AQA combined science consolidation pack

Name -

B4 – Bioenergetics – /19

Date due in -

C5 – Energy changes - /25

Date due in -

P3 – Particle model of matter - /19

Date due in -

How to use this consolidation pack

This pack will help you to prepare for your Monday consolidation test on the 6th October. You will only be assessed on the topics on the front cover.

Your Thursday prep intervention sessions/home-learning will also be preparing you for this with the required skills.

Each section will start with a knowledge organiser and then a series of exam questions that you need to answer.

After you have answered the exam questions you need to mark all questions in green pen and put your mark for each section on the front.

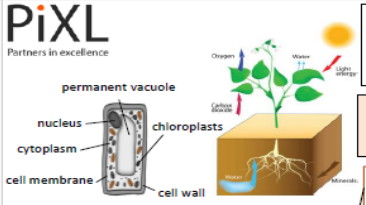
Below are the grade boundaries for 2025 GCSE combined science higher paper. You are all sitting higher for AP1, you can all do it!

These are the average percentages for each paper to achieve this grade.

4/4 22%
5/4 28%
5/5 33%
6/5 38%
6/6 44%
7/6 49%
7/7 54%
8/7 58%
8/8 63%
9/8 67%
9/9 71%

B4 Bioenergetics

PiXL
Partners in excellence



Respiration, stored as insoluble starch, fats or oils for storage, cellulose for cell walls, combine with nitrates from the soil to form amino acids for protein synthesis

Plants use the glucose produced in photosynthesis in a variety of ways

Photosynthetic reaction

The plant manufactures glucose from carbon dioxide and water using energy transferred from the environment to the chloroplasts by light

Photosynthesis	*Plants make use of light energy from the environment (ENDOTHERMIC) to make food (glucose)*	Carbon dioxide + Water $\xrightarrow{\text{light}}$ Oxygen + Glucose
		$CO_2 + H_2O \xrightarrow{\text{light}} O_2 + C_6H_{12}O_6$

The rate of photosynthesis is affected by temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll

Factors affecting the rate of photosynthesis	Factor	How the rate is affected	Limiting factors (why the rate stops going up)
	Temperature	*As the temperature of the environment the plant is in increases rate of photosynthesis increases (up to a point) as there is more energy for the chemical reaction.*	Photosynthesis is an enzyme controlled reaction. If the temperature increases too much, then the enzymes become denatured and the rate of reaction will decrease and stop
	Light intensity	*Light intensity increases as the distance between the plant and the light sources increases. As light intensity increases so does the rate of photosynthesis (up to a point) as more energy is available for the chemical reaction.*	At point X another factor is limiting the rate of photosynthesis. This could be carbon dioxide concentration, temperature or the amount of chlorophyll
	Carbon dioxide concentration	*Carbon dioxide is needed for plants to make glucose. The rate of photosynthesis will increase when a plant is given higher concentrations of carbon dioxide (up to a point).*	At point X another factor is limiting the rate of photosynthesis. This could be light intensity, temperature or the amount of chlorophyll
	Amount of chlorophyll	*Chlorophyll is a photosynthetic pigment that absorbs light and allows the reaction between water and carbon dioxide to occur (photosynthesis)*	Another factor could limit the rate of photosynthesis. This could be light intensity, temperature or the carbon dioxide concentration

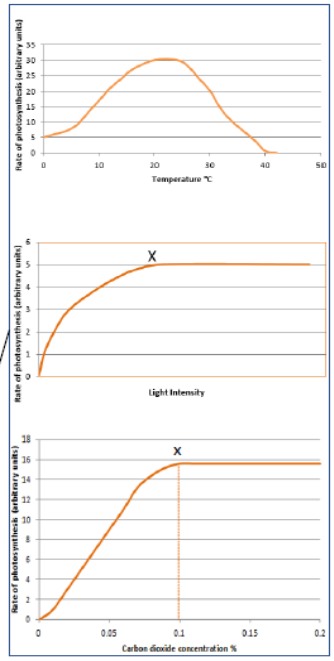
Control conditions in greenhouses to reduce limiting factors can improve crop yields

Heating	Used to provide optimum temperatures for maximum plant growth.
Artificial lighting	Enhances the natural sunlight especially overnight and on cloudy days.
Extra carbon dioxide	Gas can be pumped into the air inside the greenhouse.

Growers must balance the economics of additional costs of controlling the conditions to maximise photosynthesis with making a profit.

AQA GCSE BIOENERGETICS part 1

Rate of photosynthesis



Light intensity obeys the inverse square law. This means that if you double the distance between the plant and the light source you quarter the light intensity

Rate of photosynthesis HT Only

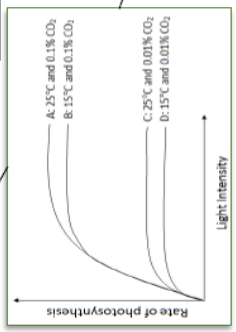
Graph lines C and D: If temperature is increased by 10°C then a slight increase in rate of photosynthesis occurs.

Explain graphs of two or three factors and decide which is the limiting factor

Graph lines A and D: If carbon dioxide concentration and temperature are increased the rate of photosynthesis increases significantly up to a point.

Graph Lines A and B: If carbon dioxide concentration is increased from 0.01% to 0.1% then a large increase in rate occurs up to a point.

Graph line A: Rate could be limited by temperature and/or amount of chlorophyll. Plant tissue can be damaged when carbon dioxide concentrations exceed 0.1%

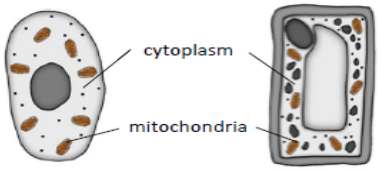


better hope – brighter future

AQA GCSE BIOENERGETICS part 2

Respiration

Cellular respiration is an exothermic reaction which is continuously occurring in all living cells



animal cell | plant cell

Electron micrograph of a mitochondrion

Anaerobic respiration

Respiration when oxygen is in short supply. Occurs during intensive exercise

During hard exercise, muscle cells are respiring so fast that blood cannot transport enough oxygen to meet their needs.

Glucose is partially oxidised to produce lactic acid which builds up in muscle tissue causing them to become painful and fatigued.

glucose → lactic acid

Anaerobic respiration releases a much smaller amount of energy than aerobic respiration.

The incomplete oxidation of glucose causes a build up of lactic acid and creates an oxygen debt

Aerobic respiration

Respiration with oxygen. Occurs inside the mitochondria continuously

Glucose is oxidised by oxygen to transfer the energy the organism needs to perform it's functions.

$C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

glucose + oxygen → carbon dioxide + water

Aerobic respiration releases a large amount of energy from each glucose molecule

Anaerobic respiration in plant and yeast cells

The end products are ethanol and carbon dioxide. Anaerobic respiration in yeast cells is called fermentation

glucose → ethanol + carbon dioxide

This process is economically important in the manufacture of alcoholic drinks and bread.

Response to exercise

During long periods of vigorous activity muscles become fatigued and stop contracting efficiently

During exercise the human body reacts to increased demand for energy		
	Heart rate increases	Top pump oxygenated blood faster to the muscle tissues and cells.
	Breathing rate and breath volume increase	This increases the amount of oxygen entering the blood stream.

An organism will receive all the energy it needs for living processes as a result of the energy transferred from respiration

For movement		To enable muscles to contract in animals.
For keeping warm		To keep a steady body temperature in a cold environment.
For chemical reactions		To build larger molecules from smaller one.

Metabolism

Metabolism is the sum of all the reactions in a cell or the body

Metabolism	
The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism.	Conversion of glucose to starch, glycogen and cellulose.
	The formation of lipid molecules from a molecule of glycerol and three molecules of fatty acid.
	The use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins.
	Respiration
	Breakdown of excess proteins to form urea for excretion.

Response to exercise HT only

The extra amount of oxygen required to remove all lactic acids from cells is called the oxygen debt

Lactic acid builds up in the muscles cells during exercise → Blood flows through the muscle cells and transports the lactic acid to the liver → The liver oxidises the lactic acid and converts it back to glucose

Exam questions

1)

This question is about photosynthesis.

(a) Plants make glucose during photosynthesis. Some of the glucose is changed into insoluble starch.

What happens to this starch?

Tick (✓) **one** box.

The starch is converted into oxygen. ☐

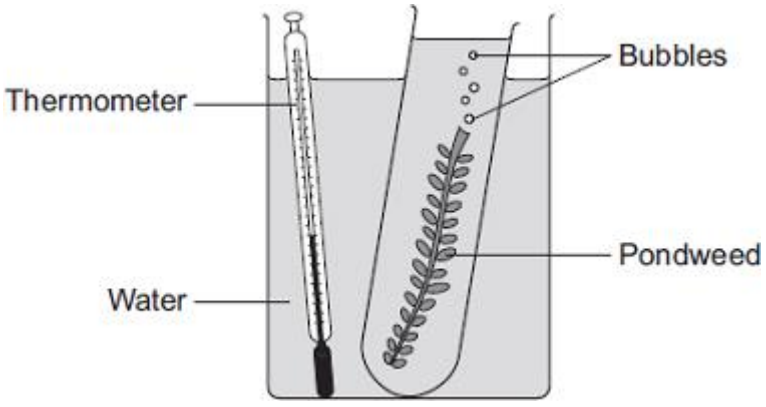
The starch is stored for use later. ☐

The starch is used to make the leaf green. ☐

(1)

(b) A student investigated the effect of temperature on the rate of photosynthesis in pondweed.

The diagram shows the way the experiment was set up.



(i) The student needed to control some variables to make the investigation fair.

State **two** variables the student needed to control in this investigation.

1. _____

2. _____

(2)

(ii) The bubbles of gas are only produced while photosynthesis is taking place.

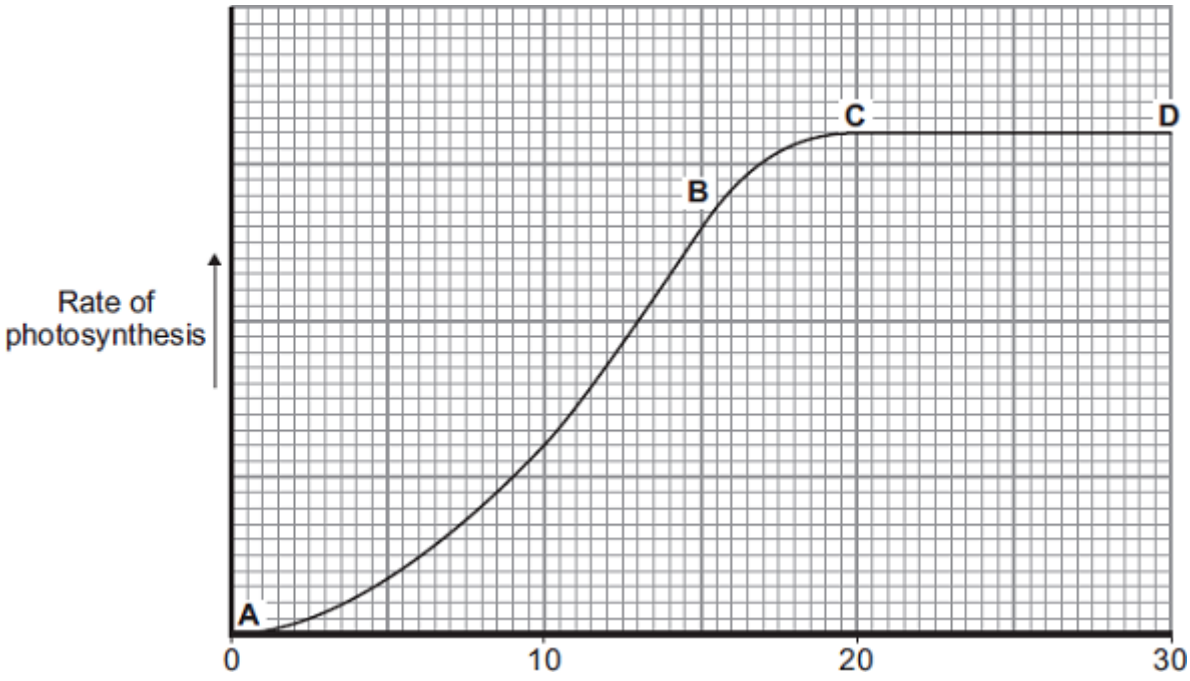
What **two** measurements would the student make to calculate the rate of photosynthesis?

1. _____

2. _____

(2)

(c) The graph shows the effect of temperature on the rate of photosynthesis in the pondweed.



Temperature in °C

(i) Name the factor that limits the rate of photosynthesis between the points labelled **A** and **B** on the graph.

_____

(1)

(ii) Suggest which factor, carbon dioxide, oxygen or water, might limit the rate of photosynthesis between the points labelled **C** and **D** on the graph.

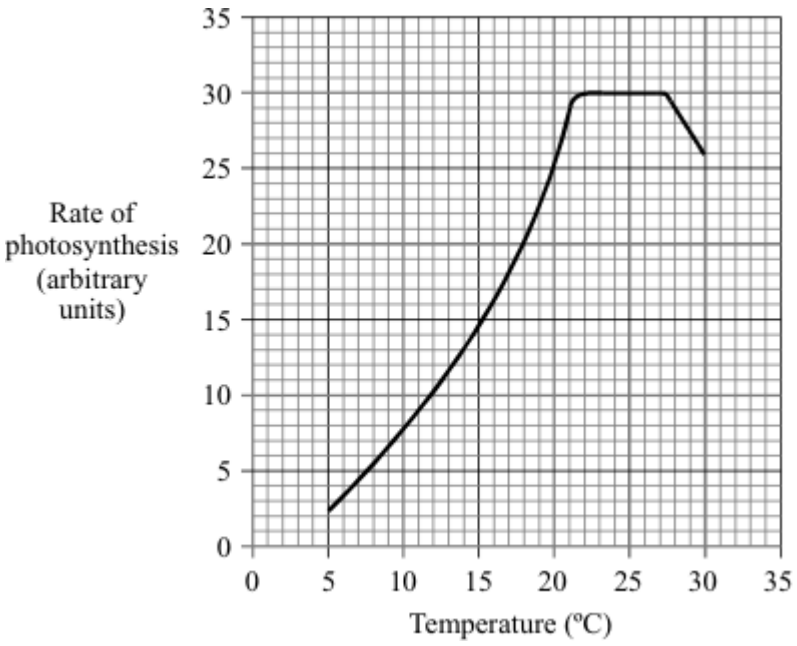
_____

(1)

(Total 7 marks)

2)

The graph shows the effect of temperature on photosynthesis.



(a) Between which temperatures is the rate of photosynthesis fastest?

_____ and _____ °C

(1)

(b) Suggest why the rate of photosynthesis stays the same between these two temperatures.

_____

_____

_____

_____

(2)

(c) A greenhouse owner wants to grow lettuces as quickly and cheaply as possible in winter.

At what temperature should he keep his greenhouse in order to grow the lettuces as quickly and cheaply as possible?

_____ °C

Explain your answer.

_____

_____

_____

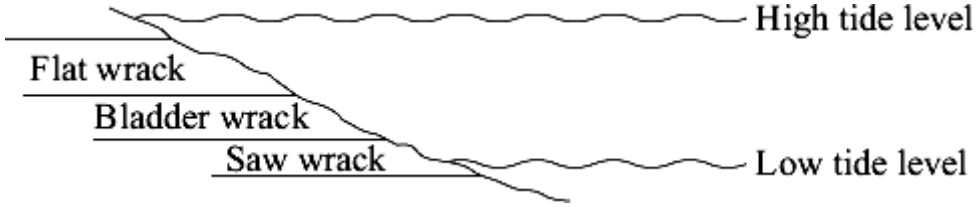
_____

(3)

(Total 6 marks)

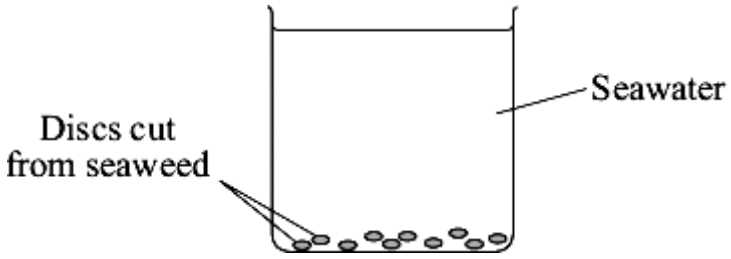
3)

The diagram shows where three seaweeds live on a seashore.
As the tide moves in and out, these seaweeds are covered with seawater for different lengths of time.



Some students investigated the rate of photosynthesis in these seaweeds.

- They cut ten small discs from one seaweed.
- They dropped the discs into seawater in a beaker.
- They recorded the time taken for the fifth disc to float to the surface.
- They repeated this experiment with the other two seaweeds.



(a) (i) Suggest why the discs floated to the surface.

_____

_____

(1)

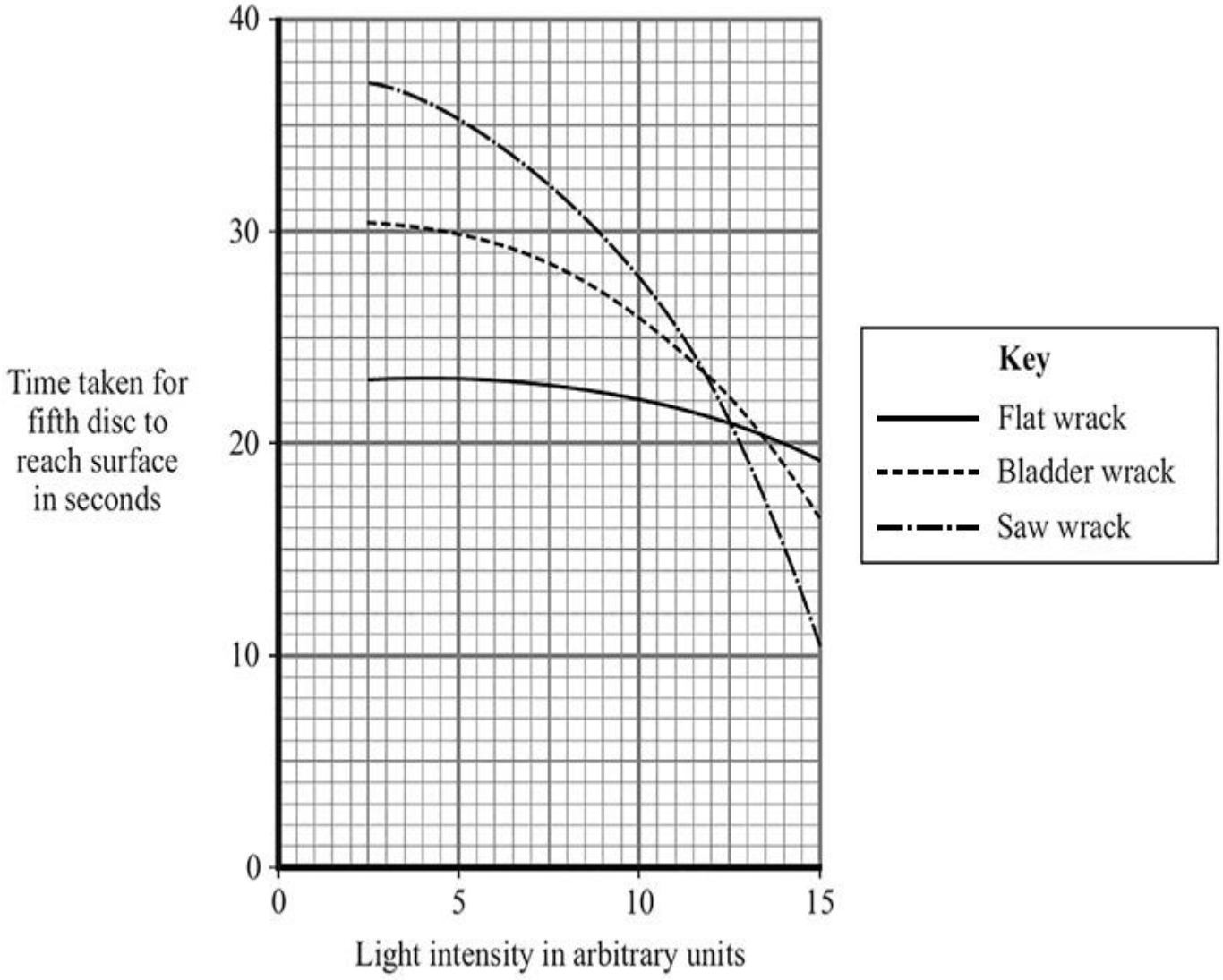
(ii) Suggest the advantage of recording the time taken for the fifth disc to reach the surface, rather than for the tenth disc.

_____

_____

(1)

(b) The students carried out their experiments at different light intensities.
The graph shows the results they collected.



(i) Compare the rate of photosynthesis for flat wrack with the rate for saw wrack at different light intensities.

_____

_____

_____

_____

(2)

(ii) Seawater absorbs light.

The growth rate of saw wrack is less than the growth rate of bladder wrack.

Suggest why.

_____

_____

_____

_____

(2)

(Total 6 marks)

Mark schemes - Bioenergetics

1)

(a) The starch is stored for use later

no mark if more than one box is ticked

1

(b) (i) any **two** from:

*do **not** accept temperature*
apply list principle
ignore reference to time

- carbon dioxide (concentration)
- light intensity
- light colour / wavelength

*allow **1** mark for light if neither intensity or colour are awarded*

- pH
- size / amount of pondweed / plant
- same / species / type pondweed
- amount of water <u>in the tube</u>

ignore amount of water alone

2

(ii) number / amount of bubbles **or** amount of gas / oxygen

allow volume of bubbles (together)
ignore 'the bubbles' unqualified

1

(relevant reference to) time / named time interval

allow how long it bubbles for
*do **not** accept time bubbles start / stop*
ignore speed / rate of bubbling
ignore instruments
*do **not** accept other factors eg temperature*
*accept how many bubbles per minute for **2** marks*

1

(c) (i) temperature

allow heat / cold / °C

1

(ii) carbon dioxide / CO_2

allow CO2
*do **not** accept CO^2*

1

[7]

2)

a) 21.5 – 22 ***and*** 27 – 27.5

for 1 mark

1

(b) *ideas of*
limiting factor / shortage of
e.g. light / carbon dioxide / water / chlorophyll

each for 1 mark
(allow 1 for 'maximum / optimum rate of enzyme activity if no reference to limiting factors) (ignore denaturation)

2

(c) 21.5 – 22° C

*(allow **first** figure from answer to (i) so that no 'double-penalty but only if this first answer is 20 or greater)*

maximum rate of photosynthesis / highest / fastest

but related to flat part of curve

most economical heating / cheapest related to heating

must relate to the temperature the candidate has given

each for 1 mark

3

[6]

3)

(a) (i) oxygen produced

1

(ii) any **one** from:

- average / mean / median
  ignore reliable / precise / accurate
- some may be anomalous
  allow some may not float

1

(b) (i) *do **not** allow answers in terms of time only*

*if candidate answers in terms of comparing rate of change then the rate of change of photosynthesis must be in the correct direction for **1** mark*

any **two** from:

- low intensity / below 12.5 / 2.5 - 12.5 (units of light) flat wrack /it, rate of photosynthesis faster **or** saw wrack rate of photosynthesis slower

  allow any value in range

- high intensity / above 12.5 / 12.5 - 15 (units of light) flat wrack / it,rate of photosynthesis slower **or** saw wrack rate of photosynthesis faster

  allow any value in range

- same (rate) at 12.5 units

2

(ii) any **two** from:

- saw wrack receives less light

  accept converse if clear reference to bladder wrack

- less photosynthesis

  if first and second responses, 'less' needed only once

  or
  less carbohydrate / sugar / starch production

- when tide is in **or** at high tide **or** any tide above low tide

  accept saw wrack covered by water / submerged longer / more

  reference to position on shore is insufficient

2

[6]

C5 – Energy changes

AQA GCSE Energy changes

Types of reaction

Endothermic	*Energy is taken in from the surroundings so the temperature of the surroundings decreases*	• Thermal decomposition • Sports injury packs
Exothermic	*Energy is transferred to the surroundings so the temperature of the surroundings increases*	• Combustion • Hand warmers • Neutralisation

Reaction profiles

Reaction profiles	*Show the overall energy change of a reaction*

The energy change of reactions (HT only)

Breaking bonds in reactants	*Endothermic process*
Making bonds in products	*Exothermic process*

Overall energy change of a reaction		
	Exothermic	Energy released making new bonds is greater than the energy taken in breaking existing bonds.
	Endothermic	Energy needed to break existing bonds is greater than the energy released making new bonds.

Bond energy calculation

Calculate the overall energy change for the forward reaction

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Bond energies (in kJ/mol): H-H 436, H-N 391, N≡N 945

Bond breaking: 945 + (3 x 436) = 945 + 1308 = 2253 kJ/mol

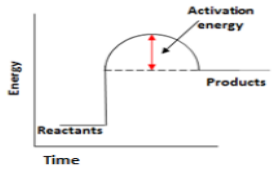
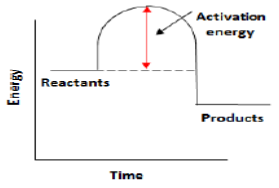
Bond making: 6 x 391 = 2346 kJ/mol

Overall energy change = 2253 - 2346 = -93kJ/mol

Therefore reaction is exothermic overall.

Reaction profiles

Activation energy	*Chemical reactions only happen when particles collide with sufficient energy*	The minimum amount of energy that colliding particles must have in order to react is called the activation energy.

Endothermic		Products are at a higher energy level than the reactants. As the reactants form products, energy is transferred from the surroundings to the reaction mixture. The temperature of the surroundings decreases because energy is taken in during the reaction.
Exothermic		Products are at a lower energy level than the reactants. When the reactants form products, energy is transferred to the surroundings. The temperature of the surroundings increases because energy is released during the reaction.

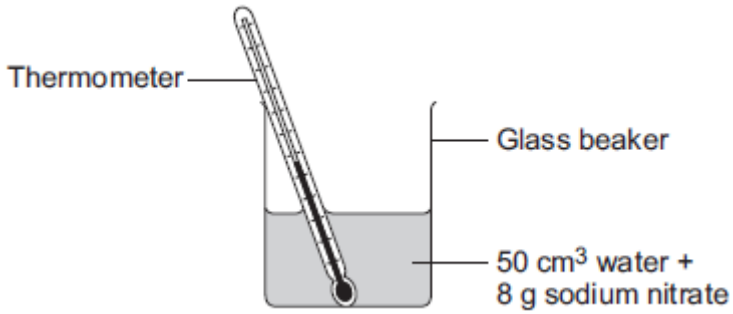
Exam questions

1)

This question is about temperature changes.

(a) A student investigated the temperature change when 8 g of sodium nitrate dissolves in 50 cm^3 of water.

The diagram below shows the apparatus the student used.



The student did the experiment five times.
Table 1 shows the results.

Table 1

Experiment	Decrease in temperature of water in °C
1	5.9
2	5.7
3	7.2
4	5.6
5	5.8

(i) Calculate the mean decrease in temperature.
Do not use the anomalous result in your calculation.

_____

_____

Mean decrease in temperature = _____ °C

(2)

(ii) Suggest **one** change in the apparatus in the diagram above which would improve the accuracy of the results.
Give a reason for your answer.

_____

_____

_____

_____

(2)

(b) The student investigated the temperature change when different masses of sodium carbonate were added to 50 cm^3 of water at 20 °C.

Table 2 below shows the results.

Table 2

Mass of sodium carbonate in g	**Final temperature of solution in °C**
2.0	21.5
4.0	23.0
6.0	24.5
8.0	26.0
10.0	26.6
12.0	26.6
14.0	26.6

Describe the relationship between the mass of sodium carbonate added and the final temperature of the solution.

Use values from **Table 2** in your answer.

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

2)

When ammonium chloride is dissolved in water, there is a temperature change.

A student investigated how the temperature of water changed when different masses of ammonium chloride were added to the same volume of water.

The water used was at room temperature.

The student's results are shown in the table.

Mass of ammonium chloride in g	**Final temperature of solution in °C**
10	14.5
20	8.5
25	5.5
30	2.5
35	1.0
40	1.0
45	1.0

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

endothermic	**exothermic**	**reduction**

When ammonium chloride dissolves in water, the change can be

described as _____ .

(1)

(ii) Give a reason for your answer to part **(a) (i)**. Refer to the table of results in your answer.

_____

_____

(1)

(b) The student added the ammonium chloride to water and stirred the mixture.

The water was in a glass beaker.

His teacher said that using a glass beaker could cause inaccurate results.

What could the student have used instead of a glass beaker to improve the accuracy?

Give a reason why this would improve the accuracy of his results.

_____

_____

_____

_____

_____

(2)

(c) The student made sure his investigation was a fair test.

State **two** control variables the student should keep the same.

Give a reason why changing each of these two control variables would affect the temperature change.

Control variable 1

_____

Reason

_____

_____

_____

Control variable 2

_____

Reason

_____

_____

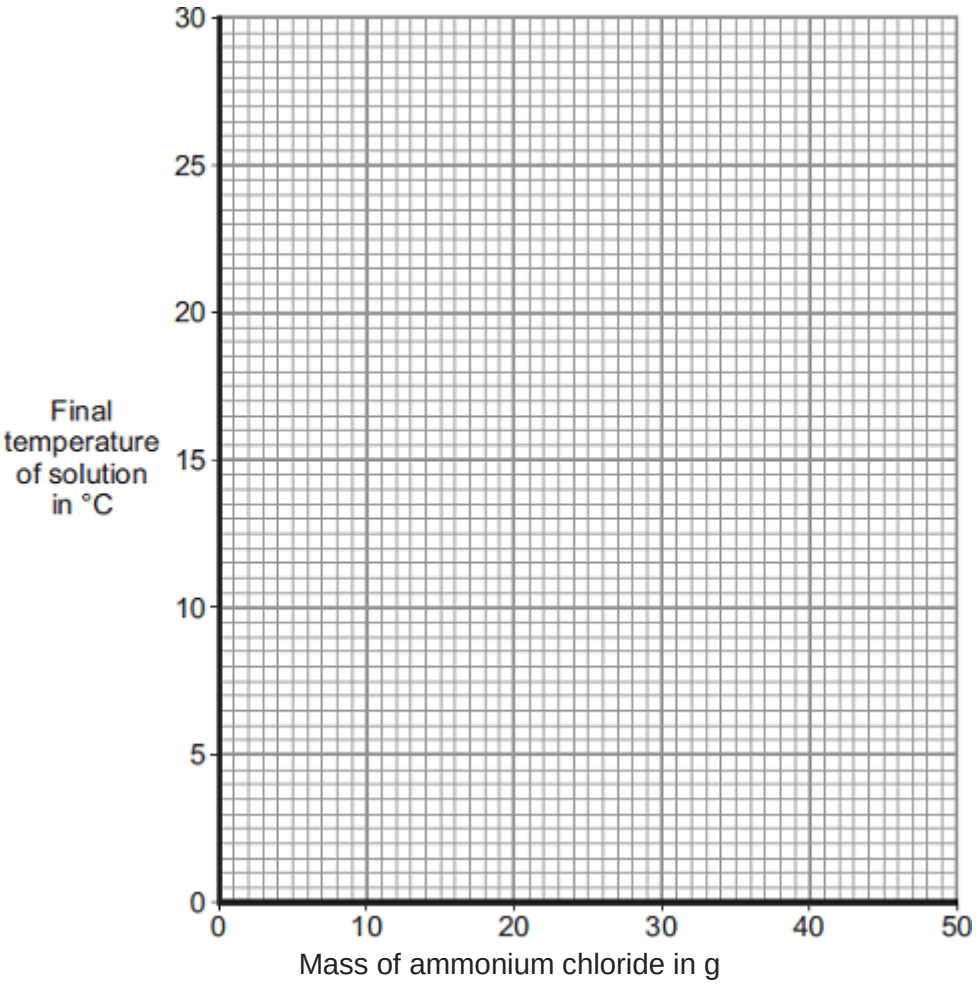
_____

(4)

(d) (i) The student's results table has been repeated below.

Mass of ammonium chloride in g	Final temperature of solution in °C
10	14.5
20	8.5
25	5.5
30	2.5
35	1.0
40	1.0
45	1.0

Plot the results on the grid.



(2)

(ii) Complete the graph by drawing two straight lines of best fit through the points.

(2)

(iii) Use the graph to estimate the temperature of the room.

Show your working on the graph.

Temperature of room = _____ °C

(2)

(e) Explain why the final temperature was the same for all masses of 35 g and greater.

_____

_____

_____

_____

(2)

(f) A second student also did one of the experiments.

This student recorded a final temperature of 14.5 °C.

Both students dissolved 20 g of ammonium chloride in water.

Use the graph to explain the difference in the two final temperatures.

_____

_____

_____

_____

_____

(2)

(Total 18 marks)

Mark schemes

1)

(a) (i) 5.75 **or** 5.8

*correct answer with or without working gains **2** marks*

*correct working showing addition of any four results and division by 4 gains **1** mark*

OR

*6(.04) for **1** mark*

2

(ii) use a polystyrene cup **or** lid

accept insulate the beaker

1

to prevent energy/heat gain

accept to prevent energy/heat transfer

*do **not** accept energy/heat loss*

OR

use a digital thermometer

allow use a data logger

easier to read (to 0.1°C)

1

(b) (as mass increases) the final temperature increases

1

then stays constant

1

correct reference to a value above 8 g up to and including 10 g as mass when the trend changes

1

[7]

2)

(a) (i) endothermic

could be answered by indicating the correct word in the box

1

(ii) final temperatures got lower **or** temperature went down

ignore comments on energy

1

(b) polystyrene / plastic cup **or** description of insulation / lagging container

ignore references to a lid

1

because (polystyrene) is an insulator **or** prevents heat / energy gain (and so temperature is more accurate)

*allow references to heat loss **or** glass conducts / absorbs heat*

1

(c) **variable**: volume **or** mass **or** amount of water

***1** mark for variable and **1** mark for reason linked to that variable*

*maximum of **4** marks for two variables and two explanations*

reason: the greater the volume / mass of water, the more heat energy it contains **or** the smaller the temperature change will be

*do **not** allow 'time taken to heat'*

variable: start temperature **or** temperature of water

reason: the higher the start temperature, the more heat energy it contains **or** the higher the final temperature will be

*do **not** allow higher temperature change*

variable: the time at which the temperature is measured

reason: if left longer may gain heat energy from surroundings **or** warm up **or** if measured too soon not all ammonium chloride will have dissolved so less temperature change

variable: rate of dissolution **or** speed of dissolving **or** amount of stirring

reason: if it dissolves faster **or** is stirred faster then it will cool more quickly **or** small particles dissolve faster

max. 4

(d) (i) all 7 points correct

*at least 4 points plotted correctly scores **1** mark*

2

(ii) straight line through first 3 or 4 points

lines must be drawn with a ruler

1

straight line through last three points

*if no other marks awarded allow curve joining lines for **1** mark*

1

(iii) valid extrapolation of line back to mass of 0 g

1

correct value read from graph

*award **1** mark for 20 − 21 if no extrapolation shown*

1

(e) not all of the ammonium chloride would dissolve

*allow water limiting factor **or** all water used*

1

so no more heat would be absorbed

or

the solution is saturated (1)

*allow water limiting factor **or** all water used*

so some ammonium chloride remains solid **or** not all will dissolve (1)

1

(f) greater volume of water was used **or** volume was twice as large

allow different volume of water

1

so temperature decrease was less than the first student's result

allow so final temperature was higher

or

starting temperature / room temperature was higher (1)

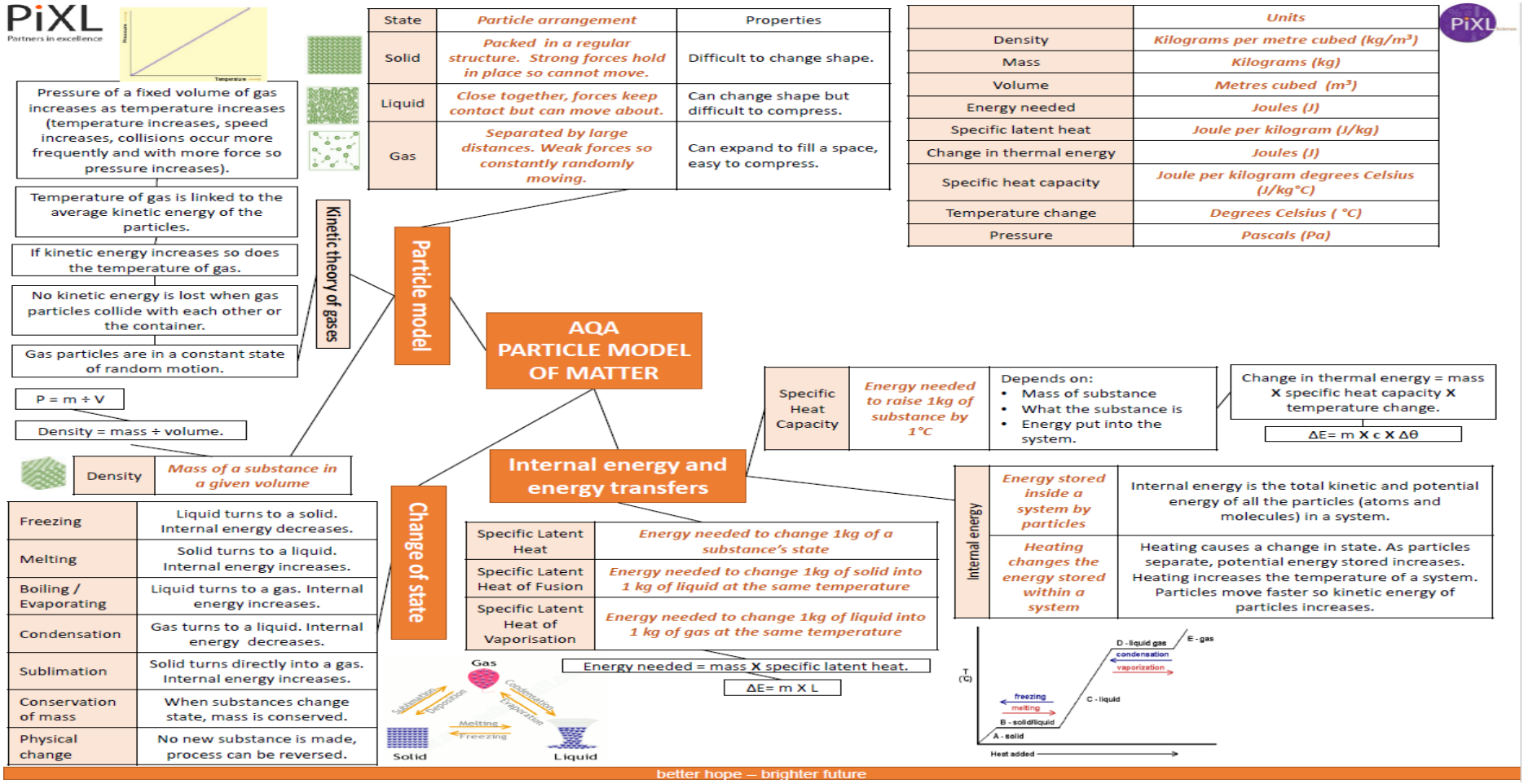
so final temperature was greater than the first student's result (1)

*accept by 6 °C **or** was any value in range 26 − 27°C*

1

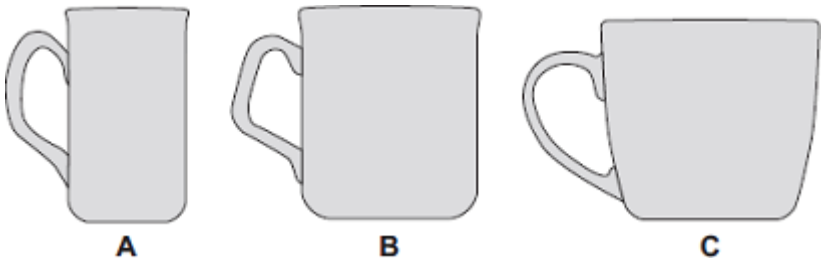
[18]

P3 – Particle model of matter



Exam questions

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

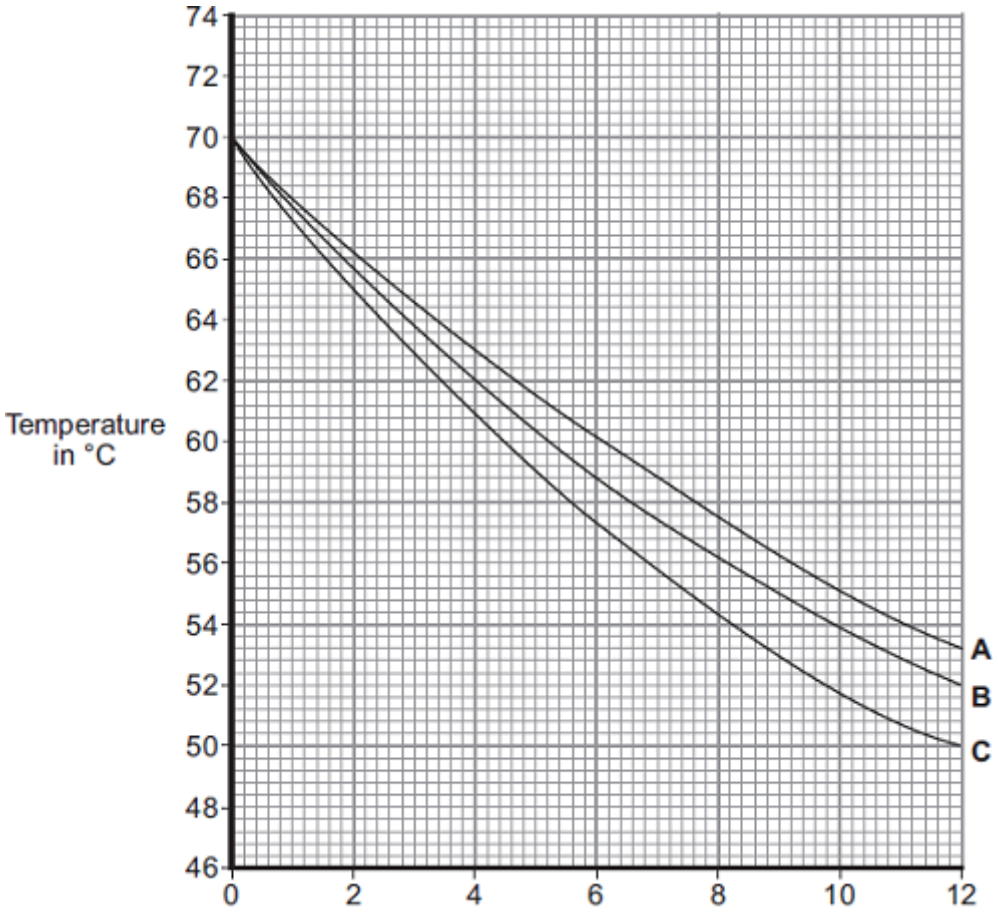


Energy is transferred from hot water in the cups to the surroundings.

(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.



Time in minutes

(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.

_____

_____

_____

_____

_____

_____

_____

_____

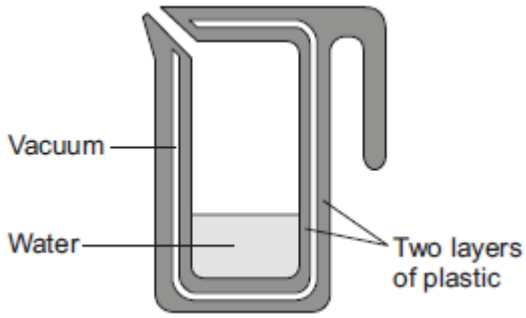
(4)

(Total 14 marks)

2)

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

(3)

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

_____

_____

_____

_____

Average power output = _____ W

(2)

(Total 5 marks)

Mark scheme

1)

(a) (i) 70

accept ± 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) ± 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 × 4200 × 8 gains **2** marks*
*correct substitution of E = 200 × 4200 × 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]

2)

(a) 78 (°C)

*allow **2** marks for correct temperature change ie 22 °C*

*allow **1** mark for correct substitution*

ie 46 200 = 0.5 × 4200 x θ

or

$$\frac{46200}{0.5 \times 4200} = \theta$$

3

(b) 6.4 (W)

*allow **2** marks for an answer that rounds to 6.4*

*allow **1** mark for correct substitution*

ie 46 200 = P × 7200

an answer of 23 000 or 23 100 or 385 gains 1 mark

2

[5]