



Question 1 (8 marks)



This question is about light and sound waves and the different speeds at which they move through the air.



Question 1a (1 mark)

Select the correct response from the choices below.

The speed of sound in air is

The speed of light in air is

- Select
- 330 ms⁻¹
- 300 000 000 ms⁻¹
- 55 000 ms⁻¹



Question 1b (3 marks)

If you watch lightning from a storm and listen until you hear the thunder, it is possible to find the distance to the lightning strike.

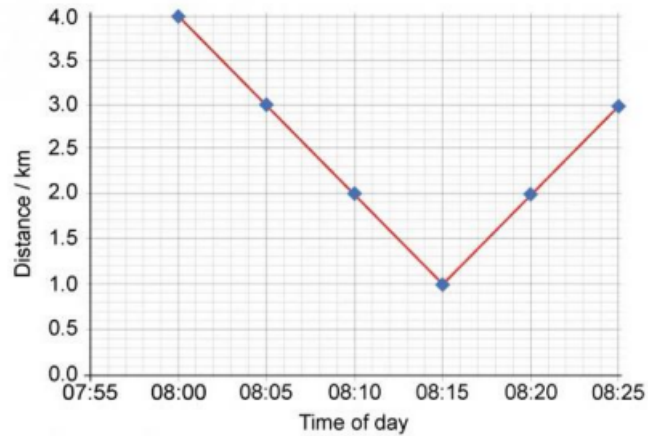
Outline what quantity you would measure and the calculation you would perform to calculate the distance.

B *I* ← → U \times_0 \times^e \int \sum Ω Σ Styles -



Question 1c (2 marks)

A student is watching a storm. He calculates the distance to the storm every five minutes and draws the following graph of his results.



Use the graph to **describe** the journey of the storm as it passes the student.

B *I* ← → x_2 x^2 \int $\frac{d}{dx}$ Ω Σ Styles -



Question 1d (2 marks)

Use information from the graph to **calculate** the speed of the storm between 08:00 and 08:10. Give your answer in km h^{-1} .

B *I* ← → x_2 x^2 \int $\frac{d}{dx}$ Ω Σ Styles -



Question 2 (9 marks)



This question is about lightning and electricity.



Question 2a (1 mark)

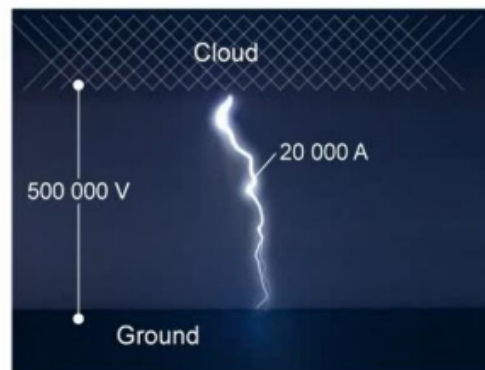
Select the sentence that best describes the process by which the water and crystals become charged:

- Electrons are transferred from the small upward moving crystals to the water drops.
- Electrons are transferred from the water drops to the small upward moving crystals.
- Protons are transferred from the small upward moving crystals to the water drops.
- Neutrons are transferred from the water drops to the small upward moving crystals.



Question 2b (3 marks)

A build-up of charge in a thunderstorm may discharge with a huge spark of lightning between the bottom of a cloud and the ground. When lightning strikes, the air is heated to a plasma (super high temperature gas) which has a low resistance so that a current can flow.



Using information from the picture, **calculate** the resistance of the plasma during the lightning strike.

B *I* ← → U x_2 x^2 \int \sum Ω Σ Styles



Question 2c (2 marks)

A bolt of lightning has a duration of $30\ \mu\text{s}$. **Calculate** the charge transferred during this time.

B *I* ← → U \times_2 \times^2 $\frac{1}{x}$ $\frac{1}{x^2}$ Ω Σ Styles -



Question 2d (3 marks)

Tall buildings are often struck by lightning. To prevent them from being damaged, metal lightning conductors are attached to buildings.



Explain how lightning conductors prevent buildings from being damaged.

B *I* ← → x₂ x² \int \sum Ω Σ Styles

Question 3 (9 marks)

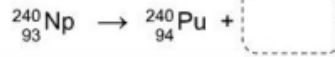
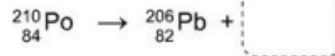
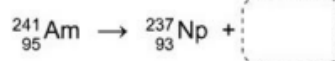
This question is about decay and half-life.

Question 3a (1 mark)

When unstable isotopes decay, they may release an alpha or a beta particle. For each of the decay equations below, **select** the particle released during decay.



Draggable:



Question 3b (3 marks)

Meitnerium-274 emits an alpha particle when it decays.

Identify the atomic number, mass number and name of the element formed when an atom of meitnerium-274 decays. You may refer to the periodic table.





Question 3c (2 marks)

After decay has taken place, the daughter nucleus emits gamma radiation. **Outline** the nature of gamma radiation.

B *I* ← → U \times_e \times^r $\frac{1}{z}$ $\frac{z}{z}$ Ω Σ Styles -



Question 3d (3 marks)

The following table lists some unstable isotopes, their half-life and some additional information regarding the elements.

Isotope	Half-life / years	Additional information
Curium-242	4 730	Artificially produced isotope, not found in nature
Carbon-14	5 700	Alongside carbon-12, this isotope is found in organic materials
Potassium-40	1 300 000 000	Found in sedimentary rocks, particularly those rocks formed by the dust from volcanoes
Uranium-238	4 500 000 000	Found in many areas around the Earth, often as an ore bonded to other elements

Evaluate the information in the table to determine which of the isotopes listed above would assist us in dating an ancient artifact used by early humans, suspected to be 10 000 years old.

B *I* ← → U \times_e \times^r $\frac{1}{z}$ $\frac{z}{z}$ Ω Σ Styles -

Question 4 (18 marks)

A change in the characteristics of a football (soccer) ball may impact the ball's performance. For this reason, FIFA has a global standard to guarantee that every game will be played with balls with identical characteristics.

The bounciness of the ball is an important factor that can affect its performance. Your class is studying factors that affect the performance of the ball. You decide that you are going to study one factor: the effect of the ball's internal air pressure.

You plan to drop the ball from a measured height towards a horizontal surface and determine the height of the first bounce. Your hypothesis for the experiment is:

Bounce height is proportional to internal air pressure because higher pressure reduces the energy loss due to deformation when the ball bounces.

Question 4a (4 marks)

Select the following variables:


Independent variable	Dependent variable	Control variables
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Drop height
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Internal air pressure
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Bounce height
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Size of ball
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Bouncing surface
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Material of the ball



Question 4b (3 marks)

FIFA's guidelines require the pressure in the ball to be between 60 kPa to 120 kPa.

Select the most appropriate option for collecting data. **Justify** your answer.

Select 

- Select
- Measurements each 5 kPa; 1 repetition at each pressure
- Measurements each 10 kPa; 3 repetitions at each pressure
- Measurements each 30 kPa; 8 repetitions at each pressure



Question 4c (2 marks)

State and **justify** one safety measure that you must take as you perform the experiment.

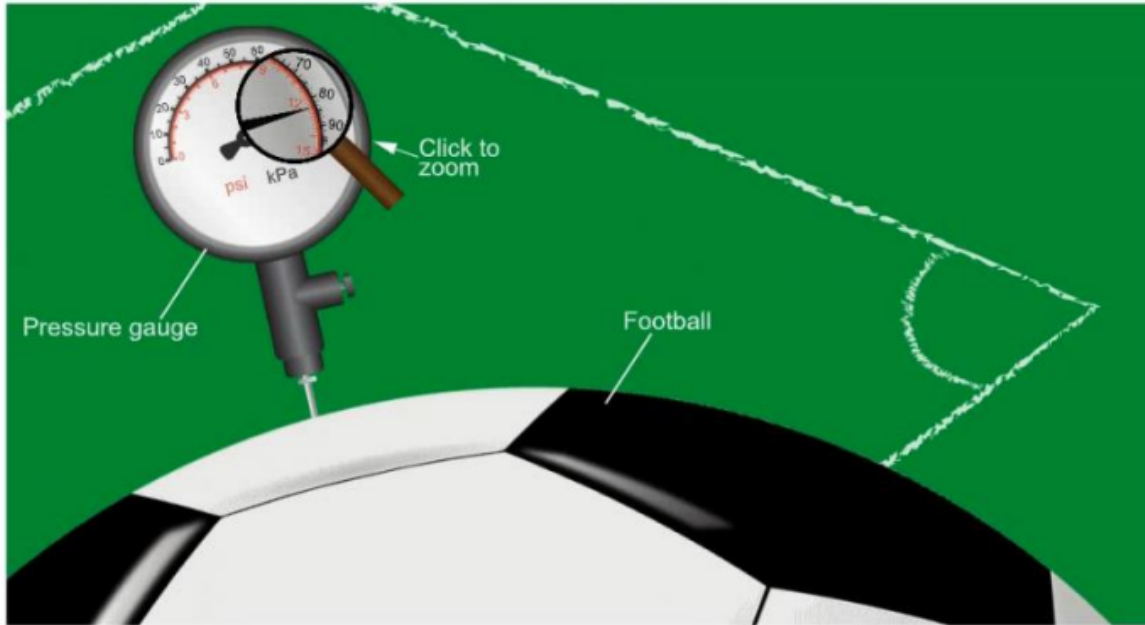
Safety measure:

Justification:



Question 4d (2 marks)

The following is an image of the pressure gauge meter that you will use:



Measure the pressure of the ball shown in the image above using an appropriate unit.

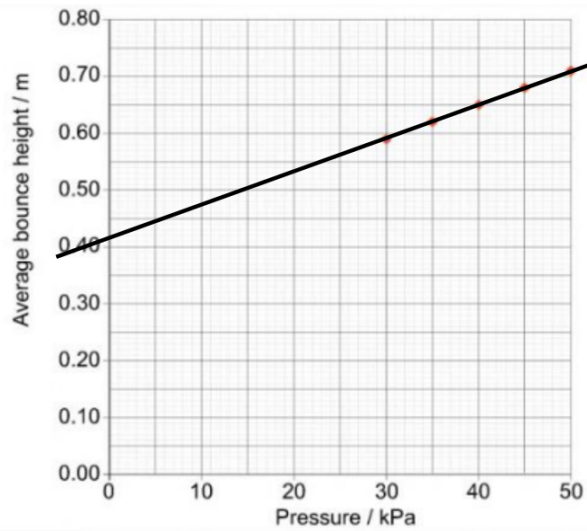
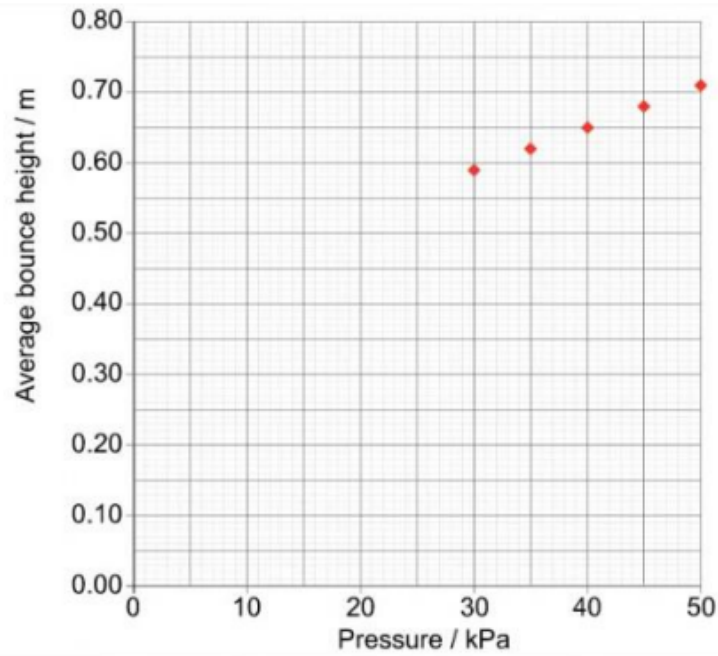
B *I* ← → U \times_2 \times^2 \int \sum Ω Σ Styles -



Question 4e (1 mark)

Some of the results from another student who performed a similar experiment are shown in the graph below.

Draw a line of best fit on the graph.





Question 4f (1 mark)

Use your line of best fit to **estimate** the bounce height for a pressure of 38 kPa.

B *I* ← → U x_e x^e \int \sum Ω Σ Styles -



Question 4g (3 marks)

Use the graph to **explain** why the y-intercept of the line of best fit has no significance.

B *I* ← → U x_e x^e \int \sum Ω Σ Styles -



Question 4h (2 marks)

The hypothesis proposed at the start of the investigation was:

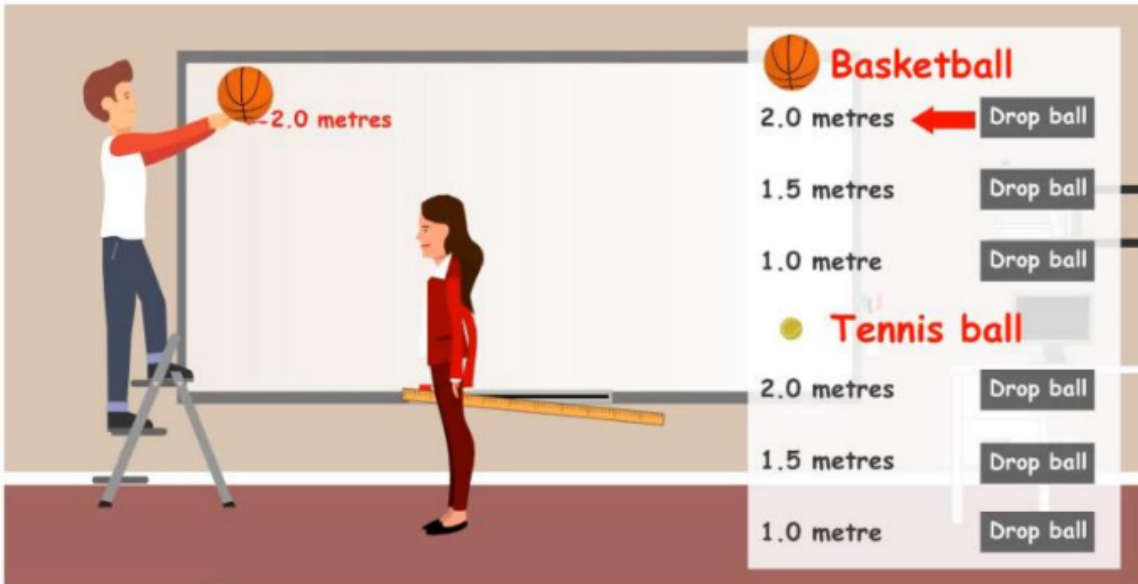
Bounce height is proportional to internal air pressure because higher pressure reduces the energy loss due to deformation when the ball bounces.

Use the graph of the results of the experiment to **evaluate** the validity of this hypothesis.

B *I* ← → U x_e x^e \int \sum Ω Σ Styles -

Question 5 (15 marks)

Another student decided to do a similar experiment using a basketball and a tennis ball.
Click on "Drop ball" to start animation.



Question 5a (6 marks)

Evaluate the validity of the method shown in the animation. In your answer, you should identify steps in the method that affect the validity of the data, what effect each step has on the validity of the data and how the method can be improved.

Step 1:

Step 2:

Effect:

Effect:

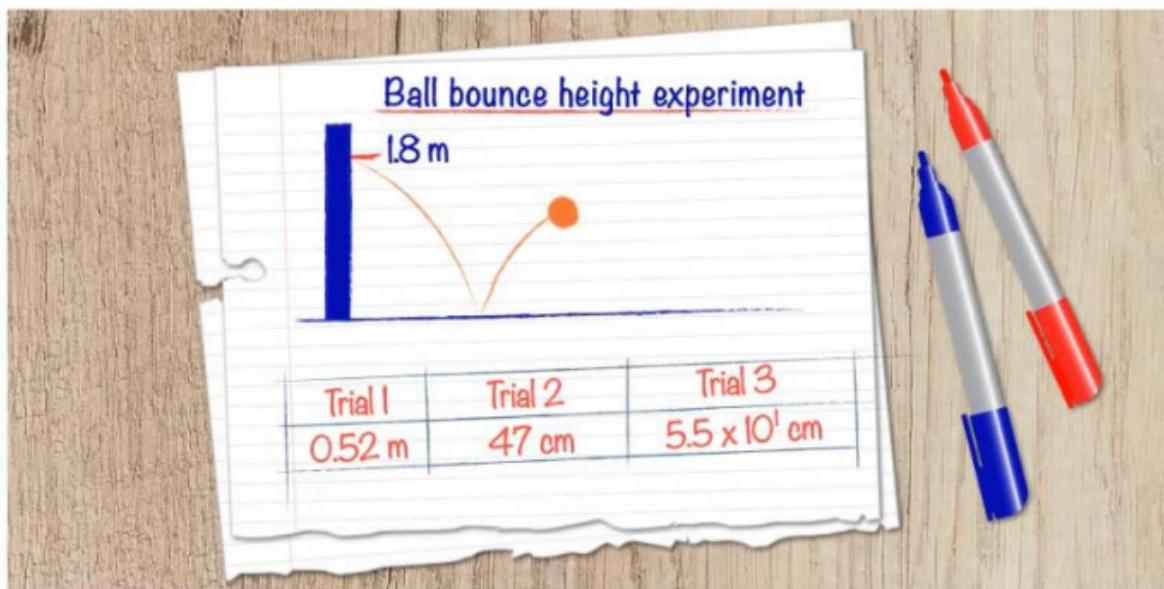
Improvement:

Improvement:



Question 5b (2 marks)

The following are the bounce height values for 3 repetitions at a height of 1.8 m: 0.52 m, 47 cm and 5.5×10^1 cm.

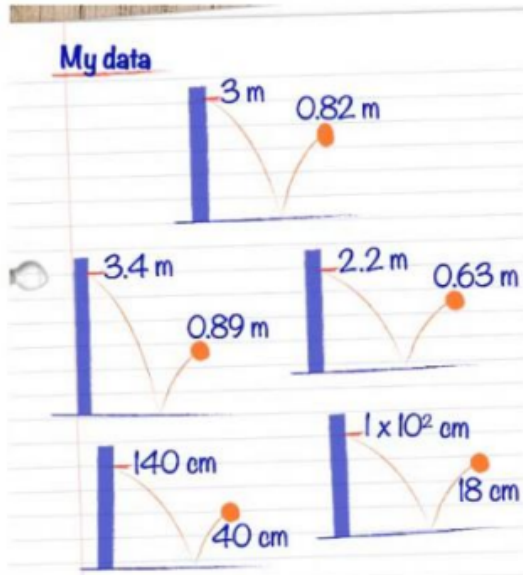


Calculate the average value of bounce height for the drop height of 1.8 m. Give your answer in metres.



Question 5c (5 marks)

The student's data is shown below.



Organize and **present** this data in a table.
You should include the answer from part (b) in your table.



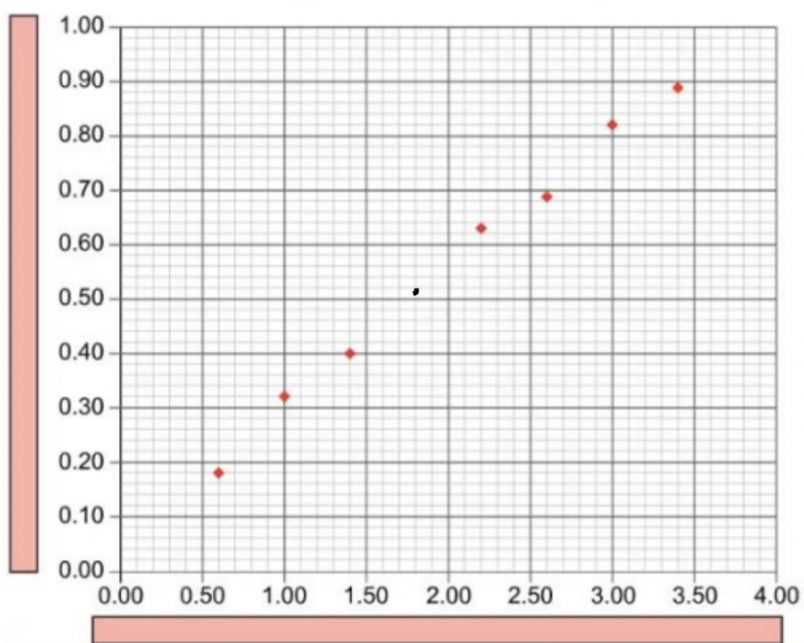
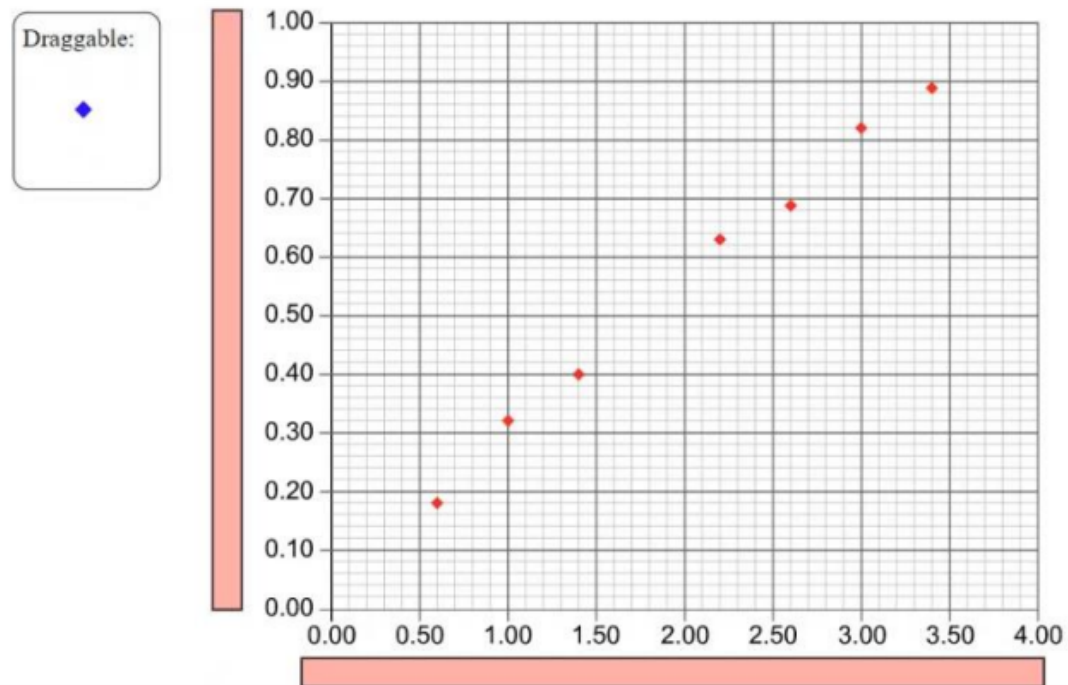
Reset



-
-
-
-

The mean data from the experiment is shown below.

State the labels for the x and y axes and **plot** your calculated data point from part (b).





Question 6 (17 marks)

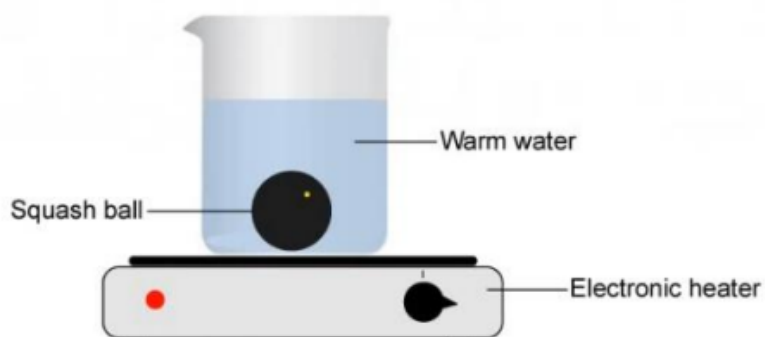


Squash is a sport played by two players in a four-walled court. A small, hollow, rubber ball is hit by the players onto the playing surfaces of the four walls of the court.



Before a game begins, the players must warm the ball to improve the way it bounces when it hits the playing surface.

In this question you will design an investigation to determine how the temperature of the ball affects its bounce height. You will place the ball into a water bath, as shown in the diagram, and slowly increase the temperature of the water bath, determining how the ball's bounce is affected by the temperature.



©



Question 6a (3 marks)

State the variables in this investigation. The independent variable has been completed for you.

Independent variable:

Temperature of the ball

Dependent variable:



Question 6b (14 marks)

Design a method to investigate the effect of changing the balls temperature. In your answer, you should include:

- a hypothesis that your method will test
- how you will manipulate the variables
- how you will collect sufficient data
- a justification of why your data is sufficient
- safety considerations.

B *I* ← → U x_2 x^e \int \sum Ω Σ Styles -



Question 7 (13 marks)



This question is about how individual lifestyle choices can have a global impact.

The climate has been changing significantly over the past 100 years. Scientific evidence shows that significant climate change is caused by changes in the atmosphere as a consequence of human activity. Individual travel choices can have an impact on a global scale.



Question 7a (1 mark)

Select the source of renewable energy from the following list.

Select

- Select
- Coal
- Uranium
- Wind
- Natural gas

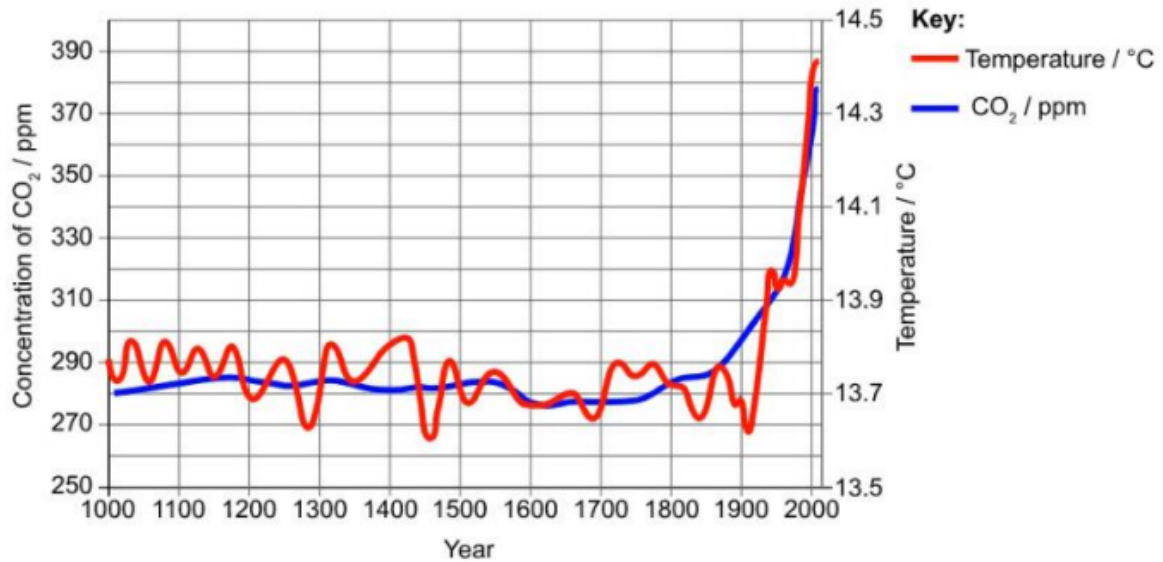


(2 marks)



Question 7b (2 marks)

Scientists have measured or calculated both the amount of carbon dioxide in the atmosphere over the last thousand years and the average global temperature.



ppm = parts per million, a measure of the number of CO₂ molecules in every million air particles.

Scientists have stated that increasing levels of CO₂ are linked to increasing global temperature.

Outline how the graph supports this statement.

B I ← → x_o x^o Ω Σ Styles - ↕



Question 7c (2 marks)

Suggest a cause for the increase in CO₂ after 1800, as seen in the graph.

B *I* ← → U x₂ xⁿ ¶ ☰ ☱ Ω Σ
Styles ▾ 📄



Question 7d (4 marks)

State two possible consequences of increasing global temperature and outline the impact of each.

Consequence 1:



Question 7e (4 marks)

Suggest one type of technology that scientists are developing to slow down the trend identified in part (b). **Outline** how the technology reduces CO₂ production and a strength and a limitation of its use.

B *I* ← → U x₂ xⁿ ¶ ☰ ☱ Ω Σ Styles ▾ 📄

Question 8 (11 marks)

Fenna is a student at a school in a city with a range of transport options. She lives 8 km away from her school. These are the options for her journey to school:



Use the information provided and your wider MYP studies to **discuss** and **evaluate** two methods of transport from the list above and recommend a method of travel for Fenna. In your answer, you should include:

- positive and negative health and well-being impacts of your two chosen methods
- positive and negative economic or social impacts of your two chosen methods
- a comparison of the impacts of your two chosen methods
- a final recommendation.

B I ← → U x₂ x² ∑ Ω Σ Styles ↵