13+ Scholarship Examinations 2017

SCIENCE

70 minutes

Contained in this package are the Biology, Chemistry and Physics sections.

You are to do THREE questions in total. Each question is worth 20 marks.

You must select one question from EACH section.

Write your name on the front of every section booklet and **circle the question attempted.**

You are advised to spend time at the start of this exam reading through the paper and selecting the questions that you wish to attempt – time has been built in to allow for this.

You will need a calculator and a ruler.

Name _____

The King's School Canterbury

Science Scholarship Paper 2017

Data Analysis

You should complete all of the questions in this section.

You are advised to spend approximately 15 minutes on this section.

Mark	

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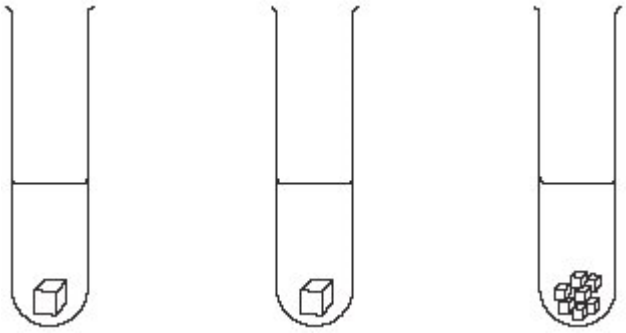
Science Scholarship 2017 – Data Analysis

Q1. Pineapple juice contains a substance that speeds up the digestion of protein.
Sarah did an experiment to investigate the digestion of gelatin. Gelatin is the protein in jelly.

In test tubes A and B she used one cube of jelly in each.
In test tube C she used one cube of jelly that she had chopped up.



A	**B**	**C**
5 g jelly cube + 15 cm^3 cold water	5 g jelly cube + 15 cm^3 fresh pineapple juice	5 g jelly cube chopped into pieces + 15 cm^3 fresh pineapple juice

She recorded how long it took for the jelly to be digested in each test tube.
The table below shows her results.

test tube	result
A	**not** digested after 2 hours
B	jelly digested in 2 hours
C	jelly digested in 1 hour

(ai) What was the purpose of test tube A?

……

……

(1 mark)

ii) Name 2 things that Sarah did to ensure that this was a **fair test.**

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(2 marks)

(iii) It is helpful to chew your food.
How do the results in test tube C show this?

……

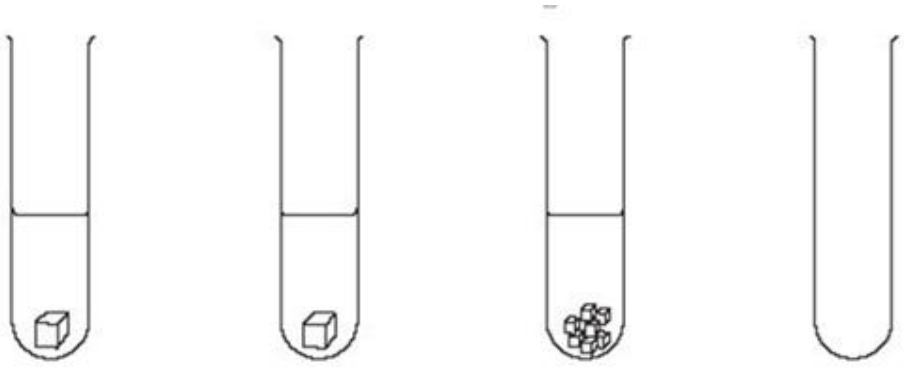
……

(1 mark)

(b) The substances that speed up digestion stop working when they have been boiled.

(i) What does Sarah need to put in a fourth test tube to test this in her experiment? Label test tube D with this information below. (2 marks)

Test tubes A, B and C contain the same as in the first experiment.



A	B	C	D
5 g jelly cube + 15 cm^3 cold water	5 g jelly cube + 15 cm^3 fresh pineapple juice	5 g jelly cube chopped into pieces + 15 cm^3 fresh pineapple	.... + ...

(ii) Predict what Sarah would observe in test tube D after 2 hours.

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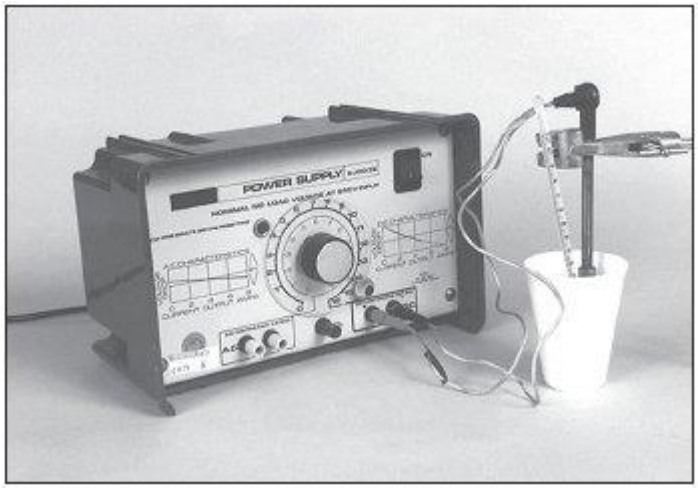
(1 mark)

Q2. Mike used an electrical heater to heat a cup of water. When the temperature reached 20°C, he started his stopwatch and measured the temperature of the water every half minute.



He switched off the heater after 4 minutes, but continued to record the temperature.

a) Describe an experimental technique that he could use to make this experiment more accurate.

……

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……

(1 mark)

His results are shown in the table.

One measurement is missing.

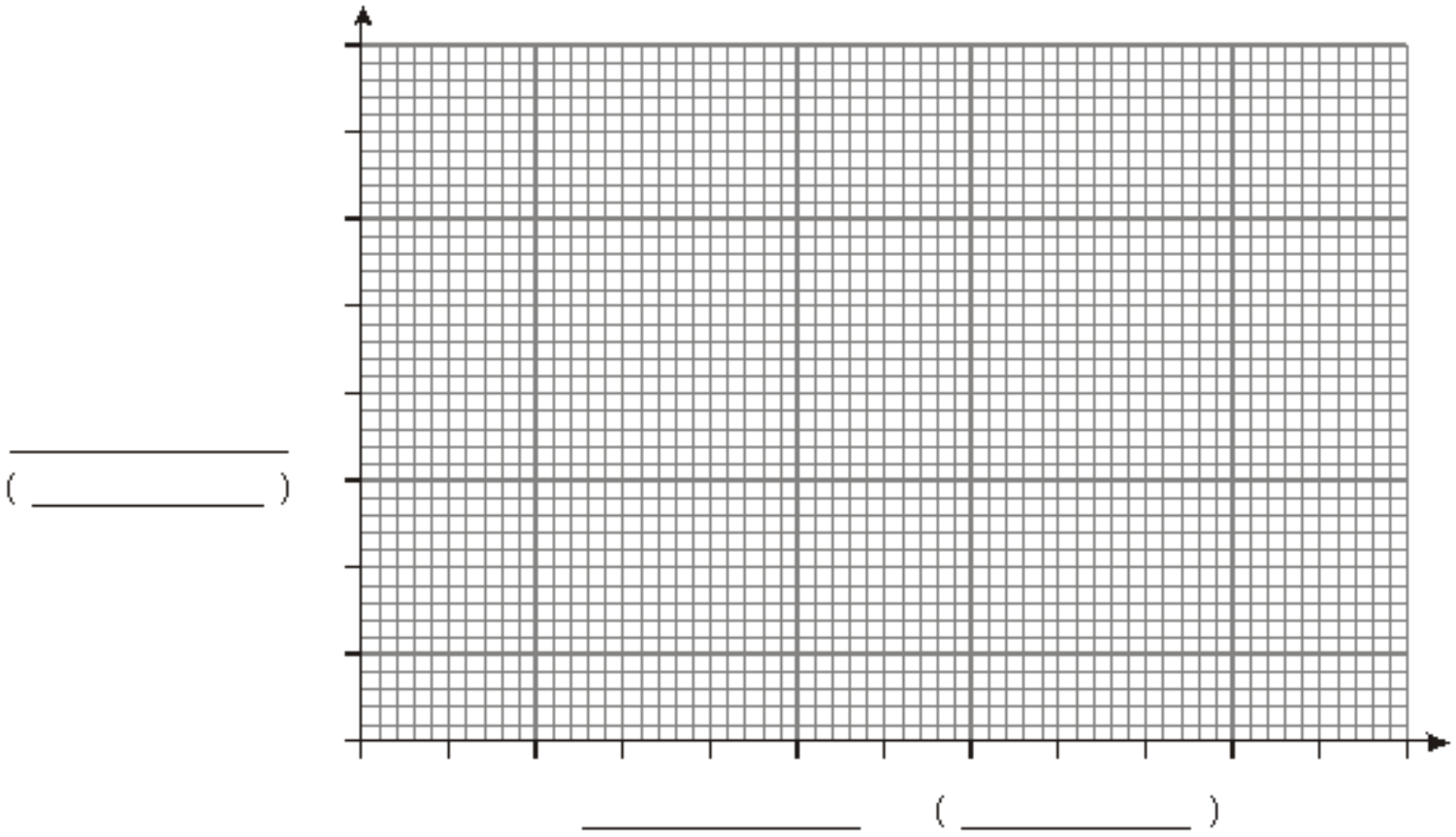
Time (minutes)	Temperature (°C)
0.0	20
0.5	26
1.0	31
1.5	36
2.0	41
2.5	46
3.0	
3.5	57
4.0	56
4.5	58
5.0	59
5.5	59

b) One of the measurements appears to be wrong. Put a circle around this result in the table.

(1 mark)

ci) Use the results in the table to draw a graph on the grid.
Label the axes.
Plot the points and draw a smooth **curve** of best fit.

(4 marks)



ii) Use your curve of best fit to find the missing value from the table.

.....°C
(1 mark)

d) Suggest one way in which this experiment could be improved.

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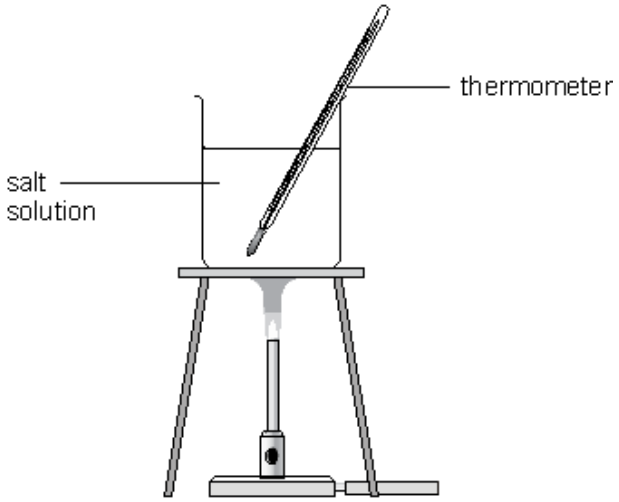
(1 mark)

Q3. Neera and Tom dissolved different masses of salt in 500 cm^3 of water.
They measured the temperature at which each salt solution boiled.



(a) They wrote down the variables that might affect the investigation.

temperature of the laboratory	mass of salt dissolved in water	starting temperature of the water
boiling point of salt solution	volume of water	type of salt used

(i) What is the independent variable in their investigation?

……

(1 mark)

(ii) What is the dependent variable in their investigation?

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(1 mark)

(iii) Which variable above would affect the experiment the least?

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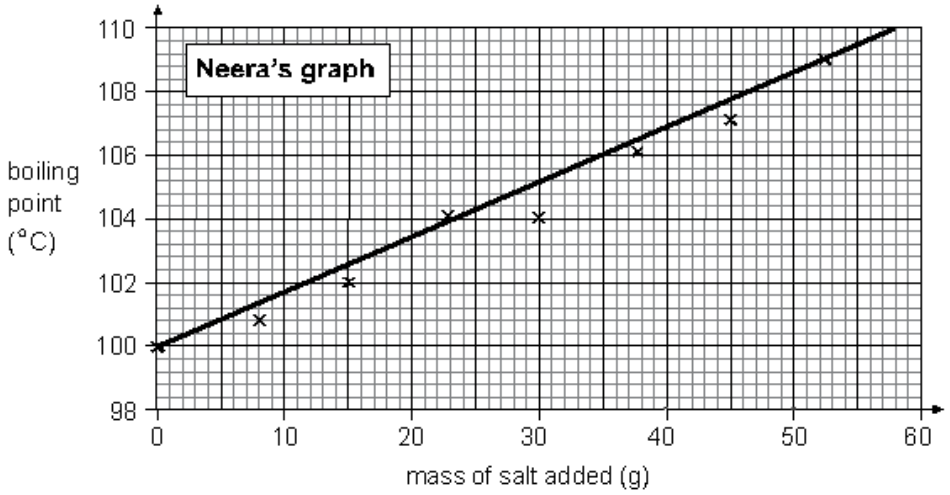
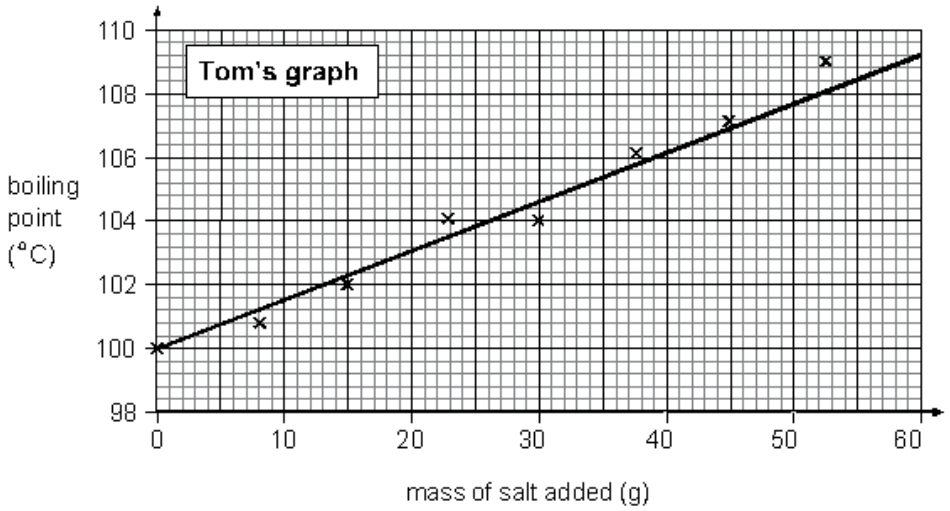
(1 mark)

(b) Neera and Tom plotted their results and drew the graphs shown below.





(i) How can you tell from the graphs that Neera and Tom started with pure water?

……

……

(1 mark)

(ii) Why is Tom's line of best fit better than Neera's line of best fit?

……

……

(1 mark)

END OF TEST

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Science Scholarship Paper 2017

Biology Section

You should complete one of the questions in this section.

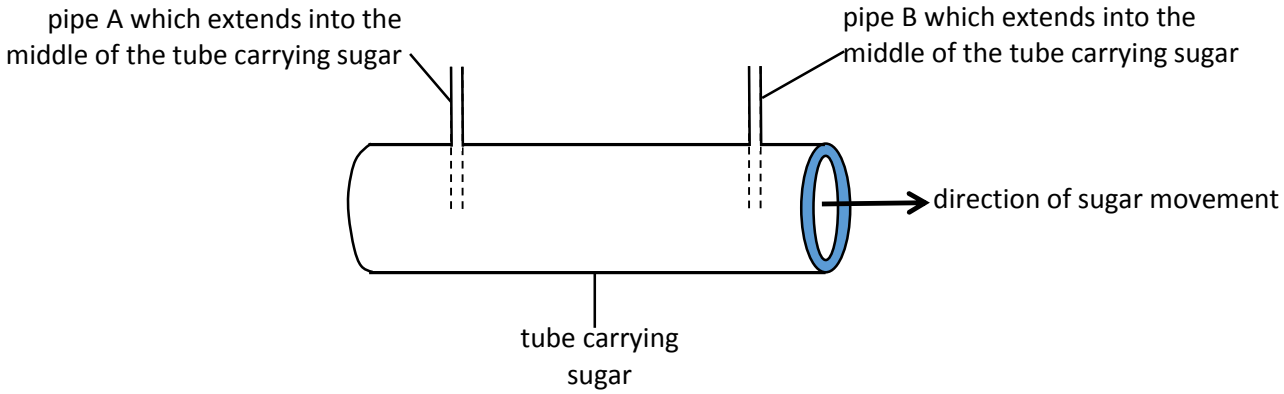
Circle the question you have attempted.

Question	Mark
1	
2	

Biology – Question 1

Many materials travel in tubes in multicellular organisms such as plants and animals.

(a) The diagram below shows one way to study sugar movement in plants.



(i) Suggest how you can use pipes A and B to investigate the rate of sugar movement in this plant.

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(3 marks)

(ii) The sugars may be transported to flowers to attract bees for pollination. Suggest two adaptations of a flower to attract bees, other than the presence of sugar.

……

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(2 marks)

On other occasions the sugar could be moved downwards to the roots.

One reason for sugars in the roots is to help the uptake of minerals such as nitrate ions from the soil. The table below shows the results of one study on the uptake of nitrate ions from soil.

Concentration of sugar in the roots / arbitrary units	Concentration of nitrates in the root / arbitrary units
0	3.0
1	3.6
2	4.8
4	7.7
8	9.7
12	9.9
15	9.9

(iii) Describe the effect of increasing sugar concentration on the uptake of nitrate ions.

……

……

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……

(2 marks)

(iv) Other than to aid mineral ion uptake, suggest one function of sugar in the root.

……

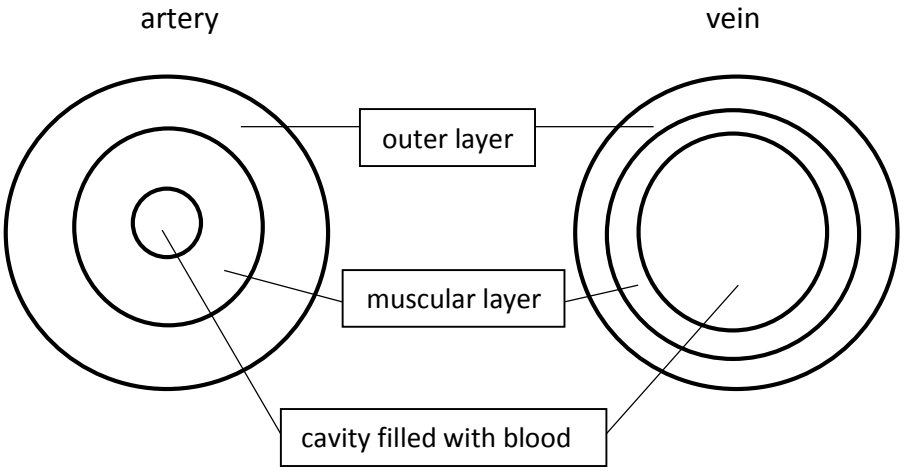
……

(1 mark)

Question continues on next page

(b) In animals blood travels in arteries and veins.

The diagram shows an artery and a vein.



(i) Using the diagram, compare the structure of the artery and the vein.

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(3 marks)

(ii) Explain how the artery in the diagram is adapted to enable all blood to be transported at a high pressure.

……

……

……

(2 marks)

(iii) Smoking cigarettes can affect the transport of blood in arteries. It can also affect the lungs. Describe how smoking can affect the lungs.

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(3 marks)

(c) Some organisms, such as fungi, do not transport materials in tubes. Fungi can release chemicals that digest food outside their bodies and then absorb the products of digestion.

(i) Give one advantage and one disadvantage of this type of nutrition.

Advantage: ……

……

Disadvantage: ……

……

(2 marks)

(ii) Nutrition is one of the characteristics of life. State two other characteristics of life.

……

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……

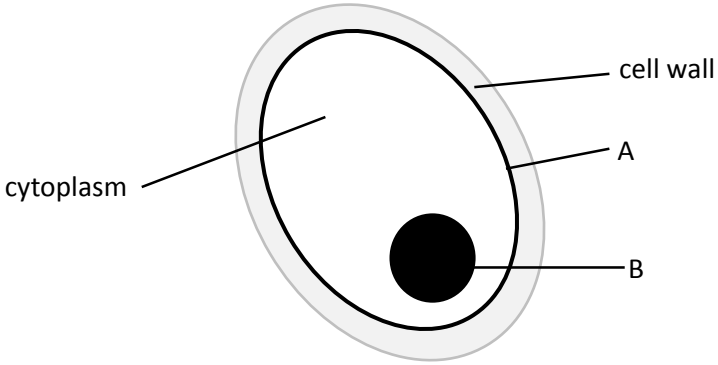
(2 marks)

End of Biology Question 1

Biology Question 2

Yeast is a single-celled organism.

The diagram shows a yeast cell.



(i) Complete the table by filling in the name of structure B and the function of both structures A and B.

Structure	Name of structure	Function of structure
A	Cell membrane	
B		

(3 marks)

If there is no oxygen present, the yeast can carry out anaerobic respiration. This respiration occurs in the cytoplasm and alcohol is released. The table shows the effect of time carrying out anaerobic respiration on the concentration of alcohol produced.

Time / hours	Concentration of alcohol / arbitrary units
0	0.0
2	0.0
20	1.2
40	4.0
50	6.5
60	6.7
65	6.7

(ii) Describe the effect of time on carrying out respiration on the concentration of alcohol produced.

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(3 marks)

(iii) Suggest two reasons for the data between 60 and 65 minutes.

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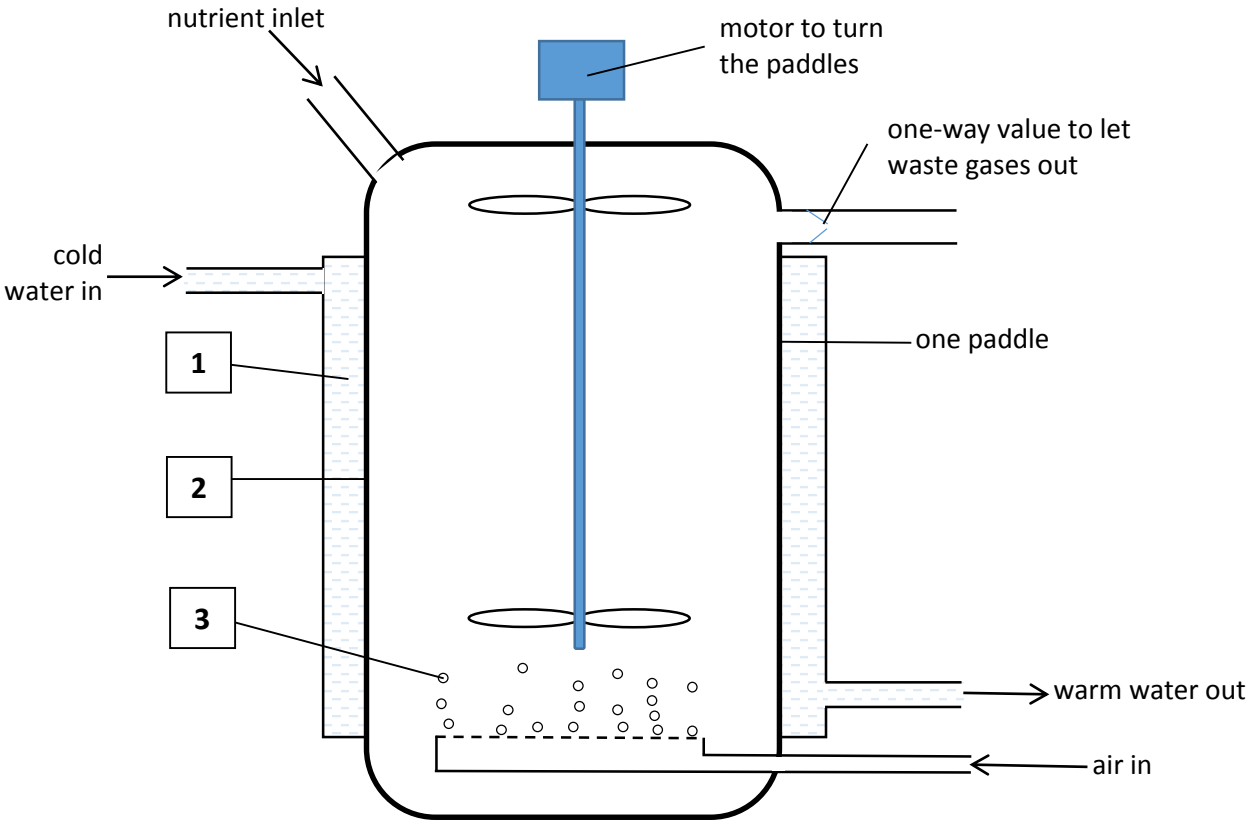
(2 marks)

Question continues on the next page.

(b) Humans have used many different microbes to make useful products. For example, bacteria can be modified to make hormones for humans, in a special vessel as shown below.



(i) Suggest the functions of the structures 1, 2 and 3.

1: .....

.....

2: .....

.....

3:.....

.....

(3 marks)

(ii) Suggest what would happen if the excess gases could not escape.

.....

.....

(2 marks)

(c) Adrenaline is a hormone found in humans. It prepares the body for action.

(i) Suggest why it causes the heart rate to increase.

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(2 marks)

(ii) Suggest why it causes the response in eyes that is shown in the diagram below.

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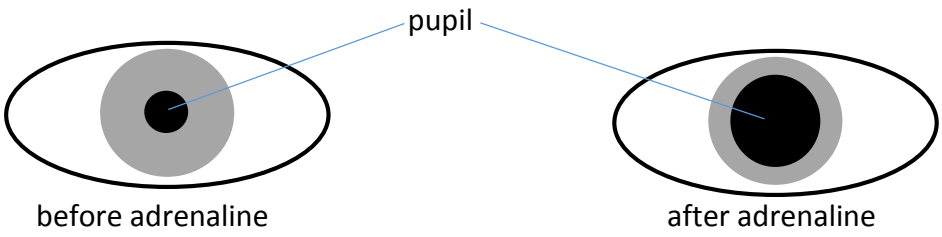
(2 marks)



(iii) Adrenaline travels through the blood circulatory system. Name one system other than either the circulatory or the hormonal system found in humans.

.....

.....

(1 mark)

(iv) Other than adrenaline, name one hormone found in a human and describe one function of this hormone.

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(2 marks)

End of Biology Question 2

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Science Scholarship Paper 2017

Chemistry Section

You should complete one of the questions in this section.

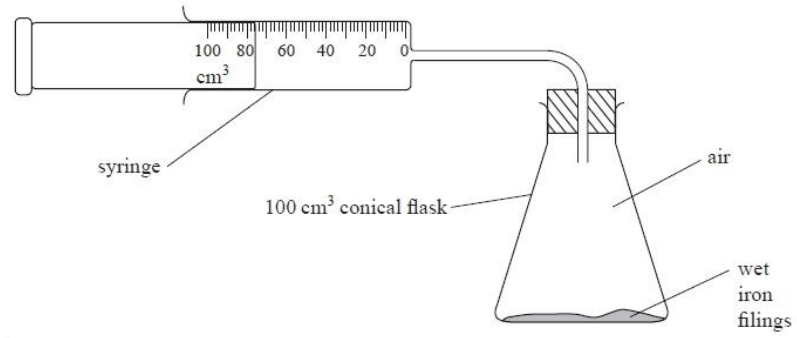
Circle the question you have attempted.

Question	Mark
1	
2	

Chemistry – Question 1

Rusting occurs when iron is exposed to **air** and **water**. During rusting, iron reacts with oxygen from the air to form an oxide.

Some students set up this apparatus to measure the volume of oxygen in a sample of air.



Each student used an excess of wet iron filings.

At the start of the experiment the reading on the syringe was recorded and the apparatus was then left for a week until the reaction was completed.

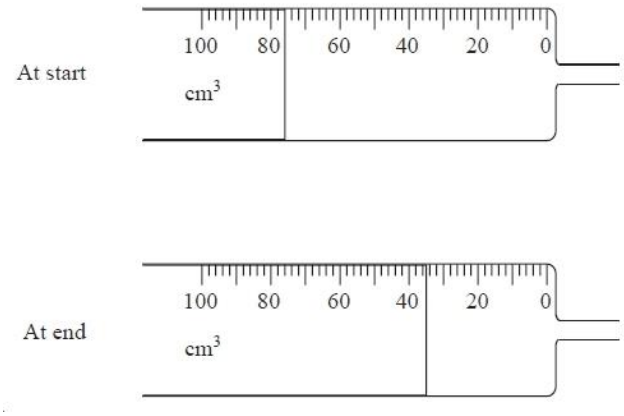
At the end of the experiment the reading on the syringe was recorded again.

(a)

(i) What is the chemical formula of oxygen?..... (1 mark)

(ii) What is the chemical name for rust?..... (1 mark)

(b)The syringes used in one student's experiment are shown below.



Record the syringe readings at the start and at the end of the experiment in the table below, and calculate the volume of oxygen used up.

Syringe reading at start in cm^3	
Syringe reading at end in cm^3	
Volume of oxygen used up in cm^3	

(3 marks)

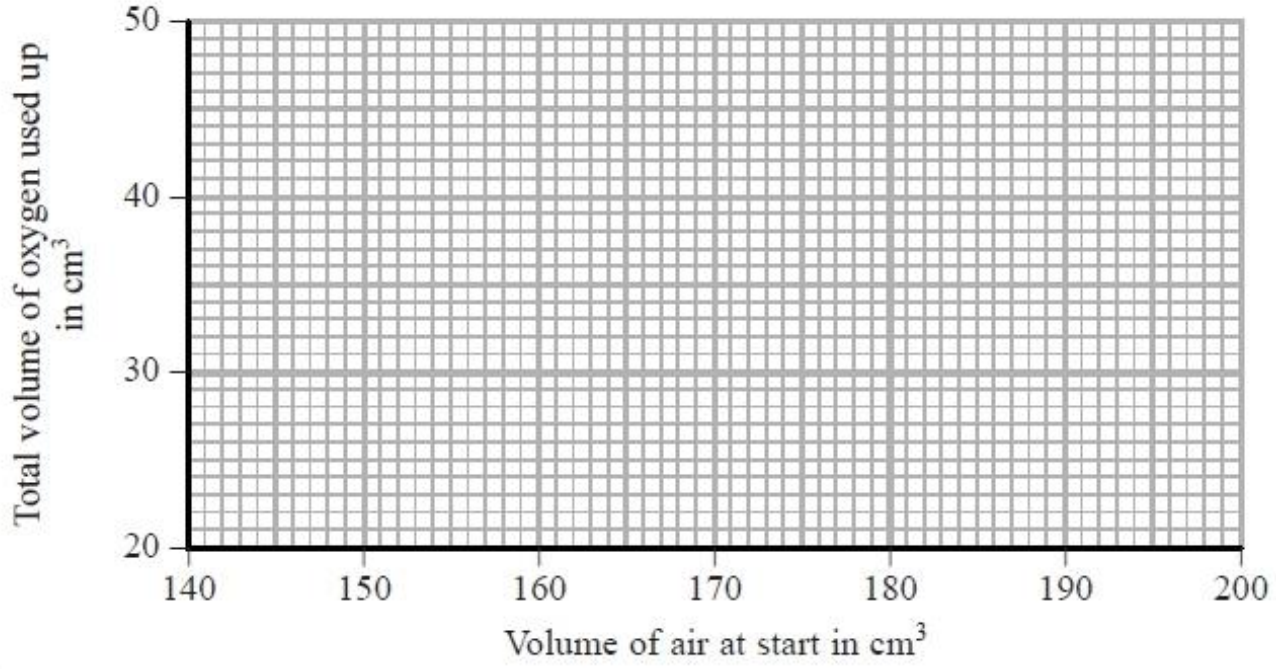
Question continues on the next page

(c) The results of the other students are shown in the table.

Total volume of air at start in cm^3	Total volume of gas at end in cm^3	Volume of oxygen used up in cm^3
200	160	40
180	144	36
165	140	25
150	120	30
185	148	37

(i) Use the results in the table to plot a graph of volume of oxygen used up against volume of air at start. Draw a straight line of best fit.

(4 marks)



(ii) One of the results is anomalous (i.e. does not fit the trend). Identify this result by circling it on the graph.

(1 mark)

(d) Another group of students carried out experiments that gave several anomalous results.
The teacher discussed possible errors that could have caused these anomalous results.

(i) Complete the table by choosing words from the following list to show what effect each error would have on the volume of oxygen used up and then explain your answer in terms of the reaction/s occurring.

decreased **increased** **no change**

Possible error causing anomalous result	Effect on volume of oxygen used up	Explanation
Iron filings not in excess		
Experiment left for one day instead of one week		
Apparatus left in a warmer place for one week		

(3 marks)

Question continues on the next page

(e) Use the following results to calculate the percentage of oxygen in air.
Give your answer to **one decimal place**.

Total volume of air at start in cm^3	140
Volume of gas at end in cm^3	111

(2 marks)

..... %

(f) Painting metalwork protects iron from rusting. Using both your knowledge and information from earlier in the question, explain how painting metalwork prevents it from rusting.

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……

……

……

(2 marks)

(Total for question = 20 marks)

End of Chemistry Question 1

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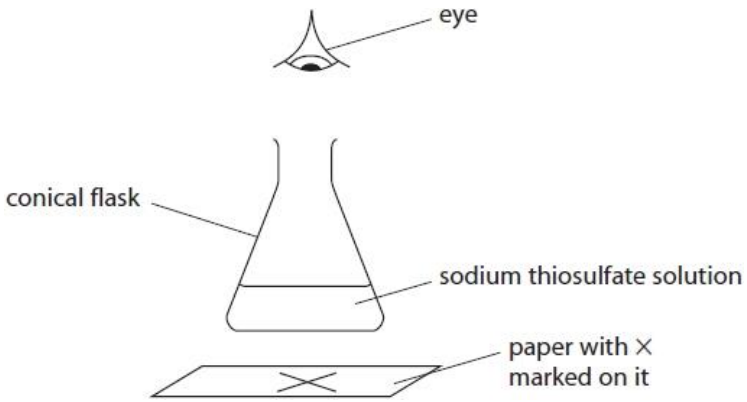
Chemistry – Question 2

Sodium thiosulfate solution and dilute hydrochloric acid react together slowly to form a precipitate of sulfur. This precipitate eventually makes the mixture go cloudy.

Some students are carrying out experiments to investigate this.

Alice uses this method:

- place 20 cm^3 of sodium thiosulfate solution and 20 cm^3 of water in a conical flask
- add 10 cm^3 of dilute hydrochloric acid to the flask
- place the flask on a piece of paper marked with a black ×
- time how long it takes before the × can no longer be seen



(a) The equation for the reaction is

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + S(s) + SO_2(g)$$

Before starting her experiments, Alice considers the risk to her of sulfur dioxide escaping from the flask. She uses this information:

concentration of sodium thiosulfate solution = 0.300 mol/dm^3

volume of sodium thiosulfate solution = 20 cm^3

volume of water = 20 cm^3

volume of hydrochloric acid = 10 cm^3

(i) At the start of the experiment, estimate the pH of the solution.

(1 mark)

.....

.....

(ii) If universal indicator were added to the solution at the start of the reaction, what colour would the solution turn?

(1 mark)

.....

(iii) What would be the most appropriate piece of equipment to use to measure out the solutions for this experiment?

(1 mark)

.....

(iv) At what point in the experiment should Alice have started a timer?

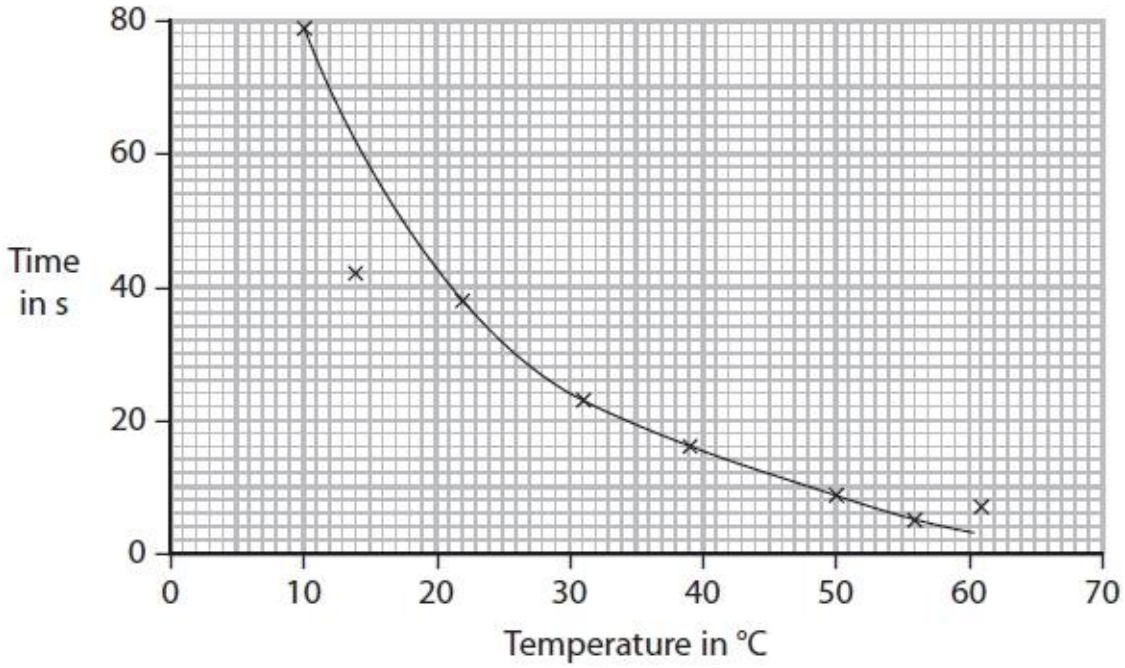
(1 mark)

.....

.....

Question continues on the next page

(b) Her first experiment investigates the effect that temperature has on the reaction. She uses the same volumes and concentrations of solutions as before, but conducts several experiments at different temperatures. The graph shows her results.



(i) The result at (14, 42) is anomalous (i.e. does not fit the trend).
Explain one mistake Alice may have made to cause this anomalous result.

(1 mark)

.....

.....

(ii) Use the graph to find the time taken for the × to be no longer seen at 35 °C.

(1 mark)

.....

(ii) Use the graph to find the temperature at which the × can no longer be seen after 52 s.

(1 mark)

.....

(c) David uses the same reaction to investigate the effect of changing the concentration of the sodium thiosulfate solution on the rate of reaction.

Give three variables that David must control in this investigation to obtain valid results.

(3 marks)

1.....

.....

2.....

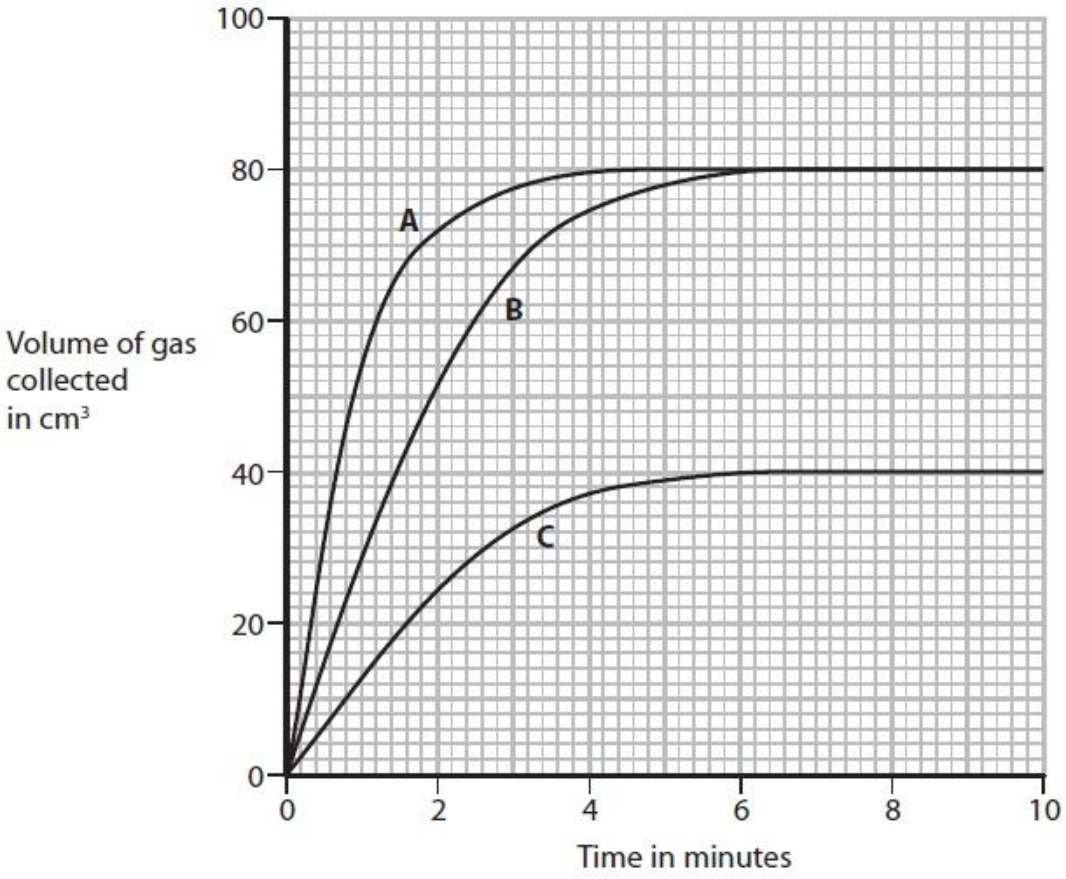
.....

3.....

.....

Question continues on the next page

(d) Tim decided to investigate the same reaction, however, he decided to collect the sulfur dioxide gas given off in a gas syringe, as he thought the results from any such experiments would be more reliable. The results for his experiments are shown below.



(i) Experiments **A** and **B** represent experiments using the same concentration of hydrochloric acid but at different temperatures.

Which letter represents the experiment at the higher temperature?

Give a reason for your choice.

(2 marks)

Letter.....

Reason.....

.....

.....

(ii) Experiments **B** and **C** represent experiments at the same temperatures and using the same volumes of hydrochloric acid.

The concentration of hydrochloric acid used in experiment **B** is 0.20 mol/dm^3.

What is the concentration of hydrochloric acid used in experiment **C**?

Explain how you worked out your answer.

(2 marks)

Concentration.....

Explanation.....

.....

.....

Question continues on the next page

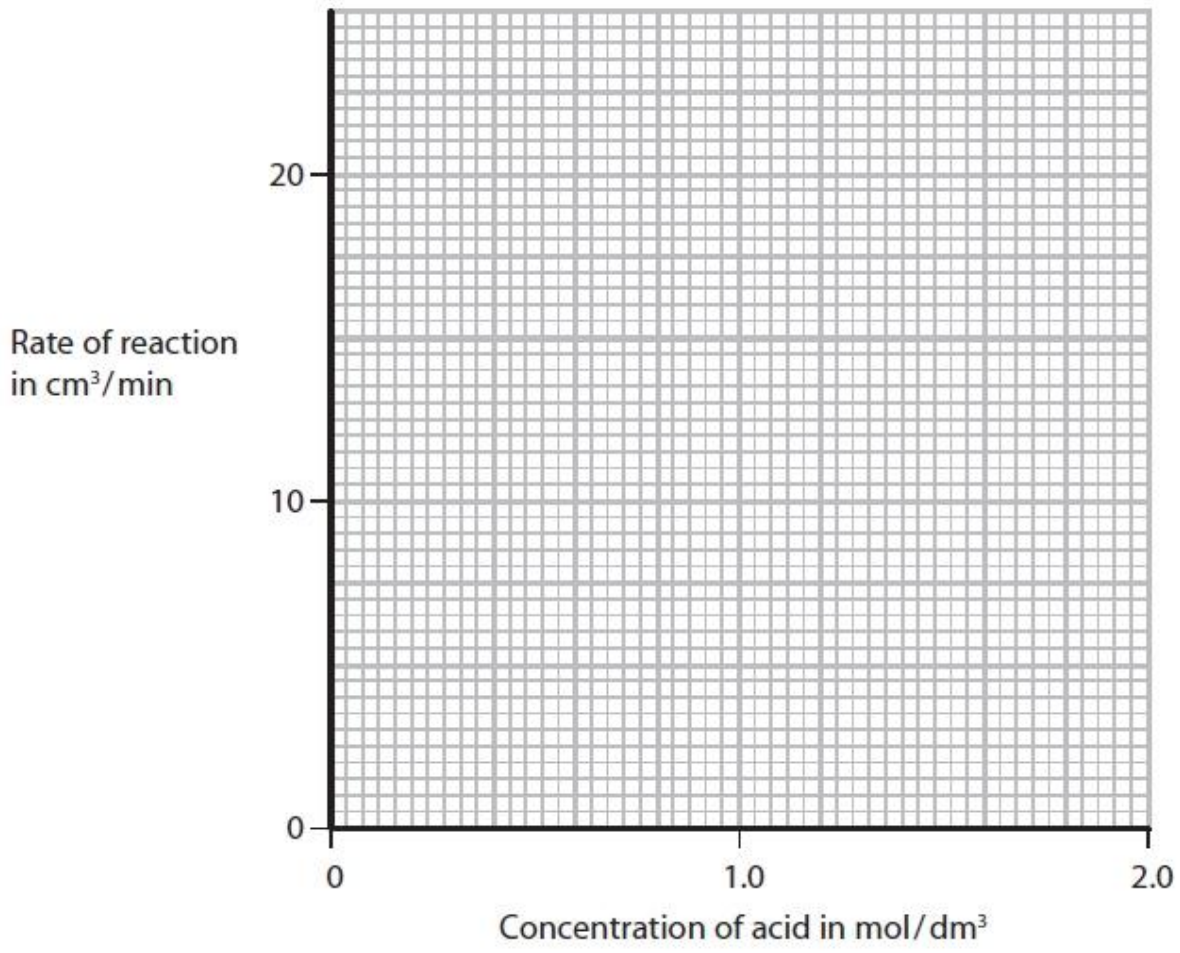
(e) (i) Tim carried out one final investigation and the results can be seen below.

The table shows his results.

Rate of reaction in cm^3/min	4.0	9.0	13.5	18.5	23.0
Concentration of acid in mol/dm^3	0.4	0.8	1.2	1.6	2.0

Plot these results on the grid. Draw a line of best fit through the points.

(4 marks)



(ii) Describe the relationship between rate of reaction and concentration of acid shown by the graph.

(2 marks)

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.....

(Total for question = 20 marks)

End of Chemistry Question 2

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Science Scholarship Paper 2017

Physics Section

You should complete one of the questions in this section.

Circle the question you have attempted.

Question	Mark
1	
2	

Physics Question 1

You may find the following information useful for this question.

Average speed = distance / time

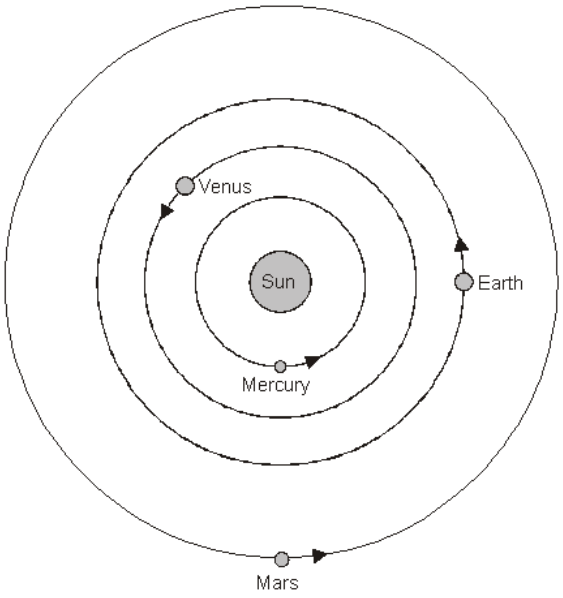
The circumference of a circle = 2 π r where r is the radius of the circle

The table below shows information about four planets.

planet	time taken to orbit the Sun (Earth years)	distance from the Sun (million km)
Mercury	0.25	60
Venus	0.5	108
Earth	1.0	150
Mars	2.0	228

The diagram below shows the orbits of the Earth, Mercury, Venus and Mars, and their position at one particular time.

not to scale



a) Show the position of each planet six months later by drawing a letter X on the orbit of each planet.

(3 marks)

b) Use the information in the table to calculate the largest and smallest distance between the Earth and Venus.

smallest ..... million km

(1 mark)

largest ..... million km

(1 mark)

c) The speed of light is 300 000 km/second.
Calculate how long light takes to reach the Earth from the Sun in seconds.

.....

..... seconds

(1 mark)

d) A light year is defined as the **<u>distance</u>** that light travels in one year.

i) Calculate the number of seconds in 1 year.

……

…….. seconds

(1 mark)

ii) Hence calculate the distance **in kilometres** that is equivalent to a light year.

……

……

……

……km

(2 marks)

iii) The sun is 8.3 **light minutes** away from the Earth. ***Show using a calculation*** that this is equivalent to the distance of 150 million km shown in the table.

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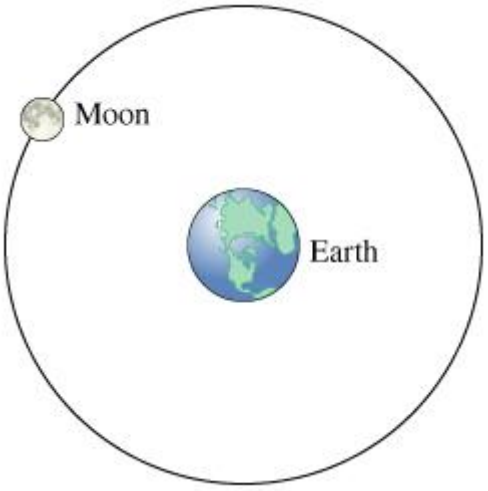
(2 marks)

e) The **radius** of the moon's orbit is 385 000km. It takes 27 days for the moon to orbit the earth once.



i) Assuming that the moon's orbit is perfectly **circular**, calculate the distance that the moon travels during one orbit. Give your answer in **metres**.

……

……m

(2 marks)

ii) Calculate the orbital speed of the moon (i.e the speed at which it is travelling as it goes around its orbit). State your answer in **metres per second**.

……

……

…… m/s

(3 marks)

f) Without calculation, look back at the table at the start of this question and state which of the 4 planets in the table you would expect to have the highest orbital speed.

……

Explain why you would expect this planet to have the highest orbital speed.

……

……

……

(2 marks)

The Earth has an orbital speed of approximately 30 km/s which is roughly 67 000 miles per hour.

g) Why are we not aware that we are travelling so fast through space?

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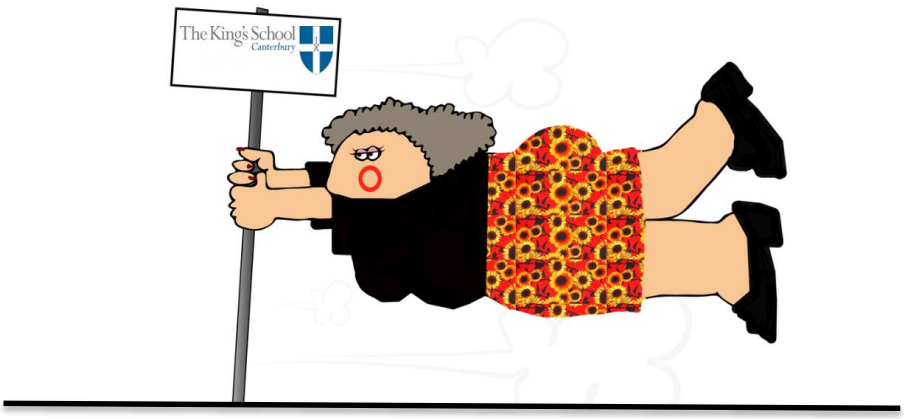
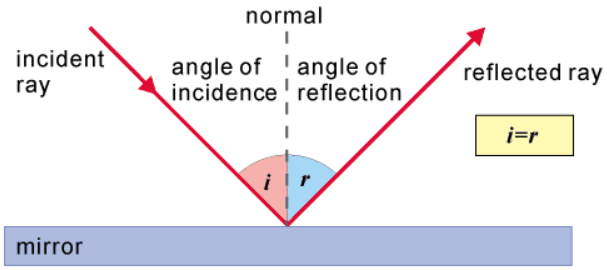
(2 marks)



End of Physics Question 1

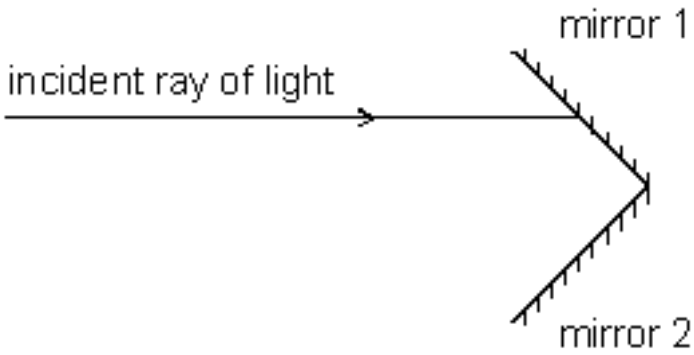
Physics Question 2

The law of reflection states that light will reflect from a surface at the same angle at which it is incident upon the surface. All angles are measured from a line perpendicular to the surface called the **normal**.



a) In the diagram below, a ray of light strikes mirror 1 at an angle of 45°.

i) Complete the diagram to show how the mirrors reflect the ray. You should draw in a normal whenever the light strikes the mirror. Use a ruler but there is no need to use a protractor.



(2 marks)

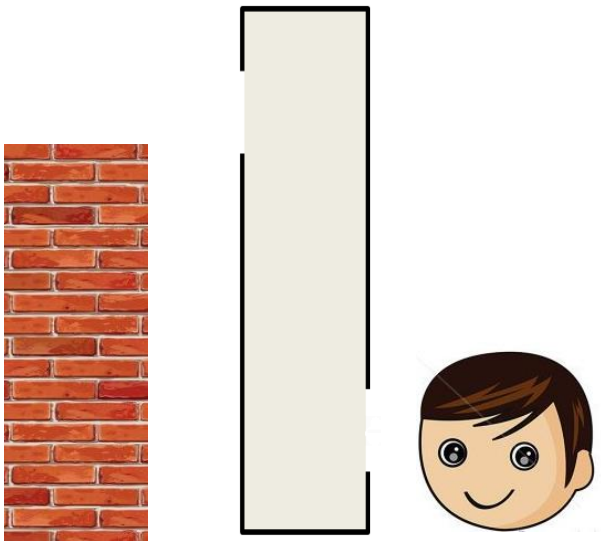
ii) Suggest a possible use for this arrangement of mirrors.

……

……

(1 mark)

iii) Fede wishes to make a periscope that he can use to see over a wall. He has a long rectangular tube with holes cut in it and **two** mirrors but is unsure of the best way to arrange the mirrors to create the periscope. Sketch on the diagram below a suitable arrangement of mirrors that he could use and draw in the path of the ray of light that would enable him to see over the wall.



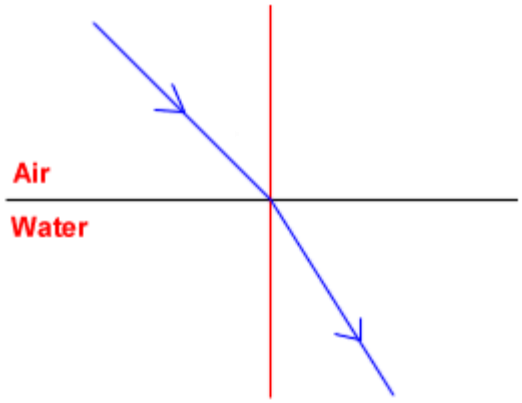
(3 marks)

Question continues on the next page….

Refraction is the bending of light as it travels from one material to another. It is due to the fact that the light changes speed as it travels into the new material.

b) On the diagram below, label the angle of incidence with the letter **i** and the angle of refraction with the letter **r**

(2 marks)



The **refractive index** of a material is a measure of how much the lights refracts when it travels through the material. It is defined using the following equation:

$$\boldsymbol{refractive\ index} = \frac{\boldsymbol{speed\ of\ light\ in\ air\ (in\ m/s)}}{\boldsymbol{speed\ of\ light\ in\ material\ (in\ m/s)}}$$

c) The refractive index of water is 1.33. If the speed of light in air is 300 000 000 m/s, calculate the speed of the light in the water.

……

……

(2 marks)

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Question continues on the next page…….

The refractive index can also be calculated using the following equation

$$refractive\ index = \frac{\sin i}{\sin r}$$

Where **sin** is a mathematical function (you will find that there should be a sin button on your calculator – if not, please ask to borrow a scientific calculator from the person supervising this exam).

d) A student carries out an investigation to find the refractive index of a block of glass. She measures the angle of refraction for a range of angles of incidence. Her results are shown below:

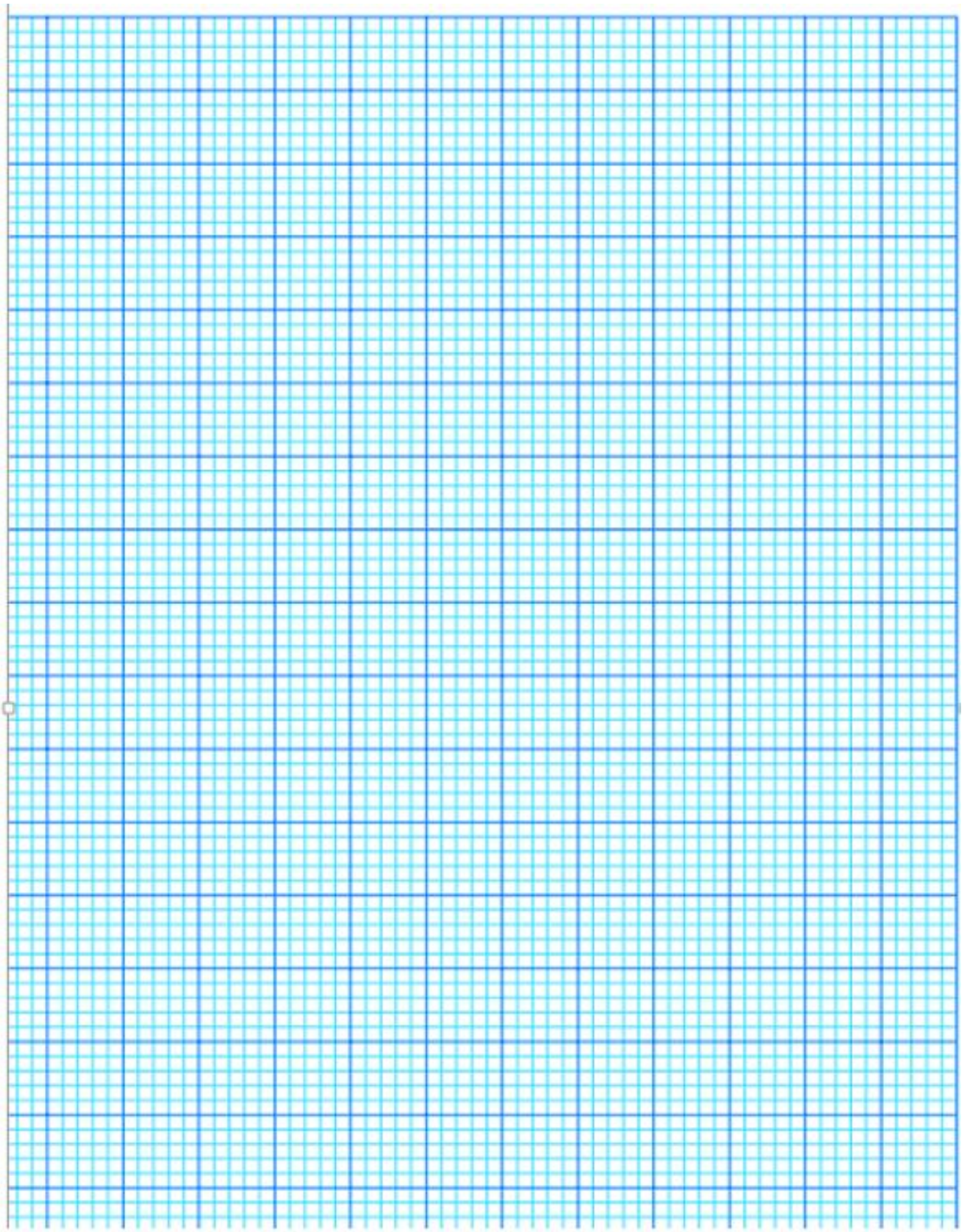
Angle of incidence, *i*	Angle of refraction, *r*	sin *i*	sin *r*
0°	0°	0.00	0.00
15°	10°	0.26	0.17
25°	16°	0.42	
35°	22°	0.57	
45°	28°	0.71	0.47

i) Complete the table to fill in the missing values for sin r

(2 marks)

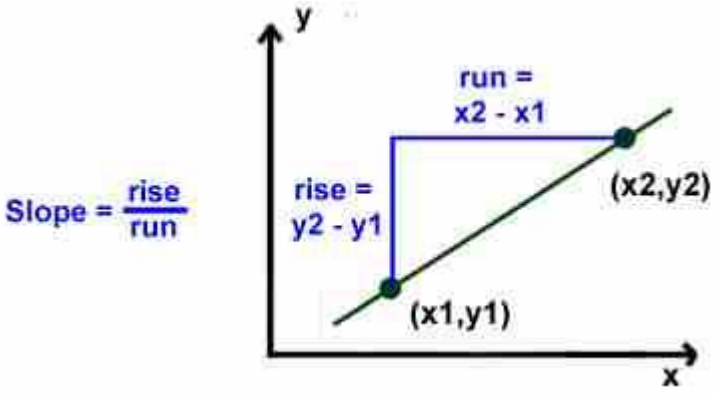
ii) Using the grid below, choose suitable scales and plot a graph with the values of **sin i** on the y axis and **sin r** on the x axis. Draw a line of best fit.

(5 marks)



Question continues on the next page….

The refractive index can now be calculated from the **gradient** (or slope) of this graph. A gradient is found by dividing the change in the values on the y axis (called the rise) by the change in the values on the x axis (called the run).



Note - you can go from any points on the line, but you should always use as much of the line as possible when finding a gradient.

iii) Find the gradient of the graph that you produced for part ii of this question and hence find the refractive index of the glass. Show all of your workings.

……

……..

……..Refractive index of glass =……..

(2 marks)

iv) Suggest a reason why it is better to find the refractive index using the gradient of your graph, rather than just choosing a pair of results from the table.

……..

……..

……..

(1 mark)

End of Physics Question 2

The King's School Canterbury

13+ Scholarship Examinations 2016

SCIENCE

1 hour 10 minutes

Contained in this package are the Physics, Chemistry and Biology sections.

You are to do THREE questions in total. Each question is worth 20 marks.

You must select one question from EACH section.

Write your name on the front of every section booklet and circle the question attempted.

You have 10 minutes to read through the question papers before writing.

You will need a calculator and a ruler.

Name _____

The King's School Canterbury

Science Scholarship Paper 2016

Biology Section

You should complete one of the questions in this section.

Circle the question you have attempted.

Question	Mark
1	
2	

Biology – Question 1

The human body has to deal with a range of different substances.

(a) Twelve pupils used a computer programme to test their reaction rates. Each student carried out the test three times and a mean average was calculated from the 36 sets of data.

The pupils then split into three groups of four called group A, group B and group C. Each group consumed a different drink and then tested their reaction rates at different times and the mean averages found.

The results are shown in the table below.

		Mean average reaction rate / seconds			
Group	**Drink consumed**	**Before drink**	**1 minute after drink**	**5 minutes after drink**	**10 minutes after drink**
A	Water	0.040	0.041	0.039	0.041
B	Coffee	0.040	0.027	0.029	0.035
C	Cola	0.040	0.030	0.028	0.036

(i) Suggest the importance of group A in the experiment.

……

……

……

(2 marks)

(ii) One of the pupils stated that 'both coffee and cola contained a chemical that improved reaction rate'. Using the table, give evidence to support the pupil's statement.

……

……

……

…… (2 marks)

(iii) To compare the effect of coffee and cola in a valid manner, the experiment had to be a fair test. Suggest two variables that should be kept constant for both the coffee and the cola.

1. ……..

2. ……..

(2 marks)

(iv) Another pupil stated that 'the chemical was being broken down in the body between 5 and 10 minutes after being consumed'. Do you agree with this pupil's statement? Give reasons for you answer.

Agree / disagree ……..

……..

……..

……..

(2 marks)

(b) Cola may contain added sugar.

(i) Give one use of sugar in the human body.

……..

……..

(1 mark)

(ii) Suggest why too much sugar in the diet may not be good for a growing person.

……..

……..

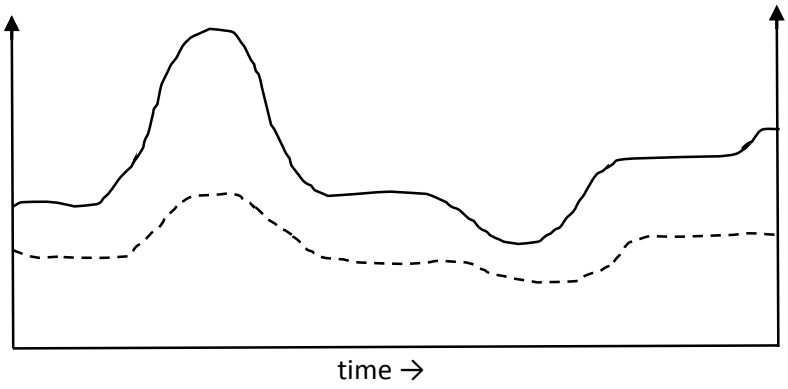
……..

……..

(2 marks)

Question continues on the next page

(iii) The graph below shows the relationship between insulin concentration in the blood and blood sugar levels in a healthy human.



Key

Solid line = glucose
Dotted line = insulin

Describe this relationship.

……

……

……

……

(2 marks)

(c) There should be no sugar in the urine of a healthy human.

The table below shows the concentration of some blood components in blood entering the kidney and in blood leaving the kidney.

Blood component	Blood entering kidney / g per litre	Blood leaving kidney / g per litre
Water	960.0	910.0
Urea	20.0	3.0
Sodium ions	3.6	3.2
Chloride ions	6.0	4.3

i) Using the data in the table, explain the role of the kidney.

……

……

……

……

……

……

(3 marks)

ii) The blood leaving the kidney has a lower oxygen concentration than the blood entering the kidney.

Suggest why kidney cells need oxygen.

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(2 marks)

iii) Describe the structure of a human body cell such as a kidney cell.

……

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(2 marks)

End of Biology Question 1

Biology Question 2

Plants are used in a number of ways by humans, including as a nutrient source and as a source of medicinal drugs.

(a) Some plants produce fruits that contain a lot of vitamin C.

i) Name one fruit that contains a lot of vitamin C.

……

(1 mark)

DCPIP is a blue dye that becomes colourless when sufficient vitamin C is added to it.

The table below gives the volumes of different concentrations of vitamin C needed to cause 1.0 cm^3 of DCPIP to become colourless.

Percentage concentration of vitamin C (%)	**Volume of the vitamin C needed to cause the DCPIP to become colourless / cm^3**
0.10	0.8
0.05	1.7
0.02	3.9

ii) Describe the effect of concentration of vitamin C on the volume of vitamin C needed to cause the DCPIP to become clear.

……

……

……

……

(2 marks)

(iii) It was found that 1.3 cm^3 of freshly squeezed lemon juice was needed to cause 1.0 cm^3 of DCPIP to become clear.

Calculate the concentration of vitamin C in this lemon juice.

Answer: …… %

(2 marks)

(b) To manufacture new plant material, photosynthesis is necessary.

(i) Suggest adaptations of a plant leaf to maximize photosynthesis.

……

……

……

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……

……

……

(3 marks)

(ii) The word equation below describes photosynthesis.

light energy + carbon dioxide + water → sugar + oxygen

Suggest why an increase in carbon dioxide may **not** cause an increase in sugar production.

……

……

……

……

(2 marks)

(c) Suggest how the structure of a photosynthetic cell in a leaf would differ from a cell that absorbs water from the soil.

……

……

……

……

(2 marks)

(d) Tobacco comes from a plant. State one substance found in tobacco smoke that is harmful.

……

(1 mark)

(e) Various stages are involved in testing a new medicinal drug.

(i) Suggest the role of each of the following two stages:

1. testing the drug on animals ……

……

(1 mark)

2. testing the drug on a small number of patients.

……

……

……

(2 marks)

(ii) Suggest why studies using a large number of patients are also used.

……

……

……

……

(2 marks)

(iii) In these large studies, half the group are given the drug and half are not. Suggest why some patients are not given the drug.

……

……

……

(2 marks)

End of Biology Question 2

Name _____

The King's School Canterbury
Science Scholarship Paper 2016

Chemistry Section

You should complete one of the questions in this section.

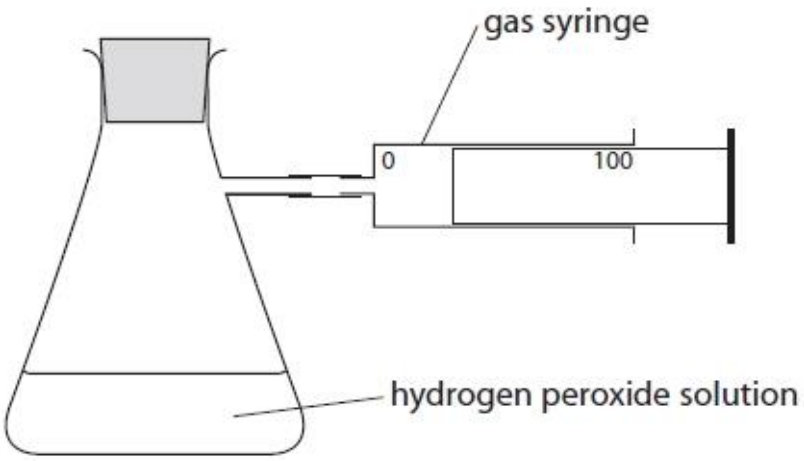
Circle the question you have attempted.

Question	Mark
1	
2	

Chemistry – Question 1

a) A student investigates the rate of decomposition of hydrogen peroxide (H_2O_2) solution.

The diagram shows the apparatus he uses in his experiments.



The equation for the decomposition is

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(i) What is the chemical name for H_2O……. **(1 mark)**

(ii) What is the chemical name for O_2……. **(1 mark)**

(iii) Using the symbol equation above state what type of substance each is:

ELEMENT, COMPOUND OR MIXTURE

(3 marks)

H_2O_2…….

H_2O……..

O_2……

(b) The student keeps the amount of H_2O_2 in the solution constant at the start of each experiment.

State two properties of the solution that he should keep the same to ensure that the amount of H_2O_2 is the same in each experiment.

(2 marks)

1 .....

2 .....

(c) The student carries out the experiment five times.

He uses a different solid in each experiment to see how effective each solid is as a catalyst in the decomposition.

He removes the bung, adds a small amount of one of the solids and quickly replaces the bung.

He records the time taken to collect 100 cm^3 of oxygen in the syringe.

Solid	Time to collect 100 cm^3 of oxygen, in seconds
A	76
B	no oxygen collected
C	35
D	11
E	54

(i) What is the definition of a catalyst?

(2 mark)

.....

.....

(ii) Which solid does not seem to act as a catalyst?

(1 mark)

.....

(iii) Which solid is the most effective catalyst?

(1 mark)

.....

(d) In the first experiment the student added 1g of solid A.

Describe what he could do with the contents of the conical flask at the end of the experiment to show that A was a catalyst, and not a reactant.

(2 marks)

.....

.....

.....

.....

.....

Question continues on the next page.

(e) The student repeats the experiment using the same apparatus, but this time he records the volume of oxygen collected at intervals of 20 seconds.

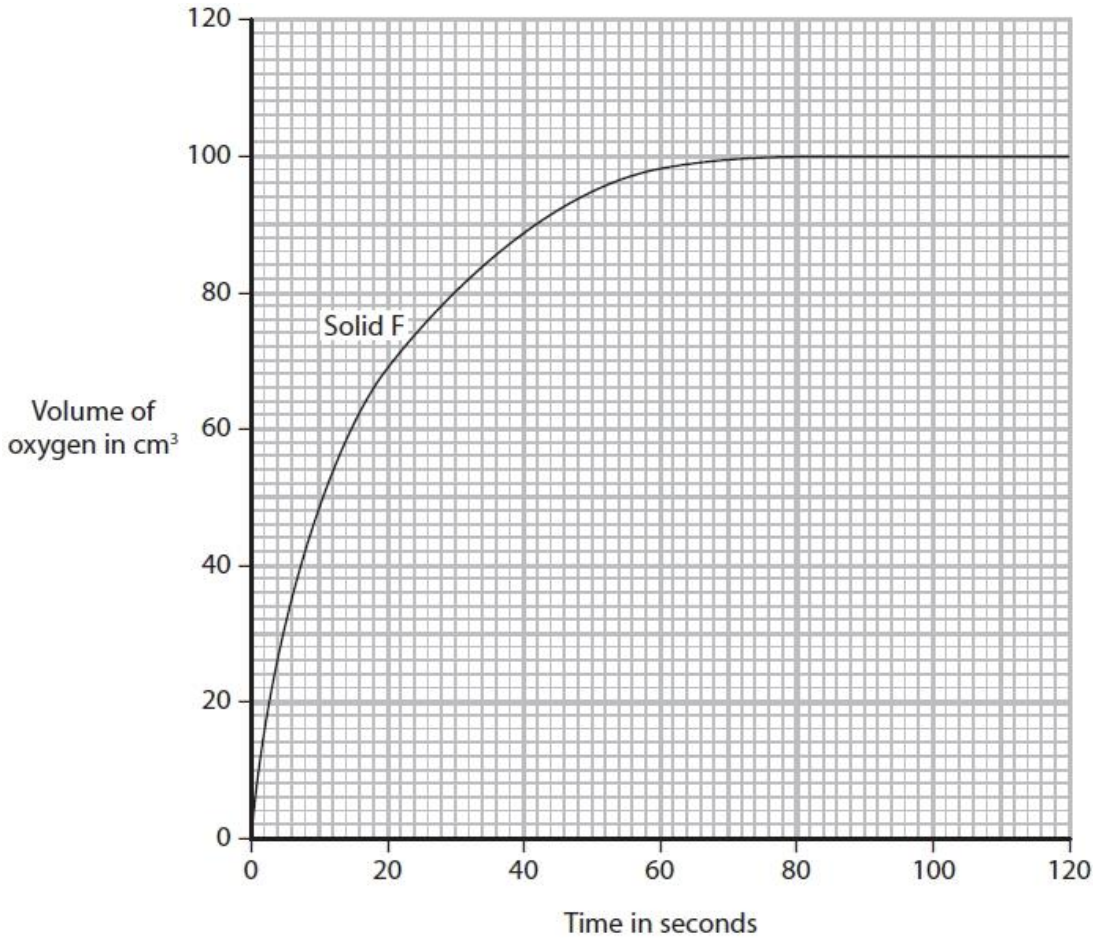
The table shows his results for two new solids F and G.

Time in seconds	Volume of oxygen collected in cm^3	
	solid F	solid G
0	0	0
20	69	36
40	89	58
60	98	74
80	100	86
100	100	96
120	100	100

(i) The grid shows the results plotted for solid F.

On the grid, plot the results for solid G.

Draw a curve of best fit. **(4 marks)**



(ii) Use your graph to estimate the volume of oxygen collected after 70 seconds for solid G.

Show on your graph how you obtained your answer.

(2 marks)

.....

(iii) How do the curves on the graph show that the reaction is faster with solid F than with solid G?

(1 mark)

.....

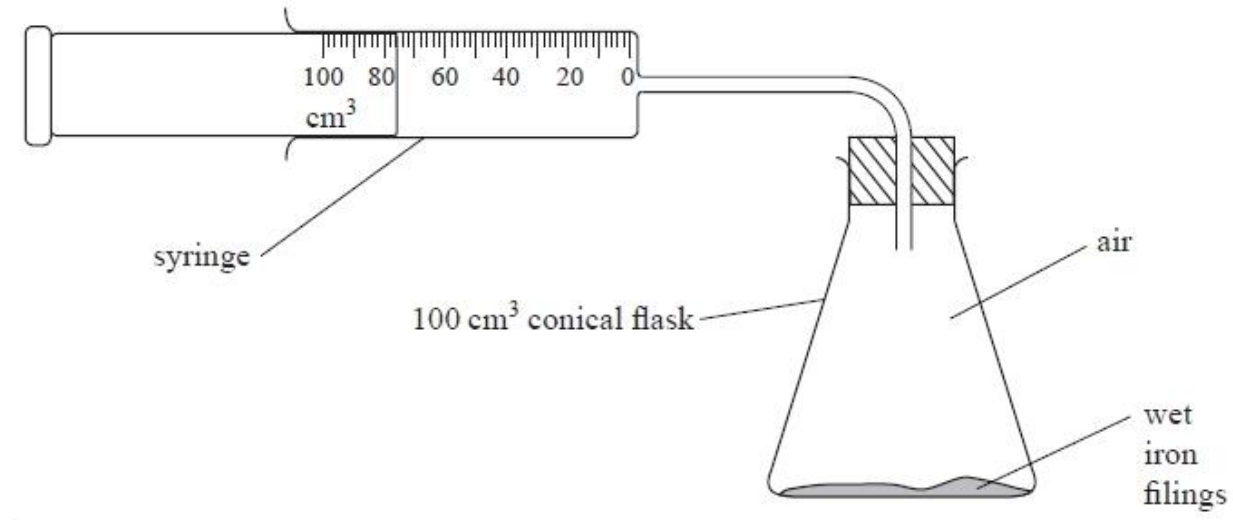
.....

End of Chemistry Question 1

Chemistry - Question 2

Rusting occurs when iron is exposed to air and water. During rusting, iron reacts with oxygen from the air to form an oxide.

Some students set up this apparatus to measure the volume of oxygen in a sample of air.



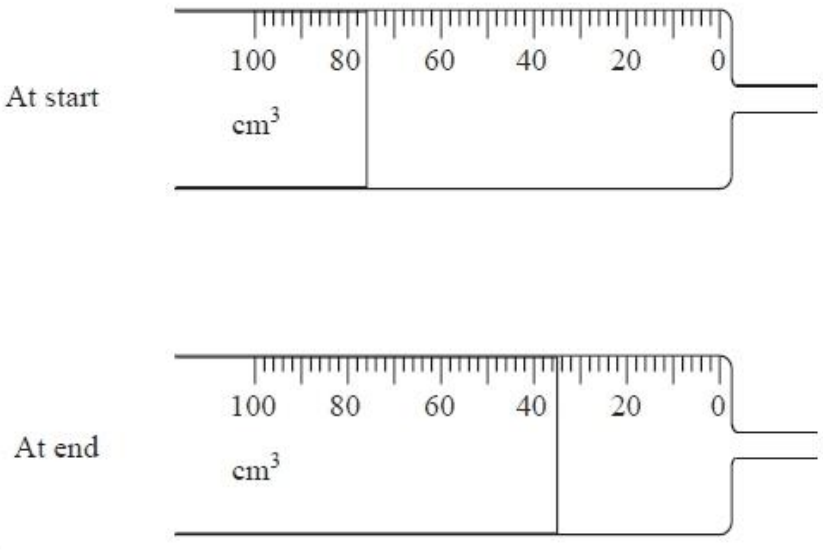
Each student used an excess of wet iron filings.

At the start of the experiment the reading on the syringe was recorded and the apparatus was then left for a week until the reaction was completed.

At the end of the experiment the reading on the syringe was recorded again.

Question continues on the next page

(a) The syringes used in one student's experiment are shown below.



Record the syringe readings at the start and at the end of the experiment in the table below, and calculate the volume of oxygen used up.

Syringe reading at start in cm^3	
Syringe reading at end in cm^3	
Volume of oxygen used up in cm^3	

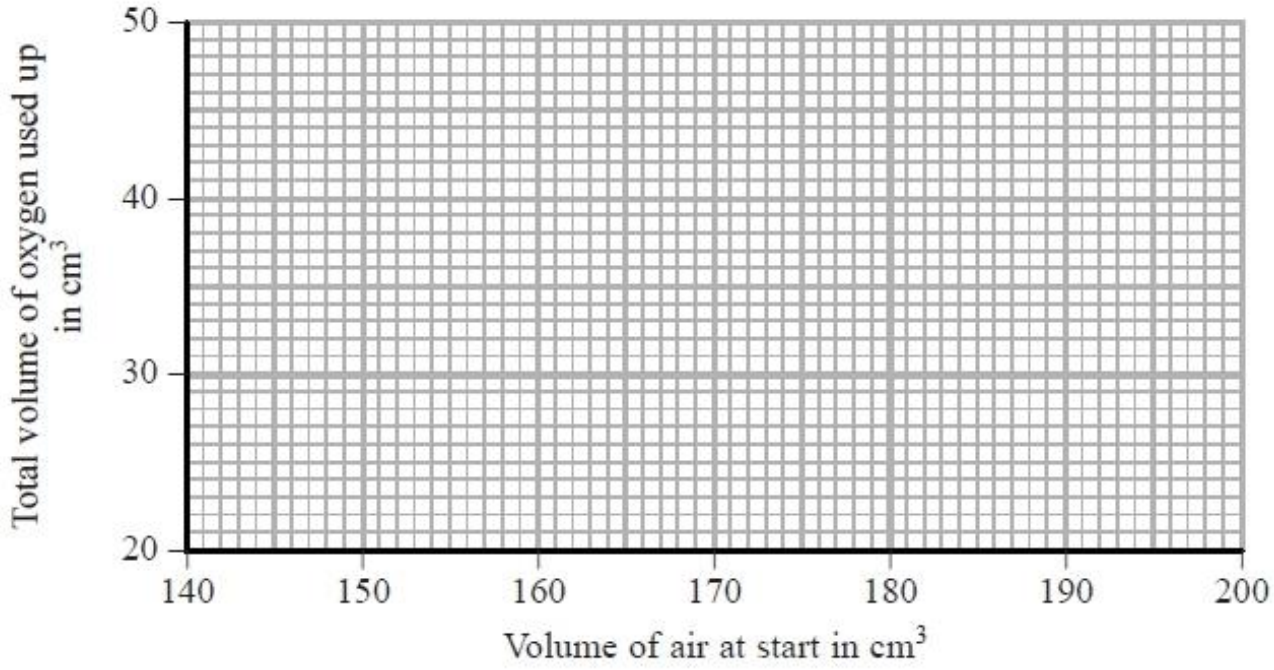
(3 marks)

(b) The results of the other students are shown in the table.

Total volume of air at start in cm^3	Total volume of gas at end in cm^3	Volume of oxygen used up in cm^3
200	160	40
180	144	36
165	140	25
150	120	30
185	148	37

(i) Use the results in the table to plot a graph of volume of oxygen used up against volume of air at start. Draw a straight line of best fit.

(4 marks)



(ii) One of the results is anomalous. Identify this result by circling it on the graph.

(1 mark)

(c) Another group of students did experiments that gave several anomalous results. The teacher discussed possible errors that could have caused these anomalous results.

Complete the table by choosing words from the following list to show what effect each error would have on the volume of oxygen used up.

decreased

increased

no change

Possible error causing anomalous result	Effect on volume of oxygen used up
iron filings not in excess	
experiment left for 1 day instead of 1 week	
apparatus left in warmer place for 1 week	

(3 marks)

(d) Use the following results to calculate the percentage of oxygen in air.
Give your answer to one decimal place.

Total volume of air at start in cm^3	140
Volume of gas at end in cm^3	111

(2 marks)

..... %

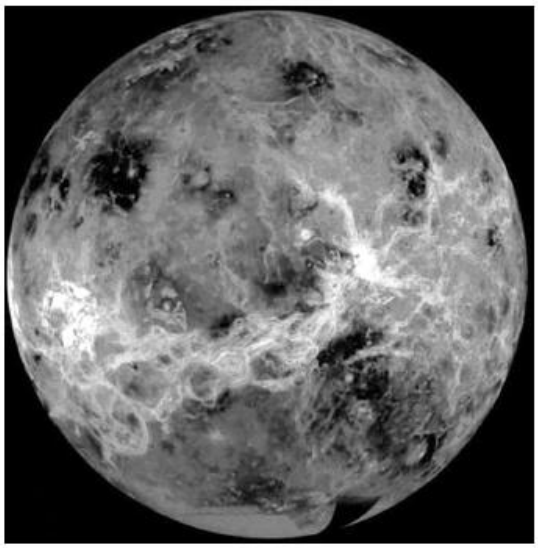
(e) Name the major component of air?

(1 mark)

……

(f) Different materials are used for different purposes in everyday life, for instance water pipes up until 1970 were made from lead (chemical symbol Pb); nowadays they are typically made from copper (chemical symbol Cu).

The photograph shows the planet Venus.



Although Venus is similar in size to the Earth, it is very different in other ways.

The temperature at the surface of Venus is about 470 °C. The atmospheric pressure is 90 times that of the Earth.

The clouds in the atmosphere of Venus are made up of droplets of sulfuric acid.

The table lists some properties of metals that could be used to make a space probe to land on Venus.

Metal	Melting point in °C	Relative density	Reaction with sulfuric acid
copper	1083	8.9	no reaction
lead	328	11.3	no reaction
magnesium	650	1.7	fizzes vigorously
nickel	1453	8.9	fizzes slowly
titanium	1675	4.5	no reaction
zinc	420	7.1	fizzes quite vigorously

The probe needs to be launched with enough energy to escape the Earth's gravity. To make this easier, the mass of the probe needs to be as low as possible. The probe also needs to withstand the conditions on the surface of Venus.

Use the information in the table to answer the following questions.

(i) Which metal in the table could be used to make a probe with the lowest density?

(1 mark)

.....

(ii) Why would this metal be unsuitable for making a probe to land on Venus?

(1 mark)

.....

.....

(g) Very small amounts of lead can be used in electrical circuits.
Why would lead **not** be suitable for use in the electrical circuits of a probe to land on Venus?

(1 mark)

.....

.....

.....

(h) Choose a metal from the table that would be the **most** suitable for making a probe to land on Venus. Give **two** reasons for your choice.

(3 marks)

Metal……

Reasons

1 .....

.....

2 .....

.....

End of Chemistry Question 2

Name _____

The King's School Canterbury

Science Scholarship Paper 2016

Physics Section

You should complete one of the questions in this section.

Circle the question you have attempted.

Question	Mark
1	
2	

Physics – Question 1

a) A child throws a ball up into the air.

i) On the diagram above, draw and label arrows to show any forces that are acting on the ball in this position. The direction of the arrow(s) should indicate the direction of the force(s).

(1 mark)

ii) The ball falls down and hits the ground. Draw and label arrows to show the forces acting on the ball now.

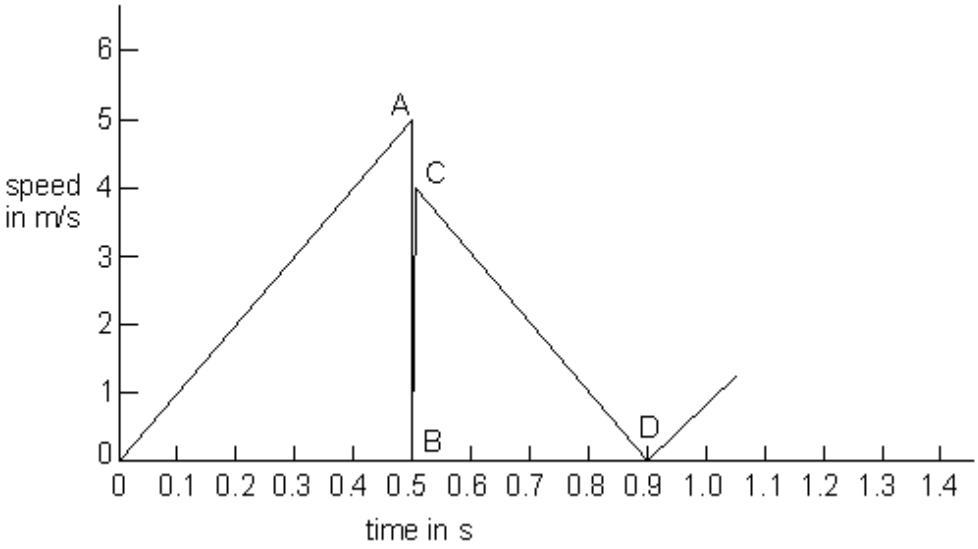
(1 mark)

You may find the following information useful for the next part of this question:

<u>Average</u> speed (in m/s) = distance travelled (in m) / time taken (in s)

Please note that you should use **<u>average</u>** (or mean) speed in this equation

b) The graph below shows the speed of a ball as it falls from a height and bounces from the floor.



The ball starts to fall and speeds up until it hits the floor.

(i) For how many seconds does the ball fall before it first hits the floor?

.....

(1 mark)

(ii) Calculate the **<u>average</u>** speed of the ball during its fall.

.....

.....

(1 mark)

(iii) Calculate the height above the floor from which the ball was dropped.

.....

.....

(2 marks)

(iv) What is happening to the ball in the time between points A and C on the graph?

.....

.....

(1 mark)

(v) In which direction is the ball moving between points C and D?

.....

(1 mark)

vi) Calculate how high the ball bounces back up from the floor.

.....

.....

(2 marks)

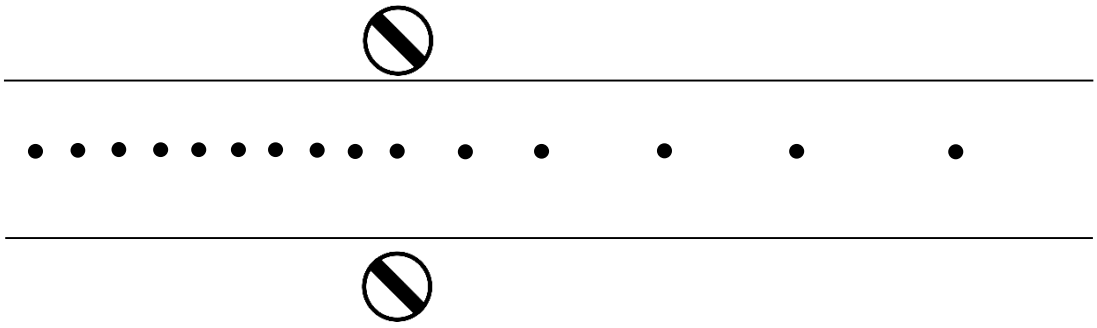
(vii) Suggest a reason why the ball did not return to the height that it was dropped from.

.....

.....

(1 mark)

c) A car engine is leaking oil. The oil drops hit the ground at regular time intervals, **2 times every second**. The diagram below shows the pattern of the drops that the car leaves on the road.



i) What can you say about the motion of the car before it reaches the speed limit signs?

……

……

(1 mark)

ii) Calculate the distance between the drops on the road before it reaches the signs if the car is travelling at 10 m/s.

……

……

(2 marks)

iii) What can you say about the forces acting on the car at this stage of its journey?

……

……

(1 mark)

Question continues on the next page

d) The acceleration of a moving object (i.e. the rate at which something is speeding up) is calculated using the following equation

$$a = \frac{v-u}{t}$$

a = acceleration in m/s^2

v = final velocity in m/s

u = initial velocity in m/s

t = time in s

i) A car is travelling at 10m/s when the driver puts her foot down for 6 seconds and accelerates up to a speed of 25m/s. Calculate the acceleration of the car.

……

……

Acceleration = …… m/s^2

(2 marks)

ii) A motorbike is travelling at 20m/s and accelerates at a rate of $1.8m/s^2$ for 5s. Rearrange the above equation to get an expression for **v** and use this to find the new velocity of the motorbike. Show all of your workings.

……

……

……

……

(3 marks)

End of Physics Question 1

Physics Question 2

People often muddle up the concept of mass and weight.

Mass is a measure of the amount of matter in an object ('matter' is anything made up from atoms). It is measured in kilograms (kg).

Weight is the force that gravity exerts on all objects with mass. It is measured in Newtons (N).

The two are related by the following equation:

Weight (in N) = mass (in kg) x gravitational field strength (in N/kg)

The gravitational field strength (usually referred to as 'g') of a planet depends on:

- The mass of the planet (the greater the mass, the greater the value of g)
- The distance from the planet (the further you go from the planet, the weaker the value of g)

a) For each of the following, decide if the statement is true or false (put a tick in the correct box).

	True	False
A 70 kg astronaut would have a mass of 0 kg at the international space station.		
You would weigh less at the top of Mount Everest.		
Your mass would decrease if you had a haircut.		
You would look slimmer if you went to the moon.		
You would weigh so much on Jupiter that it could break your bones.		

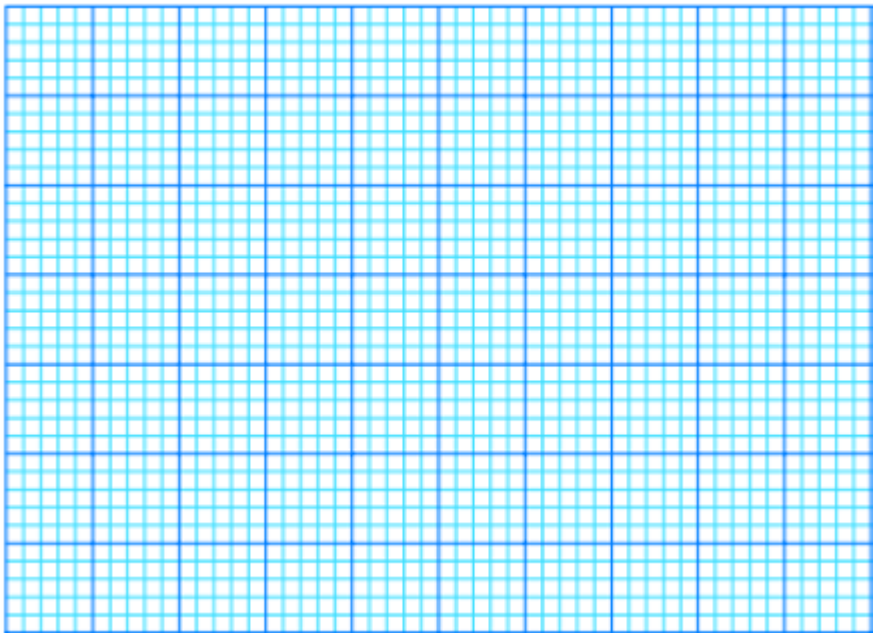
(5 marks)

b) Springs can be used to measure weight.

The table below contains data about a spring inside bathroom scales used for weighing people.

Weight/N	Length/cm
0	2.40
200	1.85
400	1.30
600	0.75
800	0.65
1200	0.50
1600	0.50

i) Use the data in the table to complete a graph on the grid below. Plot length on the y-axis and weight on the x-axis and draw a curve of best fit.



(3 marks)

ii) What is the original length of the spring?

……

(1 mark)

iii) By how much does the spring **compress** (i.e. 'squash') when a boy who weighs 500N stands on the scales?

……

……

(2 marks)

iv) Suggest the range of weights over which these scales are useful.

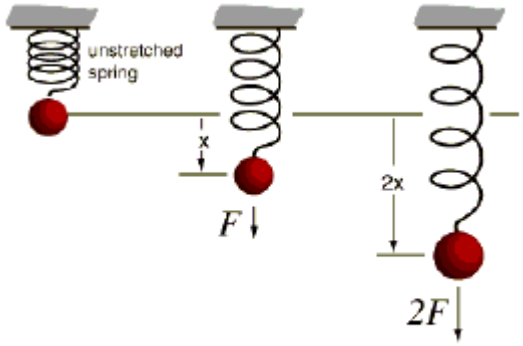
……

……

(1 mark)

Question continues on the next page.

c) A spring is said to obey Hooke's law if the extension (i.e. how far it has stretched from its original length) is directly proportional to the force applied. This means that the force and the extension are related by a common factor for example, if you doubled the force, you would also double the extension.



Mathematically this is expressed as

$$F = k\,x$$

where F is the force (in N)

x is the extension (in m)

and k is a constant value called the **stiffness constant**.

The greater the value of k, the stiffer the spring.

i) According to this equation, what might be a suitable unit for the stiffness constant k?

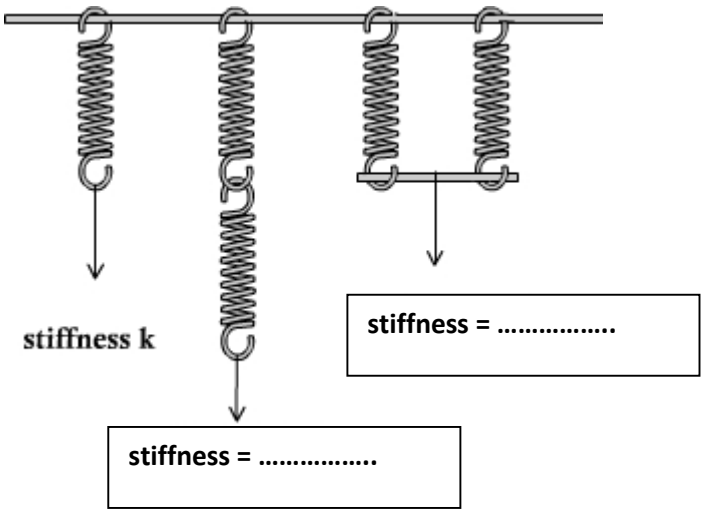
……

(1 mark)

ii) Sketch the shape of the graph that you would expect to produce for a spring obeying Hooke's law.

(1 mark)

iii) A spring of stiffness k is now joined with an identical spring in the arrangements shown below. On the diagram**, write an expression <u>in terms of k</u>** for the new stiffness of the spring arrangements (you may like to consider whether the arrangement is more or less 'stiff' than the single spring).



(2 marks)

Question continues on the next page.

iv) For each of the situations in the previous question, explain *why* you have given these expressions for the stiffness constant. You should use the Hooke's Law equation to help to justify your answers.

2 springs in series (i.e. end to end)

……

……..

……

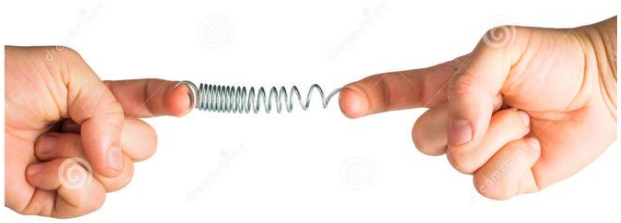
2 springs in parallel (i.e. side to side)

……

……

……

(4 marks)



End of Physics Question 2