Question 1 (11 marks)

Knowing and understanding

This task (questions 1 and 2) addresses the key concept of **relationships** and focuses on **criterion A** (Knowing and understanding).

Formic acid is the simplest carboxylic acid.

Question 2 (13 marks)

The "hardness" of water is related to the concentration of dissolved ions.

Question 3 (26 marks)

Investigation skills

This task (questions 3 to 5) addresses the key concept of **change** and focuses on **criterion B** (Inquiring and designing) and **criterion C** (Processing and evaluating).

Bones and teeth from different animals contain different amounts of calcium carbonate.

Scroll down to continue

Question 4 (6 marks)

Chemical changes can be used to identify the source of animal bones and teeth.

Question 5 (18 marks)

Hens can be given food supplements to increase the thickness of their eggshells.

Question 6 (12 marks)

Applying science

The global context is **orientation in space and time** with a focus on **natural and human landscapes and resources.** This task (questions 6 and 7) addresses the key concept of **systems** and assesses **criterion D** (Reflecting on the impacts of science).

Complex systems are used in crude oil processing.

Question 7 (14 marks)

The natural landscape determines the type of system used to transport crude oil.

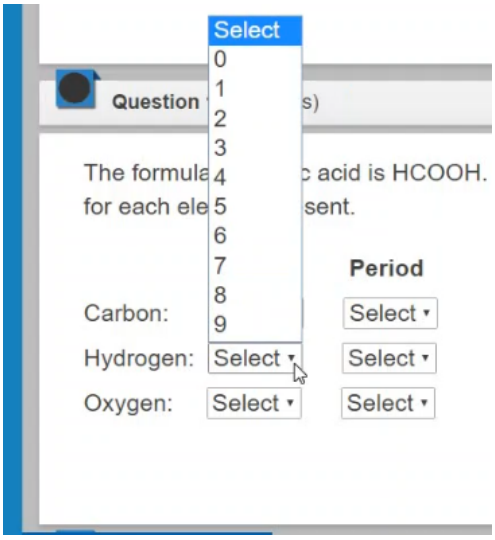
Question 1 (11 marks)

In 1671 John Ray, an English naturalist, distilled a liquid collected from ants. He produced a strong smelling acidic liquid that he named formic acid from the Latin word *formica* meaning ant. Formic acid is the simplest carboxylic acid.

Question 1a (3 marks)

The formula of formic acid is HCOOH. Use the periodic table to **identify** the group and period for each element present.

	Group	Period
Carbon:	Select	Select
Hydrogen:	Select	Select
Oxygen:	Select	Select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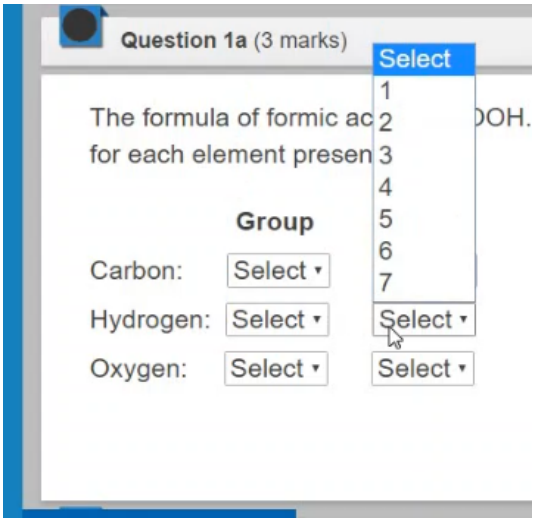
Question 1a (3 marks)
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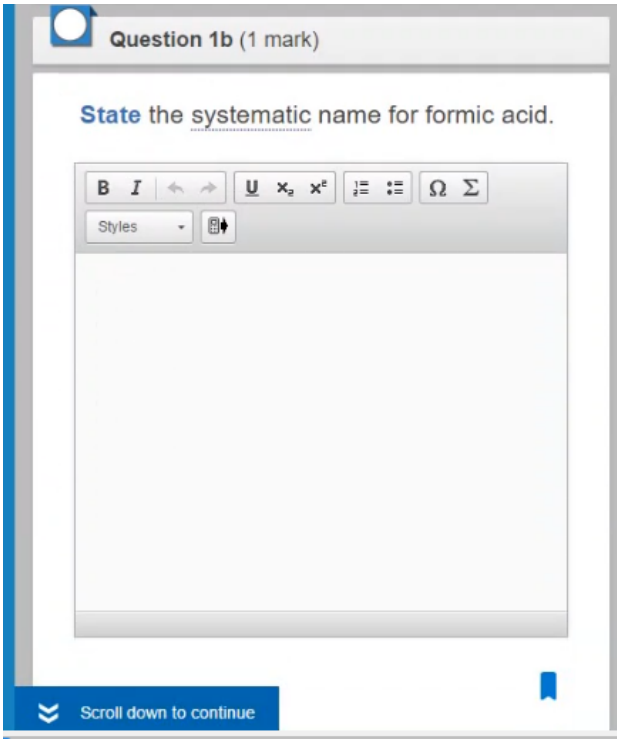
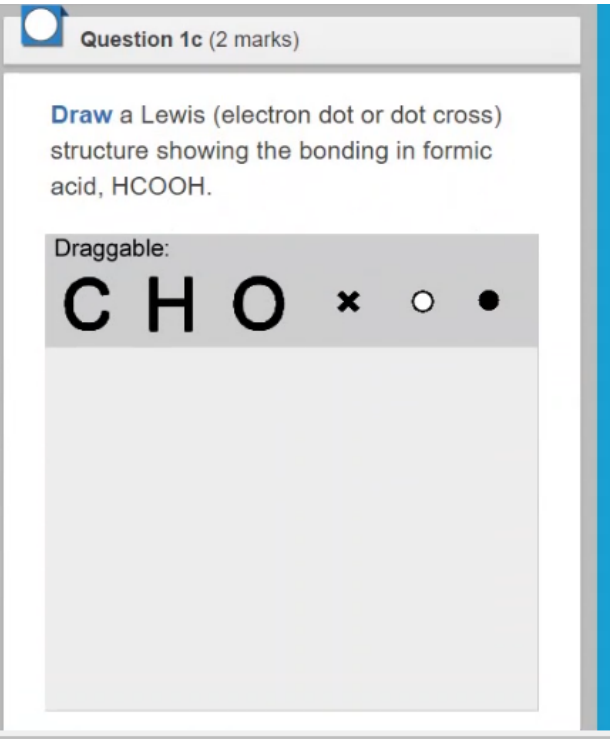

Question 1b (1 mark)
State the systematic name for formic acid.
Styles
Scroll down to continue


Question 1c (2 marks)
Draw a Lewis (electron dot or dot cross) structure showing the bonding in formic acid, HCOOH.
Draggable:
C H O

Question 1d (4 marks)

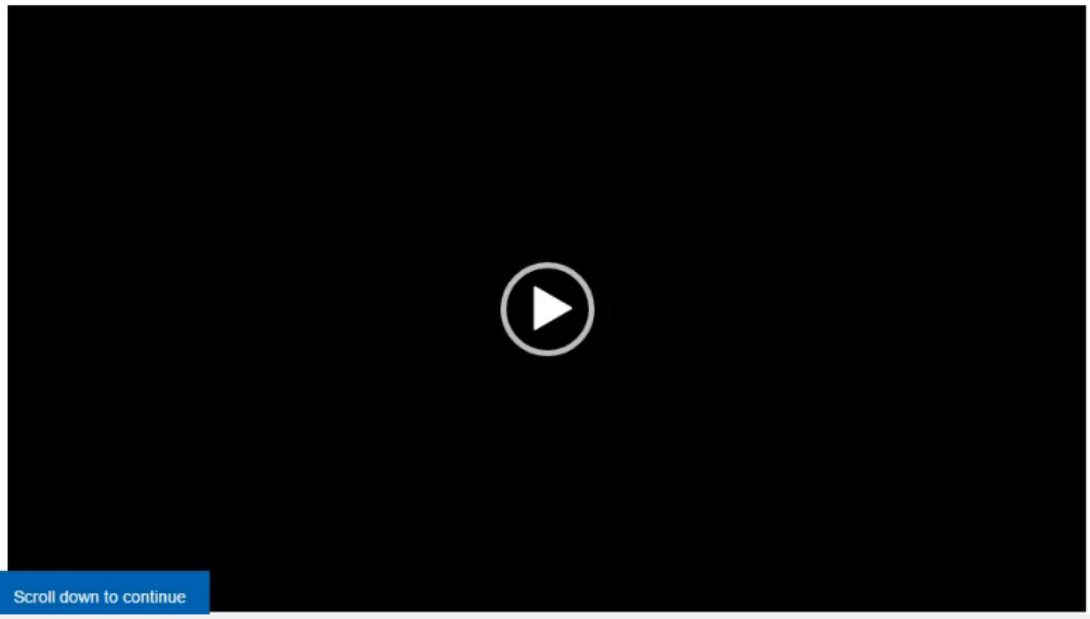
Formic acid partially dissociates in water to form an equilibrium. **Write down** a balanced equation for this equilibrium including state symbols.

Question 1e (1 mark)

State how the acid can be neutralized.

Question 2 (13 marks)

Natural sources of water can contain different dissolved ions. Water containing mainly group 2 ions such as calcium and magnesium (Ca^{2+} and Mg^{2+}) is known as "hard" water.



Scroll down to continue

The most common method to investigate the "hardness" of water is by looking at the foam produced when the water is treated with soap. There is less foam formed when soap is used with hard water compared to soft water.

Many methods can be used to soften hard water. These methods work by removing the Ca^{2+} and Mg^{2+} ions from the water. One method softens water by forming a precipitate of an insoluble solid in an aqueous solution. The table below compares the solubility in water of different combinations of anions with Ca^{2+} and Mg^{2+} ions.

Solubility in water at 25 °C of Ca^{2+} and Mg^{2+} ions.

Anion	Mg^{2+}	Ca^{2+}
Cl^-, Br^-, I^-	soluble	soluble
SO_4^{2-}	soluble	insoluble
OH^-	insoluble	insoluble
CO_3^{2-}, PO_4^{3-}	insoluble	insoluble

Question 2a (2 marks)

State the number of protons and neutrons in an $^{24}Mg^{2+}$ ion.

Question 2b (1 mark)

Use the information in the table to **determine** the formula of magnesium phosphate.

Question 2c (4 marks)

Identify two physical properties that distinguish between magnesium and chlorine at a temperature of 25 °C.

Property 1:

How this property distinguishes between magnesium and chlorine:

Property 2:

How this property distinguishes between magnesium and chlorine:

Scroll down to continue

Question 2d (1 mark)

State the type of bond that would form in a reaction between magnesium and chlorine.

B I U x_2 x^2 Ω Σ Styles

Question 2e (4 marks)

Using the solubility data in the table above, **explain** how you would remove Ca^{2+} ions only from hard water.

Question 2f (1 mark)

Crystals of magnesium sulphate pentahydrate ($MgSO_4.5H_2O$) are heated to form magnesium sulphate.

State the number of moles of water formed if 0.5 moles of $MgSO_4.5H_2O$ are heated.

Question 3 (26 marks)

Many animals are at risk of extinction because of illegal trading of their teeth and bones. Teeth and bones from different animals contain different percentages by mass of calcium carbonate. Scientists can use calcium carbonate data to identify which animals bone samples come from and check that the bones are not being traded illegally.

The percentage by mass of calcium carbonate in bones and teeth from different animals are shown below.

Animal	Percentage by mass of calcium carbonate / %	
	Teeth	Bone
Elephant	20.93	22.58
Horse	28.80	24.70
Human	29.82	23.10
Monkey	29.93	23.12
Dolphin	22.12	15.16

Metal carbonates react with hydrochloric acid to form a metal chloride, water and a gas which will turn limewater cloudy.

The symbol equation for the reaction of calcium carbonate with hydrochloric acid is shown below

$$CaCO_3(s) + 2HCl\ (aq) \longrightarrow salt\ (aq) + CO_2(g) + H_2O\ (l)$$

Question 3a (1 mark)

Select the salt produced in the reaction above.

Select
Select
$CaCl_2$
CaO
CaCl
H_2

on 3b (4 marks)

Question 3b (4 marks)

A scientist investigating teeth and bones developed the following research statement:

"The higher the percentage of calcium carbonate in the bones or teeth, the larger the volume of carbon dioxide produced when reacted with acid."

Identify the variables in this investigation.

Independent variable:

Dependent variable:

Control variable 1:

Control variable 2:

Scroll down to continue

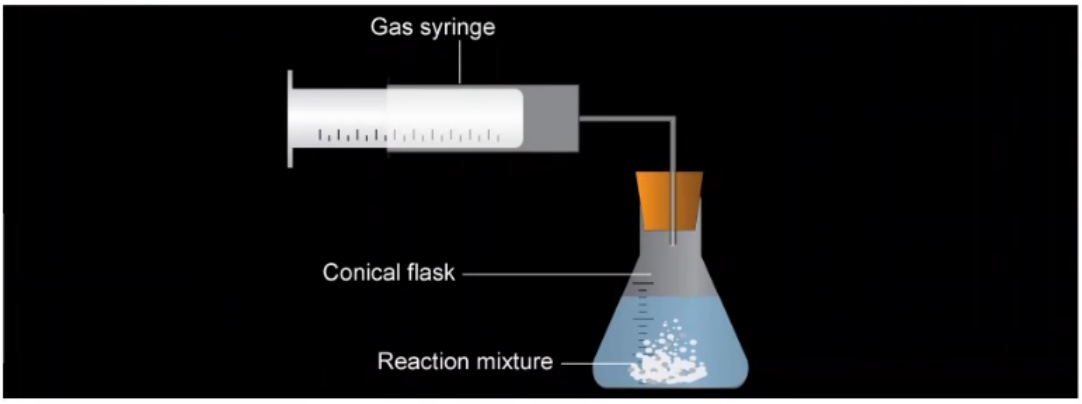
Question 3c (4 marks)

Design a table suitable for recording and processing your data. You should select the number of rows and columns and add labels.

Reset

Question 3d (17 marks)

The percentage by mass of calcium carbonate can be determined using the following equipment.



©

Using the equipment above, **design** a method to determine the mass of calcium carbonate in the teeth or bones. In your answer should include:

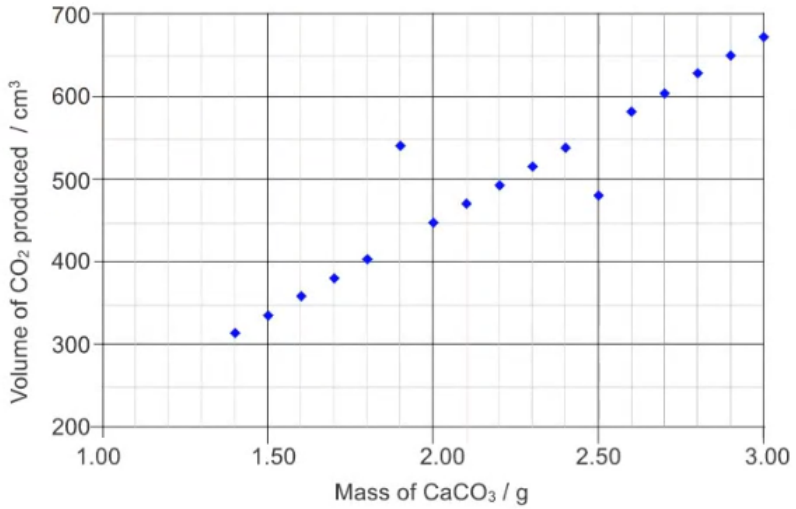
- a list of any additional equipment you will need
- details of your method for manipulating the variables
- details of the data you will collect
- how you will use your data to decide which tooth or bone contains the most calcium carbonate
- a statement of any assumptions that you have made.
- how you will ensure that your method is safe.

B I U x_2 x^2 Ω Σ Styles

Scroll down to continue

Question 4 (6 marks)

The graph below shows the volume of carbon dioxide produced when calcium carbonate reacts with hydrochloric acid.



Scroll down to continue

Question 4a (2 marks)

The data points for 1.9 g and 2.5 g of calcium carbonate do not appear to be correct.

Comment on the data for 1.9 g and 2.5 g and **suggest** what could be done to check the data for these two points.

B I U x_2 x^2 Ω Σ Styles

Question 4b (4 marks)

Animal	Percentage by mass of calcium carbonate / %	
	Teeth	Bone
Elephant	20.93	22.58
Horse	28.80	24.70
Human	29.82	23.10
Monkey	29.93	23.12
Dolphin	22.12	15.16

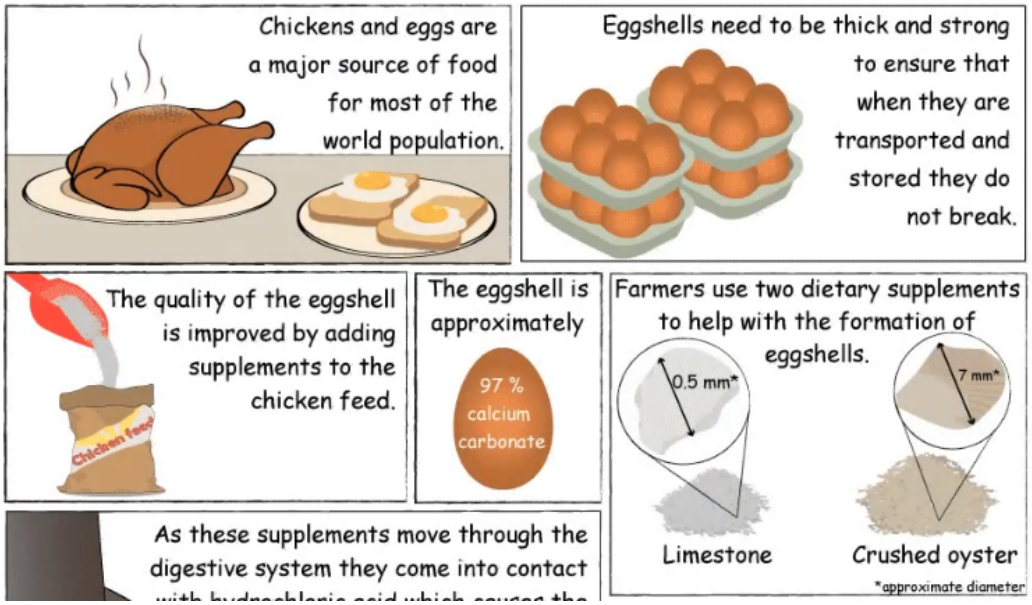
One bone sample of mass 9.71 g was placed in hydrochloric acid and produced 540 cm^3 of carbon dioxide.

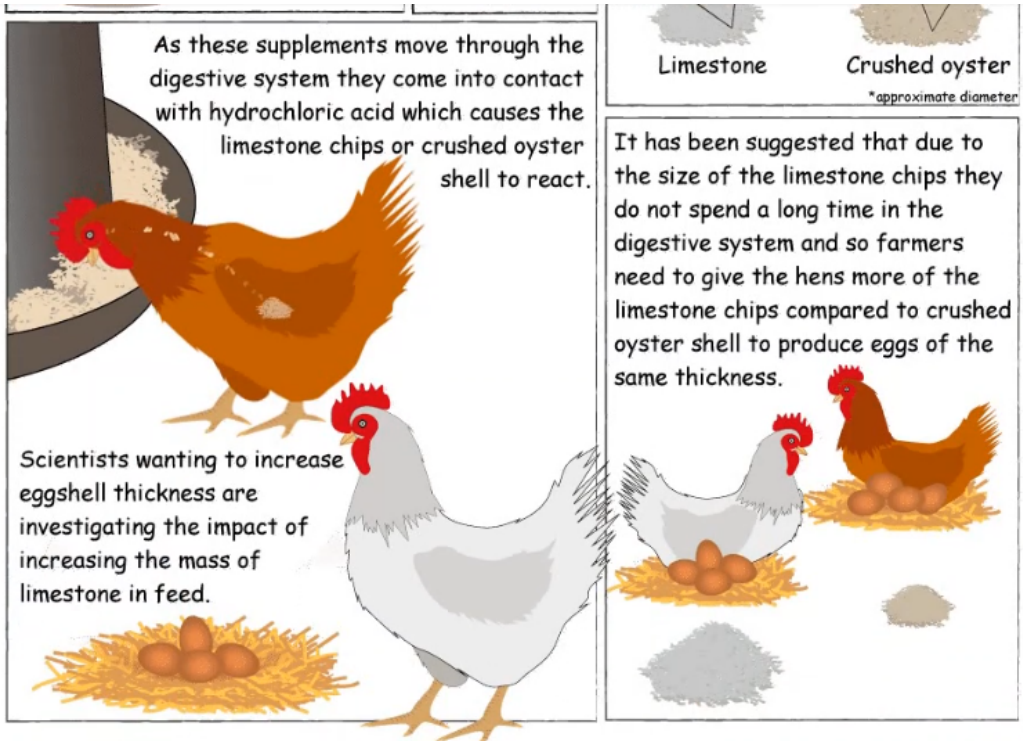
Using data from the graph and the table, **calculate** the percentage by mass of calcium carbonate in the bone sample and **identify** which animal the sample comes from.

B I U x_2 x^2 Ω Σ Styles

Scroll down to continue

Question 5 (18 marks)





Some scientists want to compare the reactions of limestone and crushed oyster shell. They take a fixed mass of limestone and add a fixed volume and concentration of hydrochloric acid to their measuring apparatus. The scientists then repeat the experiment with crushed oyster shell.

Question 5a (3 marks)

It is important investigations take place in a safe environment. **Select** the meaning of each hazard symbol.

Image 1

Image 2

Image 3

©

Image 1: Select

Image 2: Select

Image 3: Select

Select the meaning of each

Im

Select
Corrosive
Irritant
Radioactive
Flammable
Toxic

Image 3: Select

Question 5b (1 mark)

Select the symbol from part (a) that would be found on the hydrochloric acid used in this investigation.

Select
Select
Image 1
Image 2
Image 3

Question 5c (2 marks)

The results for the limestone reactions are shown in the table below.

Trial 1

Time / s	Volume of CO_2 produced from limestone samples / cm^3			Average volume of gas produced / cm^3
	Trial 1	Trial 2	Trial 3	Average
0	0	0	0	0
10	17	16	15	16
20	33	30	31	32
30	46	48	44	46
40	57	67	55	
50	70	70	70	70
60	81	83	82	82
70	93	91	92	92

Analyse the data and **determine** an **appropriate** average volume of gas produced at a time of 40 seconds. **Justify** your answer.

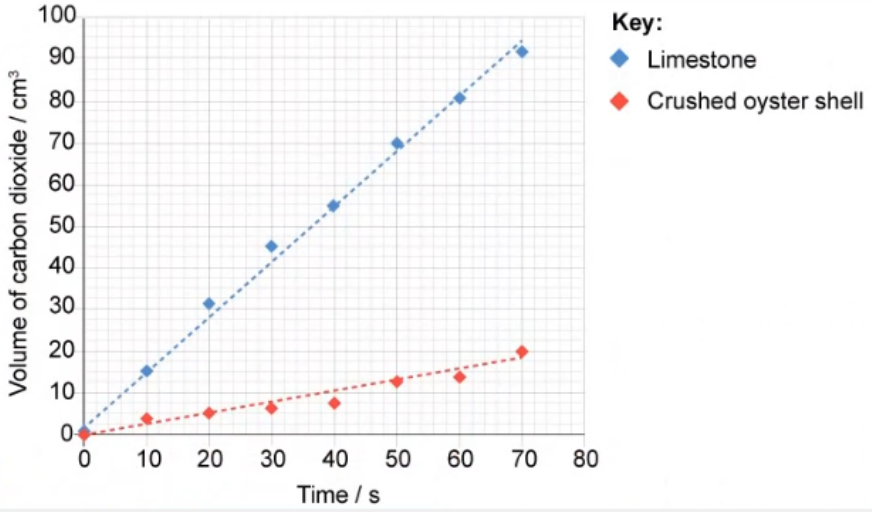
B I U x_2 x^2 Ω Σ Styles

Question 5d (2 marks)

The volume of CO_2 produced for limestone and oyster shell is shown in the graph below.

This media is not interactive

Volume of carbon dioxide produced against time for equal masses of limestone and crushed oyster shell supplements



Scroll down to continue

Using the data in the graph, **calculate** the average rate of carbon dioxide produced for an equal mass of the limestone and crushed oyster shell over the first 60 seconds.

$$\text{Rate of reaction} = \frac{\text{total volume of gas produced}}{\text{total time taken}}$$

Food supplement	Rate of gas production / $cm^3\ s^{-1}$
Limestone (0.5 mm)	
Crushed oyster shell (7 mm)	

Reset

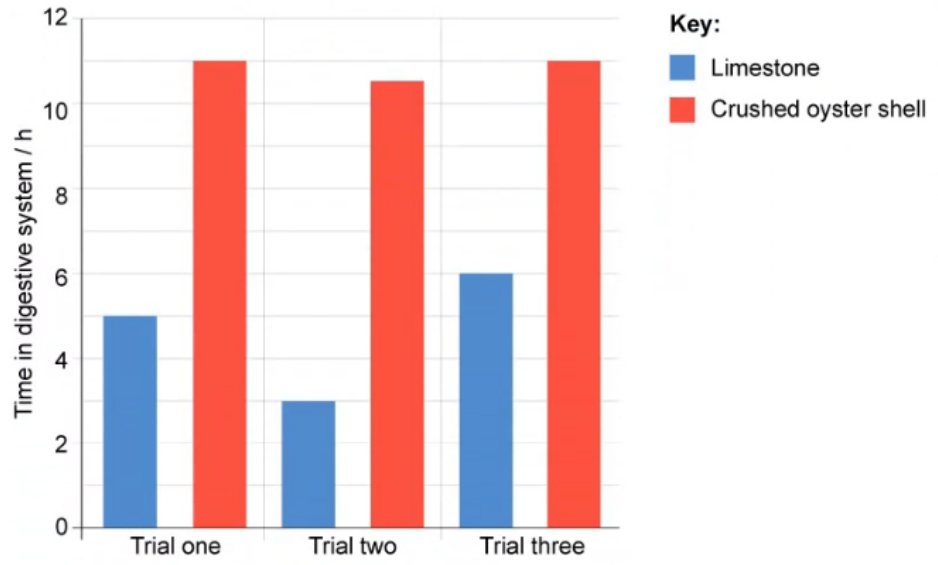
Question 5e (3 marks)

Using your answer from part (d), **suggest** why the limestone produced more carbon dioxide in the same time as the crushed oyster shell.

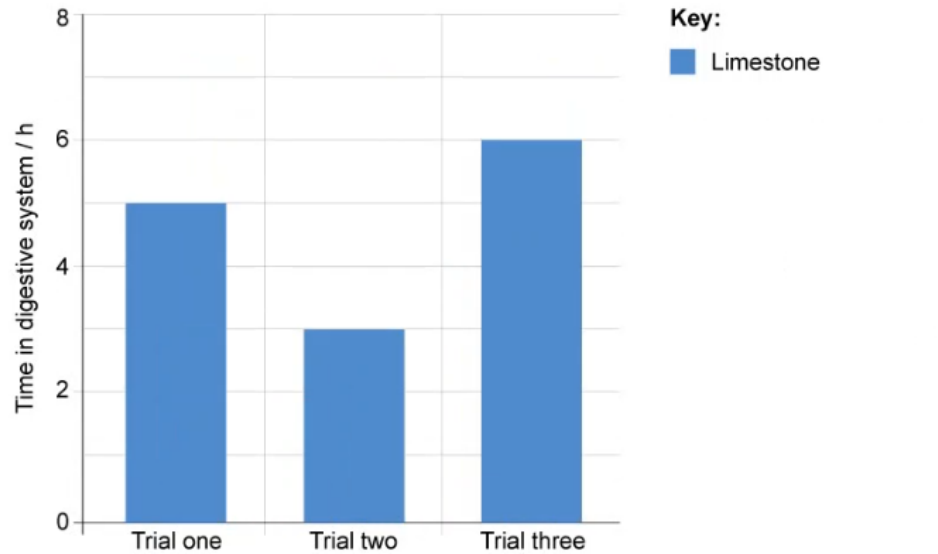
B I U x_2 x^2 Ω Σ Styles

The scientists discovered that the hens require more limestone supplement than crushed oyster shell to give the same thickness of egg shell. A further investigation determined how long the limestone or crushed oyster shell remained in the hen's digestive system. The results are shown below.

All data | Limestone graph | Crushed oyster shell graph

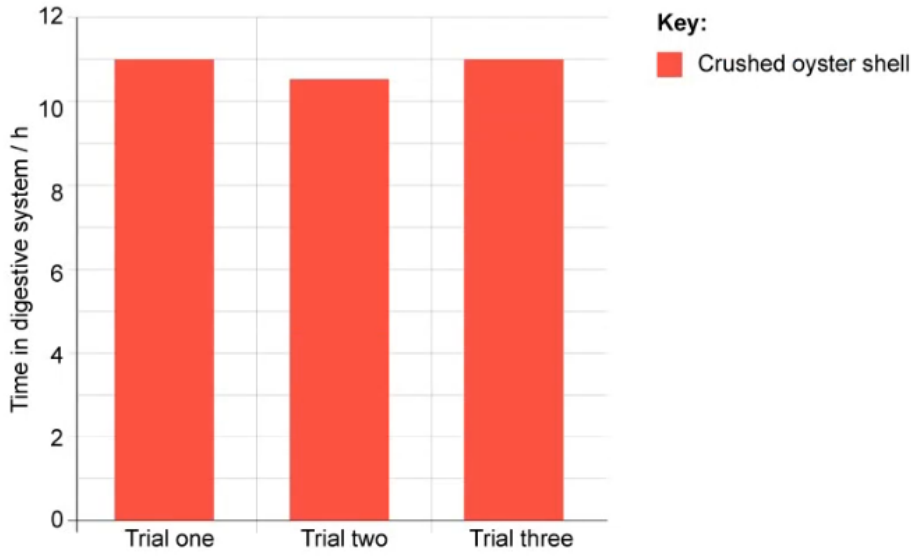


All data | Limestone graph | Crushed oyster shell graph



Scroll down to continue

All data | Limestone graph | Crushed oyster shell graph



Scroll down to continue

Question 5f (2 marks)

Using the data in the graph, **explain** why the crushed oyster shell is a better supplement for the hens than the limestone chips.

Styles

Scroll down to continue

Question 5g (4 marks)

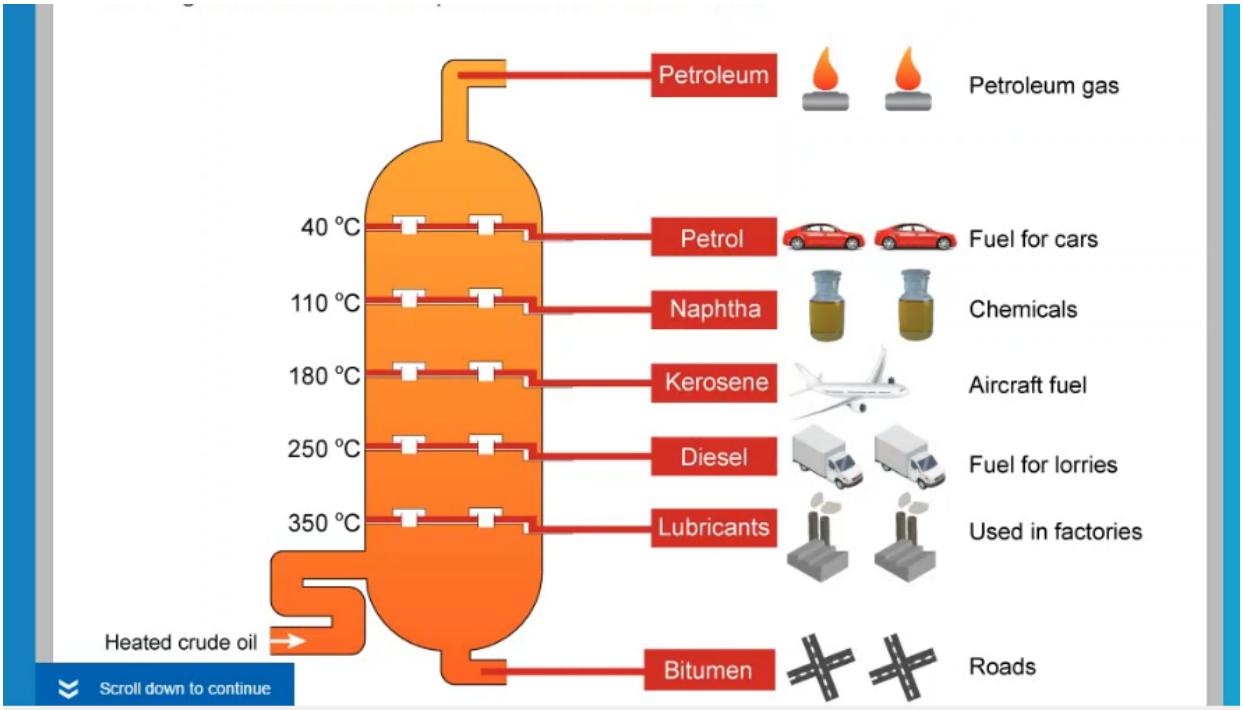
Use the graph to **compare** the reliability of the limestone and oyster shell data.

Question 5h (1 mark)

Suggest one way to improve the validity of the data.

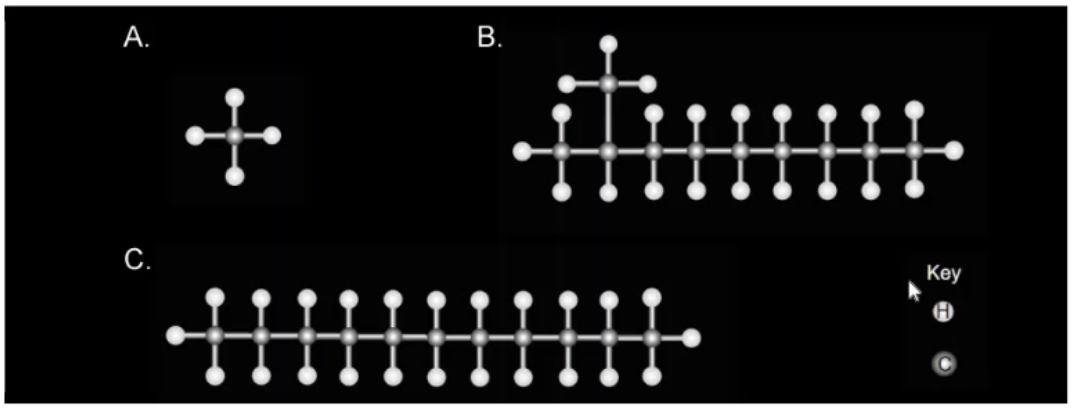
Question 6 (12 marks)

Crude oil is a mixture of different sized hydrocarbons and other chemicals and is a source of various fuels. Crude oil can be separated into useful products by fractional distillation. The diagram below shows the process of fractional distillation.



Question 6a (1 mark)

Select the hydrocarbon that would be distilled with petroleum gases.



Select
Select
A
B
C

Question 6b (3 marks)

Outline the process of fractional distillation.

B I U x_2 x^2 Styles

Question 6c (8 marks)

Accidental oil spills in seas, lakes and rivers can have consequences for birds, fish and other wildlife. Some methods used to clean up oil spills are shown below.

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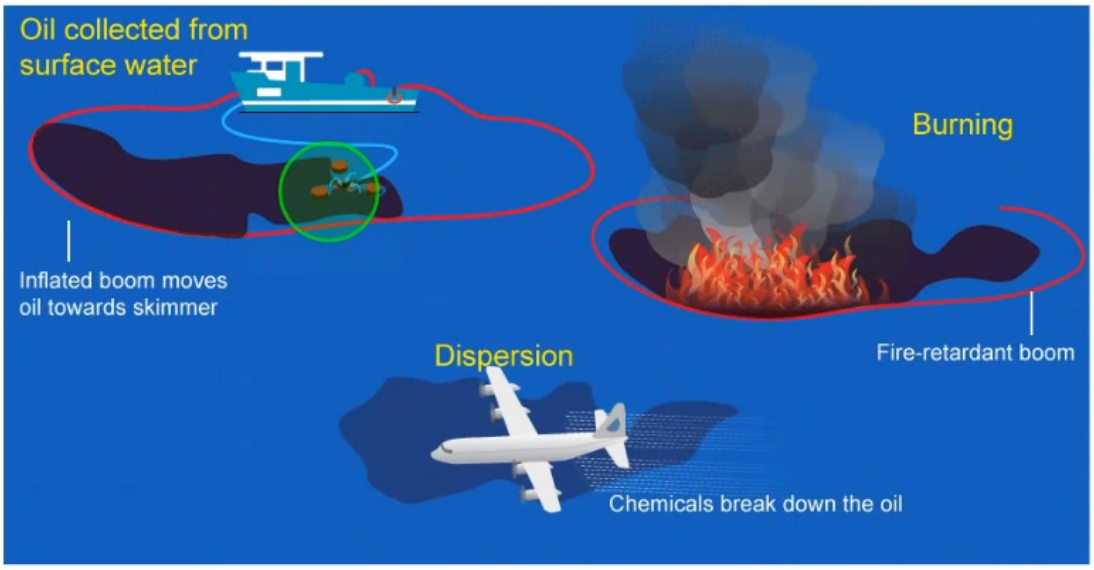
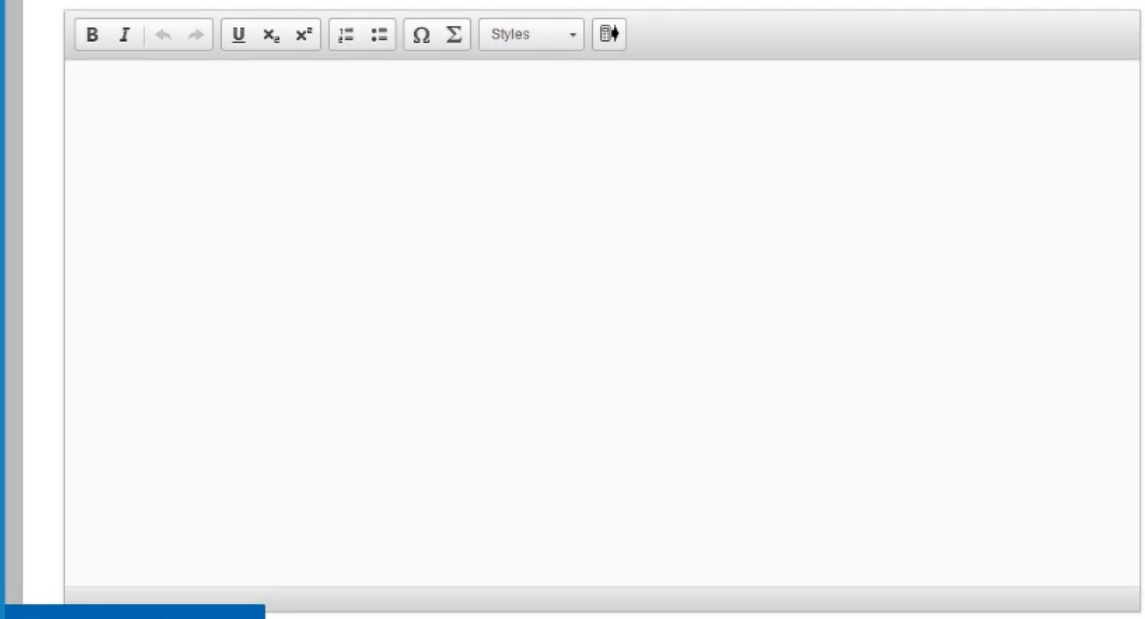
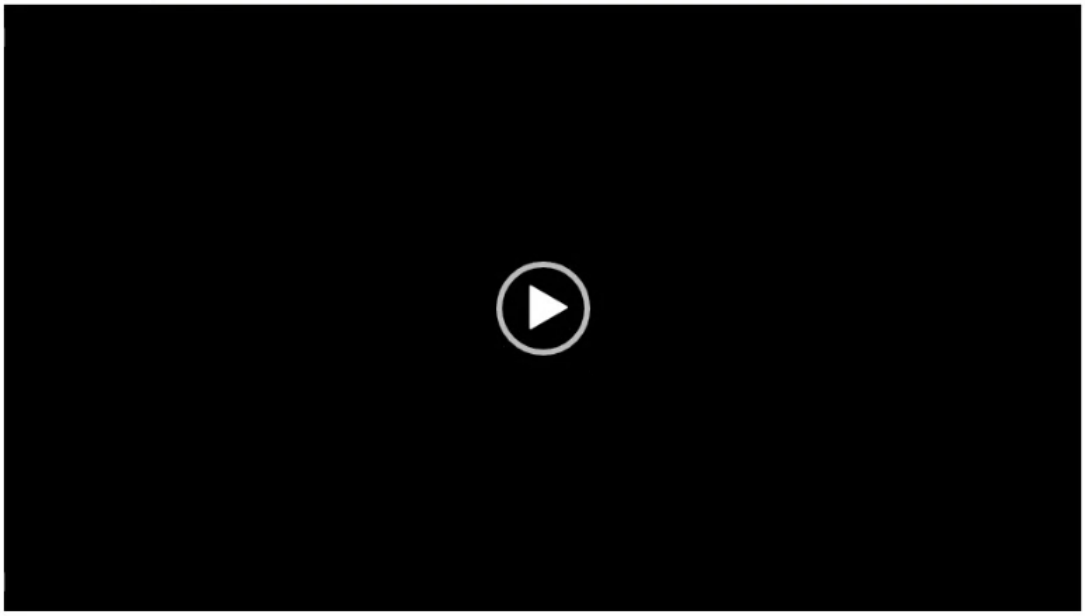


Discuss and **evaluate** the three methods for cleaning oil spills and identify one method as being the best for the environment.



Question 7 (14 marks)

Video and map | Script



Video and map | Script

Crude oil and oil products must be transported from the oil field to refineries and on to other industrial facilities.

There are several options currently in use for transportation of crude oil over long distances.

Pipelines, rail, road and sea are some of the options.

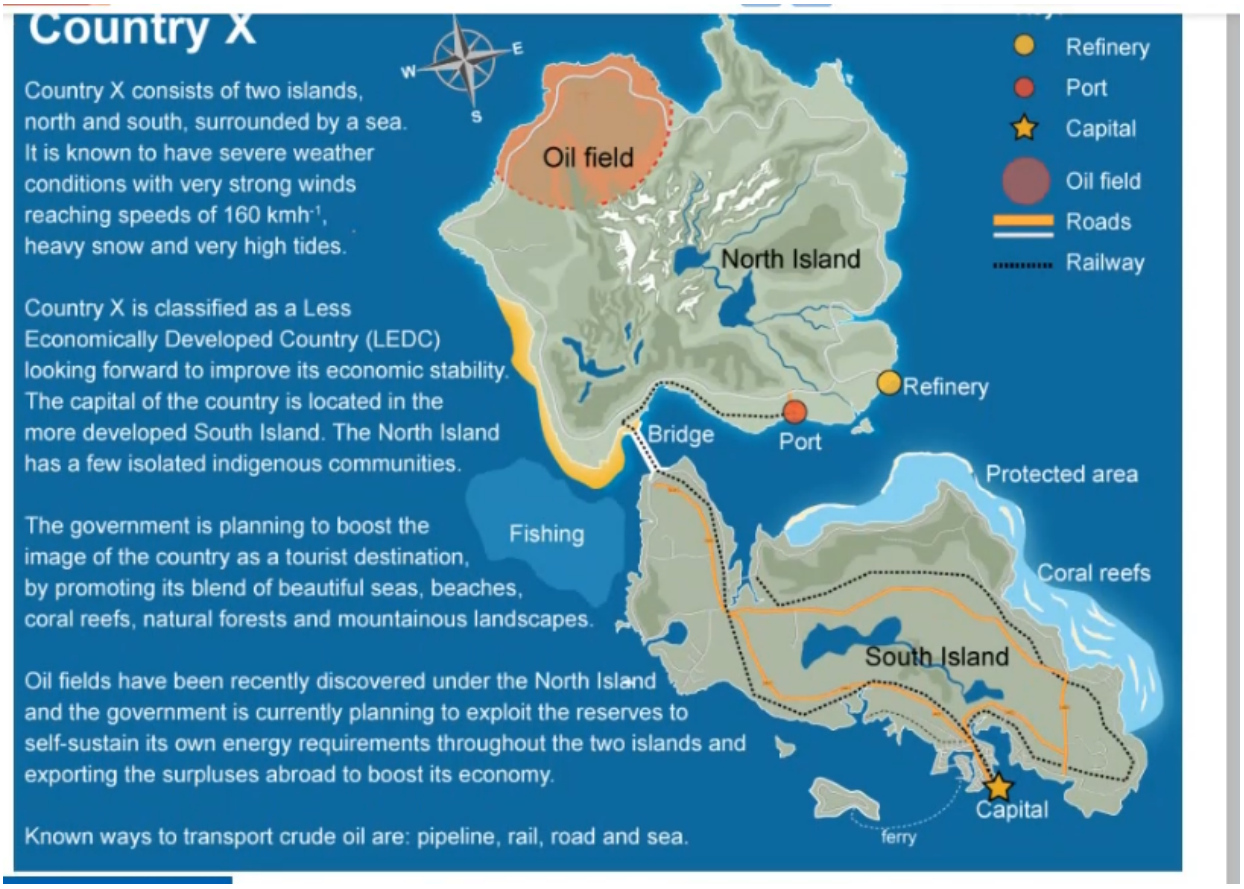
The pipes can be above ground or buried at depths of up to 2 metres.

Once construction is complete, routine maintenance will involve checking for blockages, cracks and other damage from corrosion.

Rail transport is economical over long distances. Rail transport uses containers known as tank cars or tank wagons that are specially designed to avoid damage if there is an accident.

Road tankers are also specially designed to avoid damage in accidents. Road tankers can travel on existing road systems.

Crude oil has been transported at sea by tankers since 1892. Transportation at sea is useful when transportation over land is not possible.



Discuss and **evaluate** the most appropriate method of transporting crude oil from the oil field to various locations within the country and exporting excess oil. In your answer you should compare a pipeline with two alternative methods of transport and include:

- advantages and disadvantages of a pipeline
- advantages and disadvantages of your alternative methods
- environmental considerations
- social considerations
- a concluding appraisal linking all the issues you have discussed.

Scroll down to continue