063 kg of water was turned into steam.

The specific latent heat of vaporisation of water is 2 260 000 J/kg

Calculate the thermal energy transferred to the water to turn it into steam.

Use the equation:

thermal energy for a change of state = mass × specific latent heat

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____

Energy = ______________________ J

(2)

(d) The mass of the steam was 0.063 kg

The volume of the steam was 0.105 m^3

Calculate the density of steam.

Use the equation:

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

Choose the unit from the box.

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

____

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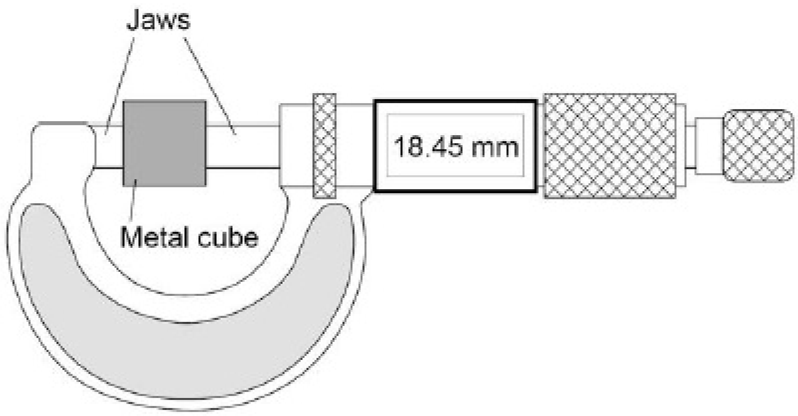
Density = ____________________ Unit ____________________

(3)

(Total 9 marks)

6. A student measured the width of a solid metal cube using a digital micrometer.

The figure below shows the micrometer.



(a) The resolution of the micrometer is 0.01 mm

The student could have used a metre rule to measure the width of the cube.

Explain how using a metre rule would have affected the accuracy of the student's measurement of width.

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(2)

(b) The mass of the metal cube was measured using a top pan balance.

The balance had a zero error.

Explain how the zero error may be corrected after readings had been taken from the balance.

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(2)

(c) The width of the cube was 18.45 mm. The density of the cube was 8.0×10^3 kg/m^3

Calculate the mass of the cube.

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Mass = ________________________________ kg

(5)

(Total 9 marks)

Mark schemes

1. (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:

- record the initial volume of air
- record the initial pressure
- push the plunger of the syringe
- to decrease the volume of air
- read the new value on the pressure gauge
- record the new value of the volume
- repeat for different volumes

(b) (when the volume is halved) the pressure doubles

*allow for **1** mark when the volume is halved the pressure increases*

2

(c) kinetic energy

1

speed

1

[8]

2. (a) kg

allow kilogram

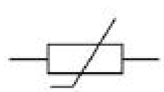
1

°C

allow degrees Celsius

1

(b)



1

(c) $P = 12^2 \times 15$

1

P = 2160 (W)

1

(d) The heating element in the kettle takes time to heat up

1

(e) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced 3–4

3–4

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

1–2

No relevant content

0

Indicative content:

- measure the mass of water using a balance
  or
  measure the volume of water using a measuring cylinder
- measure the initial temperature of the water
- pour the water into the kettle
- put temperature probe in the water
  or
  put a thermometer in the water
- switch kettle on
- record temperature
- measure time with a stopclock
- use an interval of 5 seconds

(f) $\Delta\Theta = 80$ (°C)

1

$E = 0.50 \times 4200 \times 80$

allow $E = 0.50 \times 4200 \times$ their value of $\Delta\Theta$

1

$E = 168\,000$ (J)

allow an answer consistent with their value of $\Delta\Theta$

1

(g) $m = 0.005$ (kg)

1

$E = 0.005 \times 2\,260\,000$

this mark may score if m is not/incorrectly converted

1

$E = 11\,300$ (J)

allow an answer consistent with their value of m

1

[18]

3. (a) the heating element of the kettle takes time to heat up

allow the kettle takes time to heat up

1

(b) $\Delta\Theta = 78$ (°C)

1

$155\,000 = m \times 4200 \times 78$

allow a correct substitution using an incorrect value of $\Delta\Theta$

1

$m = \frac{155\,000}{4200 \times 78}$

allow a correct rearrangement using an incorrect value of $\Delta\Theta$

1

$m = 0.4731$ (kg)

allow a correct calculation of mass using an incorrect value of $\Delta\Theta$

1

$m = 0.47$ (kg)

1

(c) Gradient = $\frac{\Delta\theta}{t}$

allow gradient = rate of temperature increase
allow calculation of gradient

1

$Pt = mc\Delta\Theta$

1

$P = \text{gradient} \times mc$

1

[9]

4. (a) The particles move in random directions.

1

The particles move with a range of speeds.

1

(b) 100 000 × 0.030 = 3000

1

p × 0.025 = 3000

allow a correct substitution using an incorrectly calculated value using pV = constant

1

$p = \frac{3000}{0.025}$

allow a correct rearrangement using an incorrect value of the constant

1

p = 120 000 (Pa)

allow a correct calculation using an incorrect value of the constant

allow correct substitution into $p_1V_1 = p_2V_2$ for first 2 marking points

1

(c) particles would have a higher (mean) kinetic energy

allow particles would have a higher (mean) speed
do not accept particles vibrate more

1

(so) increased number of collisions with the walls of the balloon per second

allow greater frequency of collisions with the walls of the balloon

1

greater forces exerted in collisions (between particles and balloon walls)

allow greater rate of change of momentum (of particles)

1

greater force exerted on same area

allow description using p=F/A

1

[10]

5. (a) greater than

1

less than

1

in this order only

(b) <u>boiling</u>

ignore evaporation

1

temperature is constant

allow temperature remains the same

1

(c)

*a correct answer that rounds to 140 000 (J) scores **2** marks*

E = 0.063 × 2 260 000

1

E = 140 000 (J)

allow 142 380 (J)

1

(d)

*an answer of 0.6 scores **2** marks*

$\text{density} = \frac{0.063}{0.105}$

1

density = 0.6

1

kg / m^3

1

[9]

6. (a) metre rule has a <u>lower</u> resolution

allow metre rule has a resolution of 1 mm / 1 cm

fewer decimal places is insufficient

1

so is less accurate (than the micrometer screw gauge)

1

(b) record the value of the zero error when there is no object on the balance

subtract / add the value of the zero error

1

subtract / add the value of the zero error

1

(c)

*an answer of 0.0502 (kg) scores **5** marks*

$V = (18.45 \times 10^{-3})^3$
or
$V = 0.01845^3$

this mark may be awarded if width is incorrectly / not converted

1

$V = 6.28 \times 10^{-6}$ (m^3)

this answer only

1

$$8.0 \times 10^3 = \frac{m}{6.28 \times 10^{-6}}$$

allow

$$8.0 \times 10^3 = \frac{m}{\text{their calculated V}}$$

1

$m = 8.0 \times 10^3 \times 6.28 \times 10^{-6}$

allow $m = 8.0 \times 10^3 \times$ *their calculated V*

1

$m = 0.0502$ (kg)

allow an answer consistent with their calculated V

1

[9]