Particle Model part 1 AQA Triple Physics

Name: ________________

Class: ________________

Date: ________________

Time: **79 minutes**

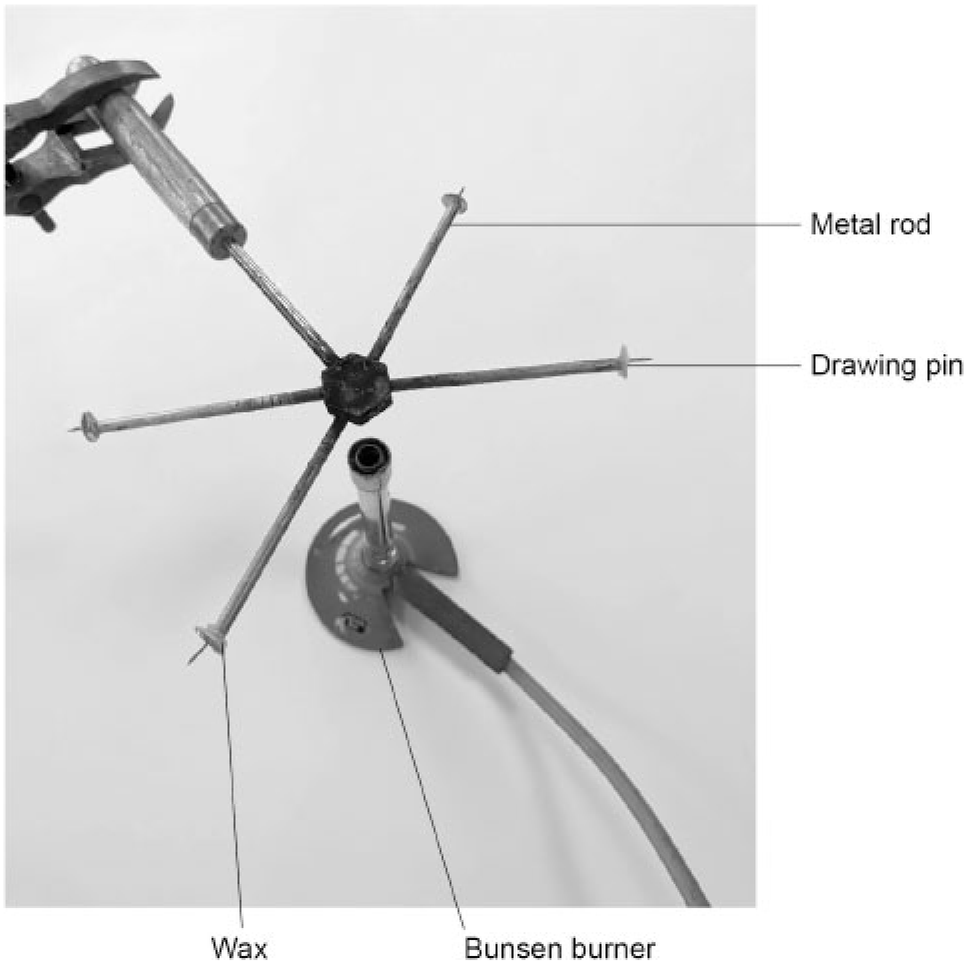
Marks: **73 marks**

Comments:

1. A student investigated the thermal conductivity of different metals.

Figure 1 shows some of the apparatus used.

Figure 1



Each rod was made from a different metal.

The metal rods are joined at the centre.

The size of each metal rod was the same.

This is the method used.

1. Attach a drawing pin to the end of each metal rod using wax.
2. Light the Bunsen burner.
3. Start a stopclock.
4. Record the time taken for the wax to melt and for the drawing pin to fall off each metal rod.

The table below shows the results.

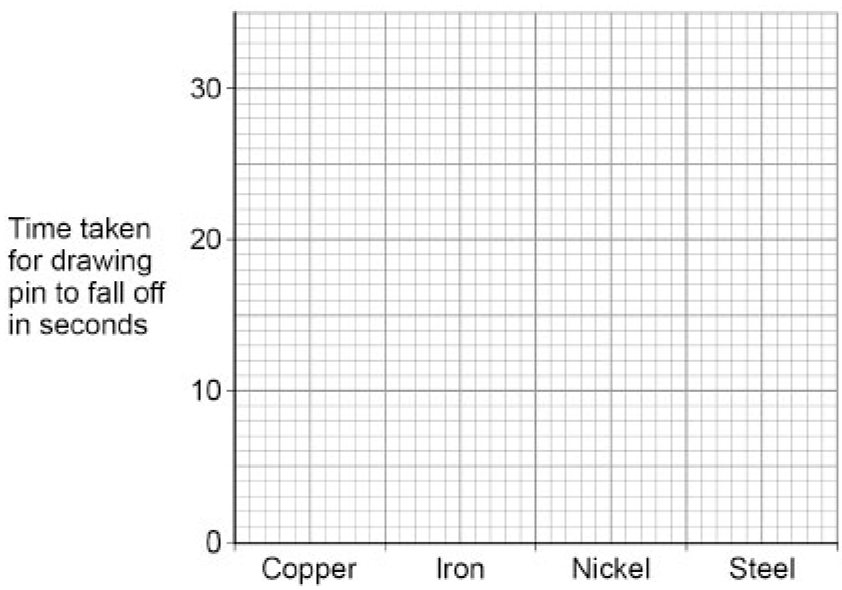
Type of metal	**Time taken for drawing pin to fall off in seconds**
Copper	10
Iron	22
Nickel	18
Steel	24

(a) Complete **Figure 2**.

You should:

- label the *x*-axis
- plot the data from the table above as a bar chart.

Figure 2



(3)

(b) Which type of metal in the table above had the greatest thermal conductivity?

Give a reason for your answer.

Tick (✓) **one** box.

Copper ☐ Iron ☐ Nickel ☐ Steel ☐

Reason ____

____

____

(2)

(c) The thermal energy transferred to the nickel rod was 132 J.

The temperature change of the rod was 20 °C.

mass of the nickel rod = 0.015 kg

Calculate the specific heat capacity of nickel.

Use the equation:

$$\text{specific heat capacity} = \frac{\text{thermal energy}}{(\text{mass} \times \text{temperature change})}$$

____

____

____

____

Specific heat capacity = ____________________ J/kg °C

(2)

Use the Physics Equations Sheet to answer parts (d) and (e).

(d) Write down the equation which links energy transferred (E), power (P) and time (t).

____

(1)

(e) At the end of the investigation, the Bunsen burner was turned off.

As the nickel rod cooled to room temperature, the rod transferred 132 J of energy to the room.

The mean power transfer was 0.33 W.

Calculate the time taken for the energy transfer.

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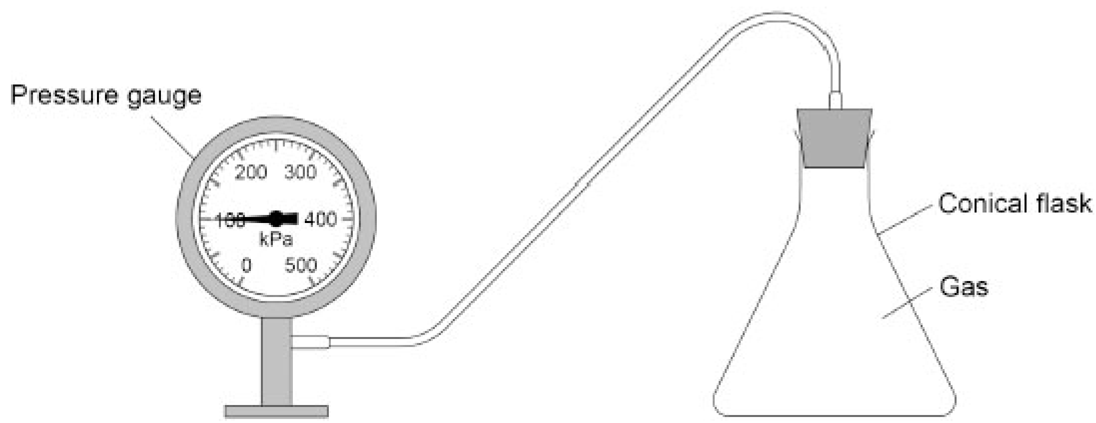
Time taken = ____________________ s

(3)

(Total 11 marks)

2. A teacher demonstrated how the pressure in a gas varies with temperature.

The figure below shows some of the apparatus used.



The teacher heated the conical flask.

The temperature of the gas in the flask increased.

(a) How did heating the gas affect the average speed of the gas particles?

Tick (✓) **one** box.

The speed decreased. ☐

The speed stayed the same. ☐

The speed increased. ☐

(1)

(b) How did heating the gas affect the average kinetic energy of the gas particles?

Tick (✓) **one** box.

The kinetic energy decreased. ☐

The kinetic energy stayed the same. ☐

The kinetic energy increased. ☐

(1)

As the temperature of the gas increased, the pressure of the gas inside the flask increased.

(c) How did increasing the pressure affect the number of collisions each second between gas particles and the walls of the flask?

Tick (✓) **one** box.

The number of collisions each second decreased. ☐

The number of collisions each second stayed the same. ☐

The number of collisions each second increased. ☐

(1)

(d) What happened to the force exerted on the walls of the flask by the gas particles when the pressure increased?

Tick (✓) **one** box.

The force exerted decreased. ☐

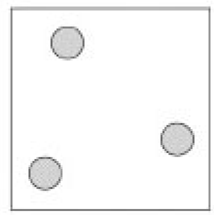
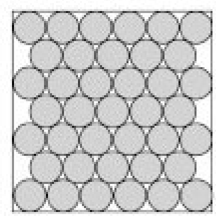
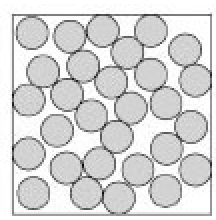
The force exerted stayed the same. ☐

The force exerted increased. ☐

(1)

(e) At different temperatures, nitrogen can be a gas, a liquid or a solid.

Draw **one** line from the state of matter to the arrangement of particles in each state.

State of matter	**Arrangement of particles**
Liquid	
Solid	
Gas	

(2)

(f) The boiling point of nitrogen is −196 °C and the melting point of nitrogen is −210 −C.

What is the state of matter of nitrogen at a temperature of −200 °C?

Tick (✓) **one** box.

Solid ☐ Liquid ☐ Gas ☐

(1)

(g) What is the state of matter of nitrogen when the temperature is lower than the melting point of nitrogen?

Tick (✓) **one** box.

Solid ☐ Liquid ☐ Gas ☐

(1)

(h) As a substance melts, the temperature of the substance is constant.

What happens to the kinetic energy **and** the potential energy of the particles as the substance melts?

Tick (✓) **one** box in each row.

	Decreases	**Stays the same**	**Increases**
Kinetic energy of particles			
Potential energy of particles			

(2)

(Total 10 marks)

3. Tides and wind are two renewable energy resources.

(a) Describe the difference between renewable energy resources and non-renewable energy resources.

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(2)

Figure 1 shows a new design of tidal turbine to generate electricity using the tides.

Figure 1

Use the Physics Equations Sheet to answer parts (b) and (c).

(b) Write down the equation which links density (*ρ*), mass (*m*) and volume (*V*).

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(1)

(c) The mass of seawater passing through the tidal turbine each second is 824 000 kg.

The density of seawater is 1030 kg/m^3.

Calculate the volume of seawater passing through the tidal turbine each second.

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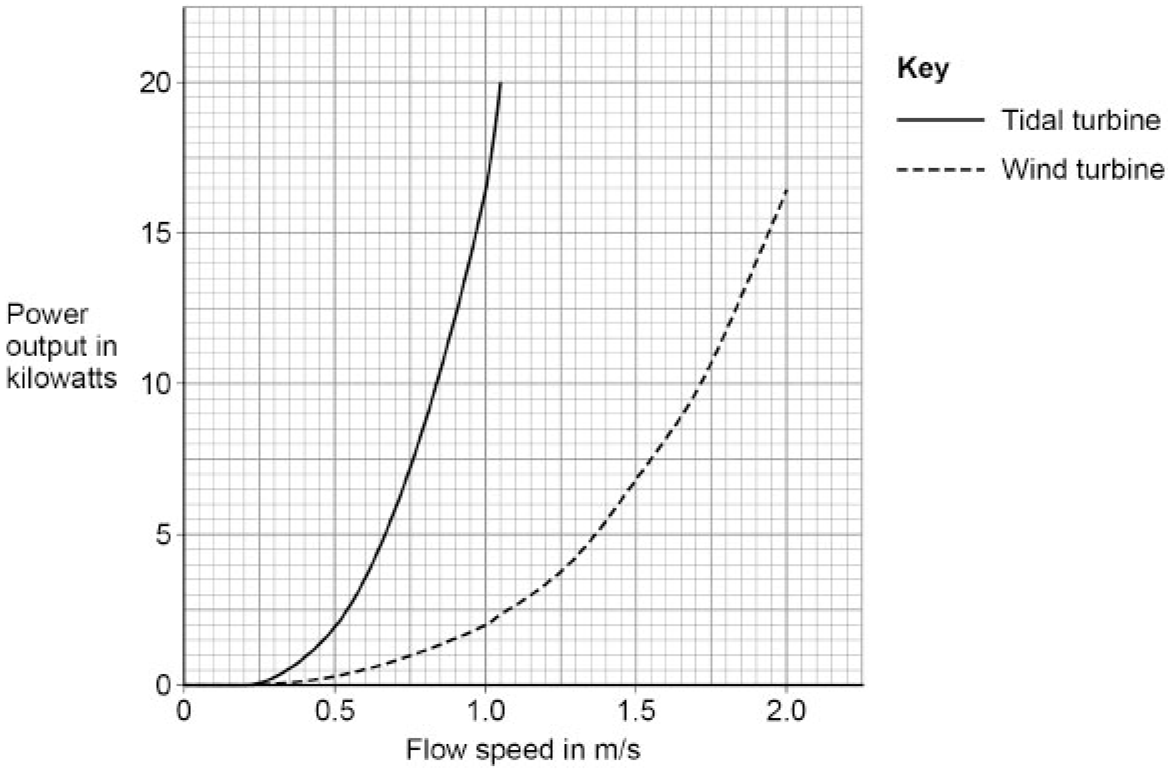
Volume = ____________________ m^3

(3)

The speed of the tide or the speed of the wind past a turbine is called the 'flow speed'.

Figure 2 shows how the power output of a tidal turbine compares with a wind turbine for different flow speeds.

Figure 2



(d) As flow speed increases, power output increases.

Give **two** other conclusions that can be made using information from **Figure 2**.

1 ____

____

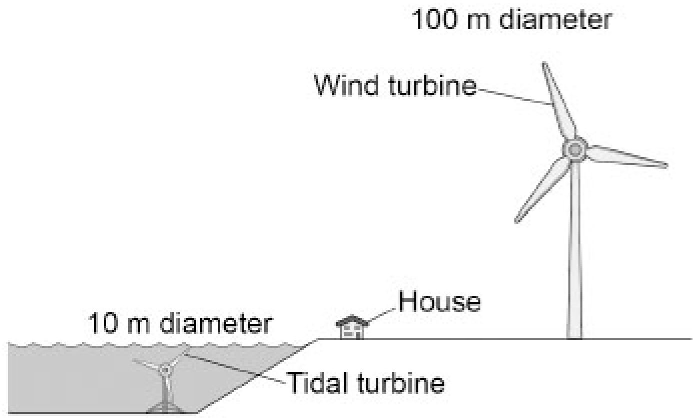
2 ____

____

(2)

(e) **Figure 3** shows the turbines used to obtain the data for **Figure 2**.

Figure 3



Compare the environmental impacts of the wind turbine and the tidal turbine in **Figure 3**.

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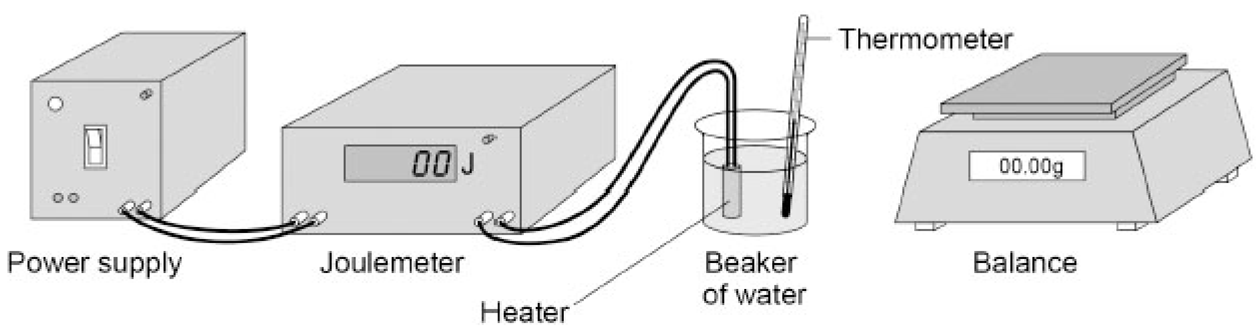
(4)
(Total 12 marks)

4. A student determined the specific heat capacity of water.

The figure below shows the apparatus used.



The joulemeter measures energy transfer.

(a) Give **one** hazard in the investigation.

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(1)

(b) Describe how the student could determine the specific heat capacity of water using the apparatus in the figure above.

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(6)

(c) One source of error in the experiment was energy loss to the surroundings.

Suggest **one** change to the apparatus to reduce energy loss to the surroundings.

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(1)

(d) The student's value for the specific heat capacity of water was 4410 J/kg °C.

The actual value for the specific heat capacity of water is 4200 J/kg °C.

Calculate the percentage difference between the student's value and the actual value.

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____

Percentage difference = ____________________ %

(2)

(Total 10 marks)

5. **Figure 1** shows a battery-powered hand warmer that contains a heating pad.

The battery transfers energy to increase the temperature of the heating pad.

Figure 1

(a) The heating pad has a mass of 0.20 kg.

When the hand warmer was switched on, the energy transferred to the heating pad was 8000 J.

specific heat capacity of heating pad = 1600 J/kg °C

Calculate the temperature increase of the heating pad.

Use the Physics Equations Sheet.

____

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____

Temperature increase = ____________________ °C

(3)

(b) The hand warmer was powered by a 5.0 V battery.

The battery transferred 180 kJ of energy to the heating pad.

Calculate the charge flow through the battery.

Use the Physics Equations Sheet.

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____

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Charge flow = ____________________ C

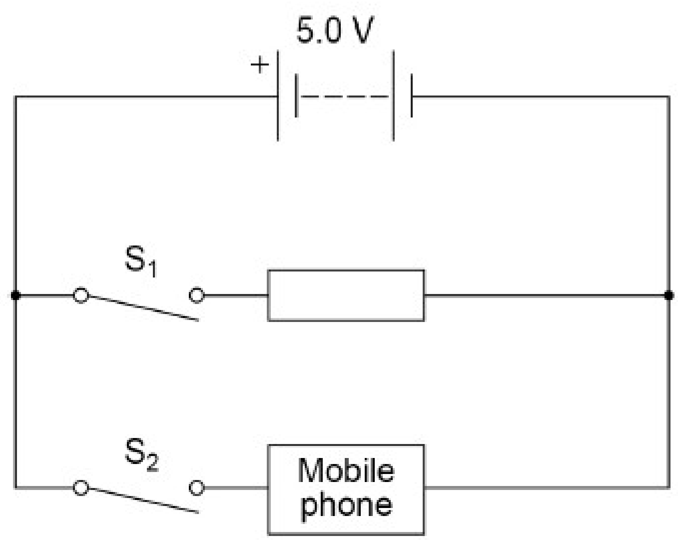
(4)

(c) The circuit inside the hand warmer can be connected to a mobile phone to recharge the mobile phone.

Figure 2 shows the circuit diagram when the hand warmer is connected to a mobile phone.

The heating pad of the hand warmer is represented by the resistor symbol.

Figure 2



Explain how closing both switches S_1 and S_2 affects the power output of the battery compared with only closing switch S_1.

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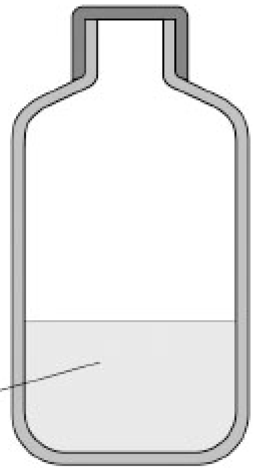
(3)

(Total 10 marks)

6. A scientist poured some liquid nitrogen into a container.

The container was then sealed.

The figure below shows the container.



(a) The liquid nitrogen was at its boiling point.

When 9950 J of thermal energy was transferred to the liquid nitrogen, 50 g of the nitrogen turned into a gas.

Calculate the specific latent heat of vaporisation of nitrogen.

Use the Physics Equations Sheet.

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Specific latent heat of vaporisation = ____________________ J/kg

(4)

(b) Explain how the internal energy of the nitrogen changed as the nitrogen turned from a liquid to a gas.

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(3)

(c) After the nitrogen had boiled, the temperature of the gas increased.

Explain how the pressure in the container changed as the temperature increased.

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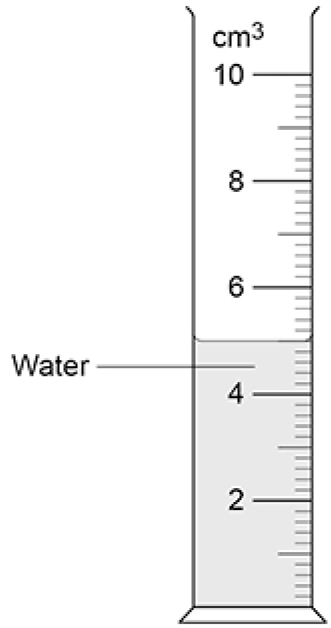
(4)

(Total 11 marks)

7. **Figure 1** shows a measuring cylinder containing some water.

Figure 1



(a) What range of volumes can be measured using the measuring cylinder?

Tick (✓) **one** box.

0.0 to 0.2 cm^3 ☐

0.0 to 2.0 cm^3 ☐

0.0 to 10.0 cm^3 ☐

(1)

A student used the measuring cylinder to measure the volume of a metal ring.

(b) The student tied the metal ring to some very thin string and lowered the ring into the measuring cylinder.

The student could have used thick string instead of thin string.

How would using thick string have affected the measured volume of the metal ring?

Tick (✓) **one** box.

The measured volume would be smaller. ☐

The measured volume would not be affected. ☐

The measured volume would be larger. ☐

(1)

(c) The table below shows the results.

Volume of water in cm^3	Volume of water and ring in cm^3	Volume of ring in cm^3
5.0	5.4	**X**

Calculate value **X** in above table.

____

____

X = _____________________ cm^3

(1)

(d) The student measured the volume of the ring three times.

The results were all the same.

Which of the following describes the student s results?

Tick (✓) **one** box.

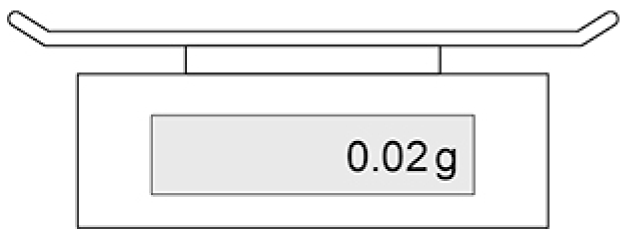
The results are anomalies.	☐
The results are repeatable.	☐
The results contain random errors.	☐

(1)

(e) The student used a balance to measure the mass of the ring.

Figure 2 shows the balance.

Figure 2



The student noticed that the balance had a reading of 0.02 g when there was no object on the balance.

How should the student correct this error **after** the mass of the ring had been measured?

Tick (✓) **one** box.

Add 0.02 to the measurement	☐
Divide the measurement by 0.02	☐
Multiply the measurement by 0.02	☐
Subtract 0.02 from the measurement	☐

(1)

Use the Physics Equations Sheet to answer parts (f) and (g).

(f) Write down the equation which links density (ρ), mass (m) and volume (V).

____

(1)

(g) A different metal ring has a volume of 0.3 cm^3.

The density of this ring is 22 g/cm^3.

Calculate the mass of this ring.

Give your answer in grams.

____

____

____

____

____

Mass = ____________________ g

(3)

(Total 9 marks)

Mark schemes

1. (a) x-axis labelled: (type of) metal

1

4 bars correctly drawn

allow a tolerance of ± ½ a small square

*allow **1** mark for 2 or 3 bars drawn correctly*

2

(b) copper

1

least time for drawing pin to fall
or
least time for wax to melt

dependent on MP1

allow less for least

allow pin fell off quicker

allow quickest time to melt the wax

1

(c)

$$c = \frac{132}{(0.015 \times 20)}$$

1

c = 440 (J/kg °C)

1

(d)

$$\text{power} = \frac{\text{energy transferred}}{\text{time}}$$

Or

$$P = \frac{E}{t}$$

1

(e)

$$0.33 = \frac{132}{t}$$

1

$$t = \frac{132}{0.33}$$

1

t = 400 (s)

1

[11]

2. (a) the speed increased

1

(b) the kinetic energy increased

1

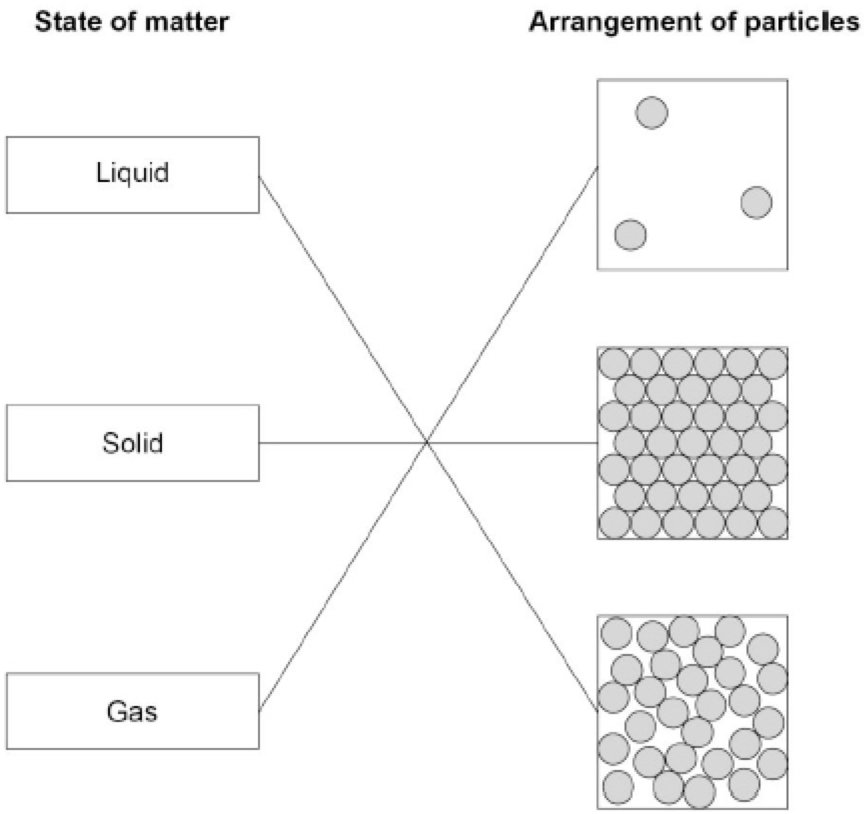
(c) the number of collisions each second increased

1

(d) the force exerted increased

1

(e)



do **not** accept more than one line from a box on the left

allow **1** mark for 1 or 2 correct lines

2

(f) liquid

1

(g) solid

1

(h)

	Decreases	Stays the same	Increases
Kinetic energy of particles		✓	
Potential energy of particles			✓

do **not** accept more than one tick in each row

2

[10]

3. (a) renewable: (an energy resource that is) replenished (as it is used)

allow replaced for replenished

ignore has an infinite supply

ignore not running out

1

non-renewable: (an energy resource that is) finite

allow limited supply

ignore running out

ignore won't last forever

1

(b)

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

or

$$\rho = \frac{m}{V}$$

1

(c)

$$1030 = \frac{824\ 000}{V}$$

1

$$V = \frac{824\ 000}{1030}$$

1

$V = 800$ (m^3)

1

(d) any **two** from:

- at very low flow speeds there is no power output
- tidal power output is (always) greater than wind power output for the same flow speeds (above 0.25 m/s)
- a change in flow speed makes a bigger difference to tidal power output than wind power output
- there is a non-linear relationship between flow speed and power output

allow wind power needs a higher flow speed to get the same power output (as tidal power)

ignore reference to exponential relationships

*do **not** accept flow speed of tidal is less than flow speed of wind*

ignore comments about reliability or efficiency

2

(e) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3-4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1-2

No relevant content

0

Indicative content

- wind turbine is much larger than the tidal turbine

- wind turbine causes more visual pollution than the tidal turbine
- tidal turbine is hidden from view (as it is under water)

- tidal turbine is less likely to cause noise pollution (as it is under water)
- wind turbine is likely to make more noise

- wind turbine needs more raw materials (for construction)

- more wind turbines needed for same power output (at the same flow speed)

- wind turbine will harm birds, whereas tidal turbine will not

- tidal turbine may harm fish, whereas wind turbine will not

[12]

4. (a) hot water / beaker
or
heater

ignore descriptions of risk

allow spilt water

allow broken glass / beaker

1

(b) **Level 3:** The method would lead to the production of a valid outcome. The 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

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 the empty beaker on the balance
- fill the beaker with water and measure the total mass of beaker and water
- mass of water = total mass – mass of beaker
- turn power supply on so heater increases the temperature of the water
- measure temperature change / increase with thermometer
- use joulemeter to measure energy transferred to water
- calculate SHC using $E = mc\Delta\theta$

a level 3 answer must have a clear method of how the mass of water is determined

(c) insulate the beaker of water

or

add a lid

allow named insulation

allow use an insulating cup

eg plastic cup

1

(d) difference = 4410 – 4200

or

difference = 210

or

% difference = $\frac{(4410 - 4200)}{4200} \times 100$

1

% difference = 5 (%)

*do **not** accept 4.76 (%)*

1

[10]

5. (a) $8000 = 0.20 \times 1600 \times \Delta\theta$

1

$$\Delta\theta = \frac{8000}{(0.20 \times 1600)}$$

1

$\Delta\theta = 25$ (°C)

1

(b) $E = 180\,000$ (J)

all subsequent marks can score using an incorrectly / not converted value of E

1

$180\,000 = Q \times 5.0$

1

$$Q = \frac{180\,000}{5.0}$$

1

$Q = 36\,000$ (C)

1

(c) (when both switches are closed) the resistance of the circuit decreases

1

(so) current increases

MP2 dependent on MP1

1

(so) power output is greater as potential difference across the battery remains the same and $P = IV$

ignore reference to $P = I^2R$ unless a quantitative comparison is included

1

[10]

6. (a) $m = 0.050$ (kg)

all subsequent marks can score using an incorrectly / not converted value of m

1

$9950 = 0.050 \times L$

1

$$L = \frac{9950}{0.050}$$

1

$L = 199\,000$ (J/kg)

1

(b) the potential energy of the particles increases

1

(but) the kinetic energy of the particles does not change (as temperature does not change)

1

(so the) internal energy increases

MP3 dependent on MP1 ***and*** *MP2*

1

(c) the (mean) kinetic energy of the gas particles increased

allow the (mean) speed of the gas particles increased

1

(so) particles exert a greater force on the walls of the container during each collision

1

(and) the frequency of collisions of the particles and the walls of the container increases

allow 'rate of' for 'frequency'

1

(so) pressure increases

this mark is dependent on scoring at least 1 other mark

1

[11]

7. (a) 0.0 to 10.0 cm^3

1

(b) the measured volume would be larger

1

(c) 0.4 (cm^3)

1

(d) the results are repeatable

1

(e) subtract 0.02 from the measurement

1

(f)

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

or

$$\rho = \frac{m}{V}$$

1

(g)

$$22 = \frac{m}{0.3}$$

1

$m = 22 \times 0.3$

1

$m = 6.6$ (g)

1

[9]