Video Script

Toys have been made of various materials throughout history.

The oldest known toy is thought to be a 4500-year-old doll found in Turkey. Toy kitchen equipment was found with the doll. The doll's head was made from terracotta, a type of clay, and had hair made of human hair.

Another toy that is thought to be about the same age is a rattle made from a different type of clay with stones inside.

As technology has developed, different materials have been used to make toys. In the 1950s, manufacturers were making toys using exciting new radioactive materials such as radium. In the 1970s, toy manufacturers used dyes and pigments that we now know are toxic.

Today, toys are made from wood, metal and various plastics. The materials and pigments that are now used have to meet strict safety standards.

Terracotta is made from baked clay. Clay is composed of a number of minerals including kaolin. One of the main compounds found in kaolin is nacrite. The formula for nacrite is $Al_2Si_2O_5(OH)_4$.

Question 1a (1 mark)

State the number of oxygen atoms in nacrite.

B I U x_2 x^2 Ω Σ Styles

Question 1b (2 marks)

Two of the elements in nacrite are aluminium and silicon. **Identify** the group and period of each element.

Aluminium: Group ▾ Period ▾

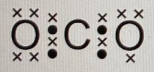
Silicon: Period ▾

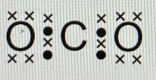
Group: 1 2 3 4 5

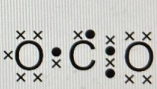
Period: 1 2 3 4 5

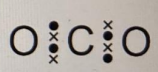
Question 1c (1 mark)

Silica is also found in clay. Silica has the chemical formula SiO_2. Silicon is in the same group as carbon and their oxides have similar formulas. Silica has a giant covalent structure but carbon dioxide has a simple molecular structure. **Select** the diagram that shows the Lewis (electron dot or dot cross) structure of carbon dioxide.

A. 

B. 

C. 

D. 

Select ▾

Select: A B C D

Question 2 (11 marks)

The Slinky was invented in 1943 and was made of a type of high carbon steel.

High carbon steel is composed of iron with carbon and manganese. In the 1970s, plastic became more common and a large number of cheaper Slinkys were produced from this new material.

Here are the compositions of four different types of carbon-based steels.

Type of carbon-based steel	% Carbon	% Manganese	% Iron	Properties
Low carbon steel	0.25	0.40	99.35	Loses its shape easily
Medium carbon steel	0.54	1.65	97.81	Ductile and long wearing
High carbon steel	0.95	0.90	98.15	Strong and holds shape memory well
Very high carbon steel	2.10	0.00	97.90	Brittle

Question 2a (1 mark)

Select the term used to describe the mixture of iron, carbon and manganese that makes up steel.

Select
Allotrope
Alloy
Compound
Ester
Select

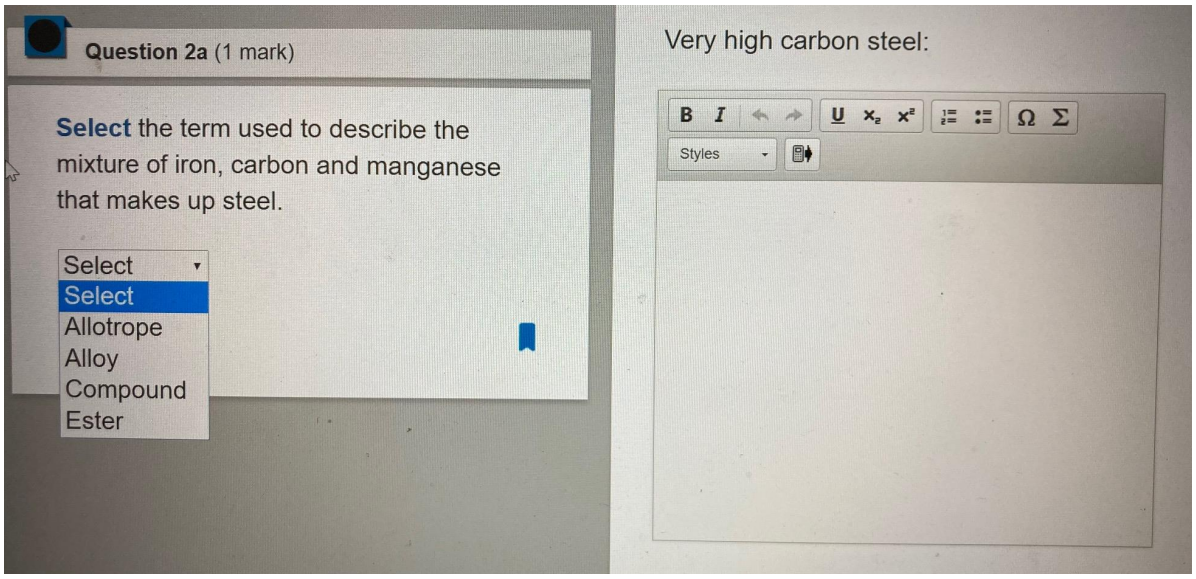
Question 2b (2 marks)

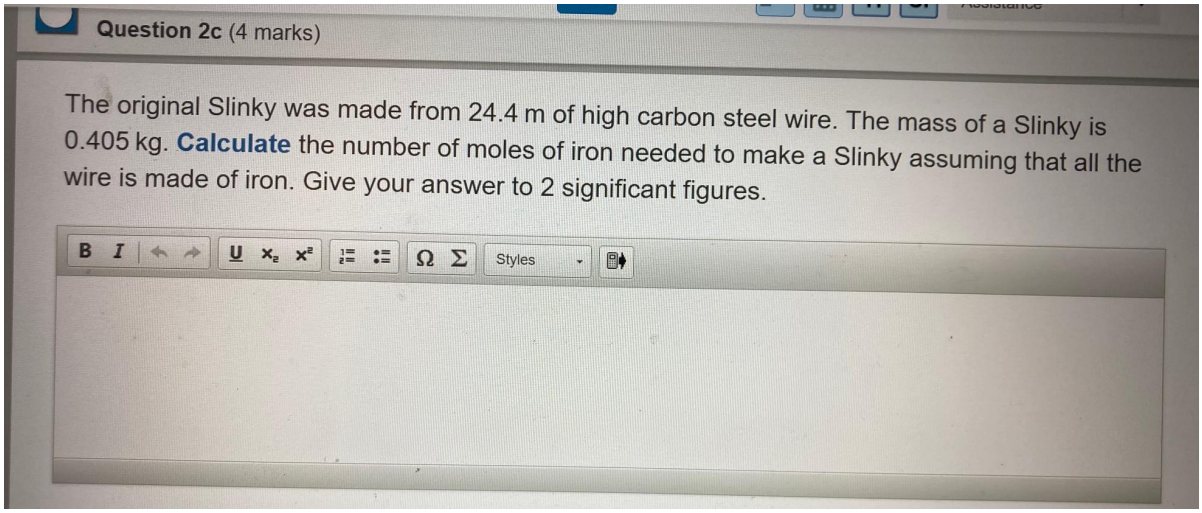
Suggest why low carbon steel and very high carbon steel would be unsuitable to make a Slinky.

Low carbon steel:

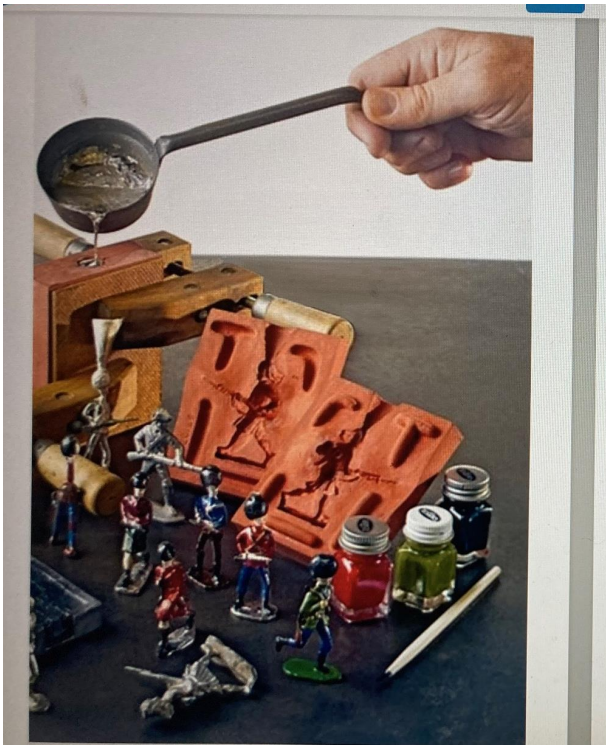
B I U x_2 x^2 Ω Σ

Styles

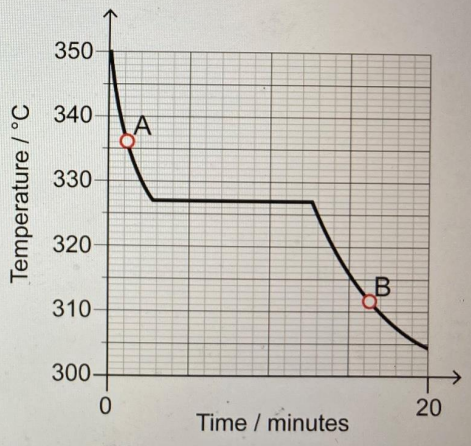

Question 2a (1 mark)
Select the term used to describe the mixture of iron, carbon and manganese that makes up steel.
Select
Select
Allotrope
Alloy
Compound
Ester
Very high carbon steel:
Styles


Question 2c (4 marks)
The original Slinky was made from 24.4 m of high carbon steel wire. The mass of a Slinky is 0.405 kg. Calculate the number of moles of iron needed to make a Slinky assuming that all the wire is made of iron. Give your answer to 2 significant figures.
Styles

The image below shows how toy figures have been made by melting lead and pouring it into clay casts. Once the molten lead has been poured into the cast it is left to cool.



A scientist heated some lead to form a liquid. The temperature of the metal was then recorded as it cooled. The graph produced from the data looked like this.



State the physical state of the lead at point B.

B I U Styles

Use the tool to **draw** the arrangement of the lead particles at point A and point B. You should include at least six particles in each diagram.

Palette

Click & Click

Point A

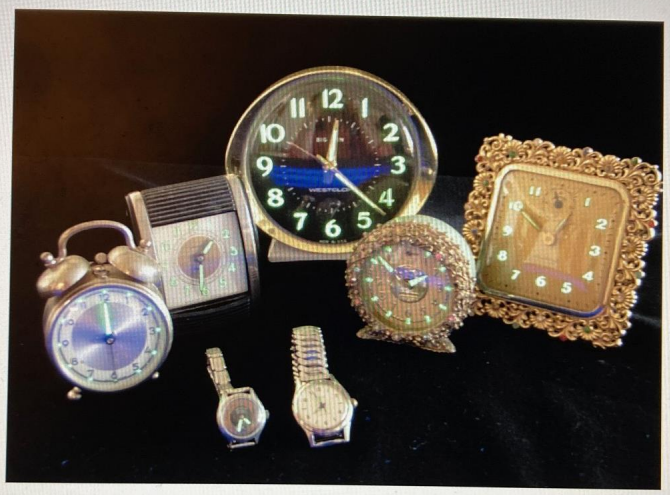
Point B

Question 2f (1 mark)

Use the graph to **state** the melting point of lead.

B I U x_2 x^2 Ω Σ Styles

Question 3 (10 marks)



In the 1950-1960s, the radioactive element radium was used to coat the numbers on watches. The numbers glowed in the dark so it was possible to see the time at night. The workers that painted the dials often became ill after long exposure to the paint.

Question 3 (10 marks)

As society became fascinated with nuclear power, children's toys were produced to encourage them to learn all about radioactive elements.
The Atomic Energy Lab in the image contained radioactive lead (Pb-210), ruthenium (Ru-106), zinc (Zn-65) and polonium (Po-210).

Question 3 (10 marks)

Today, toys that glow in the dark do not contain radioactive materials but rely instead on the properties of strontium nitrate and zinc sulphide to emit light.

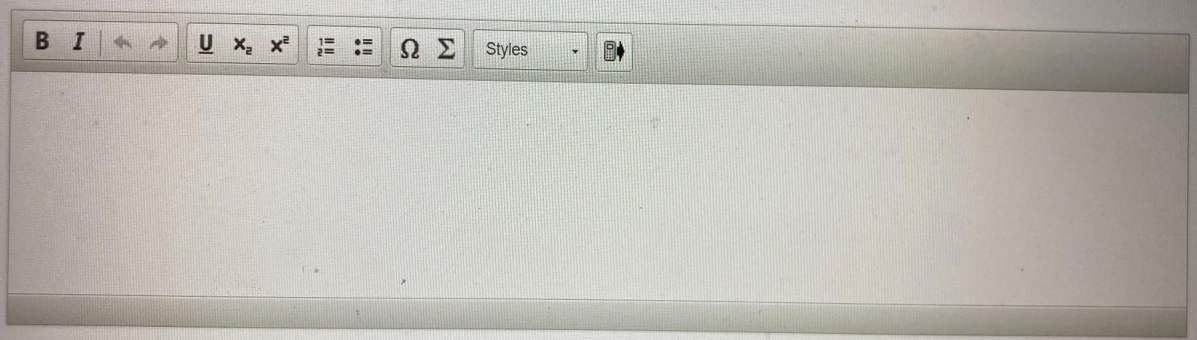
Question 3a (2 marks)

Strontium nitrate ($Sr(NO_3)_2$) can be made by reacting strontium carbonate ($SrCO_3$) with nitric acid (HNO_3). **State** the name of the products to complete the **word** equation for this reaction.

Strontium carbonate + nitric acid → strontium nitrate + [ ] + [ ]

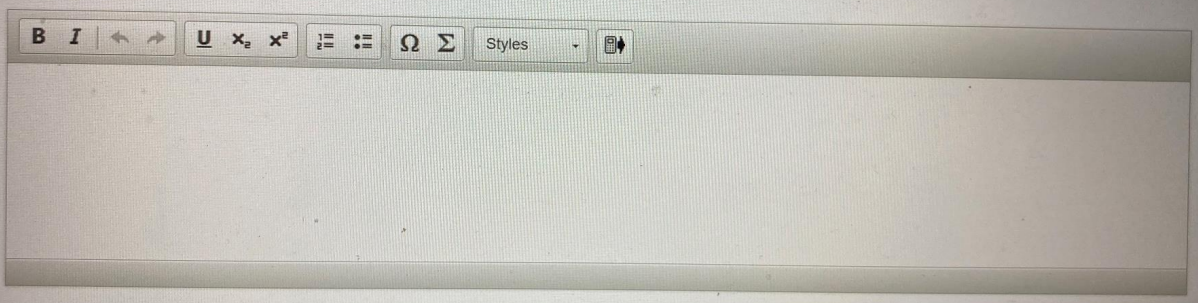
Question 3b (3 marks)

Write down the balanced **symbol** equation for the word equation in part (a). You do not need to include state symbols in your equation.



Question 3c (2 marks)

Outline why having toys with zinc sulphide would be better for your health than those containing radium.



Question 3d (2 marks)

Determine the number of protons, neutrons and electrons in an atom of $^{210}_{84}Po$ and $^{210}_{82}Pb$.

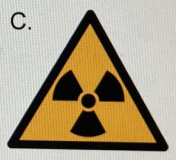
	$^{210}_{84}Po$	$^{210}_{82}Pb$
Protons:		
Neutrons:		
Electrons:		

Question 3e (1 mark)

Select the hazard symbol that would be used on the Atomic Energy Lab toy if it were available today.

A. 

B. 

C. 

D. 

©

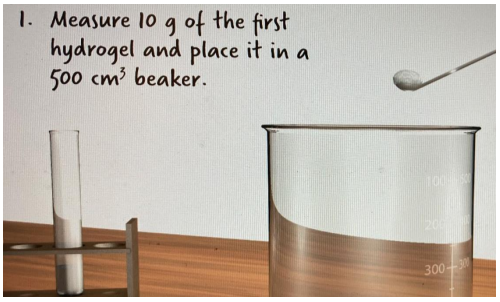
Select ▾

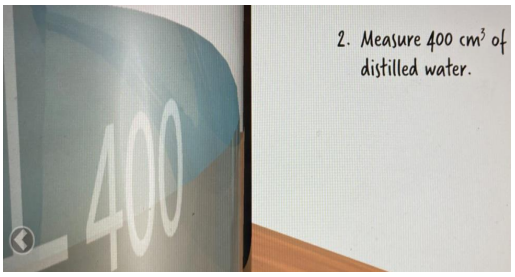
Question 4 (16 marks)

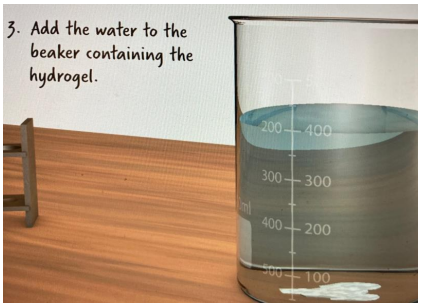
Hydrogels are synthetic molecules that can absorb large volumes of water.

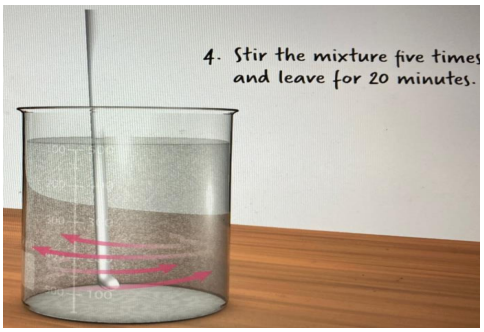
Students from one MYP school carried out an experiment to compare the absorbency of different hydrogels.

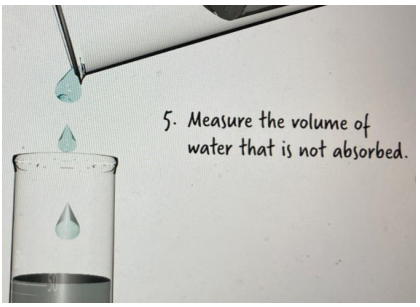
The students followed the method below:

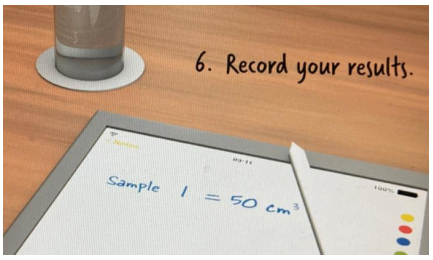


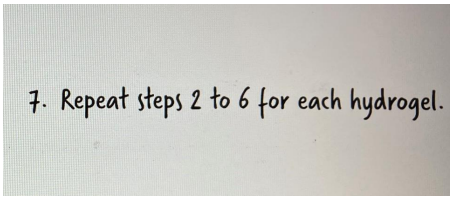












Question 4a (4 marks)

Identify the variables in the students' method.

Independent variable:

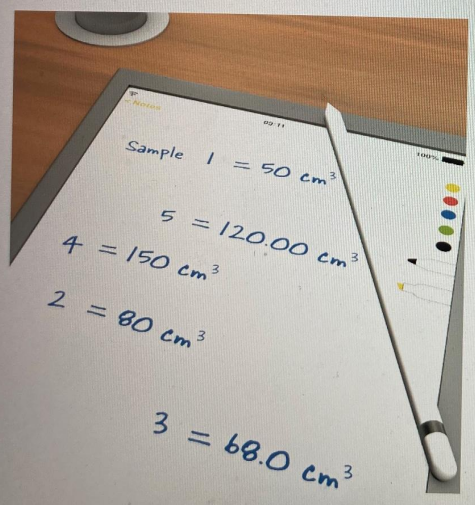
Styles

Dependent variable:

Styles

Question 4b (4 marks)

The students' raw data is shown below.



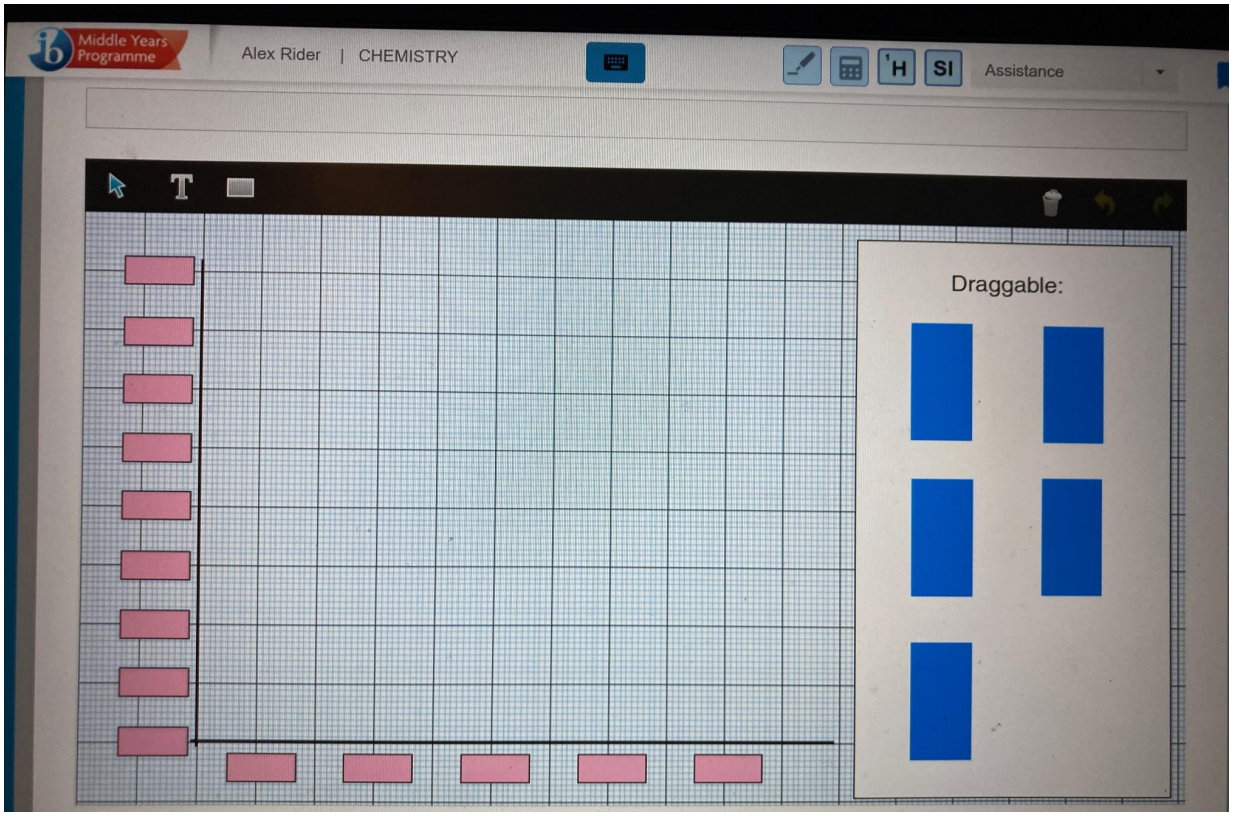
Organize and **present** the students' raw data collected during the experiment.

Create New Table

Reset

Plot the data from part (b) in an appropriate graph. Add a title and the labels for the axes in the boxes underneath the graph.

Title:



x axis label:

y axis label:

Question 4d (1 mark)

The students' research question was:

> Do different hydrogels absorb different volumes of water?

State whether the students' data can answer this research question and **justify** your response.

Question 4e (3 marks)

Using the data in part (b), **explain** which hydrogel you could use to absorb 340 cm^3 of water.
You should use calculations to support your answer.

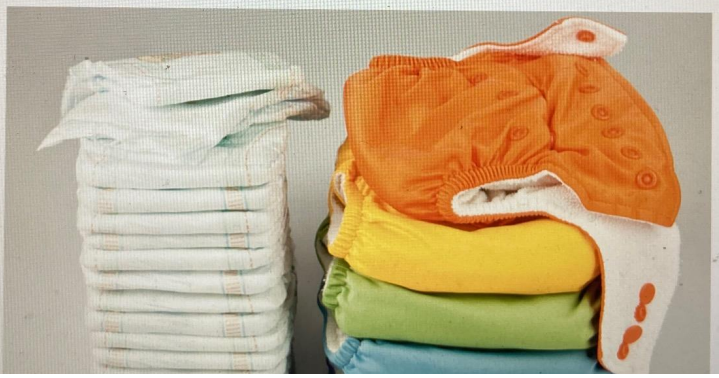
B I U x_2 x^2 Ω Σ Styles

Question 5 (20 marks)

The main absorbent material in disposable nappies is hydrogel.

According to a study carried out by the Environment Agency in the UK, 2–3 % of all household waste is estimated to be disposable nappies. This is approximately 3×10^9 nappies, equivalent to approximately 5×10^8 kg of waste (nappy + body waste) each year.

The alternative is reusable nappies. Reusable nappies reduce the demands on landfill but they affect the environment in other ways due to the water and energy used in washing and drying them.



The tables below give some information comparing the production and use of disposable and reusable nappies. This information is based on nappies being used for 2.5 years. Disposable nappies are made from plastic backing, hydrogels and an absorbent material called fluff pulp. Reusable nappies are made from cotton and are used with a wool or plastic outer layer.

Use the information provided in both tabs below.

Production | Usage

Production

Factor	Disposable nappies 	Reusable cotton nappies 
What the nappy is made of	Plastic backing, hydrogels, paper	Cotton nappy with wool or plastic outer (**Note:** the outer has not been included in the figures below)
Making the nappies: Mass of plastics used (including hydrogel) / kg	15	0
Are pesticides used?	No	Yes
Mass of fluff pulp used / kg	108	0
Mass of cotton used / kg	0	2.3
Energy used / kWh	338	57
Water used that will be polluted afterwards / dm^3	10500	1100
Total raw materials used / kg	123	2.3

	Factor	Disposable nappies 	Reusable cotton nappies 
Usage	*Using the nappies:* How many times is the same nappy used?	1	167 (as 6 nappies used in total)
	Energy used in laundry / kWh	none	141 per nappy
	Mass of detergents used / kg	0	32
	Water used that will be polluted afterwards / dm^3	1500	6200
	Disposing of the nappies: Mass of waste / kg	221	30
	Where solid body waste (faeces) ends up	In landfill sites	In the waste water supply with other toilet waste

Question 5a (5 marks)

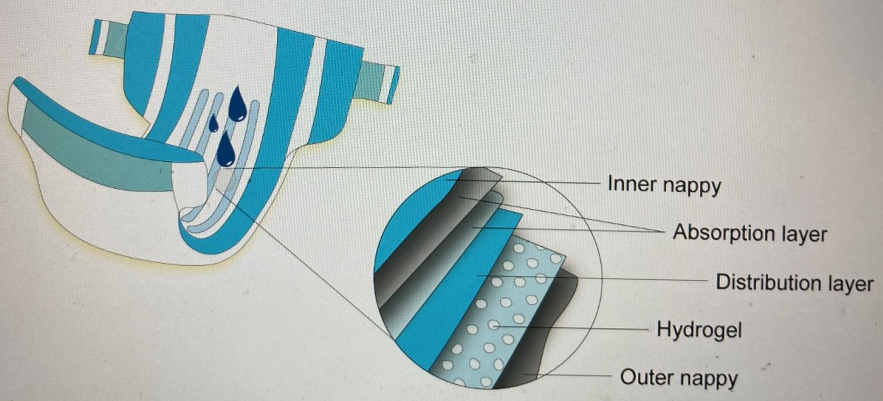
Using the data provided in the tables **discuss** which type of nappy causes less harm to the environment. In your answer you should include:

- environmental impacts
- advantages and disadvantages for a baby's carer
- your opinion about which type of nappy has a lower impact on the environment.

B I U x_2 x^2 Ω Σ Styles

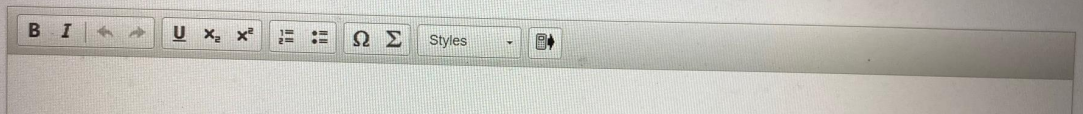
Question 5b (15 marks)

A student wants to investigate five different brands of nappies to determine which one absorbs the most liquid. Disposable nappies will contain a mixture of hydrogel and fluff pulp as absorbents.



Design a method that the student could follow to identify the brand that absorbs the most liquid. In your answer you should include:

- the independent, dependent and two control variables
- a list of equipment you will need
- how you will collect sufficient data
- details of the method you will use.



Question 6 (8 marks)

Question 6a (3 marks)

The table below shows some data about the composition of different nappy brands.

Nappy composition	Pugs	Hamps	Little Angels	Little Ones	Cuties
Fluff pulp / g	6.97	0.71	2.35	5.36	1.28
Hydrogel / g	1.88	3.97	3.56	2.76	5.43
Total mass of fluff pulp + hydrogel / g	8.85	4.68	5.91	8.12	6.71
Water absorbed by fluff pulp / g	188.2	19.2	63.4	144.7	34.56
Water absorbed by hydrogel / g	56.4	119.1	106.8	82.8	162.9
Nappy's total absorption / g	244.6	138.3	170.2	227.5	197.5

One of the students came up with the following research statement:

> The more hydrogel in nappies, the more absorbent they are.

Using the data in the table, **discuss** the validity of the research statement.

B I U x_2 x^2 Ω Σ Styles

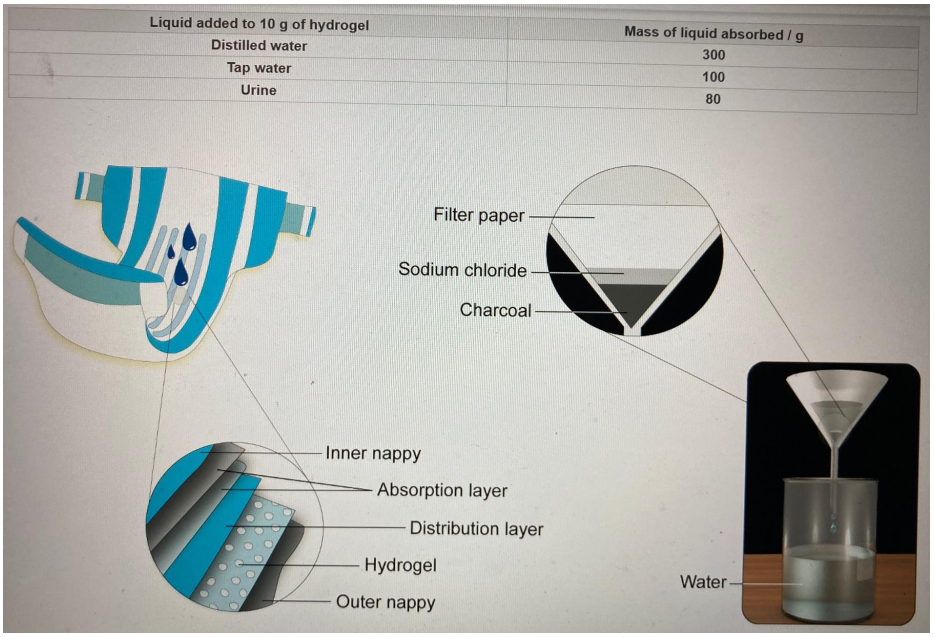
Question 6b (3 marks)

Formulate a hypothesis that would be supported by the data in the table.

If:

then:

Liquid added to 10 g of hydrogel	Mass of liquid absorbed / g
Distilled water	300
Tap water	100
Urine	80



Question 6c (2 marks)

The table below shows data about the mass of different liquids that can be absorbed by hydrogel. A solution of sodium chloride can be used to model urine.

The data in the table shows that hydrogel does not absorb urine very well. Use the two diagrams to **suggest** the function of fluff pulp in nappies.

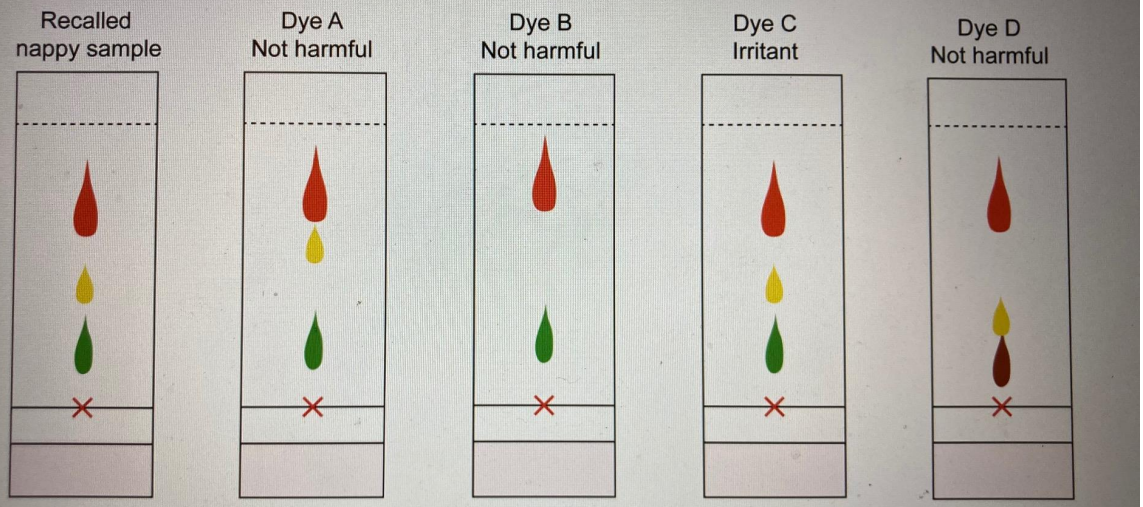
Question 7 (8 marks)

Nappy producers use dyes to make some nappies look appealing. A new brand of nappy has been released but is suspected to have caused skin irritation due to the dyes used. The dyes are being tested using chromatography.

A sample of three nappies were analysed using chromatography. The results are shown below with the potential hazards of four dyes.

are being tested using chromatography.

A sample of three nappies were analysed using chromatography. The results are shown below with the potential hazards of four dyes.



Question 7a (2 marks)

Identify the dye that the nappy sample contains. **Justify** your answer.

B I U x_2 x^2 Ω Σ Styles

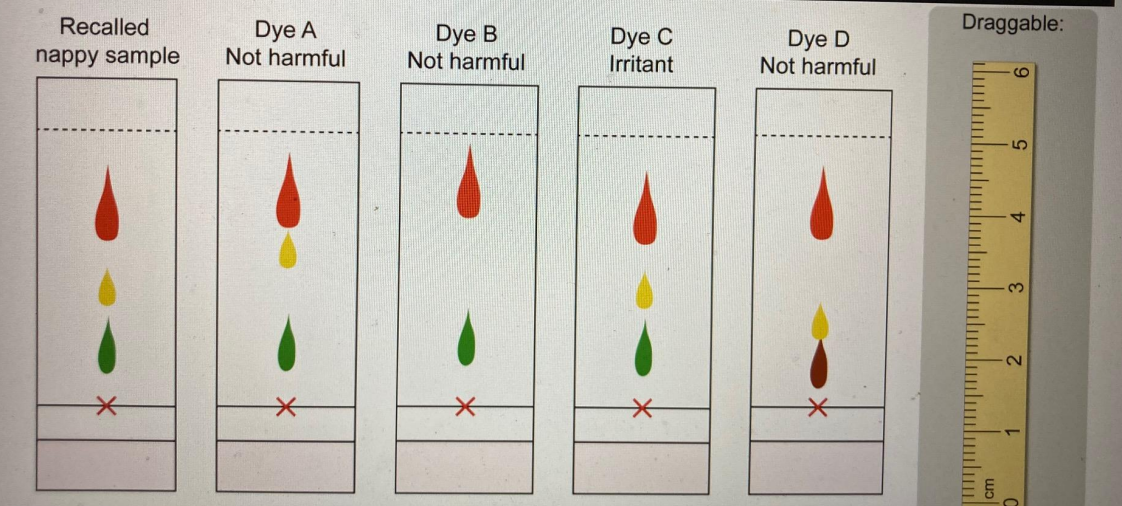
Question 7b (3 marks)

For each of the other dyes, **explain** why they are not contained in the nappy sample.

B I U x_2 x^2 Ω Σ Styles

Question 7c (3 marks)

In chromatography, the Rf value compares the distance moved by each spot with the distance moved by the solvent front. **Calculate** the Rf value of the spot responsible for the irritation.



Scroll down to continue

Question 8 (10 marks)

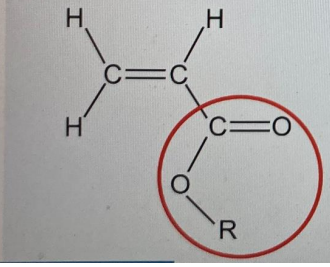
Plastic is a synthetic material made from a variety of organic polymers. Polymers are made up from a large number of monomers that are chemically bonded together.

Question 8a (3 marks)

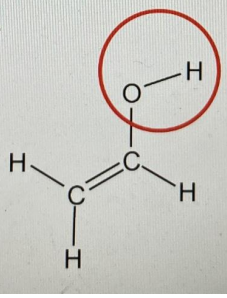
Below are different monomers used to make different types of plastic.

Select the class name of the group that is circled in the monomers below:

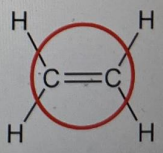
A.

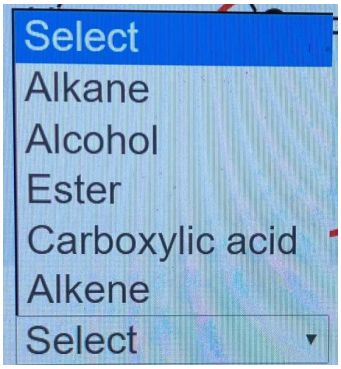


B.



C.





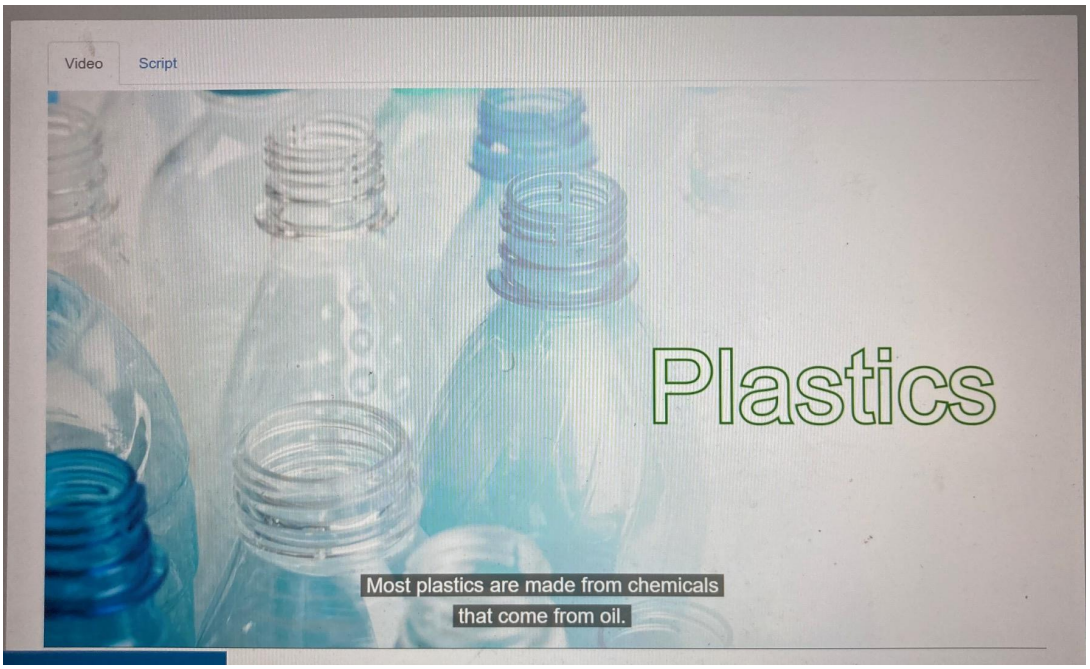
	PET – 500 cm^3 coffee cups	PLA – 500 cm^3 coffee cups
Will it biodegrade	No	Yes, in managed composting facilities
Made from	Oil	Annually renewable plants
Should single use bottles be refilled	No, not recommended	Yes
Can be recycled	Yes, where facilities exist	No, they biodegrade and return to nature
Releases harmful toxins when incinerated	Yes	No
Greenhouse gases savings during production	0 %	60 % less than PET
Oil saved	–	1 dm^3 for every 24 cups produced compared to PET

Production capacity / k tonnes y^{-1} (2015–2016)	990	220
Cost / € kg^{-1}	0.9	2
Temperature at which it starts to melt / °C	260	160
Specific heat capacity / Jkg^{-1} °C^{-1}	1000	1800

Q. 8b (7 marks)
Michelle, Yuri and Paul are excited to open their own new coffee shop. They are deciding which type of cups to buy. They want their cups to be environmentally friendly, practical to use and inexpensive to maximise profit.

Using the table above, **explain** the advantages and disadvantages of using PLA compared to PET for the take-away cups in the coffee shop. In your answer you should:

- outline the physical properties required in a coffee cup
- describe the advantages and disadvantages that PLA has compared to PET
- justify whether PLA would make a suitable replacement for PET.



Video | Script

Most plastics are made from chemicals that come from oil. Scientists are finding innovative solutions to produce plastics that are more sustainable to limit their impact on the environment. One solution is to produce plastics using algae.

Oil-based plastics are made from fossil fuels and have unlimited uses. During their production they release greenhouse gases. Oil-based plastics are long lasting and certain products can be reused many times. Scientists have estimated that it could take up to 450 years after disposal for these plastics to degrade.

Oil-based plastics can be recycled or otherwise they can end up in waterways that lead into oceans. Once in the oceans, plastics form large islands of waste that pose threats to wildlife. Fish, turtles and birds can eat the plastic or get entangled in it.

oceans. Once in the oceans, plastics form large islands of waste that pose threats to wildlife. Fish, turtles and birds can eat the plastic or get entangled in it.

If the plastic is recycled, it is broken down and made into new plastic. Alternatively, it can be reused and made into household items that can be sold to generate income in less economically developed countries. In some areas of the world, this refashioning of plastics into new products can be the only source of income.

As a sustainable alternative, plastics can be made using algae. Large volumes of water are needed to grow the algae. Sea water or freshwater can be used. When it is growing, algae takes in dissolved carbon dioxide from the water. At present, these new plastics are creating jobs in various regions of the world.

Currently, algae-based plastics have limited uses such as wrappers and bags. These type of plastics need to be stored carefully as they are sensitive to the environment and may break down before use. Algae-based plastics biodegrade quickly and do not leave behind any pollutants that are harmful to the environment. Because the products biodegrade in a very short time, they can only be used once so high production rates are needed to meet demand.

Using your experience from your wider MYP studies and the information above, **discuss** and **evaluate** the impact of algae-based biodegradable plastics as a replacement for oil-based plastics. In your answer you should consider:

- the sustainability of **production** of algae-based and oil-based plastics
- the environmental impacts of the **production** and **end of use** of algae-based and oil-based plastics
- the social impacts of the **production, use** and **end of use** of algae-based and oil-based plastics
- your opinion about replacing oil-based with algae-based plastics.