

Name: _____
Particle Model part 5 AQA Triple Physics
Class: _____

Date: _____

Time: **91 minutes**

Marks: **90 marks**

Comments:

1.

The diagram below shows a cyclist riding along a flat road.



(a) Complete the sentence.

Choose answers from the box.

chemical	elastic potential	gravitational potential	kinetic
-----------------	--------------------------	--------------------------------	----------------

As the cyclist accelerates, the _____ energy store in the cyclist's body decreases and the _____ energy of the cyclist increases.

(2)

(b) The mass of the cyclist is 80 kg. The speed of the cyclist is 12 m/s.

Calculate the kinetic energy of the cyclist.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

Kinetic energy = _____ J

(2)

(c) When the cyclist uses the brakes, the bicycle slows down.

This causes the temperature of the brake pads to increase by 50 °C.

The mass of the brake pads is 0.040 kg.

The specific heat capacity of the material of the brake pads is 480 J/kg °C.

Calculate the change in thermal energy of the brake pads.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

Change in thermal energy = _____ J

(2)

(d) How is the internal energy of the particles in the brake pads affected by the increase in temperature?

Tick **one** box.

Decreased

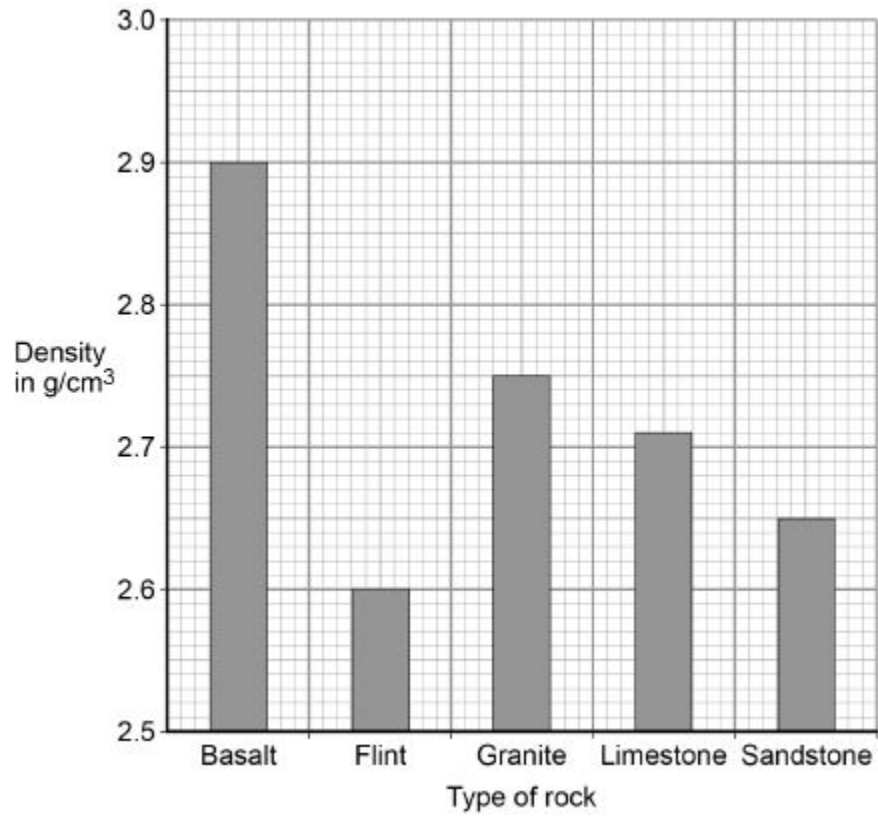
Increased

Not affected

(1)

(Total 7 marks)

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)

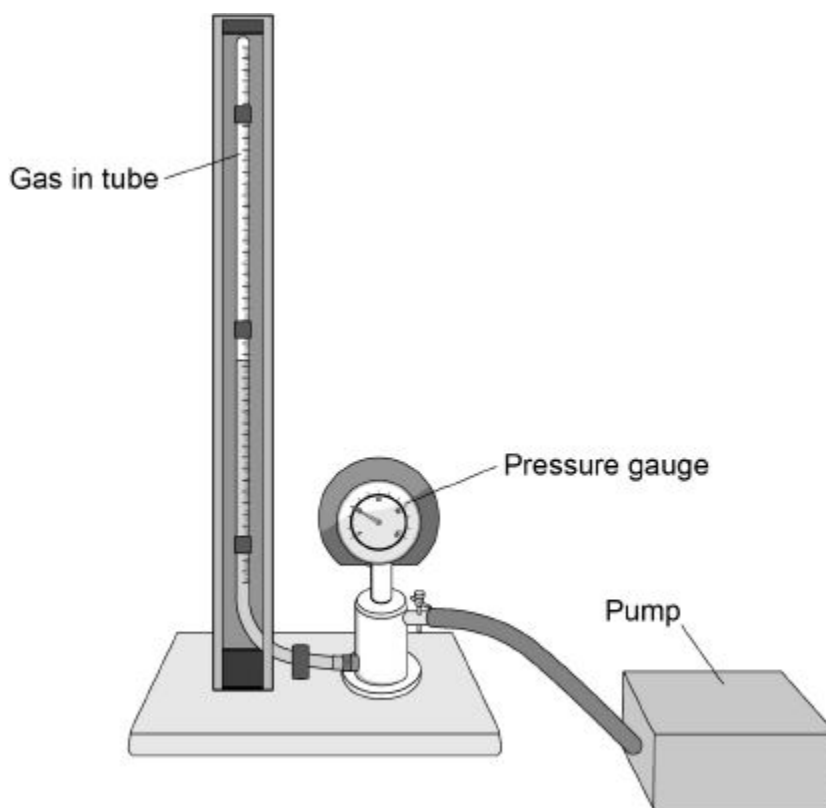
(Total 9 marks)

3.

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.

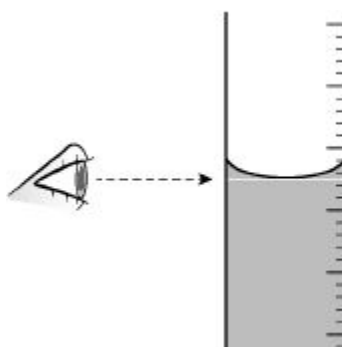
1. _____

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)

4.

The diagram below shows a wind turbine.



(a) At a particular wind speed, a volume of $2.3 \times 10^4 \text{ m}^3$ of air passes the blades each second.

The density of air is 1.2 kg/m^3 .

Calculate the mass of air passing the blades per second.

Mass of air per second = _____ kg

(3)

- (b) The power output of the turbine is directly proportional to the kinetic energy of the air passing the blades each second.

Describe the effect on the power output when the wind speed is halved.

(3)

- (c) At a different wind speed, the wind turbine has a power output of 388 kW.

The mass of air passing the wind turbine each second is 13 800 kg.

Calculate the speed of the air passing the blades each second.

Assume that the process is 100% efficient.

Speed of air = _____ m/s

(3)

(Total 9 marks)

5.

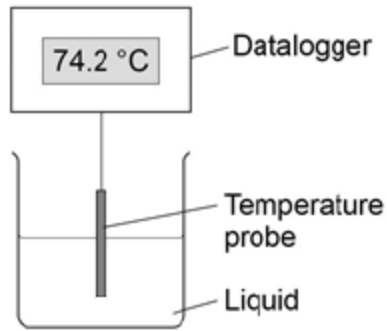
Two students investigated the change of state of stearic acid from liquid to solid.

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

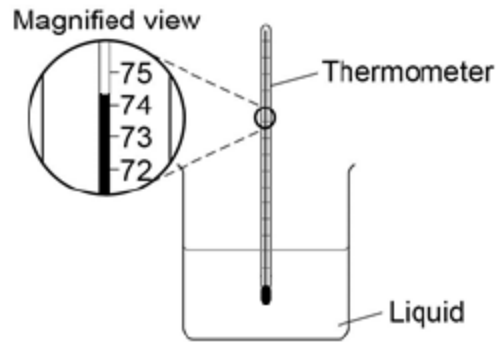
Figure 1 shows the different apparatus the two students used.

Figure 1

Student A's apparatus



Student B's apparatus



(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

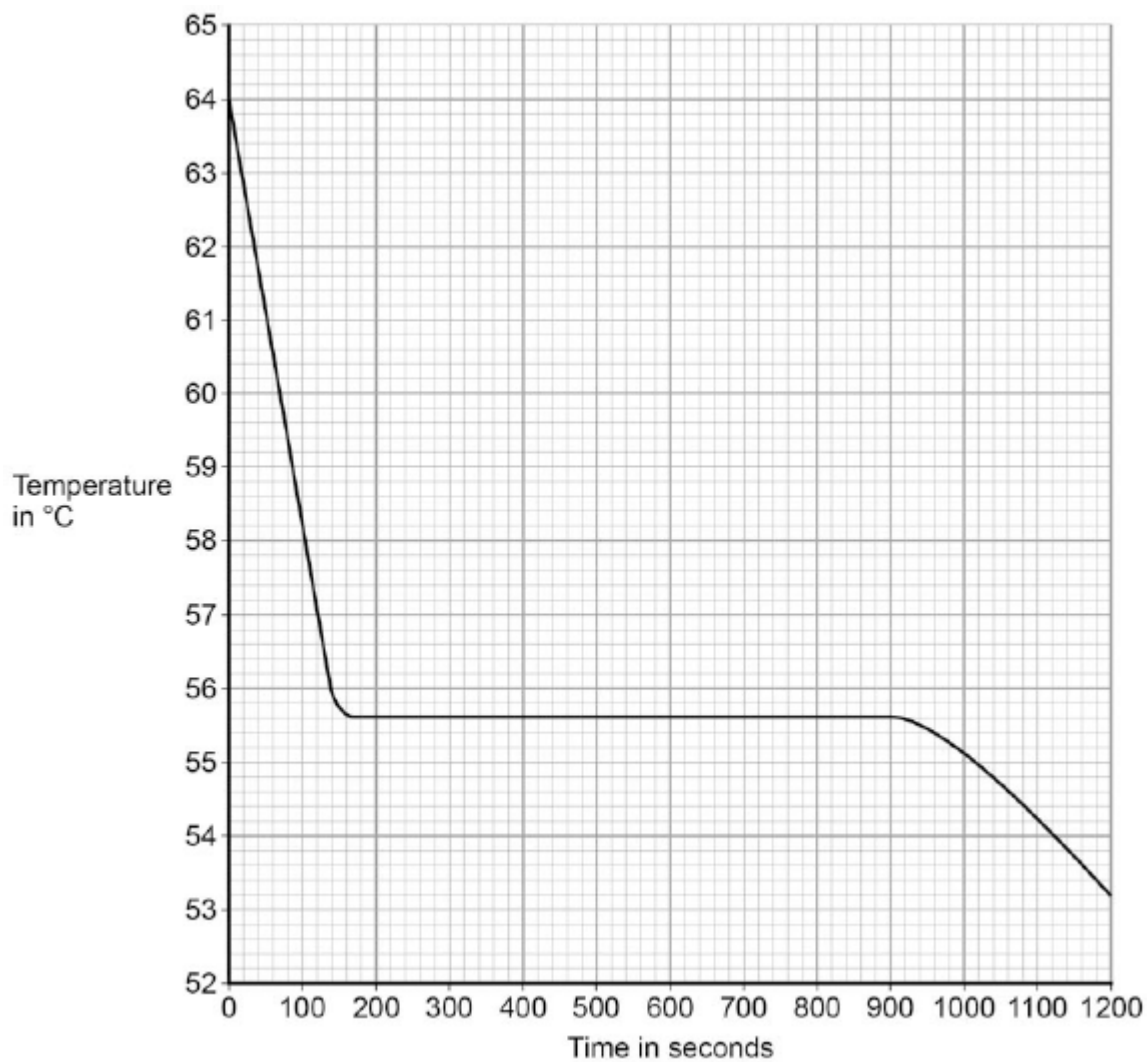
A random error

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)

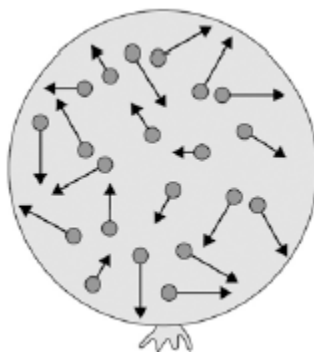
- (f) After 1200 seconds the temperature of the stearic acid continued to decrease.

Explain why.

(2)

(Total 9 marks)

6. 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 m³.

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

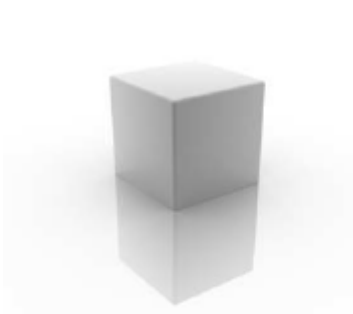
m³ / kg	kg / m³	kg m³
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Density = _____ Unit _____

(3)
(Total 7 marks)

7.

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



Metal cube

© Whitehouse/iStock/Thinkstock,



Small statue

© Marc Dietrich/Hemera/Thinkstock

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

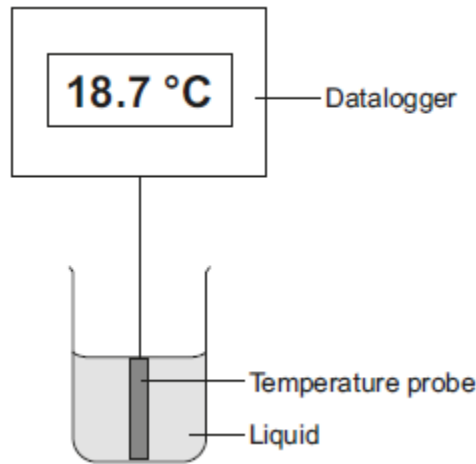
(Total 6 marks)

8.

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



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

Tick (✓) **one** box.

	Tick (✓)
control	
dependent	
independent	

(1)

(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

Probe A	Probe B	Probe C
99.8	100.1	103.2

Which **one** of the temperature probes, **A**, **B** or **C**, was **least** accurate?

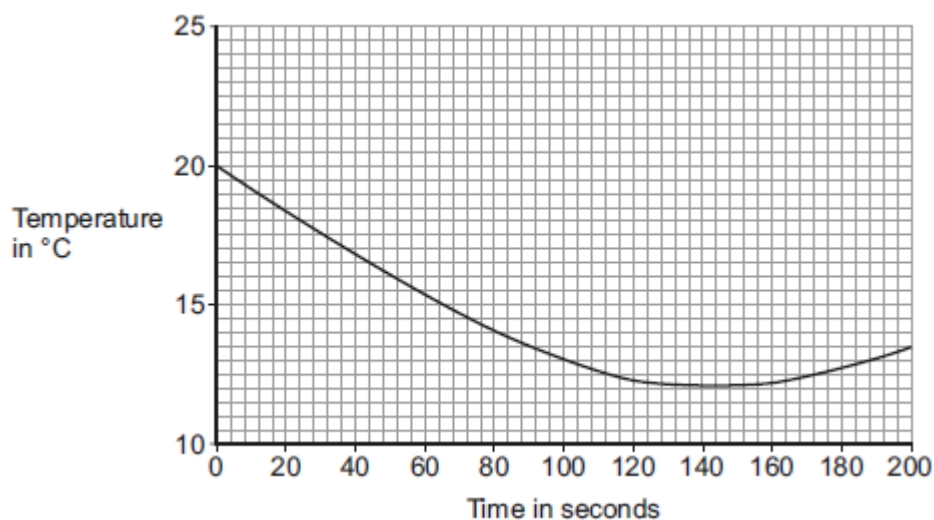
Write the correct answer in the box.

Give a reason for your answer.

(2)

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

Figure 3



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

Temperature = _____ °C

(1)

(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: _____

(2)

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

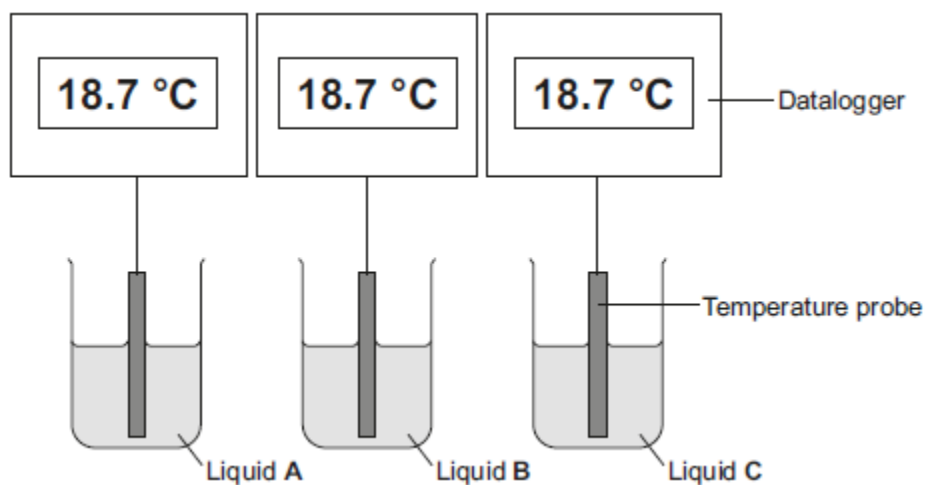
(1)

(Total 7 marks)

9.

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

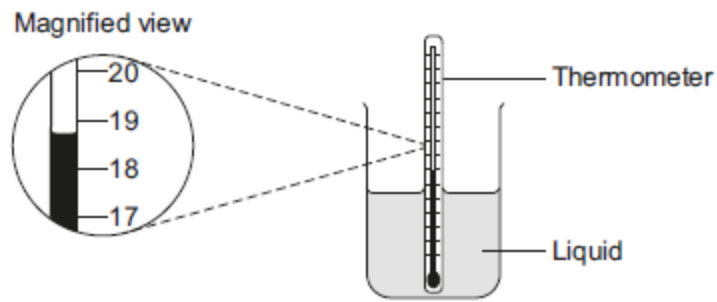


- (a) The temperature and volume of each liquid was the same at the start of the investigation. State **one** further control variable in this investigation.

(1)

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

Figure 2



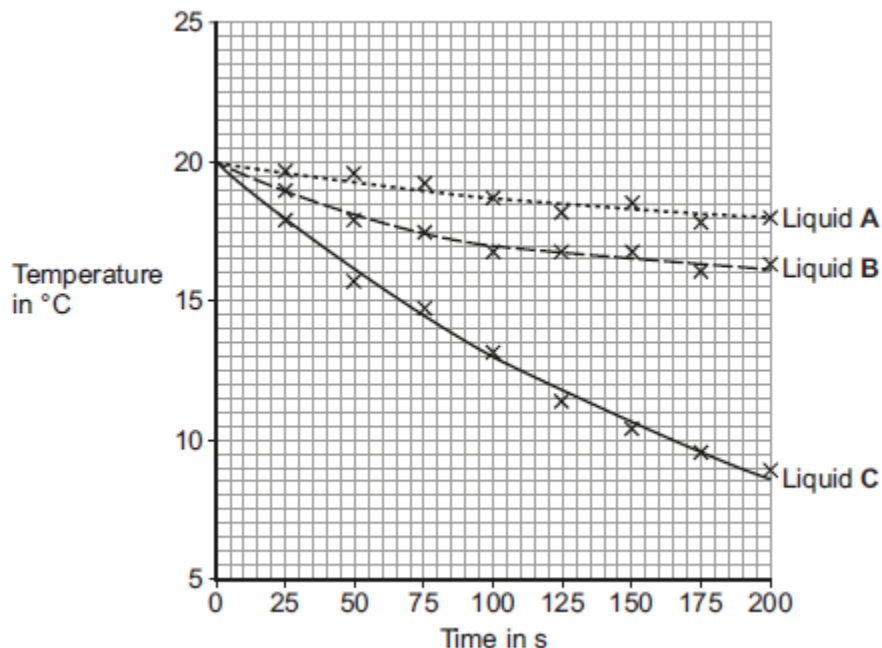
1. _____

2. _____

(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.

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**.

(1)

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

Liquid _____

Reason _____

(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?

(1)

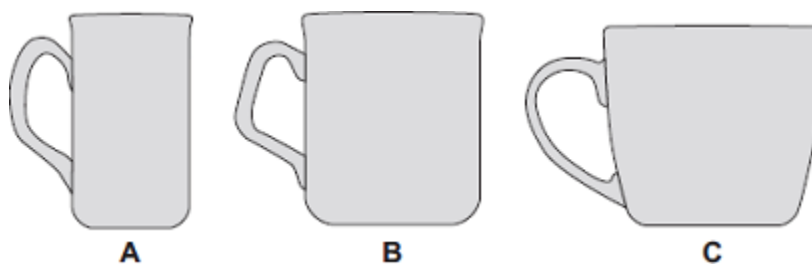
- (d) Explain how the evaporation of a liquid causes the temperature of the remaining liquid to decrease.

(3)

(Total 11 marks)

10.

The diagram shows three cups **A**, **B** and **C**.

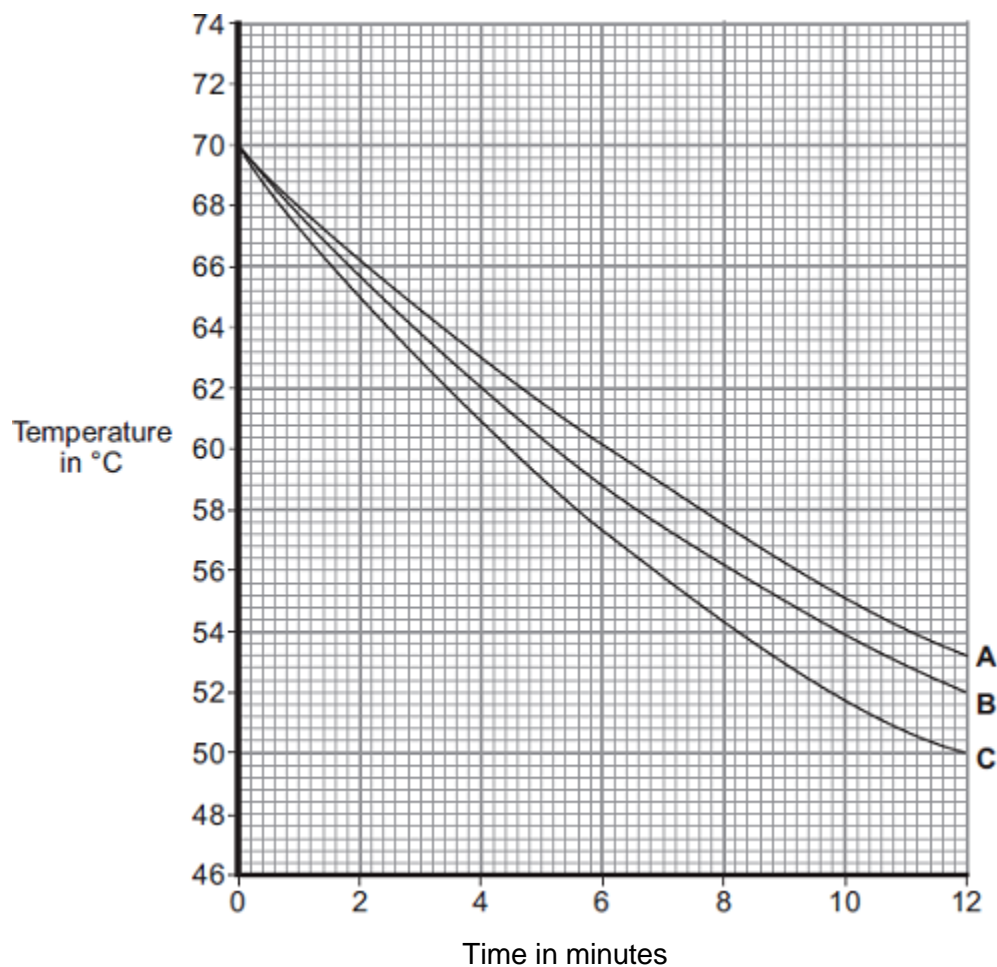


Energy is transferred from hot water in the cups to the surroundings.

- (a) Some students investigated how the rate of cooling of water in a cup depends on the surface area of the water in contact with the air.

They used cups **A**, **B** and **C**. They poured the same volume of hot water into each cup and recorded the temperature of the water at regular time intervals.

The results are shown on the graph.



- (i) What was the starting temperature of the water for each cup?

Starting temperature = _____ °C

(1)

- (ii) Calculate the temperature fall of the water in cup **B** in the first 9 minutes.

Temperature fall = _____ °C

(2)

- (iii) Which cup, **A**, **B** or **C**, has the greatest rate of cooling?



Using the graph, give a reason for your answer.

(2)

- (iv) The investigation was repeated using the bowl shown in the diagram.

The same starting temperature and volume of water were used.



Draw on the graph in part **(b)** another line to show the expected result.

(1)

- (v) After 4 hours, the temperature of the water in each of the cups and the bowl was 20°C.

Suggest why the temperature does **not** fall below 20°C.

(1)

- (b) (i) The mass of water in each cup is 200 g.

Calculate the energy, in joules, transferred from the water in a cup when the temperature of the water falls by 8°C.

Specific heat capacity of water = 4200 J / kg°C.

Energy transferred = _____ J

(3)

(ii) Explain, in terms of particles, how evaporation causes the cooling of water.

(4)

(Total 14 marks)

Mark schemes

1.	(a) chemical	1
	kinetic	1
	<i>in this order only</i>	
	(b) $E_k = 0.5 \times 80 \times 12^2$	1
	$E_k = 5760 \text{ (J)}$	1
	<i>an answer of 5760 (J) scores 2 marks</i>	
	(c) $E = 0.040 \times 480 \times 50$	1
	$E = 960 \text{ (J)}$	1
	<i>an answer of 960 (J) scores 2 marks</i>	
	(d) increased	1
		[7]
2.	(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	
	<ul style="list-style-type: none">part fill a measuring cylinder with watermeasure initial volumeplace object in watermeasure final volumevolume of object = final volume – initial volume	
	<ul style="list-style-type: none">fill a displacement / eureka can with waterwater level with spoutplace object in watercollect displaced watermeasuring cylinder used to determine volume of displaced water	

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

density = 2.70 (g/cm³) 1

an answer of 2.70 (g/cm³) 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]

3.

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

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

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

$$V = 8.0 \text{ (cm}^3\text{)}$$

1

an answer of 8.0 (cm³) 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]

4.

(a) $1.2 = \frac{m}{2.3 \times 10^4}$

1

$$m = 1.2 \times 2.3 \times 10^4$$

1

$$m = 27\,600 \text{ (kg)}$$

allow an answer of 28 000 (kg) or 2.8×10^4 (kg)

or

$$m = 2.76 \times 10^4 \text{ (kg)}$$

1

an answer of 27 600 (kg) scores 3 marks

(b) mass of air passing the turbine blades is halved which decreases kinetic energy by a factor of two

1

(wind speed is halved) decreasing kinetic energy by a factor of four

1

so kinetic energy decreases by a factor of eight

1

allow power output for kinetic energy throughout

(c) $388\,000 = 0.5 \times 13\,800 \times v^2$

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

1

$$v^2 = \frac{(2 \times 388\,000)}{13\,800}$$

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

or

$$v^2 = \frac{388\,000}{(0.5 \times 13\,800)}$$

or

$$v^2 = 56.2$$

1

$$v = 7.50 \text{ (m/s)}$$

an answer that rounds to 7.50 (m/s) only

1

[9]

5.

- (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) $0.40 \times 199\,000$

1

$$79\,600 \text{ (J)}$$

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]

6.	(a) range of speeds	1
	moving in different directions <i>accept random motion</i>	1
	(b) internal energy	1
	(c) density = mass / volume	1
	(d) 0.00254 / 0.0141	1
	0.18	1
	<i>accept 0.18 with no working shown for the 2 calculation marks</i>	1
	kg / m ³	1
		[7]

7. **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]

8.	(a) dependent	1
	(b) (probe) C <i>allow 103.2</i>	1
	largest difference between reading and actual temperature <i>reason only scores if C chosen</i> <i>accept larger</i> <i>it is 3.2 greater is insufficient</i> <i>comparing C with only one other probe is insufficient</i>	1
	(c) (i) 12(°C) <i>accept a value between 12.0 and 12.2 inclusive</i>	1
	(ii) 140 (seconds) <i>accept an answer between 130 and 150 inclusive</i>	1
	<u>temperature</u> starts to rise <i>only scores if time mark awarded</i> <i>accept the <u>temperature</u> was lowest (at this time)</i>	1
	(iii) increase <i>accept faster (rate)</i>	1
		[7]
9.	(a) surface area or duration of experiment <i>accept shape of beaker</i> <i>size of beaker is insufficient</i>	1

(b) any **two** from:

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

2

(c) (i) 0.07 (°C/s)

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

2

(ii) rate of temperature change is greater at the start

accept rate of evaporation is greater at the start

or

rate of temperature change decreases

allow rate of evaporation decreases

allow temperature decreases faster at the start

1

(iii) A

reason only scores if A is chosen

lower temperature decrease (over 200 seconds)

accept lower gradient

1

(iv) no effect (as rate of evaporation is unchanged)

allow larger temperature change (per second as mass of liquid is lower)

1

(d) particles with more energy

accept particles with higher speeds

1

leave the (surface of the) liquid

1

(which) reduces the average (kinetic) energy (of the remaining particles)

allow reference to the total energy of the liquid reducing

1

10.

(a) (i) 70

*accept \pm half a square
(69.8 to 70.2)*

1

(ii) 15

*accept 14.6 to 15.4 for 2 marks
allow for 1 mark 70 – 55
ecf from (b)(i) \pm half a square*

2

(iii) C

1

biggest drop in temperature during a given time

accept it has the steepest gradient this is a dependent

1

(iv) starting at 70 °C and below graph for C
must be a curve up to at least 8 minutes

1

(v) because 20 °C is room temperature

accept same temperature as surroundings

1

(b) (i) 6720

correct answer with or without working gains 3 marks

6 720 000 gains 2 marks

correct substitution of $E = 0.2 \times 4200 \times 8$ gains 2 marks

correct substitution of $E = 200 \times 4200 \times 8$ gains 1 mark

3

(ii) the fastest particles have enough energy

accept molecules for particles

1

to escape from the surface of the water

1

therefore the mean energy of the remaining particles decreases

accept speed for energy

1

the lower the mean energy of particles the lower the temperature (of the water)

accept speed for energy

1

[14]