



OUNDLE

School

2019 Academic Scholarship

Science

Theory Paper

Time Allowed: **1 hour**

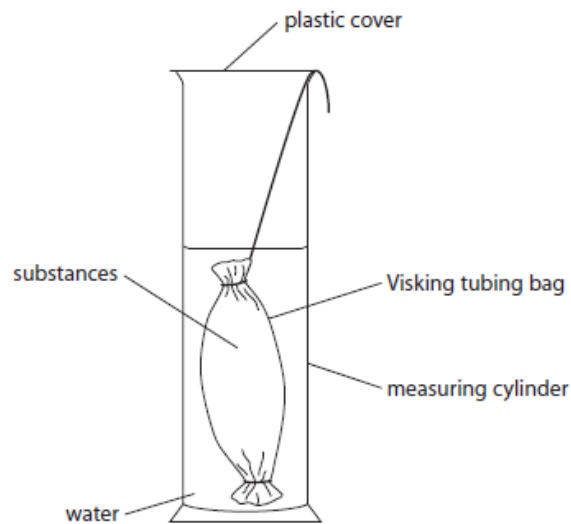
Name:

Biology Section

Question 1

This is an experiment to demonstrate digestion of starch by the enzyme amylase. Use the following information to answer the questions which follow.

- Amylase is a molecule (an enzyme) that breaks down insoluble starch to form soluble glucose. This process happens very quickly at the right temperature.
- Starch is a large, insoluble molecule.
- Glucose (sugar) is very small and soluble.
- Visking tubing has tiny holes in it.
- At the start of the experiment, starch and amylase was placed inside the Visking tubing.



After one hour (plenty of time for any reactions to have taken place) the liquid inside the Visking tubing was tested. Then the liquid outside the Visking tubing (inside the measuring cylinder) was also tested.

- a. The water inside the tube was tested using Iodine solution and then Benedict's solution. What results would you expect for these two tests?
Explain your answers for each.

Iodine Solution:

.....

.....

Benedict's Solution:

.....

..... [4]

[Total: 4 marks]

Question 2

Samples of sperm from two men were looked at under the microscope. The image shows the two dishes when looked at under a microscope.



- a. What is the mean number of sperm cells per dish?

.....
..... [2]

- b. Man B has a lower chance of fertilisation. What does fertilisation mean?

.....
.....
..... [2]

- c. Give two reasons why Man A has a greater chance of fertilisation than Man B.

Reason 1:

.....

.....

Reason 2:

.....

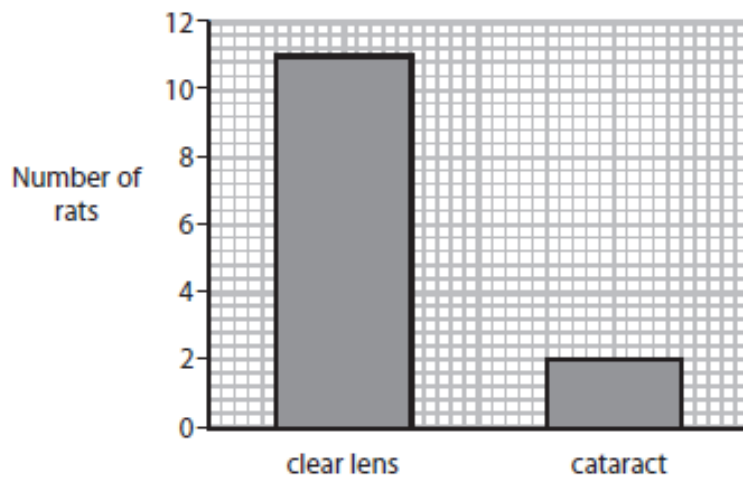
..... [2]

[Total: 6 marks]

Question 3

The lens of the eye is normally transparent to allow light through to the back of the eye. Read the account below of an experiment, then answer the questions.

- Cataracts develop when proteins in the lens clump together.
- Lanosterol is a chemical that helps to break up these clumps of protein.
- In 2015, scientists investigated the ability of lanosterol to cure cataracts. They put drops of lanosterol solution into the eyes of rats with cataracts.
- After six days of treatment they counted the number of rats with clear lenses and the number of rats that still have cataracts.
- The graph below shows their data.



The drugs company that makes lanosterol states that their product “*cures cataracts in people*”.

- a. Give two reasons why this could be true.

.....
..... [2]

- b. Give two reasons why this might not be true.

.....
..... [2]

- c. When scientists evaluate, they look at all the evidence available and come to a balanced conclusion.

Evaluate the statement made by the drugs company that lanosterol cures cataracts.

.....

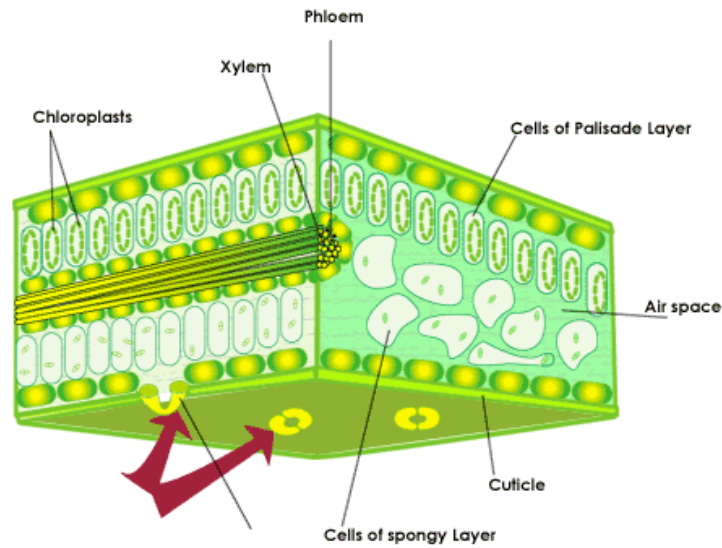
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..... [2]

[Total: 6 marks]

Question 4

The image shows a leaf cross section.



- a. Complete the following passage, filling in the blank spaces with the correct terms.

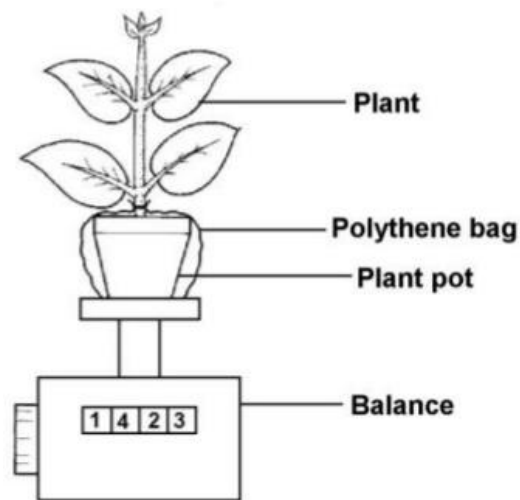
All living things so they can release energy from food molecules. Animals usually gain their food molecules by consuming other organisms. Plants make a carbohydrate called during the process of This requires green molecules called which are contained within special structures inside plant cells called

[5]

- b. The red arrows in the diagram above represent the movement of which gas during the day?

..... [1]

This is a potometer. It is used to measure the rate of water loss from plants. The stomata on the underside of leaves lose water vapour which is, in turn, replaced by water taken up from the soil by the roots.



- c. What is the purpose of the polythene bag?

.....
.....
..... [1]

- d. A control experiment is a separate, related experiment, that shows whether any measured or observed changes were not going to happen anyway. In the space below, sketch what a suitable control experiment would look like.

[2]

[Total: 9 marks]

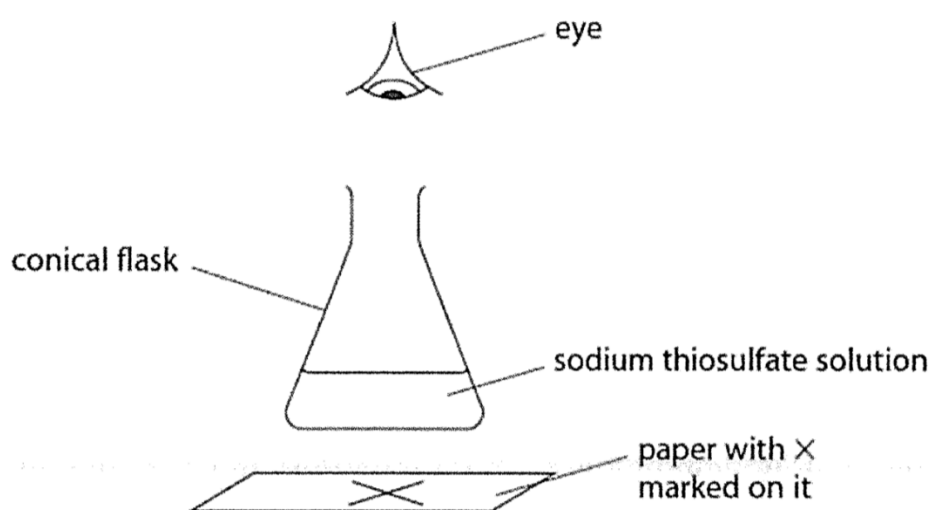
Chemistry Section

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

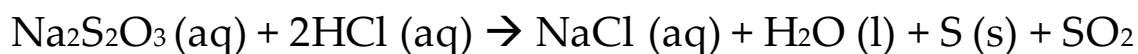
Some students are carrying out experiments to investigate this.

Alice uses the following method:

- Place 20 cm³ of sodium thiosulfate solution and 20 cm³ of water into a conical flask.
- Add 10 cm³ of dilute hydrochloric acid into the flask.
- Place the flask on a piece of paper marked with a black ×.
- Time how long it takes before the a black × can no longer be seen.



The equation for the reaction is as follows:



Before starting her experiments, Alice considers the risk to her of sulfur dioxide escaping from the flask. When considering this, she uses the following 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

- a. Estimate the pH of the solution at the start of the experiment.

..... [1]

- b. If universal indicator were added to the solution at the start of the reaction, what colour would the solution turn?

..... [1]

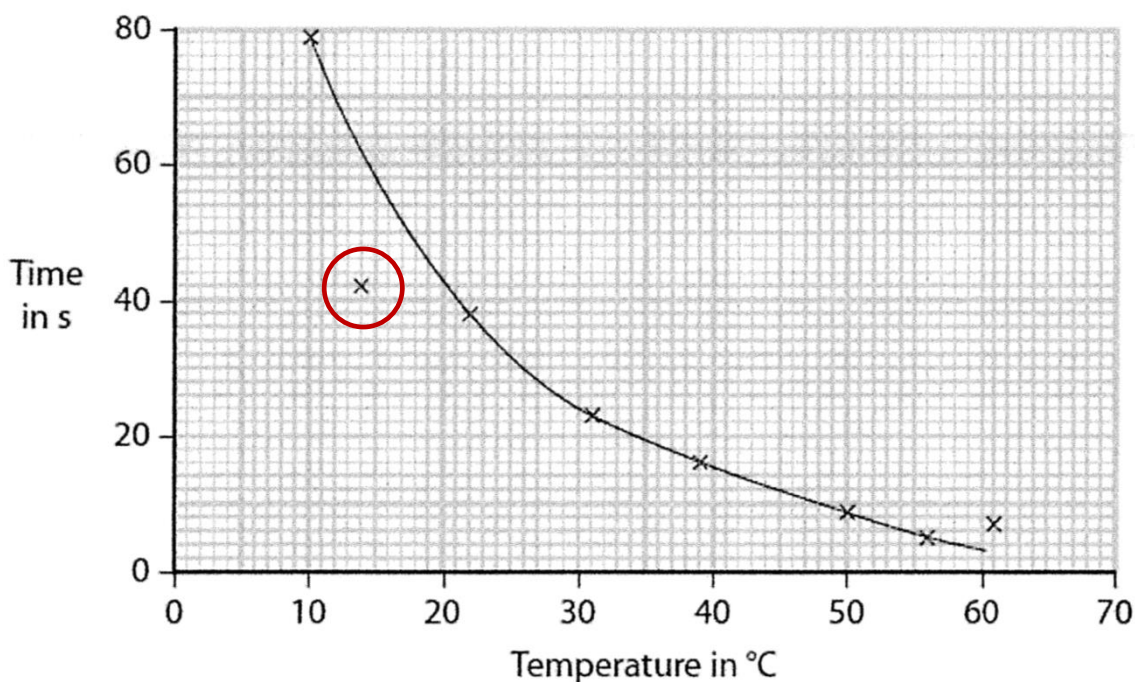
- c. What would be the most appropriate piece of equipment to use to measure out the solutions for this experiment?

..... [1]

- d. At what point in the experiment should Alice have started a timer?

..... [1]

Alice's 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 below shows her results.



The result circled is anomalous (i.e. it does not fit the trend).

- e. Explain one mistake Alice might have made in order to generate this anomalous result.

.....
..... [1]

f. Use the graph to find the time taken for the black + to be no longer seen at 35°C.

..... [1]

g. Use the graph to find the temperature at which the black + can no longer be seen after 52 s.

..... [1]

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

Give three variables that David must control in this investigation so that he can obtain valid data.

1.

.....

2.

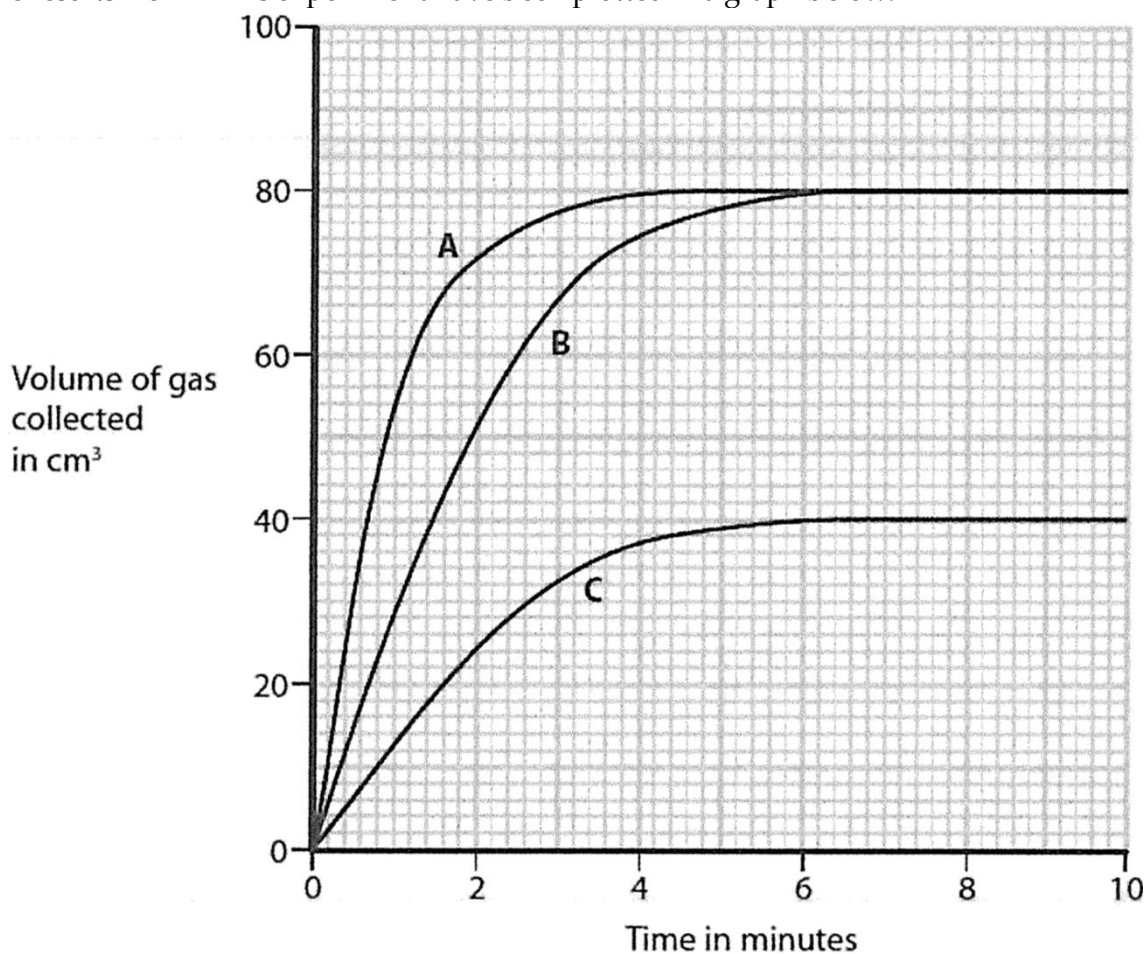
.....

3.

..... [3]

Tim decided to investigate the same reaction. He decided to collect the sulfur dioxide gas given off using a gas syringe, as he thought it would make the results he obtained more reliable.

The results from Tim's experiment have been plotted in a graph 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 higher temperature? Explain how you came to your answer.

Letter:

Explanation:

.....

..... [2]

- j. Experiments B and C represent experiments at the same temperature 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 came to your answer.

Concentration:

Explanation:

.....

..... [2]

Tim carried out one final investigation, his results are in the table below.

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

- k. Describe the relationship between rate of reaction and concentration of acid shown Tim's results.

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.....

..... [2]

- l. Explain the relationship between rate of reaction and concentration of acid shown Tim's results.

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..... [2]

- m. In some chemical reactions a catalyst can be added. Define the term 'catalyst' and give an everyday example you may have heard of.

Definition:

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Example: [2]

[Total: 20marks]

Physics Section

Question 1

The International Space Station (ISS) is a habitable artificial satellite, in low Earth orbit. It was completed in 2011 and the station is expected to operate until 2028. The ISS is the largest human-made body in low Earth orbit and can often be seen with the naked eye from Earth.



You must show all your working to get as many marks as possible

The ISS maintains a height above the Earth's surface of approximately 400 km and it completes 16 orbits of the Earth each day.

For the sake of this question, assume that the ISS orbits in a perfectly circular path and that the Earth's radius is 6000 km.

- a. How long, in seconds, does it take for the ISS to complete one orbit of the Earth?

time = s [1]

- b. How far, in metres, does the ISS travel when completing one orbit of the Earth? Give your answer in standard form.

Circumference of a circle = $2\pi r$

Assume that $\pi = 3$ in order to make the calculation easier.

distance = m [3]

- c. Calculate the average speed, in m/s, of the ISS as it orbits the Earth.

speed = m/s [3]

- d. Convert your answer to part c into miles per hour.
1 mile = 1600 m

speed = miles per hour [2]

- e. The ISS has been continuously occupied since November 2000. Calculate approximately how many complete orbits of the Earth it has made since this date.

number of orbits = [3]

[Total: 12 marks]

Question 2

Archimedes Principle and Buoyancy

Archimedes principle is used to explain buoyancy and why things float. Archimedes principle states that any objects (such as a brick) immersed in a fluid (such as water) experiences an upthrust (U) equal to the weight of fluid displaced.

$$\text{Upthrust} = \text{weight of the fluid displaced}$$

Consider a float, in the form of a cube, secured to the bottom of a deep pool of fresh water by a rope.

Length of each side	=	20 cm
Density of float material	=	400 kg/m ³
Density of fresh water	=	1000 kg/m ³

- a. Calculate the weight of the float.

weight of float = [3]

- b. Calculate the weight of the water displaced.

weight of displaced water = [2]

- c. Calculate the force acting on the rope.

force acting on the rope = [2]

- d. The rope breaks. Describe the motion of the float, assuming that the pool is very deep.

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..... [2]

[Total: 9 marks]