Question 1 (9 marks)

Ancient objects can provide information about human progress and cultural changes. Mirrors are an example of objects that changed as new materials and technologies became available.

Question 1a (1 mark)

Ancient Egyptians used polished metals, such as gold, to make mirrors. Scientists have dated gold mirrors to be over 3500 years old. The mirrors were in perfect condition, as if they had never been used.

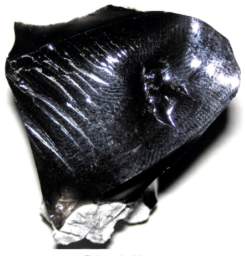
Scroll down to continue

Select a reason for the perfect condition of the gold mirrors.

- ✓ Select
- Gold is conductive
- Gold is ductile
- Gold is malleable
- Gold is unreactive

Question 1b (2 marks)

The oldest mirrors ever found were made of polished volcanic rock.



Obsidian

Obsidian mirror

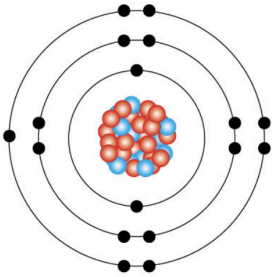
Two compounds present in the volcanic rock are listed below. **Write down** the missing name and formula.

Name	Formula
	Al_2O_3
Iron (III) oxide	

Reset

Question 1c (1 mark)

Samples of the volcanic rock were found to contain traces of an unknown element X.
The electron structure of element X is shown below.



Element X
2, 8, 7

Identify element X.

Question 1d (2 marks)

Analysis showed that one isotope of element X had 20 neutrons. **Determine** the mass number of this isotope.

Question 1e (3 marks)

Some scientists believe that the first man-made mirror was a slab of selenite found in Egypt. Selenite is hydrated calcium sulphate, $CaSO_4.2H_2O$. Hydrated salts are ionic compounds with a constant number of water molecules as part of their structure.

©

The formula $CaSO_4.2H_2O$ means that one mole of $CaSO_4$ contains two moles of water. **Calculate** the mass of water present in 5 moles of the hydrated salt.

Question 2 (15 marks)

Stained glass windows are one example of artwork using glass.

Question 2a (1 mark)

The chemicals used to colour glass are mostly oxides of transition metals. The periodic table below shows pictures of objects in which some elements may be found.

1	2											3	4	5	6	7	0
H																	
	Be											B		N	O	F	
	Mg											Al		P	S	Cl	Ar
		Sc	Ti	V	Cr	Mn	Fe	Co	Ni		Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La†	Hf	Ta		Re	Os	Ir	Pt		Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac‡	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							

Identify one of the transition metals pictured in this periodic table, giving the name of the metal and its symbol.

Question 2b (1 mark)

Glass is a material that contains a mixture of compounds, such as silicon dioxide, SiO_2, sodium oxide, Na_2O, and calcium oxide, CaO, melted together at high temperatures. **Identify** the element in these compounds that is in group 2 and period 4.

B I U x_2 x^2 Ω Σ Styles

Question 2c (4 marks)

A 35.0 g sample of commercial glass contains 26.3 g of SiO_2 and 3.4 g of CaO; the remainder is Na_2O. **Calculate** the number of moles of sodium oxide in the sample. Give your answer to two significant figures.

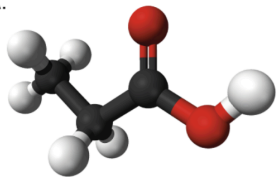
B I U x_2 x^2 Ω Σ Styles

Question 2d (1 mark)

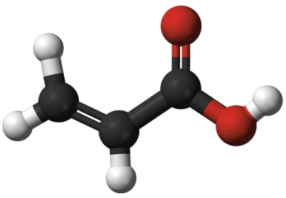
Nowadays, most artists make stained glass using acrylic paint. One of its components is acrylic acid, IUPAC name propenoic acid. The molecular formula is $C_3H_4O_2$.

In the following models, C atoms are black, H atoms are white and O atoms are red. **Select** the model showing acrylic acid.

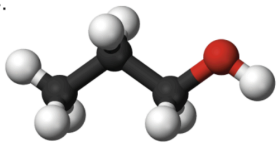
A.



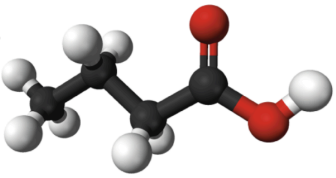
B.



C.



D.

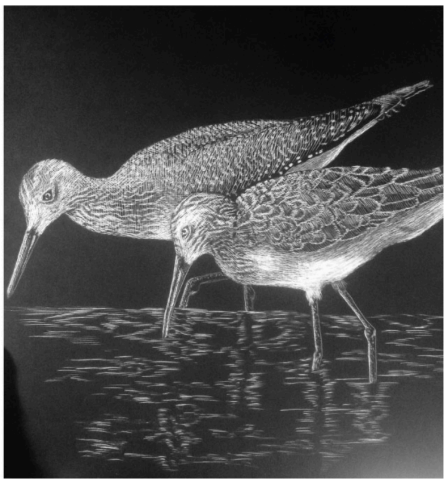


✓ Select
A
B
C
D

continue

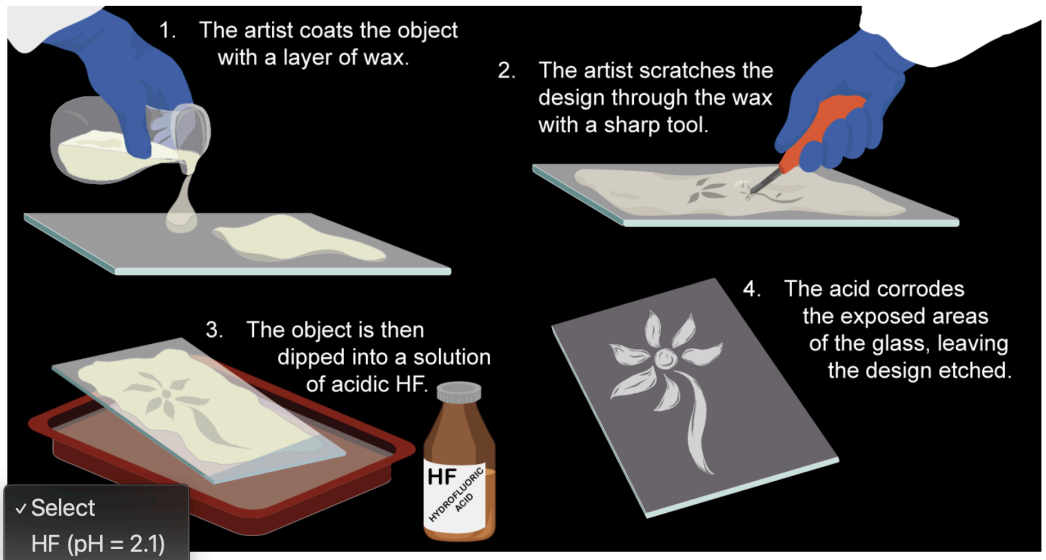
Question 2e (1 mark)

The images below show some artwork using etched glass.



©

Glass etching involves the use of hydrogen fluoride (HF) also known as hydrofluoric acid. The acidic HF corrodes the surface to leave a design on the glass. The process of etching is shown below.

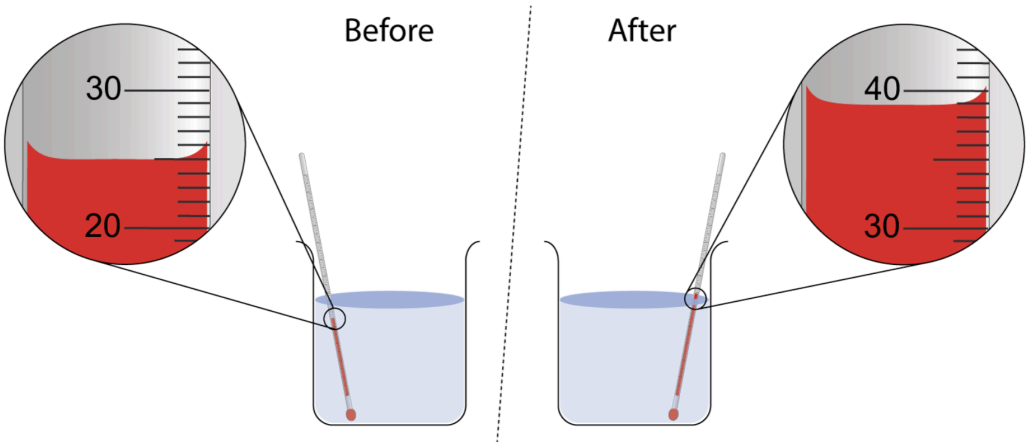


o work on a piece of glass. She knew that the best results are obtained with
n pH 3.5. **Select** the most acidic chemical.

Select
✓ Select
HF (pH = 2.1)
HF (pH = 3.5)
HF (pH = 4.6)
H_2O (pH =7)

Question 2f (2 marks)

The artist added HF to water. The diagram below shows the temperature of the water before adding HF and after it was added.



Before adding the HF, the reading on the thermometer was 25°C. **Measure** the temperature after the HF was added and **calculate** the temperature change.

Question 2g (1 mark)

Use your answer to part (f) to **select** the type of reaction.

Select

Question 2h (4 marks)

After the etching process is complete, the excess HF needs to be removed using an alkaline solution. **Select** the options to complete the balanced equation if HF was removed with calcium hydroxide ($Ca(OH)_2$).

? HF + $Ca(OH)_2$ → ? ? + ? H_2O

Question 3 (6 marks)

Hydrogen peroxide (H_2O_2) has many uses. The video below gives some examples.

Video | Script

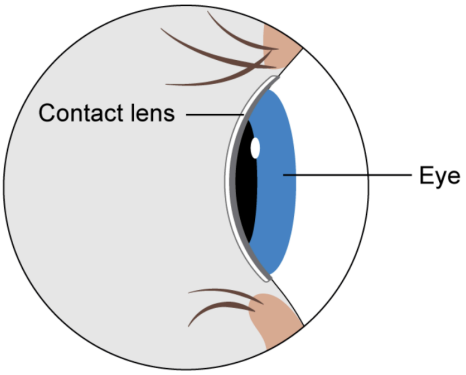
Hydrogen peroxide is a chemical with the formula H_2O_2.

Hydrogen peroxide has a number of uses which include household cleaning and cleaning wounds, removing stains, making hair colour lighter and as a high-power rocket fuel.

Hydrogen peroxide has been used to send rockets into space and as a fuel in cars attempting to break the land speed record.

Question 3a (1 mark)

H_2O_2 is commonly used to clean contact lenses. If the H_2O_2 is not fully removed after cleaning, it will cause irritation to the eyes. The H_2O_2 is trapped between the contact lens and the surface of the eye.



Select which of the following hazard symbols you would expect to find on a bottle of H_2O_2.

A.

B.

C.

D.

✓ Select
A
B
C
D

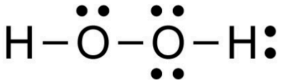
n 3b (1 mark)

Question 3b (1 mark)

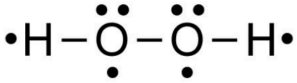
Select which of the following diagrams represents the Lewis structure for H_2O_2.

A.

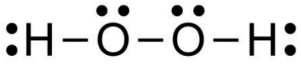
B.



C.



D.



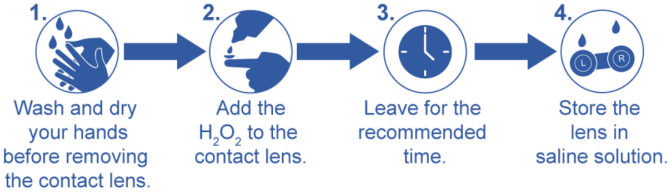
Select
A
B
C
D

n 3c (1 mark)

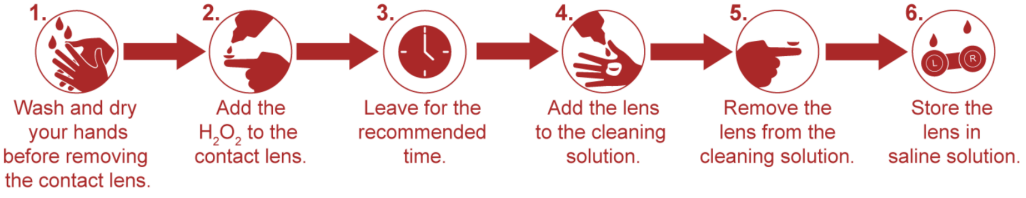
Question 3c (1 mark)

Contact lenses must be cleaned to remove any bacteria that may be attached to the surface. They can be cleaned in either a one-step or a two-step process.

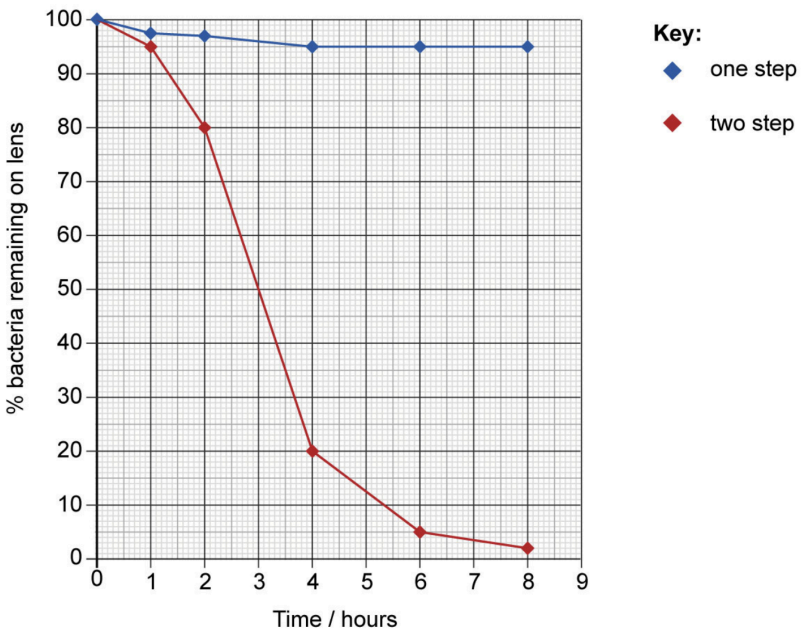
One step



Two step



A scientist wanted to investigate whether the one-step or two-step cleaning process was better. She covered contact lenses with bacteria and then compared the two processes. The percentage of bacteria remaining on the lens was plotted against time. The results are shown below:



State the percentage of bacteria that have been removed with a one-step cleaning process after 4 hours.

Question 3d (1 mark)

State the time required to remove 95% of the bacteria using the two-step process.

B I U Styles

Question 3e (2 marks)

Use the data in the graph to **justify** which process and time you would recommend to clean contact lenses.

Question 4a (2 marks)

Oxygen and water are produced when hydrogen peroxide (H_2O_2) breaks down. The chemical term for this process is decomposition. The decomposition of H_2O_2 happens naturally at a slow rate, as shown in the equation below:

$$2H_2O_2\,(aq) \rightarrow 2H_2O\,(l) + O_2\,(g)$$

Outline how you would test that oxygen was produced.

Question 4b (3 marks)

H_2O_2 decomposes faster when a catalyst is added. A catalyst is a substance which increases the rate of reaction, without being used up itself.

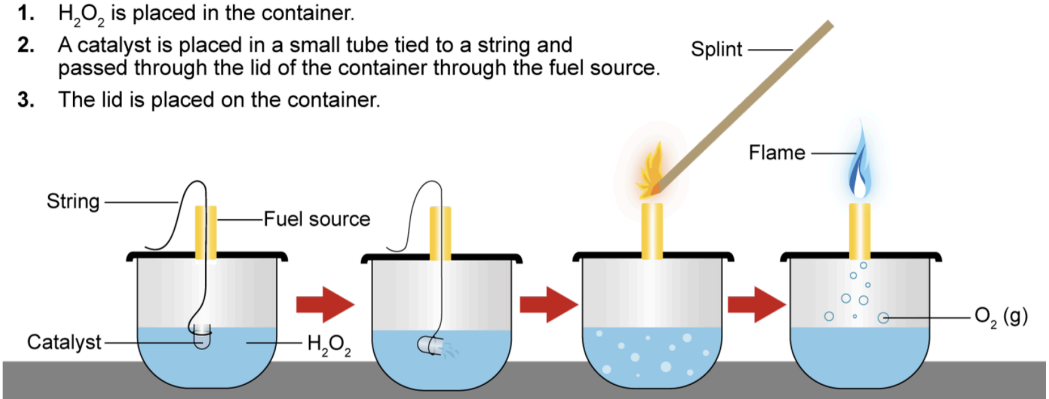
A student has a catalyst in two states: a solid and a solution. **Formulate** a hypothesis to test which state will give the greatest increase in rate of reaction. You should use collision theory in your answer.

If:

Question 4c (4 marks)

A student wanted to investigate a number of catalysts to determine which one would decompose H_2O_2 the fastest. The student set up their equipment modelled on a rocket engine. Their equipment and method are shown below:

1. H_2O_2 is placed in the container.
2. A catalyst is placed in a small tube tied to a string and passed through the lid of the container through the fuel source.
3. The lid is placed on the container.



4. The small tube is lowered so that the catalyst mixes with the H_2O_2.
5. The gas produced is lit.
6. The time taken for the flame to stop burning is measured.
7. The test is repeated for other catalysts.

Identify the variables in this investigation.

Independent variable:

Control variable one:

Dependent variable:

Control variable two:

Scroll down to continue

Question 4d (3 marks)

The student formulated the following hypothesis:

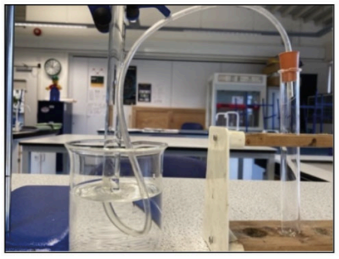
> The best catalyst will produce the flame that burns the longest because more oxygen is released.

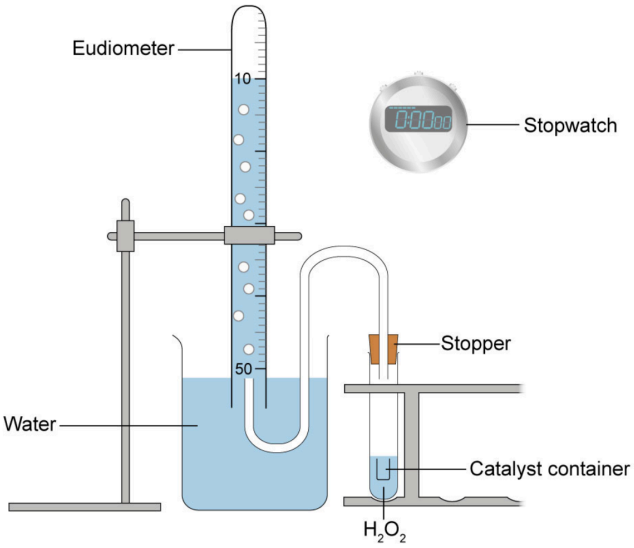
State and **justify** whether this hypothesis is valid.

B I U x_2 x^2 Ω Σ Styles

Question 4e (3 marks)

A second student has suggested an alternative method to determine which catalyst would decompose H_2O_2 the fastest. The experimental set-up is shown below.

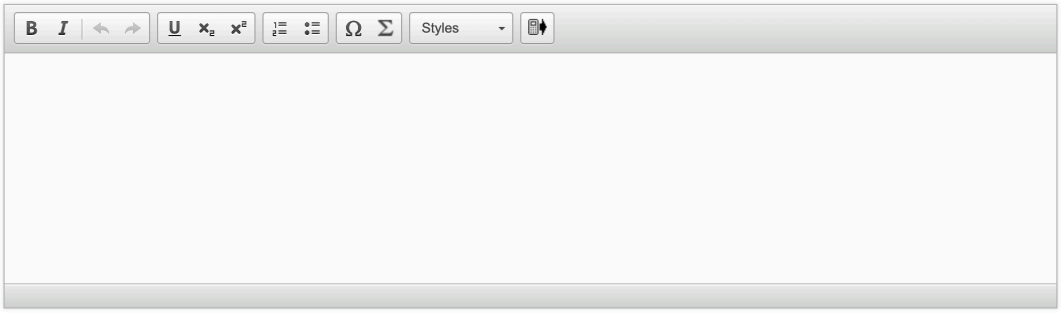




The volume of gas collected after 30 seconds for three trials is shown in the table.

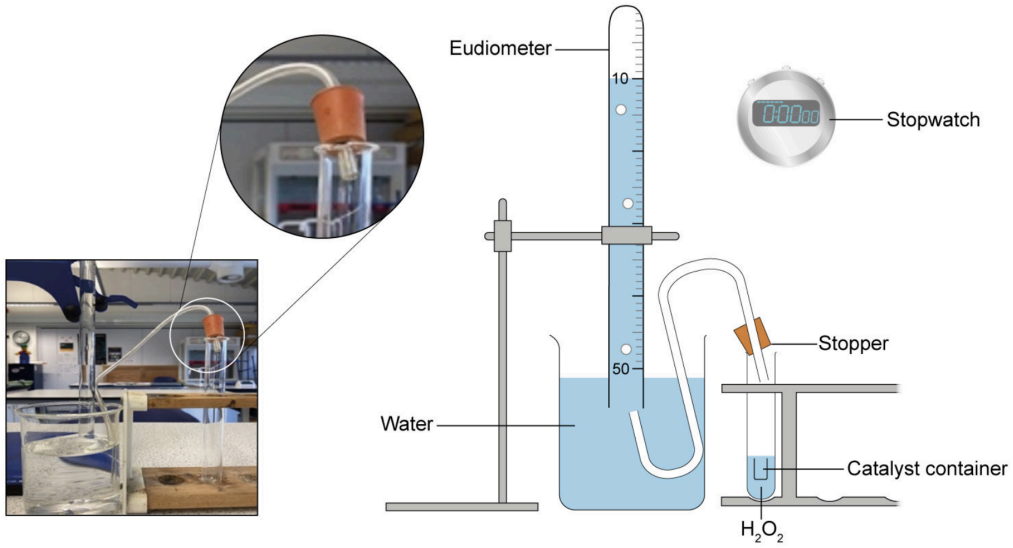
Volume from trial one / cm^3	Volume from trial two / cm^3	Volume from trial three / cm^3
43	44	45

Calculate the average volume of oxygen collected for this experiment and **determine** the rate of oxygen production.



Question 4f (3 marks)

The student carried out a fourth trial and their equipment is shown below. The volume of oxygen collected was 50 cm^3.

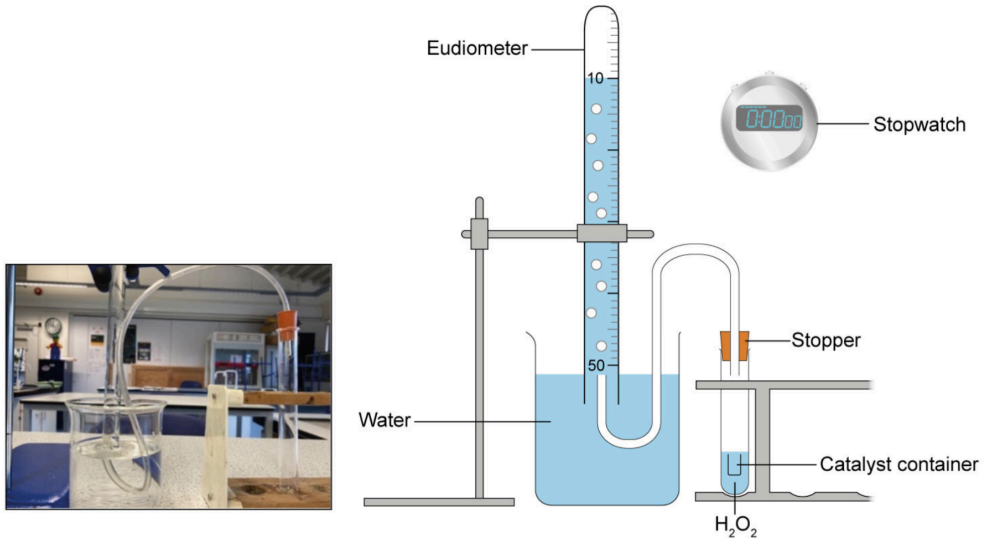


Suggest two reasons why the result for this trial was not consistent with the trials above.
Justify your answer.

Question 5 (16 marks)

The students decided to use the method in the picture below to compare the effect of different catalysts on the decomposition of hydrogen peroxide (H_2O_2). H_2O_2 decomposes according to the following equation.

$$2H_2O_2\,(aq) \rightarrow 2H_2O\,(l) + O_2\,(g)$$



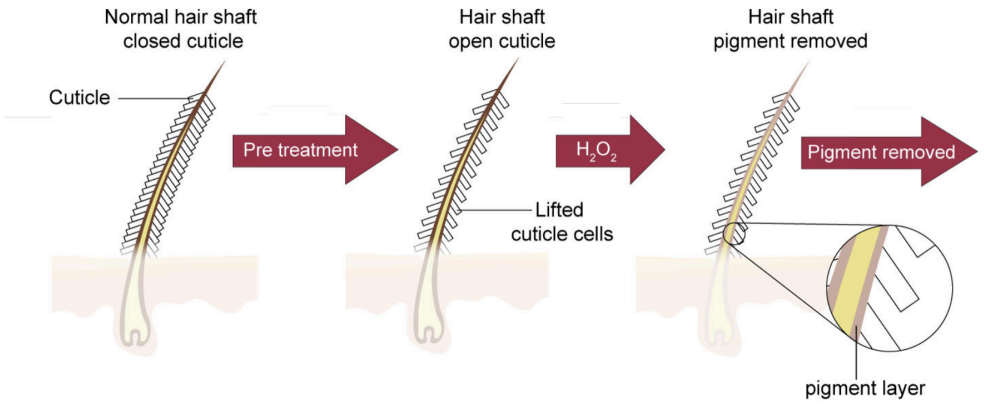
You are provided with a eudiometer for collecting and measuring the volume of the oxygen produced, the catalysts: $MnCl_2(s)$, $ZnCl_2(s)$, $CuCl_2(s)$, $FeCl_2(s)$, $NiCl_2(s)$ and a solution of hydrogen peroxide.

Design an investigation to determine the rate of decomposition of hydrogen peroxide with each catalyst. One control variable in your investigation is the concentration of hydrogen peroxide. In your answer, you should include:

- the independent variable, the dependent variable and one other control variable
- a list of additional equipment you will use
- details of your method
- details of the data you will collect
- how you will ensure that your method is safe.

Question 6 (11 marks)

Hydrogen peroxide (H_2O_2) is used to change hair colour by removing the natural colour pigments in hair follicles as shown below.



H_2O_2 is placed on the hair and then left for a set time. The results of such an investigation using five different natural hair colours are shown in the diagram below.

Time / min	Colour
0	
30	
60	
90	

Question 6a (3 marks)

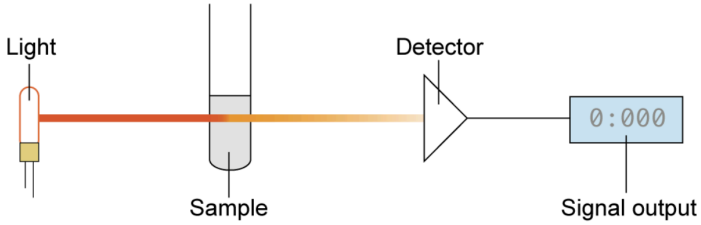
Interpret these results and **explain** them using scientific reasoning.

Question 6b (5 marks)

The concentration of the H_2O_2 used in the beauty industry is important and it is sold in different concentrations depending upon its use. For example, a high concentration of 10.5 to 12 % might be used as a disinfectant, while a low concentration of 3% could be used as a contact lens cleaner.

Suppliers to the beauty industry are often not regulated. It is possible that the H_2O_2 may not be the correct concentration, so care should be taken.

If the concentration of H_2O_2 is too high, it could cause skin burns. Analytical chemistry can be used to check the concentration of H_2O_2 using the equipment shown below.

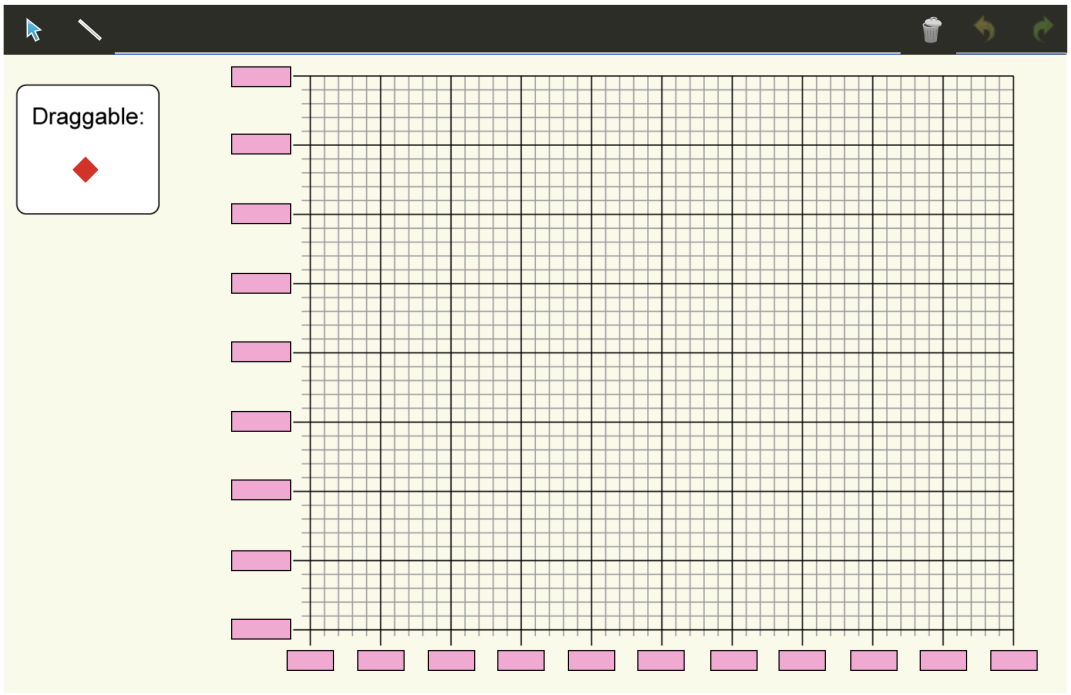


The signal output is proportional to the concentration of H_2O_2. The results for different known concentrations are shown in the laboratory page below.

Present this data using a graph.

MYP TESTING AGENCY

H_2O_2 concentration / %	Signal strength (no units)
1	700
2	1450
3	2150
4	2950
6	4200
8	5400
10	6700



Title:

x axis label:

y axis label:

Question 6c (1 mark)

Use your graph in part b to **predict** the signal output expected for a 5% solution of H_2O_2.

Question 6d (2 marks)

The scientists have been provided with four bottles of H_2O_2 from a hair salon owner. They need to test each bottle to see if the solution in any of them has a concentration above 4%.

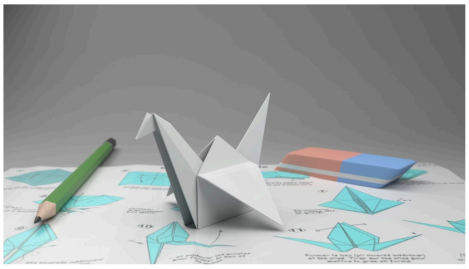
The average signal output of the four bottles was 2960. **Comment** on the validity of using an average.

Question 7 (9 marks)

Paper comes in different sizes, thicknesses, colours, textures and chemical compositions. It can be used for writing, drawing, painting and printing photos. Using paper is a way to record our thoughts and ideas.

©

Origami is an art form that is associated with Japan.



©

Question 7a (1 mark)

Suggest one property of paper that allows it to be used in origami.

B I U Styles Ω Σ

Question 7b (1 mark)

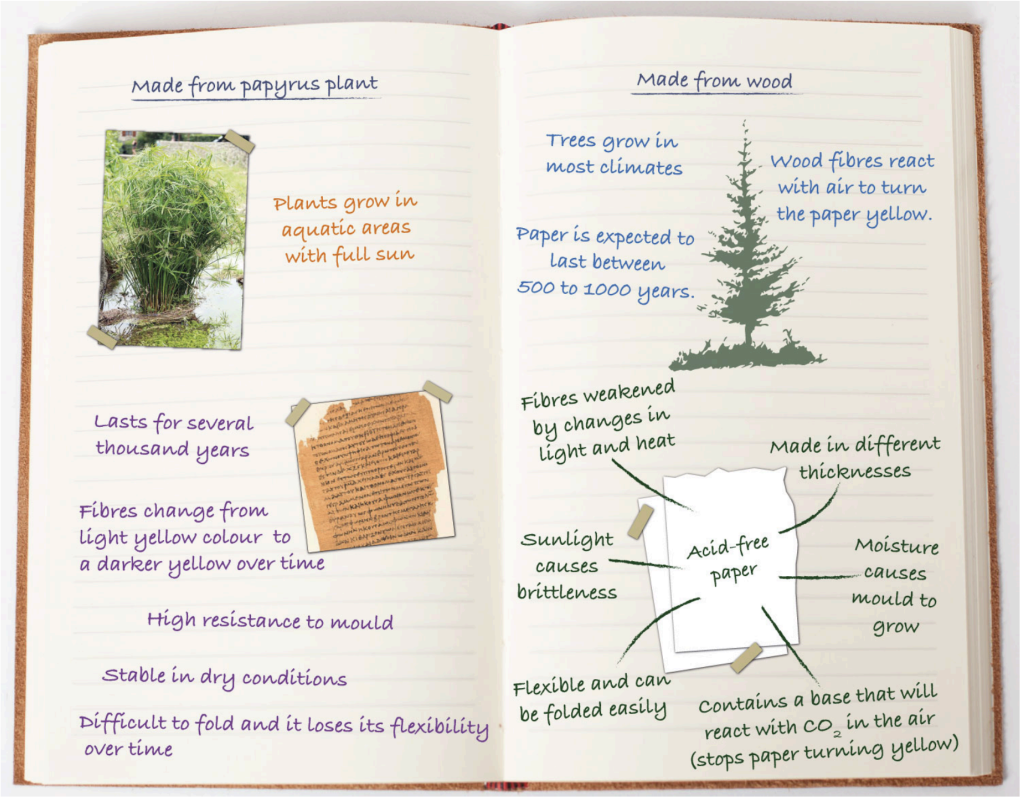
Suggest a reason why some papers are coated with an extra layer of plastic or wax.

Question 7c (1 mark)

Chlorine is a common chemical used in the production of paper. Chlorine is used to turn the paper white. The reaction between chlorine and paper produces a toxic gas. An alternative method to turn the paper white uses hydrogen peroxide (H_2O_2), in a reaction producing oxygen. **State** a reason why paper producers would choose to use H_2O_2 instead of chlorine.

Question 7d (6 marks)

Museums and libraries have collected documents throughout history. Written information has been found on a variety of materials, which have included papyrus and paper. Preservation of these documents is a complex process. Documents written on papyrus can be several thousand years old. Modern documents that need to be kept a long time are printed on high quality "acid-free" paper. Information about ancient papyrus and modern acid-free paper is given below.

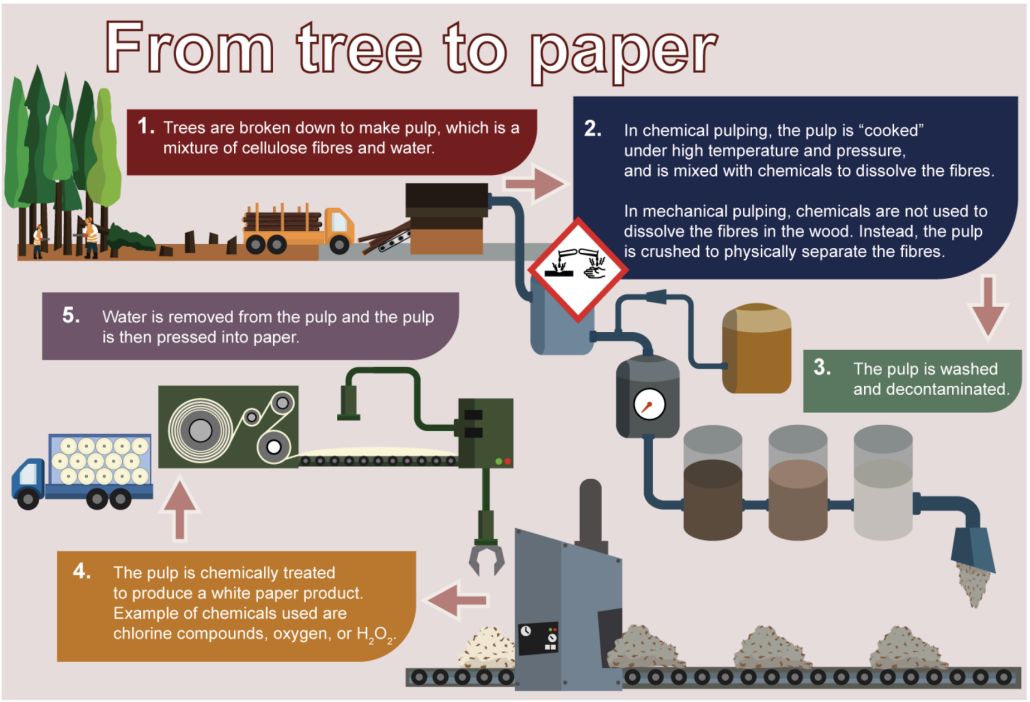


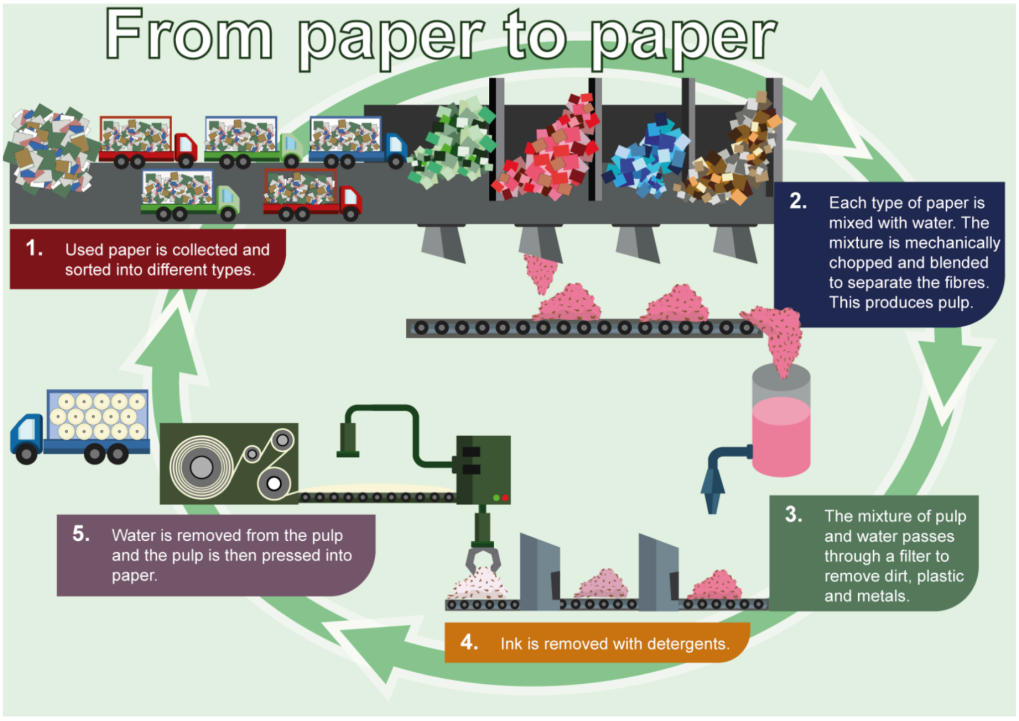
A researcher has suggested that papyrus from ancient Egyptian times is the best material for long-term preservation of documents. Use the information in the graphic to **discuss** the researcher's claim. In your answer, you should include:

- the advantages and disadvantages of papyrus
- the advantages and disadvantages of acid-free paper
- a conclusion with justification of the best paper type for long-term preservation.

Question 8 (10 marks)

Over the centuries, paper has been made from a wide variety of materials, such as cotton, bamboo, wood, linen rags and hemp. Regardless of the source, you need plant fibre to make paper. Today, that fibre comes mainly from two sources — wood and used paper.



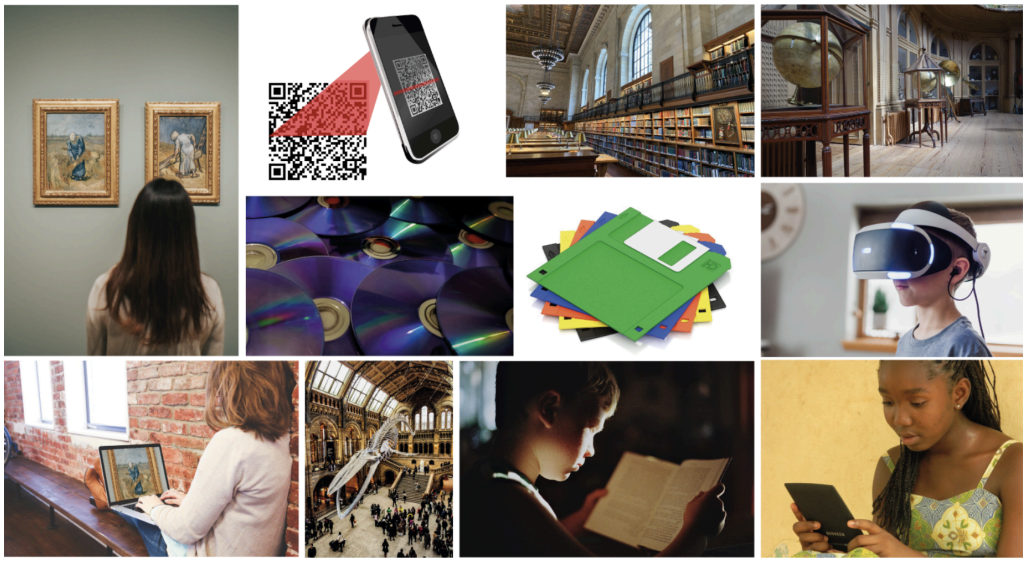


Using the infographic and knowledge from your wider MYP studies, **discuss** the implications of both types of paper production. In your answer, you should include:

- a comparison of the impacts on the environment
- a comparison of the impacts on the economy
- your conclusion, with justification, on which paper production process is best.

Question 9 (6 marks)

Prior to the 20th century, most information was stored in the form of paper documents. There is now a trend to save information by using cloud storage or other electronic methods.



Suggest and **justify** the **cultural** advantages and disadvantages of paper and electronic information storage.