Question 1 (11 marks)

Throughout history, cobalt compounds have been used to produce various blue colours in designs and structures. Examples are shown here of a plate and bottles.

Question 1a (1 mark)

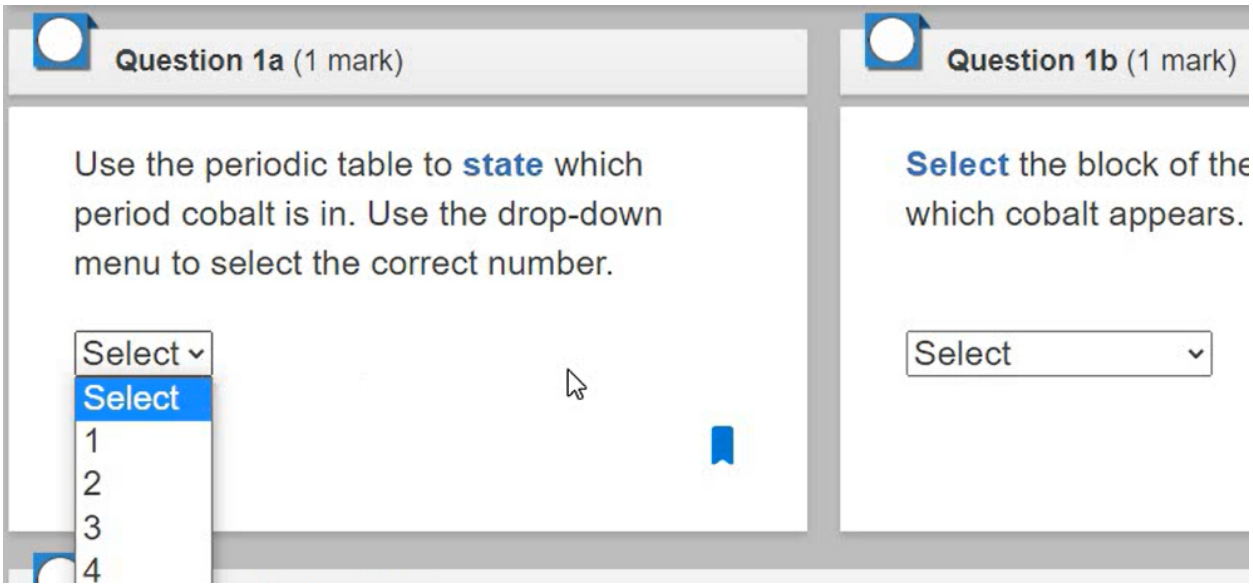
Use the periodic table to **state** which period cobalt is in. Use the drop-down menu to select the correct number.

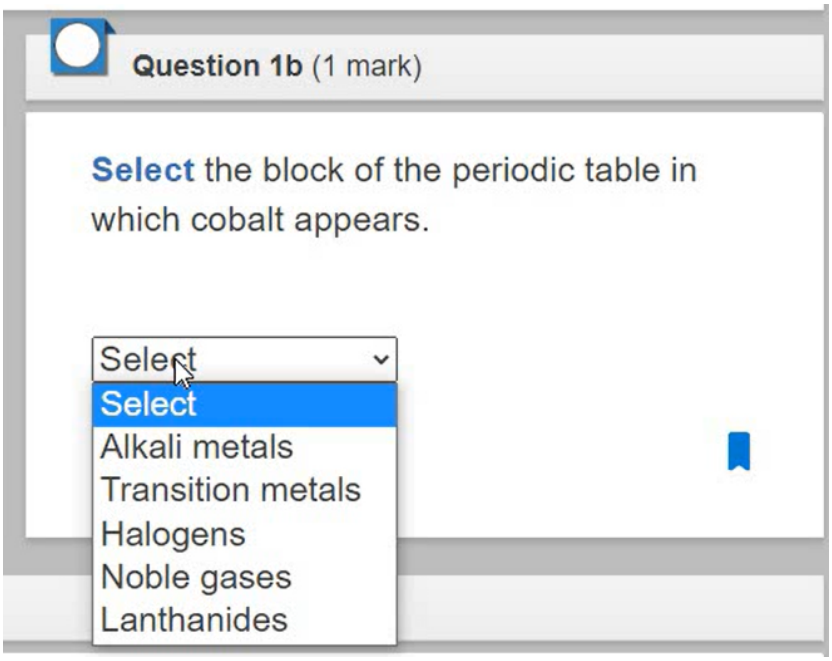
Select

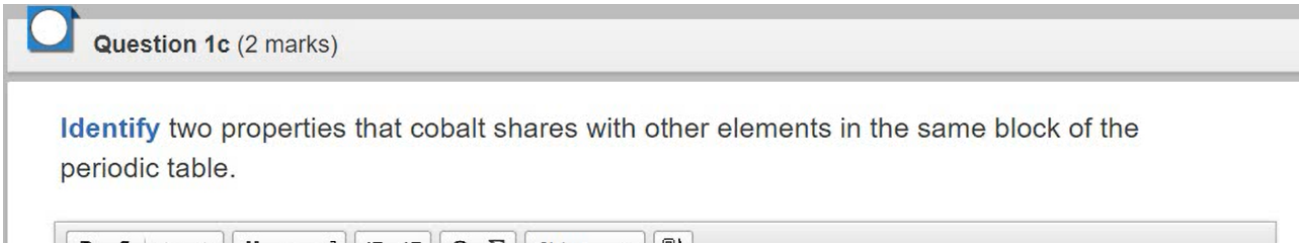
Question 1b (1 mark)

Select the block of the periodic table in which cobalt appears.

Select


Question 1a (1 mark)
Use the periodic table to state which period cobalt is in. Use the drop-down menu to select the correct number.
Select
Select
1
2
3
4
Question 1b (1 mark)
Select the block of the
which cobalt appears.
Select


Question 1b (1 mark)
Select the block of the periodic table in which cobalt appears.
Select
Select
Alkali metals
Transition metals
Halogens
Noble gases
Lanthanides


Question 1c (2 marks)
Identify two properties that cobalt shares with other elements in the same block of the periodic table.

Question 1d (3 marks)

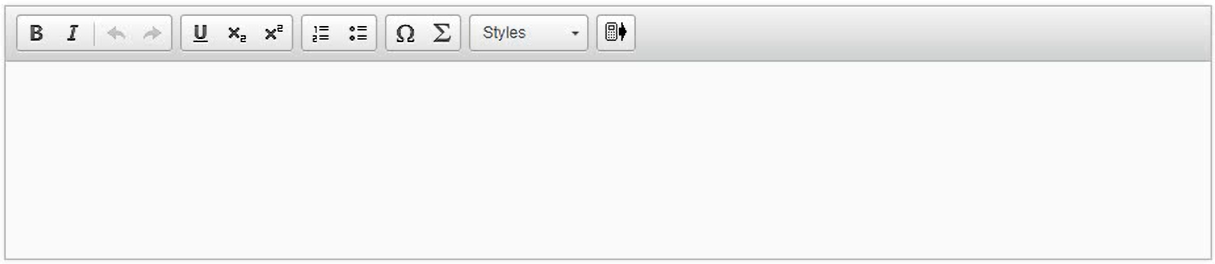
Cobalt can form Co^{2+} ions. **State** the number of protons, neutrons and electrons in a Co^{2+} ion.

Number of protons	Number of neutrons	Number of electrons

Question 1e (2 marks)

Cobalt (II) chloride paper is used to test for water. **State** the formula for cobalt (II) chloride and **state** the type of bonding found in this compound.

Formula:



Type of bonding:

Select

- Select
- ionic
- covalent
- metallic
- hydrogen

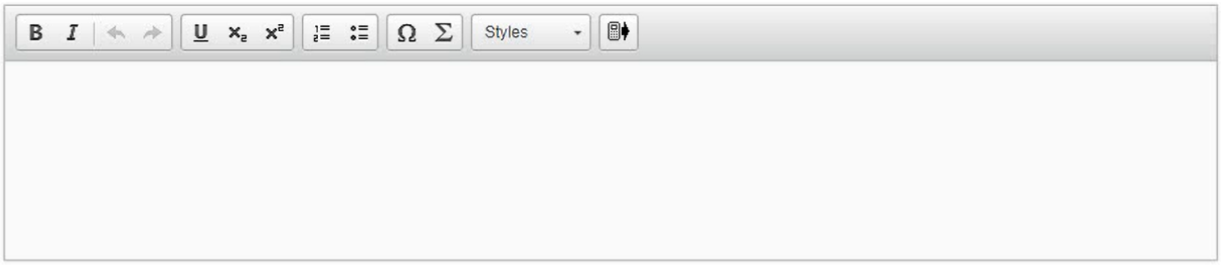
f (2 marks)

Question 1f (2 marks)

The main compounds used to produce the blue colours in pottery and glass are $CoAl_2O_4$, cobalt (II) aluminate, CoO and $CoCO_3$.

State the names for the compounds CoO and $CoCO_3$.

CoO:



$CoCO_3$:

Animation showing recycling of glass to make sand.

Question 2a (3 marks)

Several jars which are made of glass need to be recycled. The jars have steel lids and plastic labels.

.....

Before the jar is recycled into silicon oxides, it has to be processed to remove unwanted components. **Select** which property could be used to separate each component.

Plastic label: Select

Steel lid: Select

Glass jar: Select

Before the jar is recycled into silicon oxides, it has to be processed to remove unwanted components. **Select** which property could be used to separate each component.

Plastic label: Select

Steel lid: Select

Glass jar:

- Select
- dissolves in water
- magnetic
- dissolves in organic solvent
- sinks in water

Question 2b (1 mark)

The following table contains the percentage chemical composition by mass of the compounds used to make glass through the ages.

Common name of compound	Chemical formula	Modern glass (bottles and windows)	Laboratory glass	Optical and crystal glass	Ancient Roman glass
Silica	SiO_2	73.6	80.0	35.0	67.0
Soda	Na_2O	5.2	4.0	-	18.0
Lime	CaO	0.6	-	-	8.0
Potash	K_2O	3.6	0.4	7.2	1.0
Magnesia	MgO	1.0	-	-	1.0
Alumina	Al_2O_3	-	2.0	-	2.5
Iron oxide	Fe_2O_3	-	-	-	0.5
Boric oxide	B_2O_3	-	13.0	-	-
Lead oxide	PbO	-	-	58.0	0.01

Using the data in the table above, **identify** the chemical formula of the compound which is only present in the ancient Roman glass.

B I U x_2 x^2 Ω Σ Styles

Question 2c (3 marks)

Calculate the molar mass of the compound you identified in part (b).

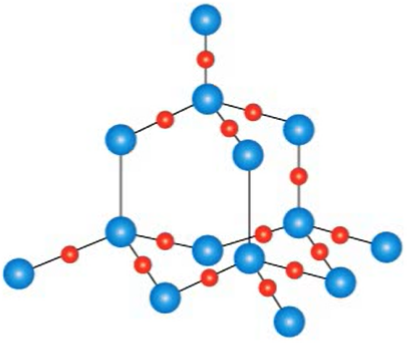
B I U x_2 x^2 Ω Σ Styles

Question 2d (3 marks)

A Roman glass bottle has a mass of 100 g. **Calculate** the number of moles of the compound from part (b) that are present in the bottle. Give your answer to three significant figures.

Question 2e (2 marks)

Silicon oxide is the major component in sand and glass and has the following structure:



Key:

- Silicon atom
- Oxygen atom

State the type of bonding found in silicon oxide and **outline** how the bond is formed.

Question 2f (2 marks)

State if silicon oxide is soluble in water. **Justify** your answer.

B I U x_2 x^2 Ω Σ Styles

Question 2g (3 marks)

Glass bottles can be recycled to make sand which can be used to replace beaches which have eroded, and plastic bottles can be recycled to make plastic pellets for use in the construction of roads and pathways.

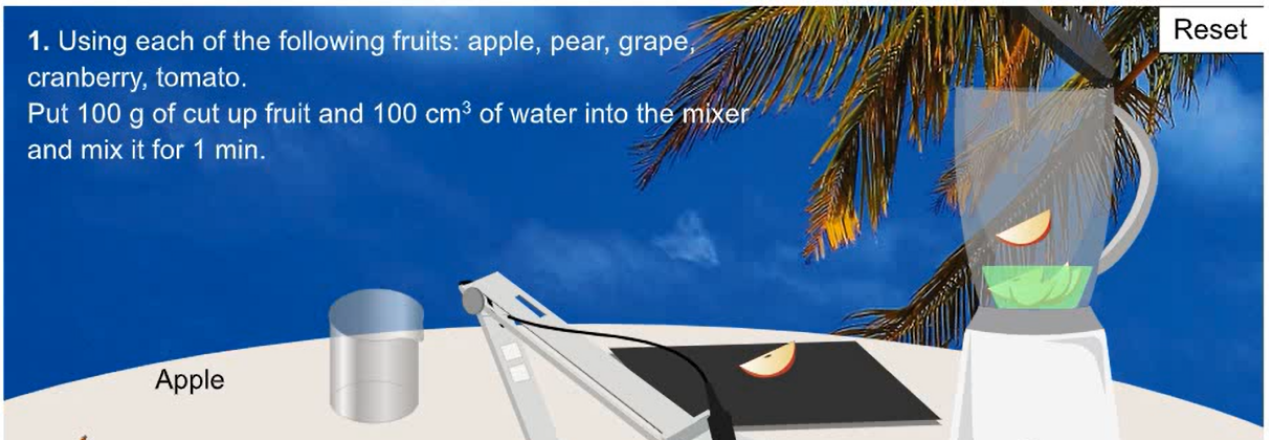
Suggest why using recycling glass and plastics would be better for the environment than burying used bottles as waste.

B I U x_2 x^2 Ω Σ Styles

The increase in travel has an impact on the health and well-being of individuals as they move from place to place globally.

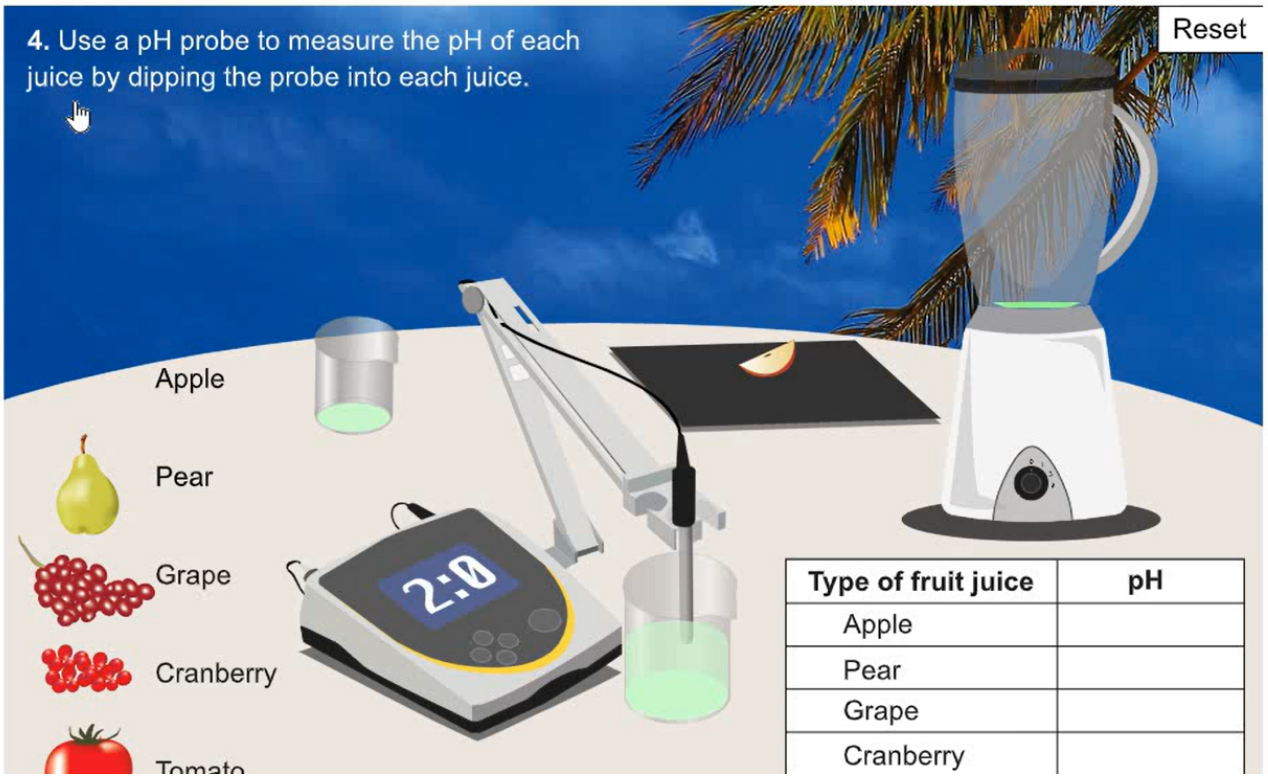
Michelle, Yuri and Pedro have recently moved to a tropical country and love the fruit juices. Fruit juices are acidic outside the body and stay acidic when digested. Fruit juices can therefore increase the acidity in the stomach and cause heartburn. The friends are interested in finding out which fruit juice is most acidic and would lower the pH in the stomach the most.

They used the following method in their practical:

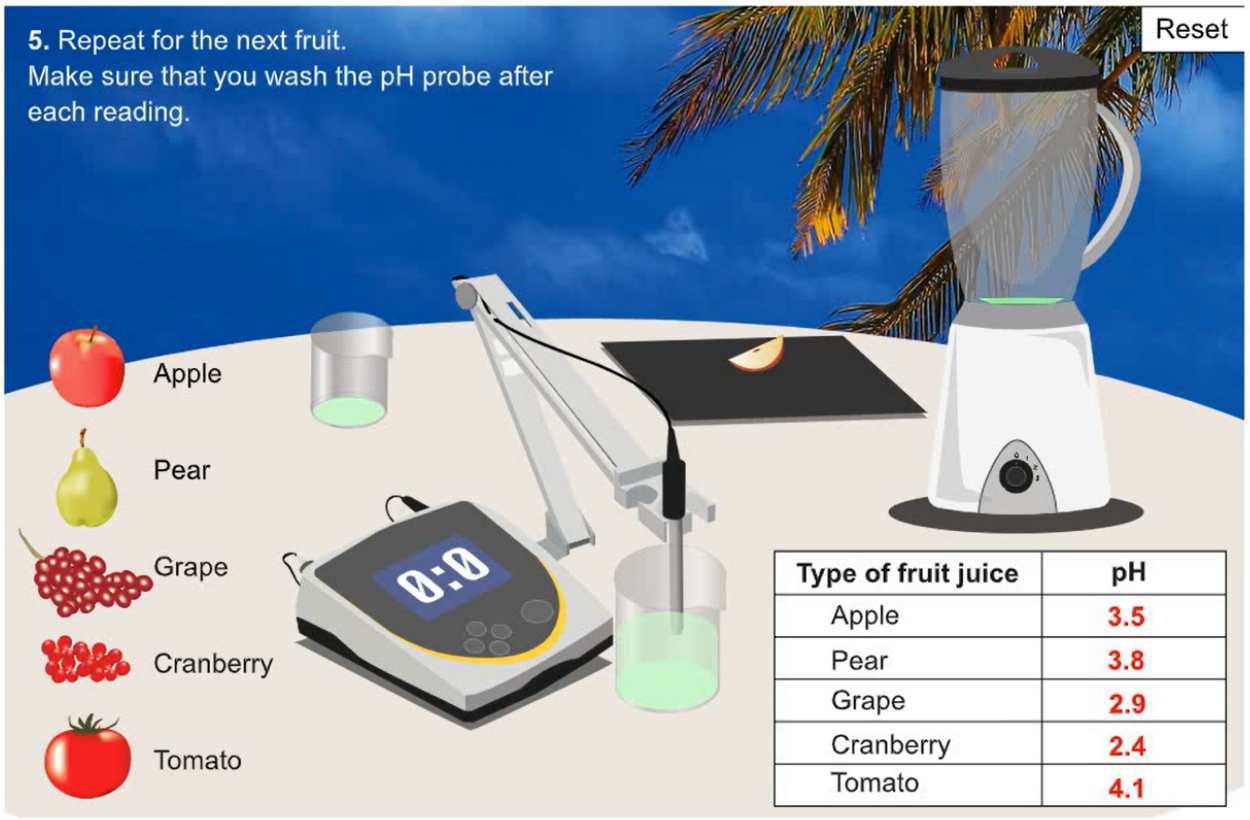

1. Using each of the following fruits: apple, pear, grape, cranberry, tomato.
Put 100 g of cut up fruit and 100 cm3 of water into the mixer and mix it for 1 min.
Reset
Apple


1. Using each of the following fruits: apple, pear, grape, cranberry, tomato.
Put 100 g of cut up fruit and 100 cm3 of water into the mixer and mix it for 1 min.
Reset
Next
Apple
Pear
Grape
Cranberry
Tomato
0:0
Type of fruit juice
pH
Apple
Pear
Grape
Cranberry
Tomato

Type of fruit juice	pH
Apple	
Pear	
Grape	



Type of fruit juice	pH
Apple	
Pear	
Grape	
Cranberry	



Type of fruit juice	pH
Apple	3.5
Pear	3.8
Grape	2.9
Cranberry	2.4
Tomato	4.1

Question 3a (4 marks)

State the variables in this experiment.

Independent variable:

Styles

Dependent variable:

Question 3b (1 mark)

State the research question that this experiment would investigate.

Question 3c (3 marks)

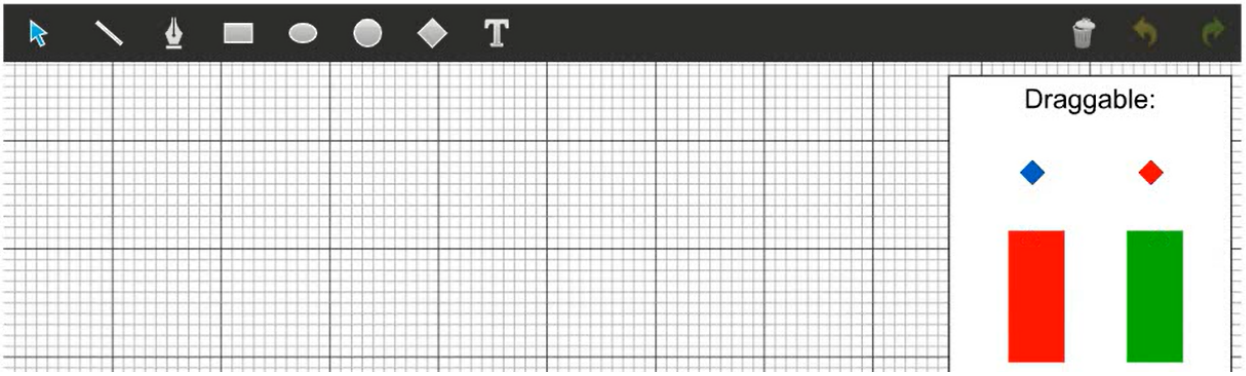
The results from the experiment are shown in the table below. Using data in the table, **identify** the fruit juice and pH that could cause the most severe heartburn. **Justify** your answer using scientific reasoning.

Type of fruit juice	pH
apple	3.5
pear	3.8
grape	2.9
cranberry	2.4
tomato	4.1

Question 3d (5 marks)

Present the data in a graph. You need to give your graph an appropriate title and label the axes.

Title



Question 3e (1 mark)

Suggest an extension for this investigation.

Styles

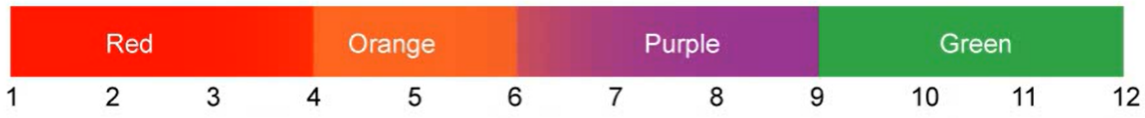
Question 3f (2 marks)

The data in the table in part (c) was from one trial for each fruit. **Outline** the benefits of carrying out more than one trial for each experiment.

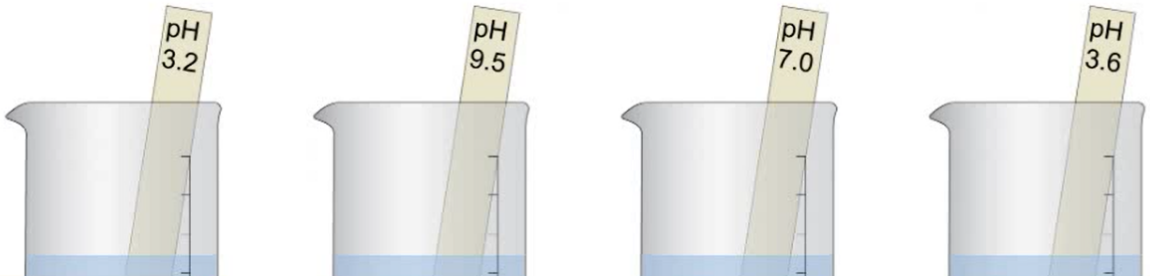
Question 3g (4 marks)

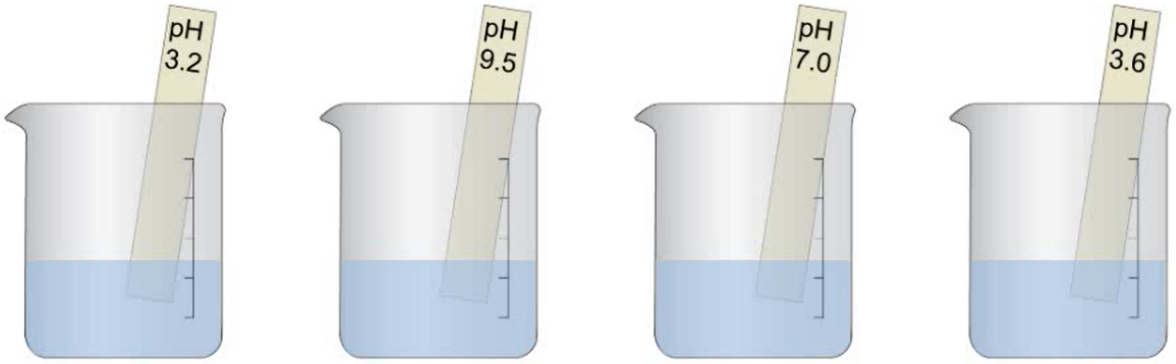
Instead of using a pH probe, indicators can be used to identify the pH of solutions. Cherry juice can be used as an indicator. The colour changes for different pHs are shown in the scale below.

Cherry juice:



Cherry juice was added to four beakers containing different clear, colourless liquids.
Use information from the scale to **select** the colour that would be seen in each beaker.





Select | Select | Select | Select

Select
Red
Orange
Purple
Green

Qu mark)

Question 3h (1 mark)

State why cherry juice cannot be used to determine the exact pH of fruit juices.

Styles

Question 4 (9 marks)

A compound called capsaicin gives the spicy flavour to chilli peppers. Scientists say there may be some evidence that capsaicin triggers stomach acid production. Increase in stomach acid may cause heartburn.

Chromatography was used to measure the capsaicin content in different chilli peppers.

Michelle, Yuri and Pedro want to find out which of the following is the spiciest:

Habanero pepper

Jalapeño pepper

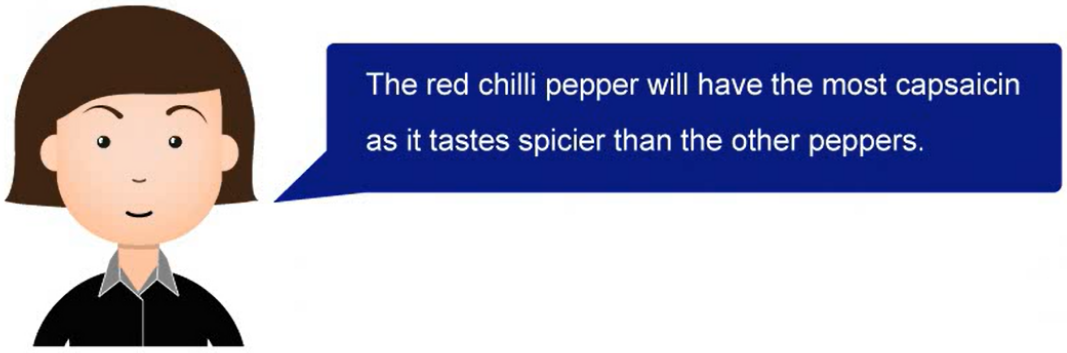
Red chilli pepper

Cayenne pepper

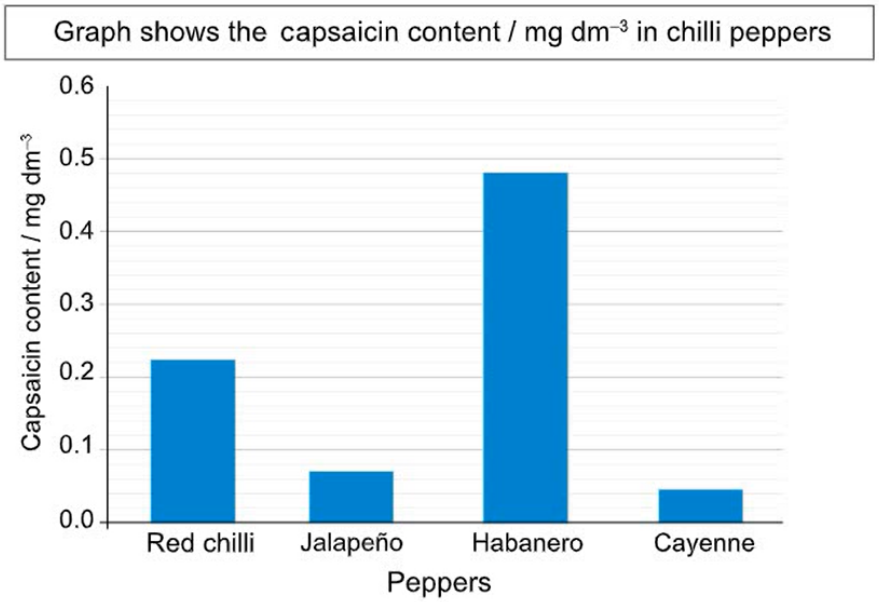
©

They give the foods to a professional lab to perform the test. Before they get the result, Michelle predicted the outcome.

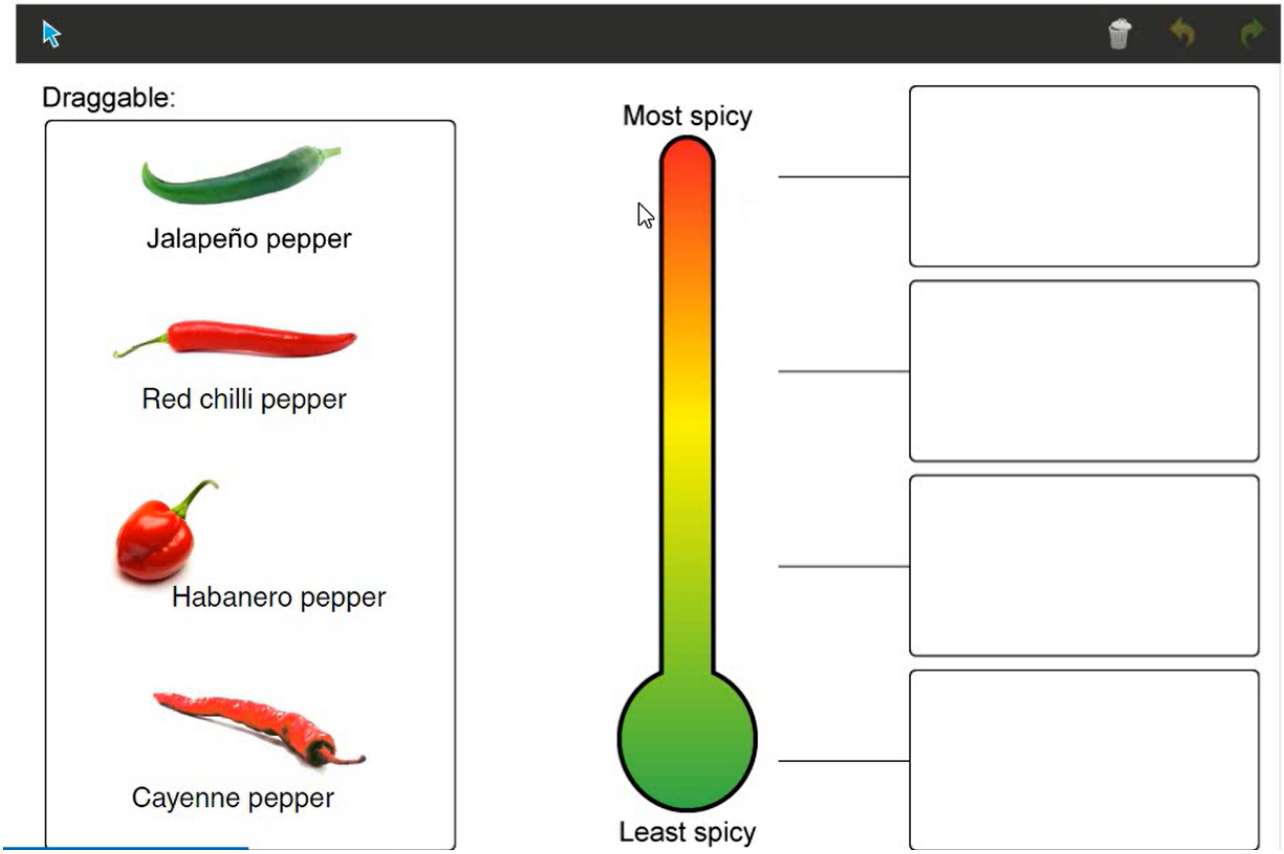
They give the foods to a professional lab to perform the test. Before they get the result, Michelle predicted the outcome.



The results of the test come back in a form of a graph:



Analyse the graph and put the chilli peppers in the order of how spicy they are.

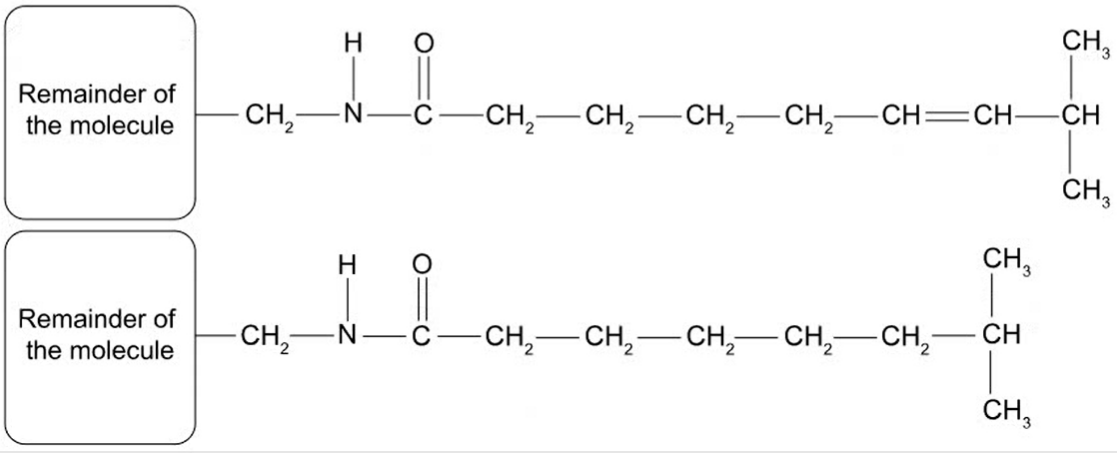


Question 4b (2 marks)

Use the data from the graph to **comment** on the validity of Michelle's prediction. **Justify** your answer.

Question 4c (2 marks)

The Scoville scale is a measurement of the spiciness of foods. The following structures show two commonly occurring members of the capsaicin family. The first structure has a Scoville heat unit measurement of 16 000 000 whereas the second structure has a Scoville heat unit measurement of 9 100 000.



There are two differences in the structures that cause the difference in Scoville heat measurement. **Identify** these two differences.

Question 4d (3 marks)

Capsaicin has a melting point of 65 °C and a boiling point of 210 °C. In the liquid state, capsaicin evaporates easily. Capsaicin can be found in jalapeños. There are several ways in which jalapeños can be added to food. The jalapeños can be:

- raw in a salad
- boiled in a water-based sauce (water boils at 100 °C)
- fried in an oil-based sauce (oil reaches temperatures above 210 °C in frying).

Formulate a hypothesis to identify which method of food preparation will produce food with the highest spiciness when using the same mass of jalapeño.

If:

Question 5 (19 marks)

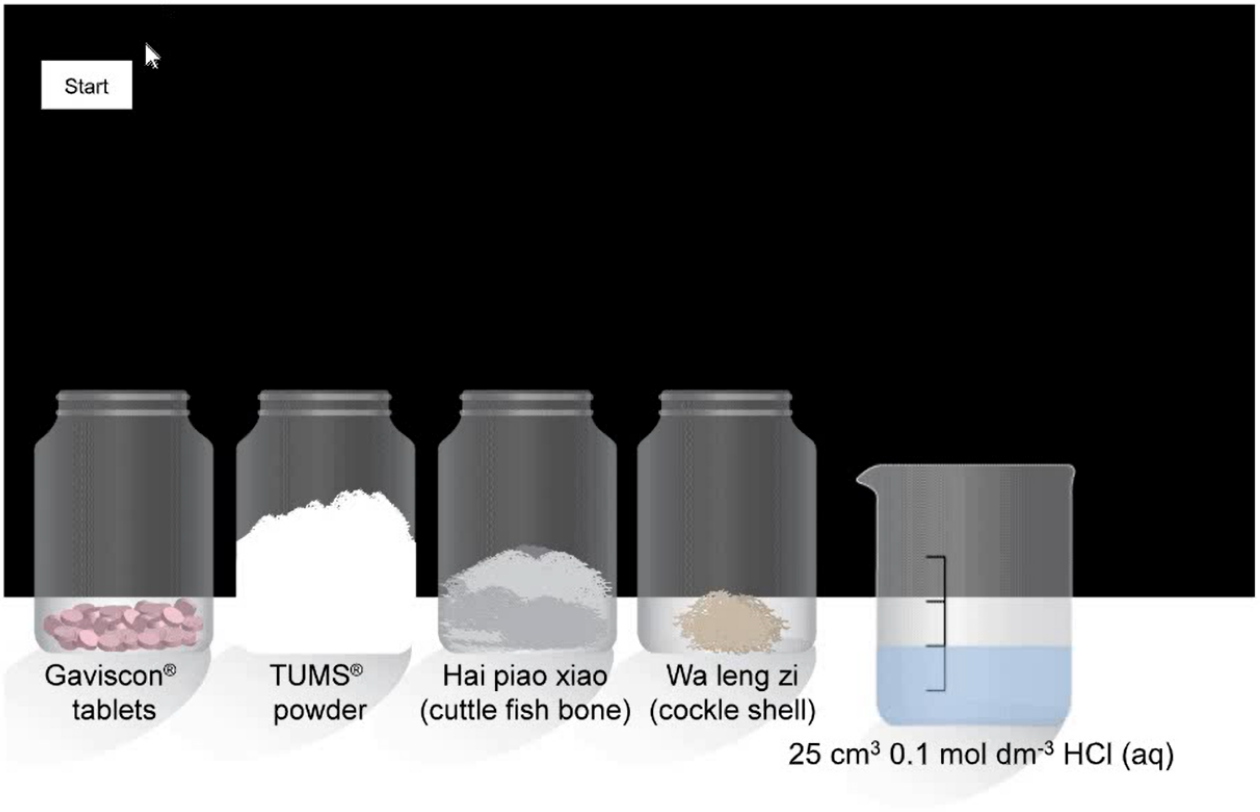
There are many treatments that can be used to stop the pain of heartburn. Some of these treatments contain metal carbonates which neutralize the stomach acid.

Gaviscon® and TUMS® are heartburn treatments that contain metal carbonates. Traditional Chinese medicine uses natural substances that also contain metal carbonates.

The reaction of metal carbonates with acids is shown below.

$$\text{metal carbonate} + \text{acid} \rightarrow \text{salt} + \text{water} + \text{carbon dioxide}$$

Michelle, Yuri and Pedro are interested to find out which heartburn remedy will neutralize the acid the most quickly. The method they will use is shown below.



You are provided with:

- 250 cm^3 of 0.1 mol dm^{-3} aqueous hydrochloric acid
- 50 cm^3 beakers
- medication: Gaviscon® tablets, TUMS® powder
- Chinese medicine natural substances: hai piao xiao (cuttle fish bone), wa leng zi (cockle shell).

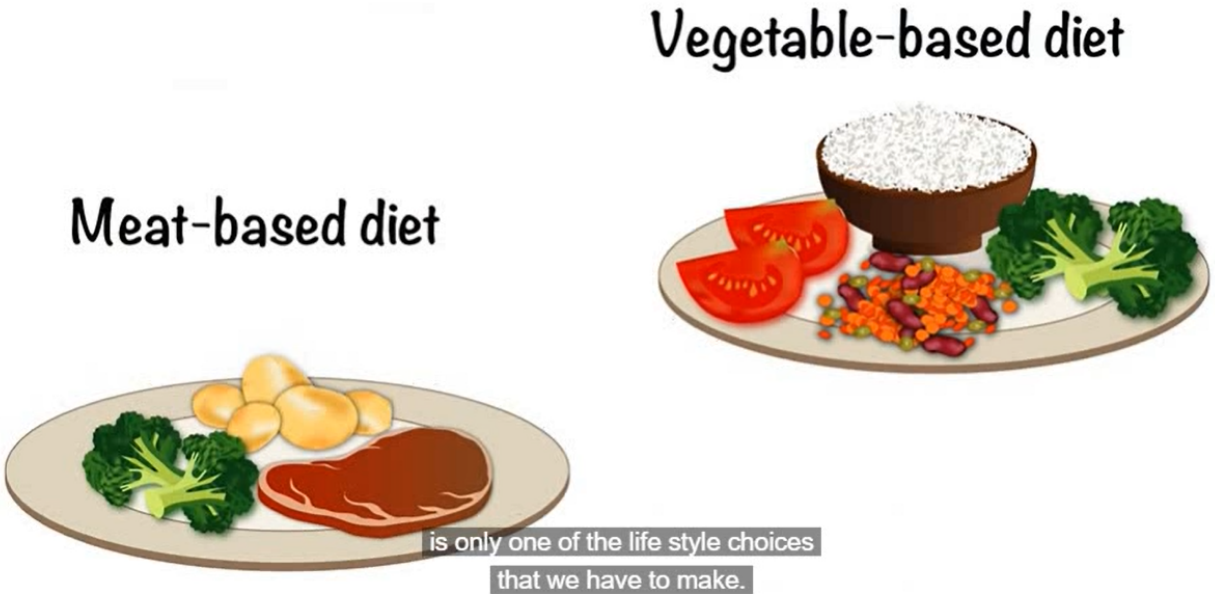
Design an investigation to find out which heartburn remedy will neutralize the acid the most quickly. In your answer, you should include:

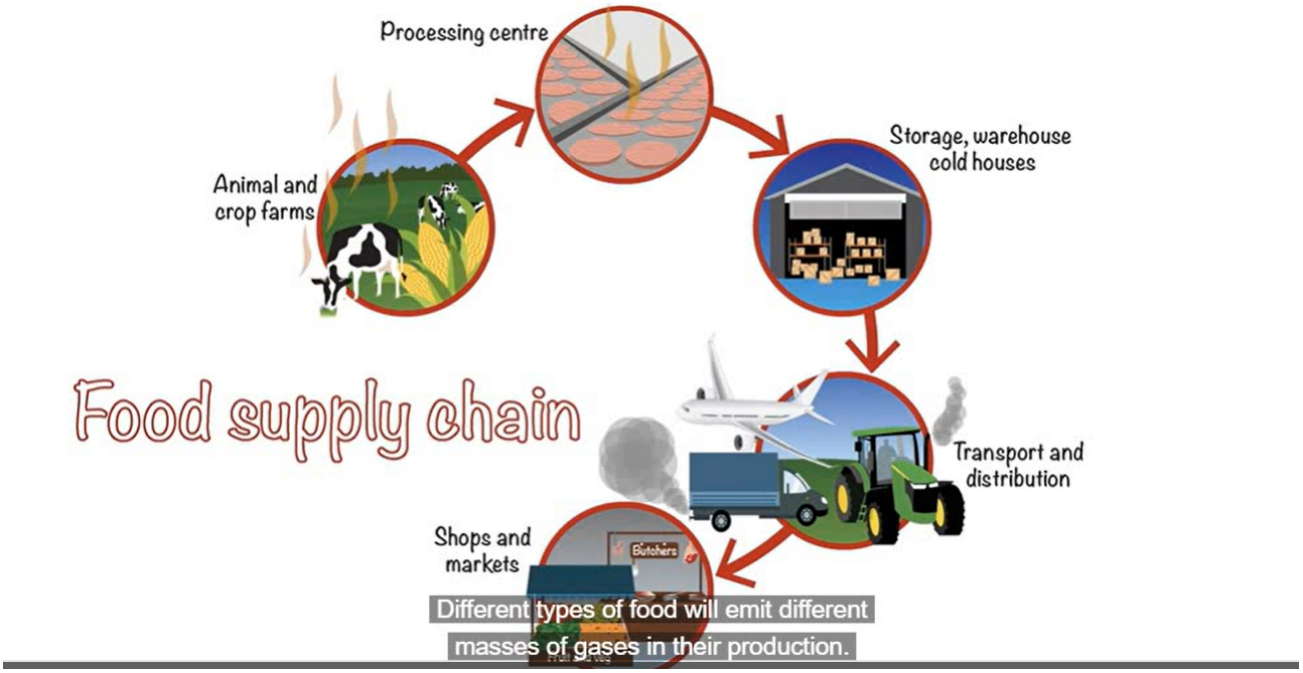
- an identification of the variables
- a list of any additional equipment you will need
- details of your method to allow you to collect sufficient data
- how you will use your data to decide which treatment will neutralize the acid the most quickly
- a statement of any assumptions that you have made
- how you will ensure that your method is safe.

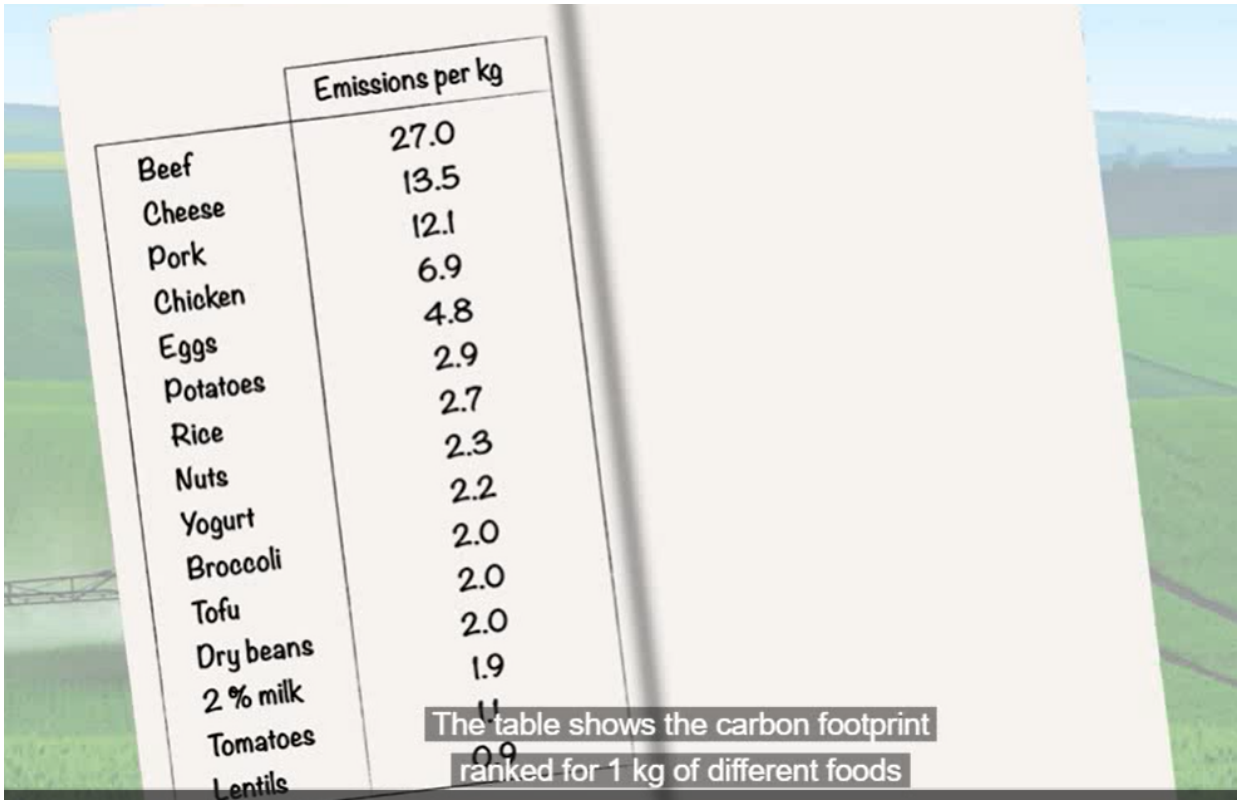
Question 6 (7 marks)

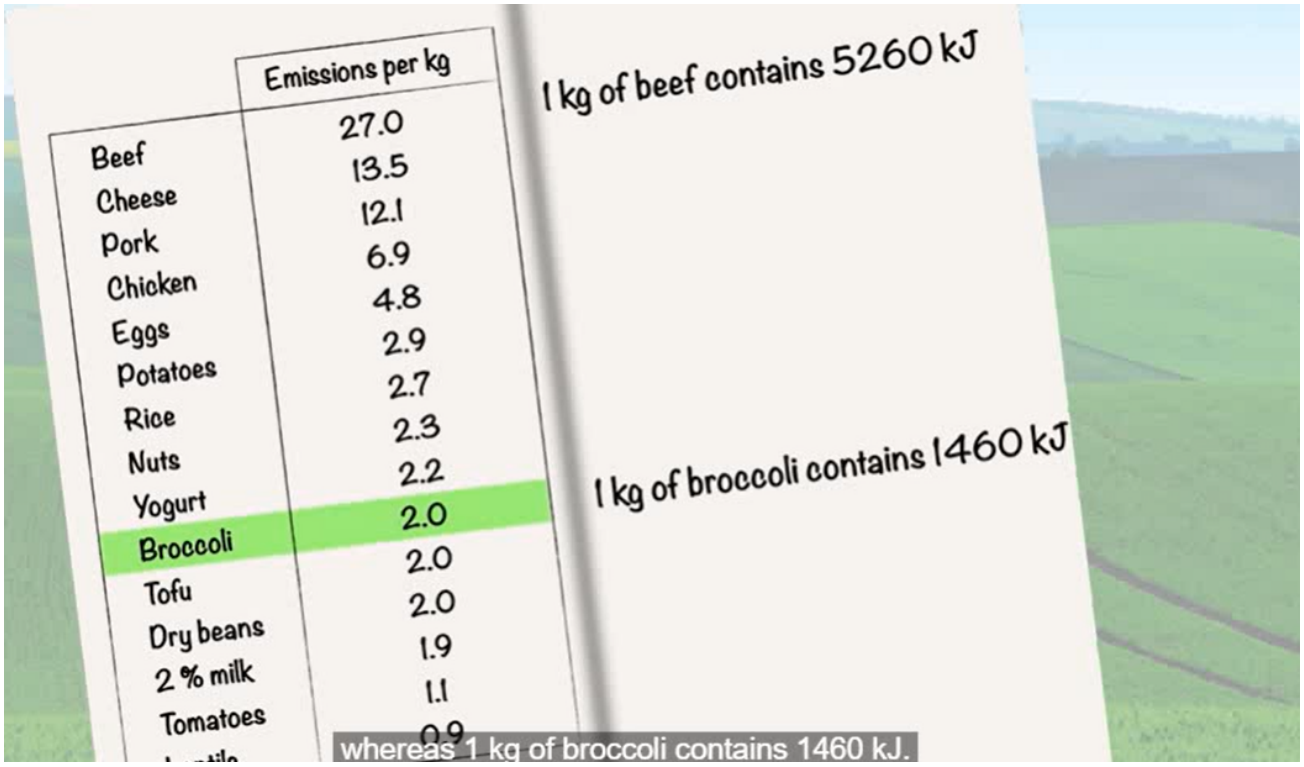
Video | Script

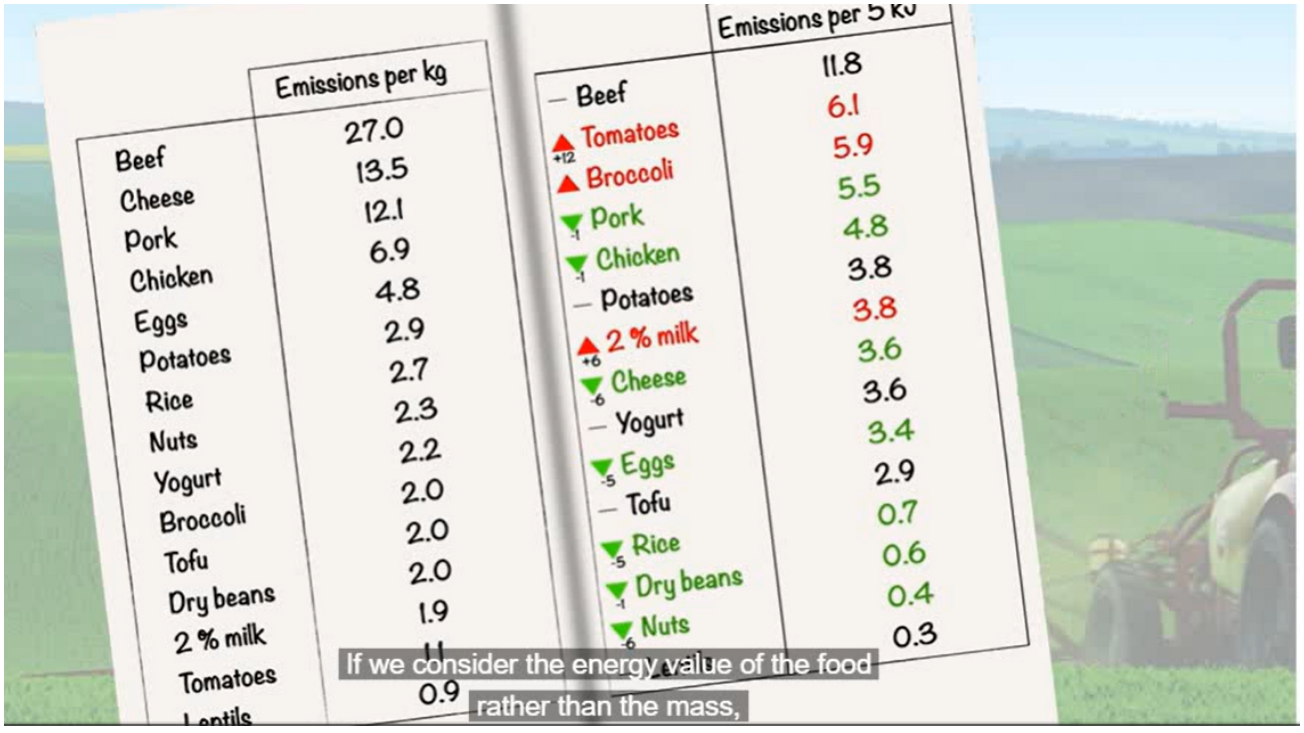
The video below gives some information about food choices.

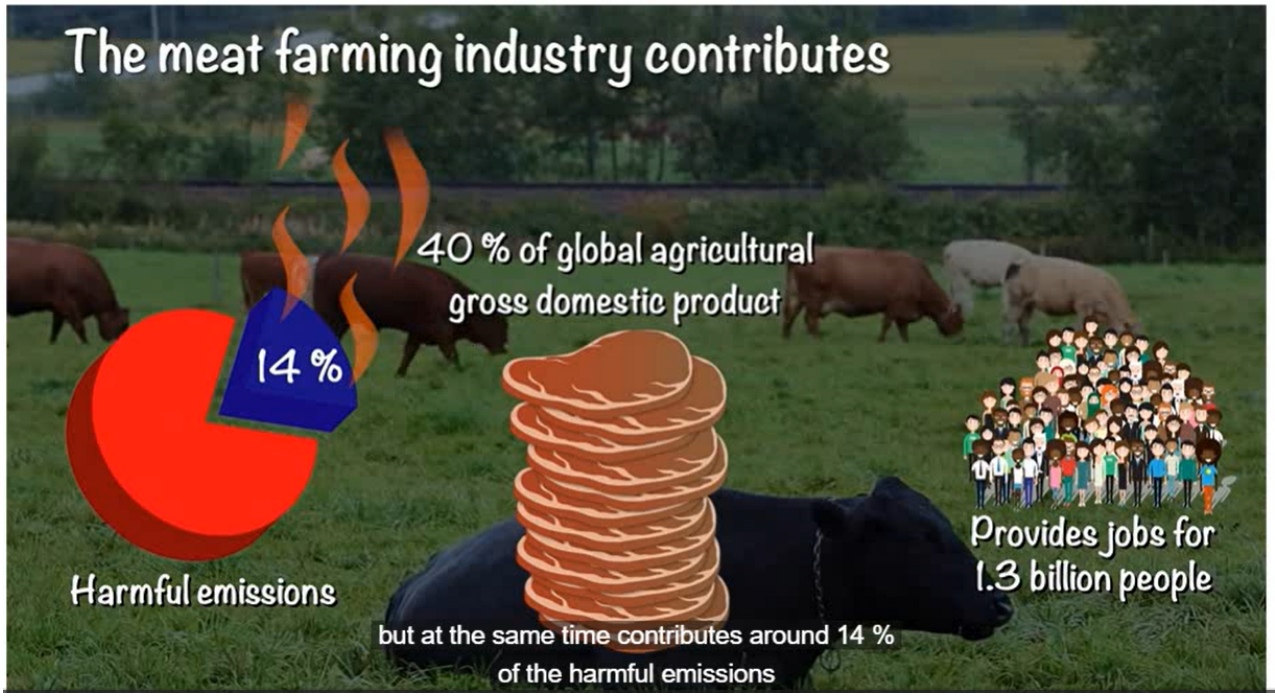



Processing centre
Storage, warehouse cold houses
Animal and crop farms
Food supply chain
Transport and distribution
Shops and markets
Butchers
Different types of food will emit different masses of gases in their production.

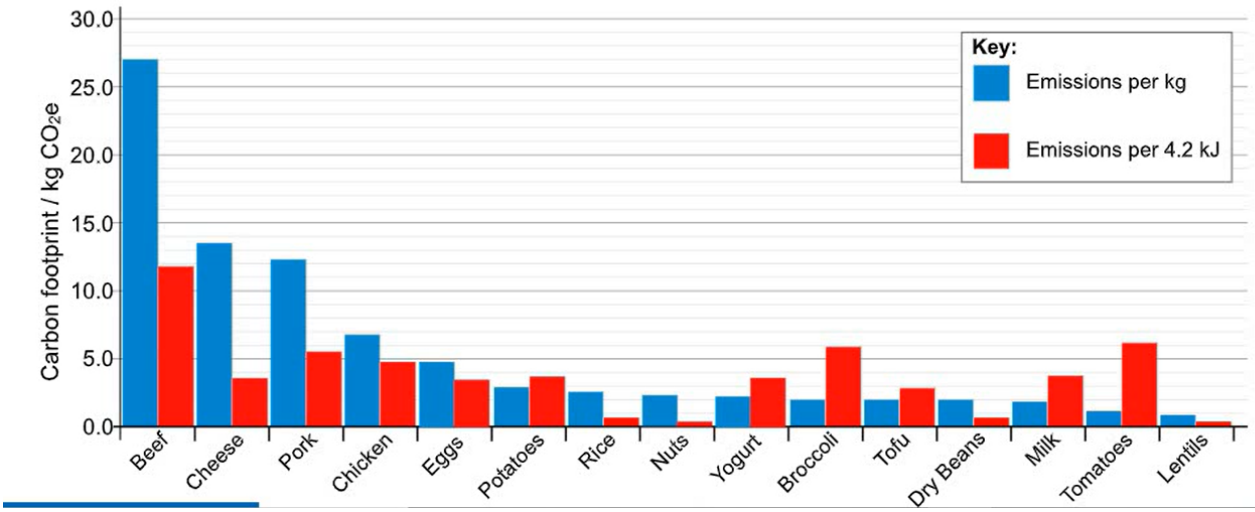

Emissions per kg
Beef 27.0
Cheese 13.5
Pork 12.1
Chicken 6.9
Eggs 4.8
Potatoes 2.9
Rice 2.7
Nuts 2.3
Yogurt 2.2
Broccoli 2.0
Tofu 2.0
Dry beans 2.0
2 % milk 1.9
Tomatoes
Lentils
The table shows the carbon footprint ranked for 1 kg of different foods


Emissions per kg
Beef 27.0
Cheese 13.5
Pork 12.1
Chicken 6.9
Eggs 4.8
Potatoes 2.9
Rice 2.7
Nuts 2.3
Yogurt 2.2
Broccoli 2.0
Tofu 2.0
Dry beans 2.0
2 % milk 1.9
Tomatoes 1.1
1 kg of beef contains 5260 kJ
1 kg of broccoli contains 1460 kJ
whereas 1 kg of broccoli contains 1460 kJ.


Emissions per kg
Beef 27.0
Cheese 13.5
Pork 12.1
Chicken 6.9
Eggs 4.8
Potatoes 2.9
Rice 2.7
Nuts 2.3
Yogurt 2.2
Broccoli 2.0
Tofu 2.0
Dry beans 2.0
2 % milk 1.9
Tomatoes 1.1
0.9
Emissions per 5 kJ
Beef 11.8
+12 Tomatoes 6.1
Broccoli 5.9
-1 Pork 5.5
-1 Chicken 4.8
Potatoes 3.8
+6 2 % milk 3.8
-6 Cheese 3.6
Yogurt 3.6
-5 Eggs 3.4
Tofu 2.9
-5 Rice 0.7
-1 Dry beans 0.6
-6 Nuts 0.4
0.3
If we consider the energy value of the food
rather than the mass,



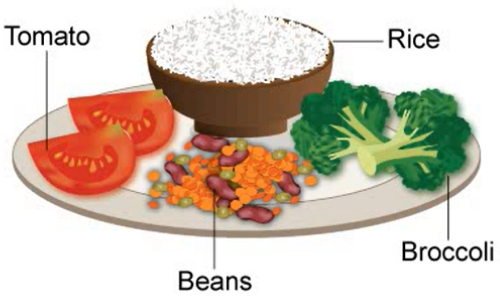
The graph below shows the mass of carbon dioxide produced for 1 kg of each food or 4.2 kJ for each food. The unit for measuring carbon footprint is kg CO_2e or kg equivalent CO_2.
This mass includes all emissions of greenhouse gases such as methane and dinitrogen oxide in addition to carbon dioxide.



Question 6a (4 marks)

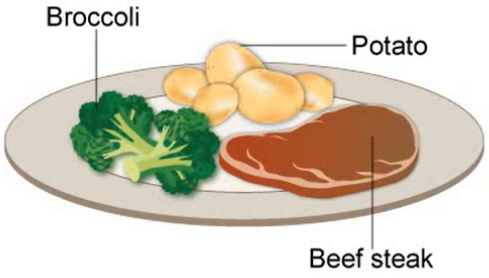
Complete the table using information from the bar chart. **Calculate** the carbon footprint for the meat-based meal to two significant figures.

Vegetable-based meal with an energy content of approximately 3000 kJ.



Food	Mass of food / kg	Carbon footprint per kg of food / kg CO_2e	Carbon footprint for the meal / kg CO_2e
Rice	0.18	2.7	0.49
Tomato	0.20	1.1	0.22
Broccoli	0.20	2.0	0.40
Beans	0.40	2.0	0.80
Total			1.91

Meat-based meal with an energy content of approximately 3000 kJ.



Food	Mass of food / kg	Carbon footprint per kg of food / kg CO_2e	Carbon footprint for the meal / kg CO_2e
Potato	0.24		
Broccoli	0.18	2.0	0.36
Beef steak	0.38	27	10.26
Total			

Question 6b (3 marks)

Outline the environmental impact of the two meals. Use data from the tables to support your answer.

B I U x_2 x^2 Ω Σ Styles

Question 7 (16 marks)

Question 7a (2 marks)

Methane, also known as natural gas, can be used as a fuel. The equation for the combustion of methane is shown below.

$$\boxed{?}\,CH_4(g) + \boxed{?}\,O_2(g) \longrightarrow \boxed{?}\,CO_2(g) + \boxed{?}\,H_2O(g)$$

Select numbers to balance the chemical equation. Make sure you select an option for every box.

Question 7b (14 marks)

Discuss and **evaluate** the benefits of capturing the methane emitted by cows. In your answer, you should include:

- the advantages and disadvantages of intensive cattle farming
- the economic impacts of intensive cattle farming
- the environmental advantages and disadvantages of using methane collected from cows as a source of energy
- the ethical aspects of using methane collected from cows as a source of energy
- a concluding appraisal.