Question 1 (8 marks)

Fuels produce energy when burned. Fossil fuels such as coal, oil, and natural gas supply most of the world´s energy. The reaction these fuels undergo is combustion. The outdoor lamp is used in camping and uses propane as a fuel.

Question 1a (1 mark)

Select the term for a reaction that releases energy.

Select
- Select
- Acid-base
- Endothermic
- Exothermic
- Redox

Question 1b (2 marks)

Select options to balance the equation for the complete combustion of propane.

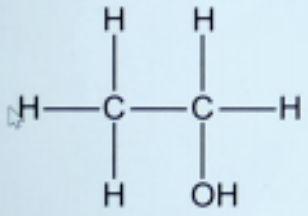
$C_3H_8 + ?\,O_2 \rightarrow ?\,CO_2 + ?\,H_2O$

Question 1c (2 marks)

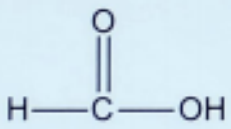
Propane is an alkane. The structures of some other organic molecules are shown below.
Identify the family that each molecule belongs to.

Question 1c (2 marks)

Propane is an alkane. The structures of some other organic molecules are shown below.
Identify the family that each molecule belongs to.



Molecule A



Molecule B

Question 1d (3 marks)

Coal is a fossil fuel. Coal is commonly used in power plants to generate electricity. **Explain** why powdered coal should be used rather than lumps of solid coal.

Question 2 (8 marks)

An alternative to the use of fossil fuels is solar power. Solar panels capture the Sun's energy and convert it into electricity. Silicon (Si) is used in 95 % of the panels sold today. Elements like gallium (Ga), arsenic (As) and tellurium (Te) can also be used in solar panels.

Question 2a (2 marks)

Use the periodic table to **identify** the missing information from the table below.

Element	Ga	As
Group	3	
Period		4

Reset

Question 2b (2 marks)

Outline why solar power is considered better for the environment than fossil fuels.

Question 2b (2 marks)

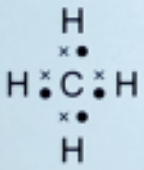
Outline why solar power is considered better for the environment than fossil fuels.

B I Styles Ω Σ

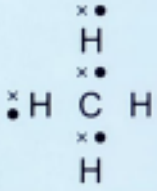
Question 2c (1 mark)

Another common fossil fuel is methane. Methane is one of the main gases used throughout the world for heating and cooking. **Select** the Lewis structure (also known as a dot diagram or a dot cross diagram) for methane.

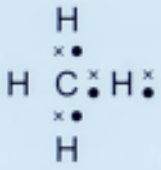
A.



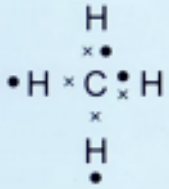
B.



C.



D.



Select

Select
A
B
C
D

Question 2d (3 marks)

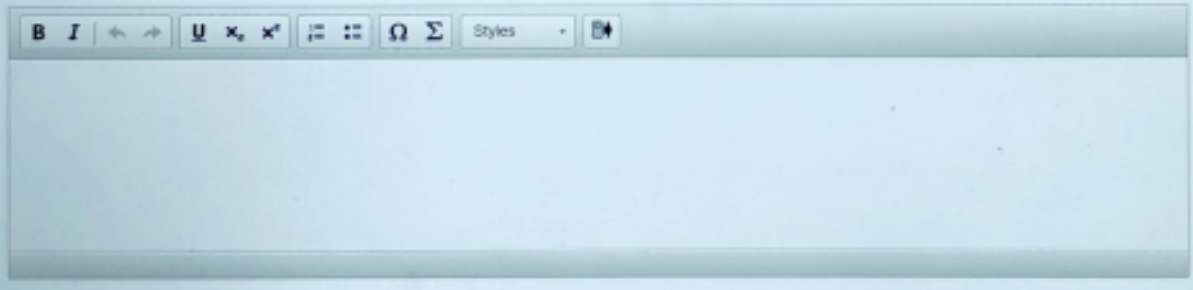
Question 2d (3 marks)

Carbon and silicon form compounds with similar formulas. Some examples are methane (CH_4) and silane (SiH_4). **Explain** why methane and silane have similar formulas.

Question 3 (12 marks)

Question 3a (2 marks)

Hydrogen was discovered by Sir Henry Cavendish in 1766 when he reacted metals with acid. He called the gas produced "inflammable air". We now call this gas hydrogen. Cavendish placed three different metals: zinc, iron and tin into acid. He observed that hydrogen was produced at different rates. **Outline** why hydrogen was produced at different rates.



Question 3b (3 marks)

Hydrogen is a colourless gas. Even though hydrogen is the most abundant element in the universe, there is not enough in our atmosphere for it to be used as a renewable energy source. When used as an energy source, hydrogen needs to be manufactured. There are several different processes used to manufacture hydrogen. Manufactured hydrogen can be classified into different categories depending on the process used. Grey, blue and green are examples of categories of manufactured hydrogen.

Category of hydrogen	Manufacturing process	Environmental impact
Grey	Natural gas or methane are combined with steam and broken down.	Carbon monoxide is produced. Carbon monoxide reacts to form carbon dioxide. Carbon dioxide is released into the atmosphere.
Blue	Natural gas or methane are combined with steam and broken down.	Carbon monoxide is produced. Carbon monoxide reacts to form carbon dioxide. Carbon dioxide is captured and stored to prevent its release into the atmosphere.
Green	Electrolysis of water.	Electrical energy intensive.

Grey and blue hydrogen are produced in the presence of a nickel catalyst. **Explain** how a catalyst works in a chemical reaction.

B I U x_2 x^2 Ω Σ Styles

Question 3c (4 marks)

Calculate the number of moles of hydrogen produced when 8.00 kg of methane react with excess water vapour when producing grey and blue hydrogen.

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$

Question 3d (1 mark)

After it is produced, hydrogen must be transported to where it is needed. To allow it to be transported safely, the hydrogen is reacted with nitrogen to form ammonia.

Suggest why it is safer to transport ammonia rather than hydrogen.

Question 3e (2 marks)

Traditional cement manufacture uses limestone which is a form of calcium carbonate. Carbon dioxide from the blue hydrogen process can be combined with calcium oxide to produce calcium carbonate.

$$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$$

State one environmental benefit of using the carbon dioxide in this process. **Justify** your answer.

Question 4 (16 marks)

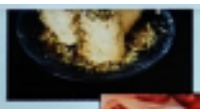
Usually eaten after dinner, or just as a treat, frozen desserts come in a variety of types depending on the country. Some examples are shown below.

Country: India
Name: Kulfi
Main ingredients: Boiled milk flavoured with pistachios, saffron or cardamom

Country: Mexico
Name: Paletas
Main ingredients: Fruit, sugar and milk

Country: United Kingdom
Name: Ice cream
Main ingredients: Cream, egg, sugar and milk

Country: Japan



Main ingredients: Boiled milk flavoured with pistachios, saffron or cardamom

Country: Mexico

Name: Paletas

Main ingredients: Fruit, sugar and milk

Country: United Kingdom

Name: Ice cream

Main ingredients: Cream, egg, sugar and milk

Country: Japan

Name: Mochi

Main ingredients: Ice cream wrapped in coloured sheets made from rice flour

One of the main ingredients of these various frozen desserts is milk. Milk is a solution of protein, fats and other substances in water. When the milk and other ingredients in frozen desserts are cooled, the water inside the milk freezes producing ice crystals which trap the other ingredients.

Question 4a (2 marks)

In the boxes below, **draw** a diagram showing the arrangement of at least 10 water molecules before and after freezing.

Draggable items:

Before freezing

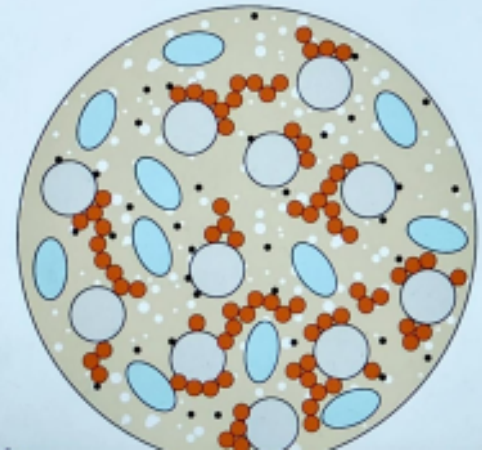
After freezing

Key:

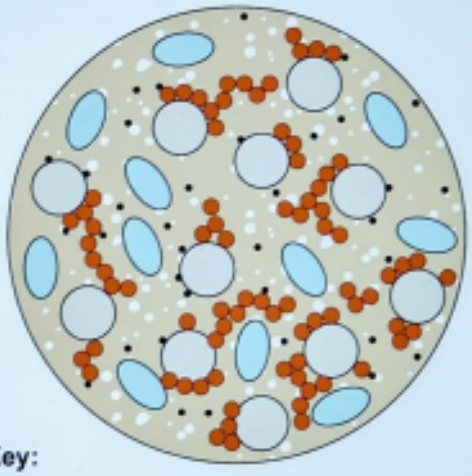
Water molecule

Question 4b (2 marks)

The size of the ice crystals produced will depend on how quickly they form and this is dependent on temperature. The structure of a frozen dessert can be seen using a microscope. The microscope image and a simplified diagram are shown below.

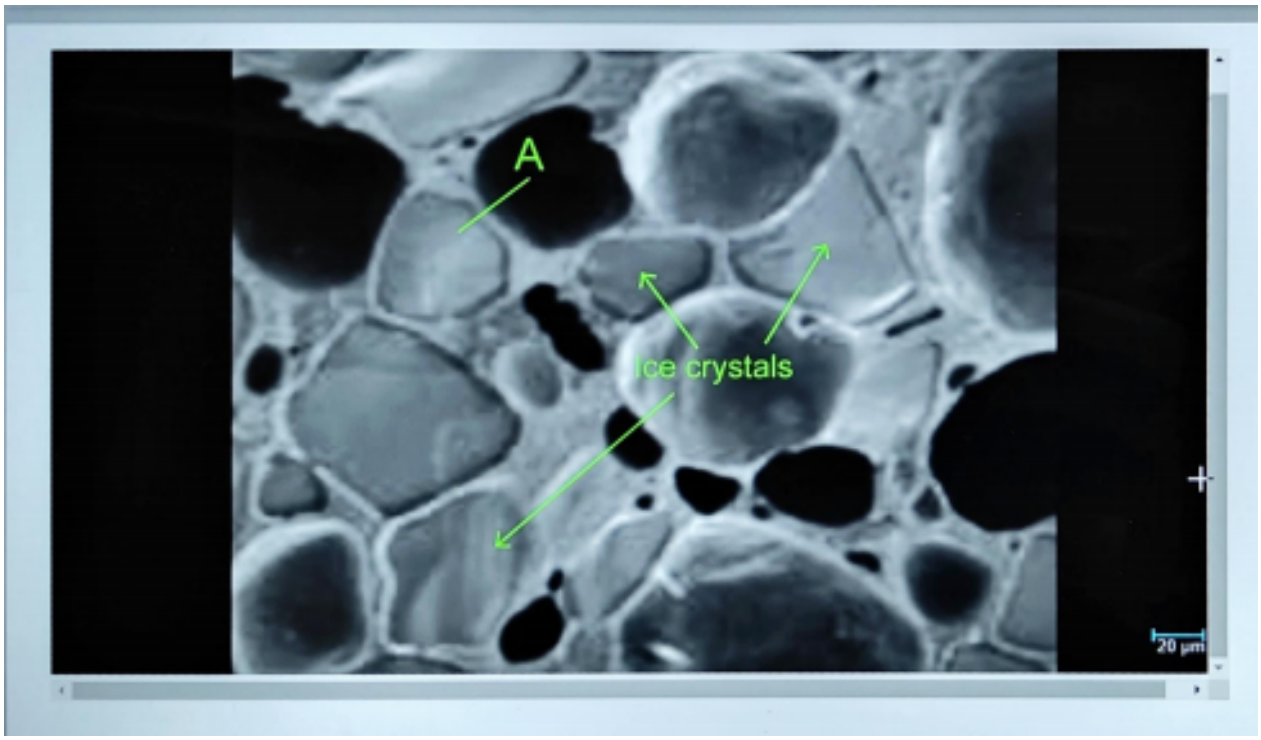


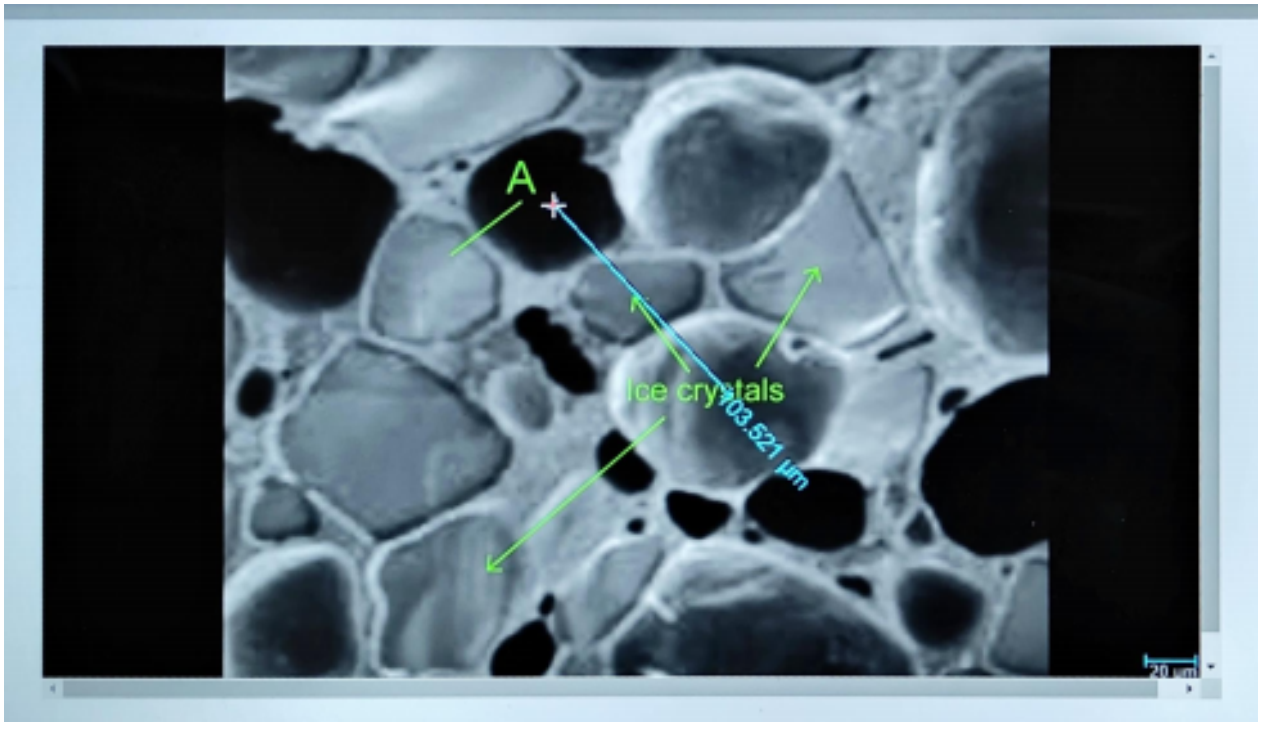
Scroll down to continue



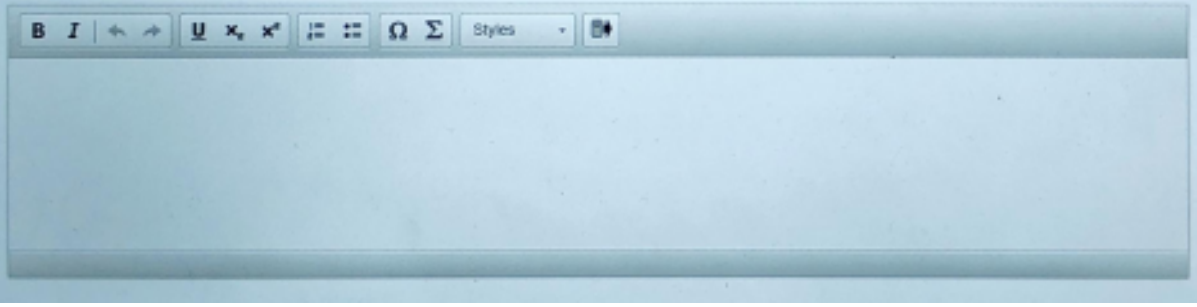
Key:

- Water and sugar
- Ice crystals
- Air bubbles
- Fat
- Milk proteins


A
Ice crystals
20 µm


A
Ice crystals
103.521 µm
20 µm

Click to open the measuring tool and **measure** the size of the ice crystal at A. You should give your measurement in metres using standard form.



A student used the following method to make ice cream at home.

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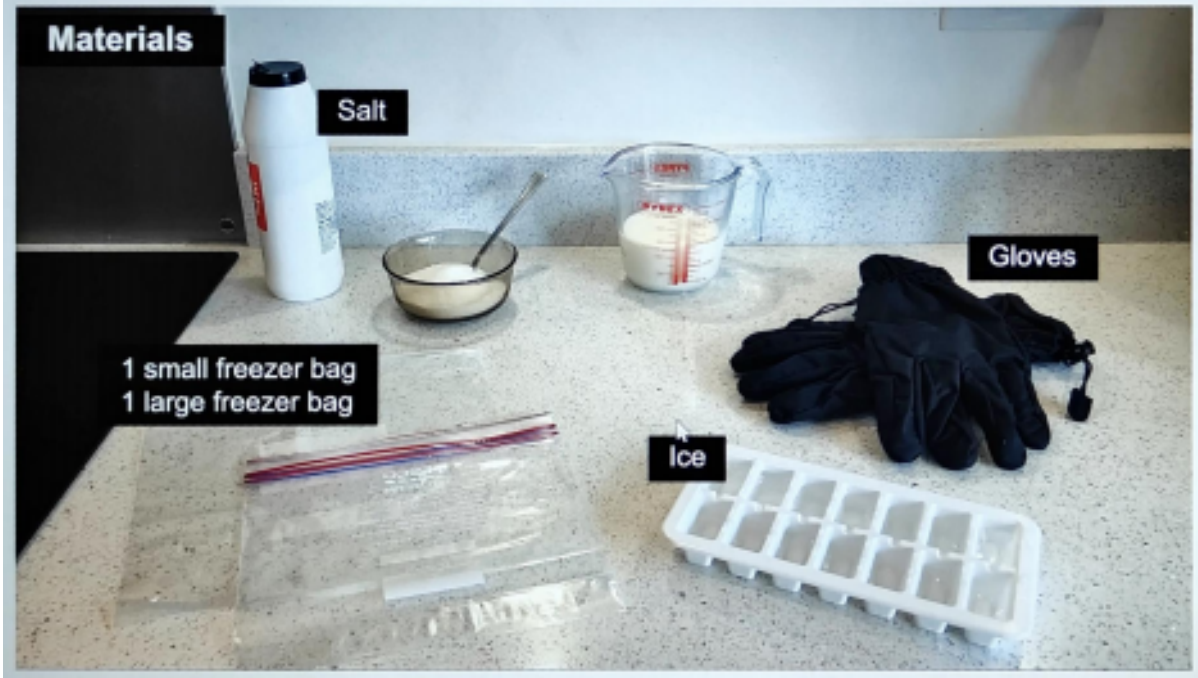


Question 4c (4 marks)

While the ice cream was being made, the student measured the temperature of the mixture and estimated the percentage of water that had frozen. Their results are shown in the table below.

Temperature / °C	Percentage of ice cream frozen / %
−2.50	0
−3.00	20
−4.50	40
−7.00	60
−15.00	80

Present this data in a graph.

x axis label:

y axis label:

Question 4d (2 marks)

Using your graph from part (c), **estimate** the temperature when 50 % of the water would be frozen.

Question 4e (3 marks)

The texture of ice cream is affected by the size of the ice crystals it contains. This size is determined by the temperature it is made at. The colder the ice cream mixture becomes, the smaller the size of the ice crystals.

Liquid nitrogen has a temperature of –196 °C. Ice cream made using liquid nitrogen will have a smoother texture than ice cream made using the method in part (c).

Formulate a hypothesis to test the effect of temperature on the texture of ice cream.

If:

Then:

Because:

Question 4f (1 mark)

A student wanted to investigate the mixtures found in frozen desserts. They were interested in how quickly different frozen desserts containing soda, water or milk melted. The student froze cubes of each liquid with dimensions 2 cm × 2 cm × 2 cm. The student's hypothesis was:

> If a frozen dessert contains milk, then it will melt the most quickly because it is not a clear liquid.

The student collected the following data.

Frozen ingredient	Time to melt		
	Trial 1	Trial 2	Trial 3
Soda	45 minutes 54 seconds	38 minutes 02 seconds	44 minutes 45 seconds
Water	42 minutes 31 seconds	48 minutes 56 seconds	43 minutes 22 seconds
Milk	1 hour 2 minutes	1 hour 6 minutes	58 minutes 34 seconds

Suggest one way that the student's data **presentation** could be improved.

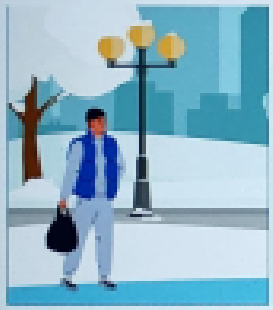
Suggest one way that the student's data **presentation** could be improved.

Question 4g (2 marks)

Outline if the data above validates the student's hypothesis.

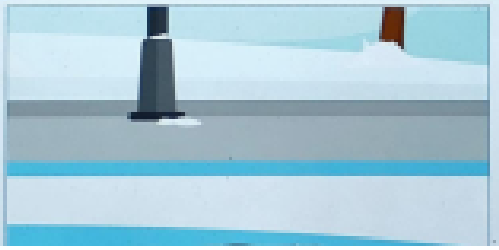
Question 5 (17 marks)

The cartoon below shows the effect of salt on ice.



A person was walking home in winter from the grocery store.

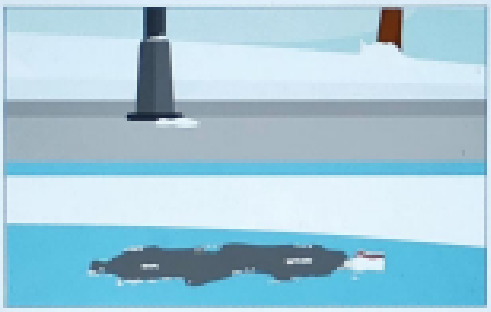
In the bottom of the bag of groceries was a bag of salt.



A person was walking home in winter from the grocery store.

The bag split and the salt spread all over the frozen ground.

In the bottom of the bag of groceries was a bag of salt.



A student passing by noticed that the ice that was previously on the ground had melted.

Question 5a (1 mark)

The student decided to investigate the time taken for salt (sodium chloride, NaCl) to melt crushed ice and solid ice. They set up their investigation as shown in the diagram below.

Formulate a research question for the student's investigation.

Question 5b (4 marks)

State the variables in this investigation.

Independent variable:

Control variable 1:

Dependent variable:

Control variable 2:

Question 5c (1 mark)

State how the set-up of the investigation in part (a) could be improved.

Question 5d (3 marks)

After studying how salt affects ice, the student wanted to investigate how quickly different household substances would melt ice compared to salt. The other substances used were sand, sugar and coffee powder. The results for salt and sugar are shown below.

Substance	Trial number	Initial ice mass / g	Remaining ice mass / g	Percentage of ice remaining / %	Percentage of ice melted / %
Salt	1	145.00	75.00	51.72	48.28
	2	160.00	90.00	56.25	43.75
	3	150.00	80.00		46.67
Sugar	1	150.00	105.00	70.00	30.00
	2	165.00	120.00	72.73	27.27
	3	145.00	100.00	68.97	

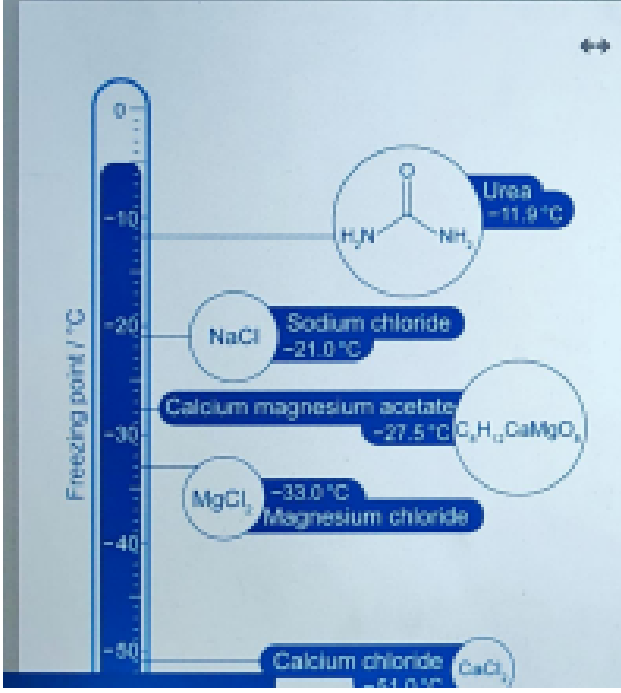
Reset

The data table above is incomplete. **Calculate** the missing values to complete the table, giving your values to a suitable number of decimal places.

Question 5e (1 mark)

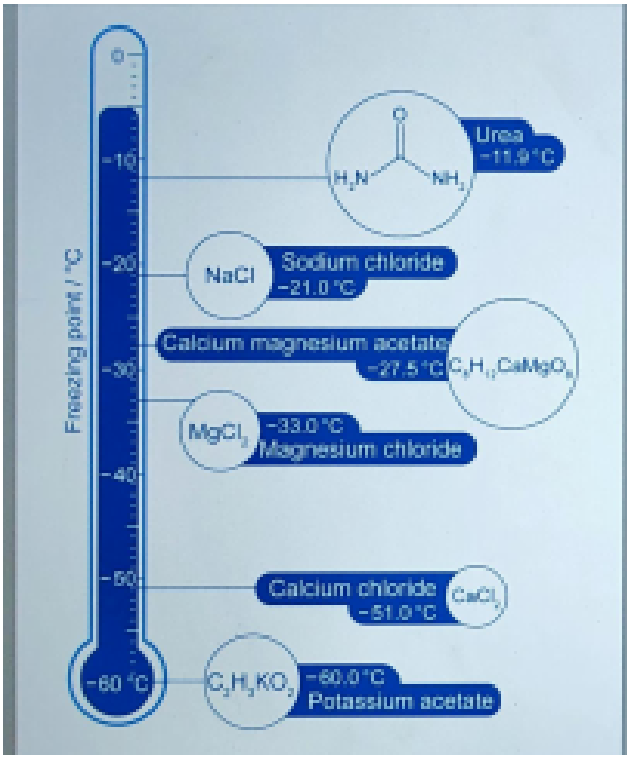
Suggest why salt was used in the investigation in part (d).

Question 5f (2 marks)



In some areas of the world, temperatures drop below 0 °C. This causes problems for transport such as cars and airplanes. The infographic below shows a variety of chemicals that can be used to remove ice and the temperature at which the ice will melt when each chemical is used.

An airport which is based above the Arctic circle uses a variety of de-icers depending upon the surface that needs to have ice removed. The average temperatures during the winter months range from −15 °C to −2 °C but with the wind it can get much colder, as cold as −45 °C.



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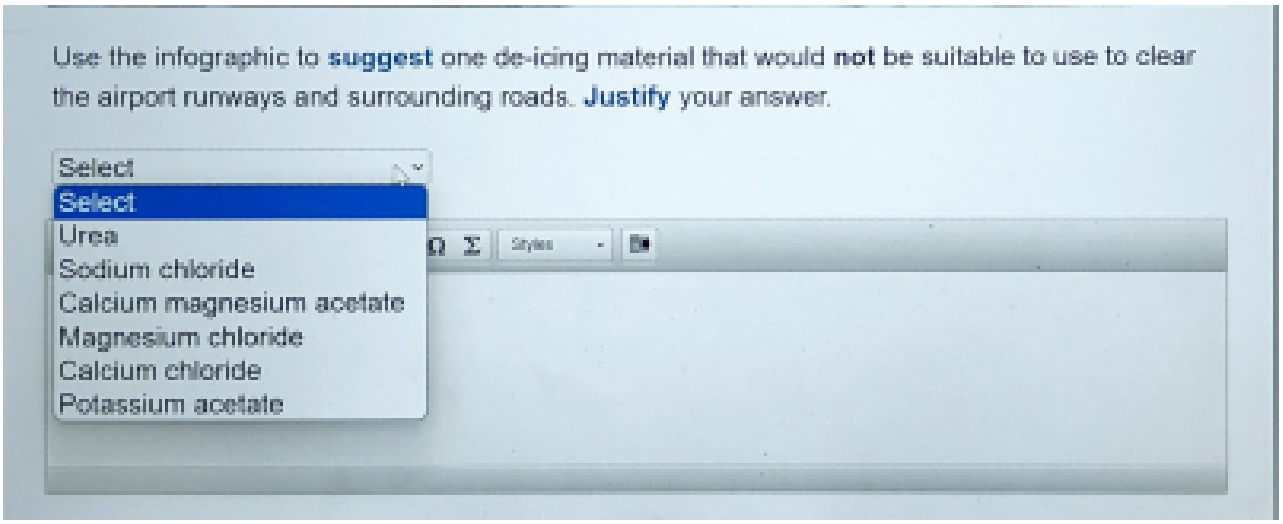
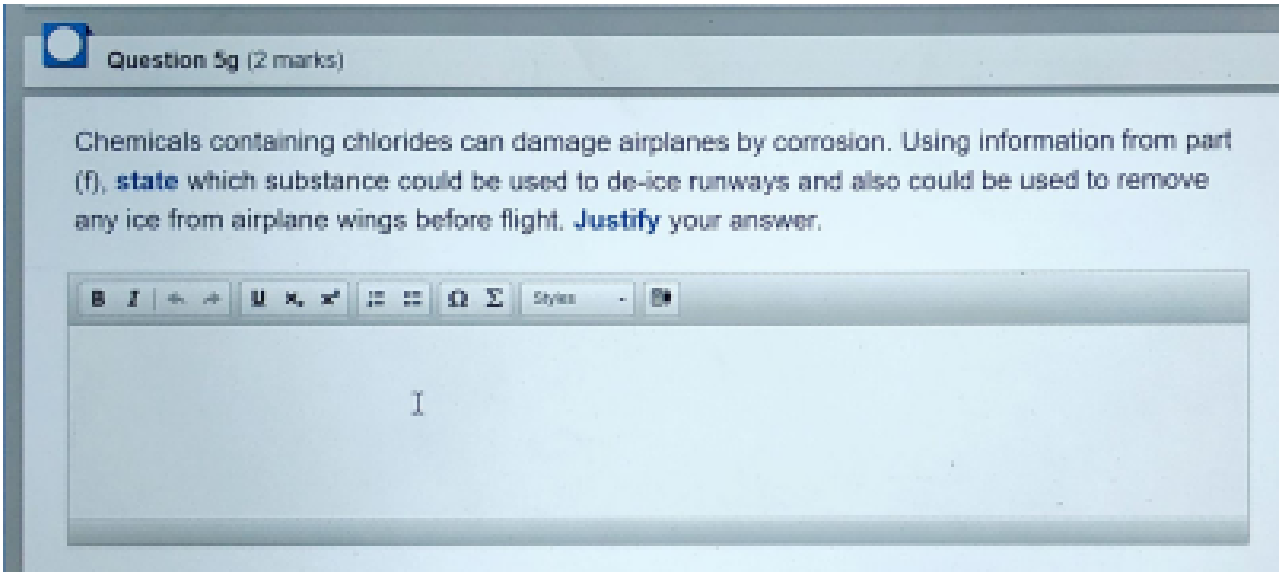
An airport which is based above the Arctic circle uses a variety of de-icers depending upon the surface that needs to have ice removed. The average temperatures during the winter months range from – 15 °C to – 2 °C but with the wind it can get much colder, as cold as –45 °C.

Use the infographic to **suggest** one de-icing material that would **not** be suitable to use to clear the airport runways and surrounding roads. **Justify** your answer.



Question 5g (2 marks)

Chemicals containing chlorides can damage airplanes by corrosion. Using information from part (f), **state** which substance could be used to de-ice runways and also could be used to remove any ice from airplane wings before flight. **Justify** your answer.



Question 5h (3 marks)

Natural snow is produced when water droplets fall at specific temperatures. As they fall, the water droplets form crystals which grow into different patterns. Machine-made snow used in laboratories to model the effects of de-icers has a different form. Machine-made snow is produced by forcing water droplets into the air. The water droplets then become coated with more water and form small balls of ice. The physical differences between natural and machine-made snow are shown in the images below.

Natural snow

Machine-made snow

Discuss the validity of using machine-made snow to compare the effects of different de-icers.

Question 6 (17 marks)

A new company is looking to provide a local community with a better de-icer for roads. You are provided with the following salts and asked to determine which will be the best one for de-icing roads: lithium chloride (LiCl), potassium chloride (KCl), magnesium chloride ($MgCl_2$), calcium chloride ($CaCl_2$), strontium chloride ($SrCl_2$).

Question 6a (1 mark)

The image below shows a bottle of strontium chloride, $SrCl_2$. **Select** the hazard represented by this symbol.

Question 6a (1 mark)

The image below shows a bottle of strontium chloride, $SrCl_2$. **Select** the hazard represented by this symbol.

Select
Select
Corrosive
Flammable
Radioactive
Toxic

Question 6b (16 marks)

Design an experiment to investigate which salt would be the best de-icer for roads. In your answer, you should include:

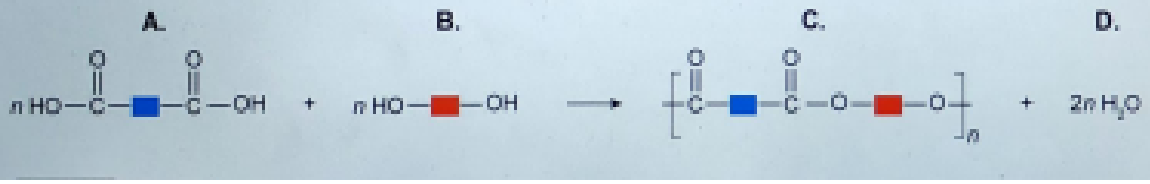
- the independent, dependent and control variables
- a list of equipment you will use
- the method you will follow
- details of measurements you will take to collect sufficient data
- any safety precautions you need to take.

Question 7 (8 marks)

The fashion industry has evolved to use a variety of textiles. Natural materials such as cotton and hemp have been used since ancient times. Newer synthetic materials such as polyester and nylon are used in weatherproof clothing. The purpose and properties of each type of material are different. As new materials are developed, we need to consider their sustainability compared to natural sources.

Question 7a (1 mark)

Polyester is a strong synthetic fibre made when an alcohol and a carboxylic acid react to form an ester. **Identify** the alcohol in this simplified reaction.



Question 7b (7 marks)

In the following table, you can find some of the common properties of different materials.

VELVET
Fibre
Natural-synthetic mix of silk and rayon
Breathability
20 %
Comfort
60 %
Wrinkle resistant
No
Function
Warming
Machine wash
No
Cost
High
POLYESTER
Fibre
Synthetic
Breathability
20 %
Comfort
60 %
Wrinkle resistant
Yes
Function
Warming/ Cooling
Machine wash
Yes
Cost
Low
NYLON
Fibre
Synthetic
Breathability
0 %
Comfort
60 %
Wrinkle resistant
Yes
Function
Warming
Machine wash
Yes
Cost
Low

*Breathability: ability of a fabric to allow sweat to evaporate

Global warming causes our planet's temperature to increase, therefore light and breathable materials are needed for clothing. Using information from the table and your wider MYP studies, **discuss** and **evaluate** the suitability of different types of fabric for sports clothing. In your answer you should include:

- properties for fabrics suitable for sports clothing
- a comparison of at least three different fabrics

Global warming causes our planet's temperature to increase, therefore light and breathable materials are needed for clothing. Using information from the table and your wider MYP studies, **discuss** and **evaluate** the suitability of different types of fabric for sports clothing. In your answer you should include:

- properties for fabrics suitable for sports clothing
- a comparison of at least three different fabrics
- your opinion about which fabric is the most suitable.

Video | Script

Buying clothes is cheaper and more accessible than ever before.
In 2018, 80 billion items were manufactured.

Manufacturing clothes produces 10 % of all greenhouse gas emissions. This means 1.2 billion tonnes into the atmosphere per year.

The textile industry is also responsible for 20 % of global waste water.

"Fast fashion" causes people to buy more clothes but to wear them less before they are thrown away. This leads to increased waste.

Clothing is the fastest growing category of waste.

In 2017, 92 million tonnes of textile waste were discarded into landfill or burned. This is the equivalent of one truck every second.

What can we do to reduce this waste?

Let's start by lowering the production of new clothing.

For special occasions, why not rent?

Used clothes can be sold or you can consider donating to a friend or someone in need.

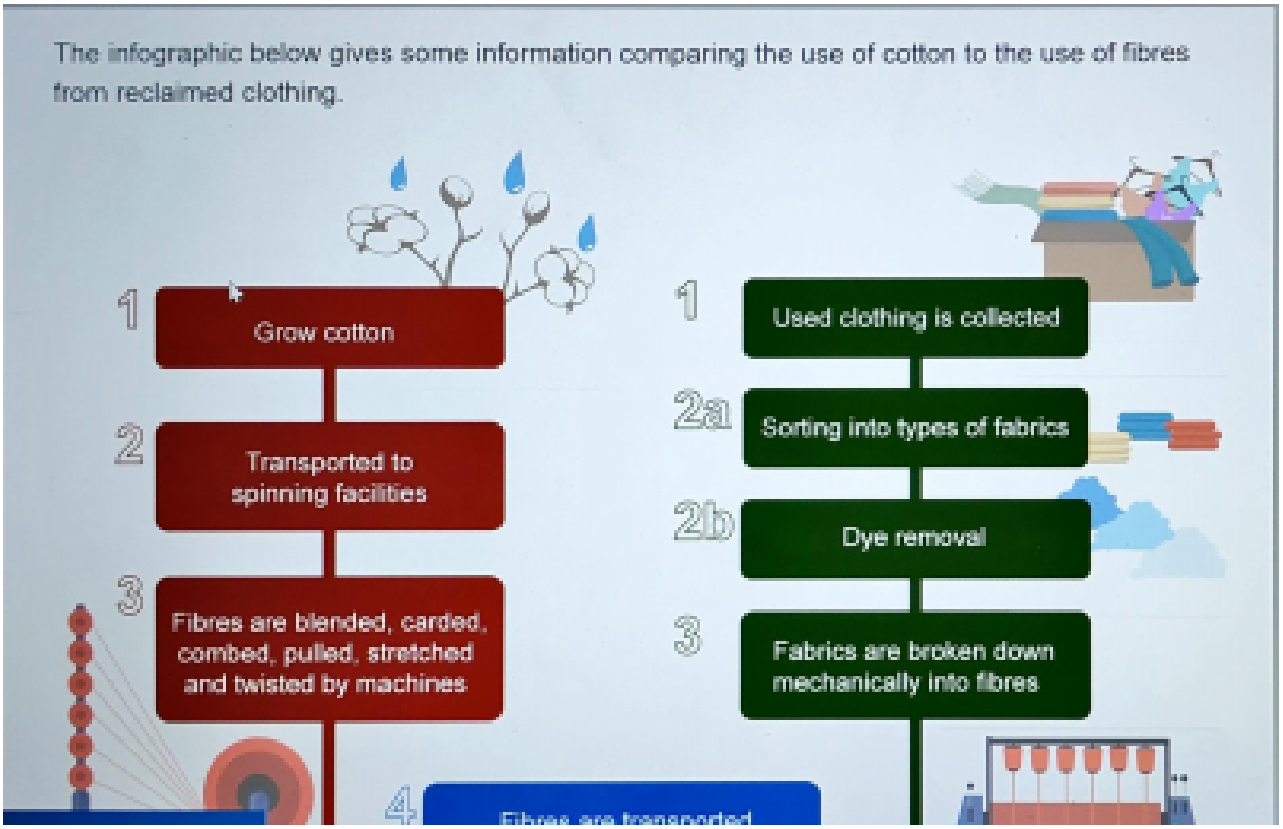
What about reclaiming?

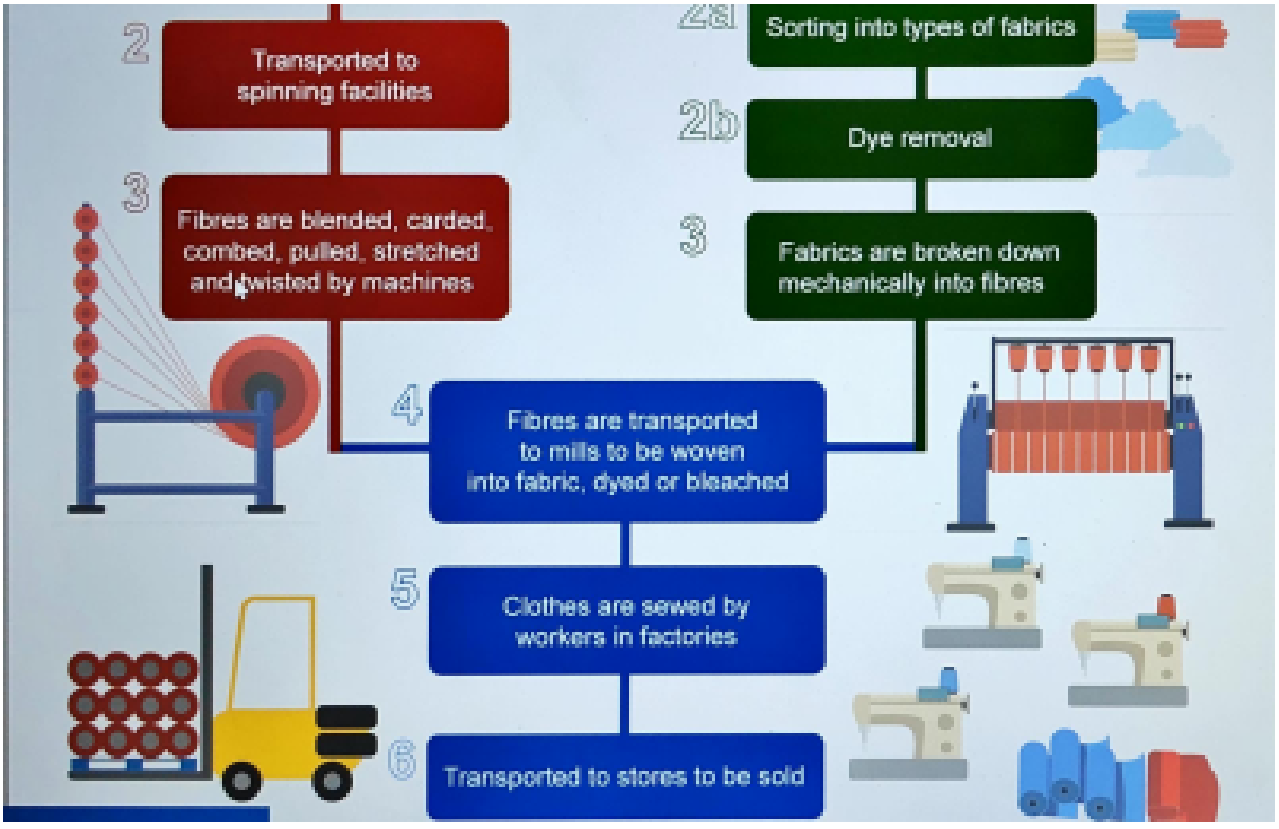
Can we break down the clothing into fibres to create reclaimed materials?

Yes! But there are some limitations.

Fabrics need to be sorted by type before they can be reclaimed, however, even a shirt made of 100 % cotton contains tags made of polyester. Fast fashion has led to poor quality materials being used in clothing. The quality of these fibres is not always good enough to reclaim.

The infographic below gives some information comparing the use of cotton to the use of fibres from reclaimed clothing.





Using information from the video and the infographic, **discuss** and **evaluate** reusing clothing as a solution to the waste created by the fashion industry. In your answer you should include:

- advantages to the environment of reclaiming compared to manufacturing new clothing
- impacts on the economy of reclaiming
- choices of an individual when considering how to reuse clothing
- a final appraisal on reusing rather than manufacturing new clothing.

Question 8b (2 marks)

In the nineteenth century, sewing machines were first developed. By 1876, almost a million homes in the US owned a sewing machine. Nowadays, owning a sewing machine is again growing in popularity.

Suggest how the sewing machine could be part of the solution to reduce clothing waste.