Question 1 (7 marks)

Atoms are made up of particles called protons, neutrons and electrons, which are responsible for the mass and charge of atoms.

Question 1a (3 marks)

Select the correct options to complete the statements below.

A proton is a particle found in the [Select ▾] of an atom. It has a relative mass of [Select ▾] and a charge of +1.

A neutron is a particle found in the [Select ▾] of an atom. It has a relative mass of 1 and a charge of [Select ▾].

An electron is a particle found in the orbitals of an atom. It has a relative mass of [Select ▾] and a charge of [Select ▾].

Question 1a (3 marks)

Select the correct options to complete the statements below.

A proton is a particle found in the [Select ▾] of an atom. It has a relative mass of [Select ▾] and a charge of +1.

A neutron is a particle found in the [Select ▾] of an atom. It has a relative mass of 1 and a charge of [Select ▾].

Select
nucleus
orbitals

An electron is a particle found in th[e] [...]f an atom. It has a relative mass of [Select ▾] and a charge of [Select ▾].

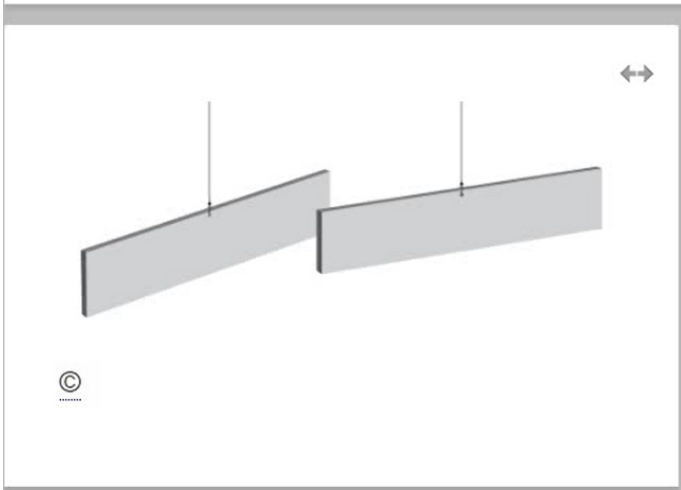
Question 1b (1 mark)

One model for explaining static electricity states that electrons can move from one atom to another because of friction. This can lead to an uneven distribution of charge.

Two identical pieces of nylon are charged with static electricity by rubbing with the same type of cloth and are suspended from a thread so that they can swing freely.

State why the nylon is charged after it is rubbed.

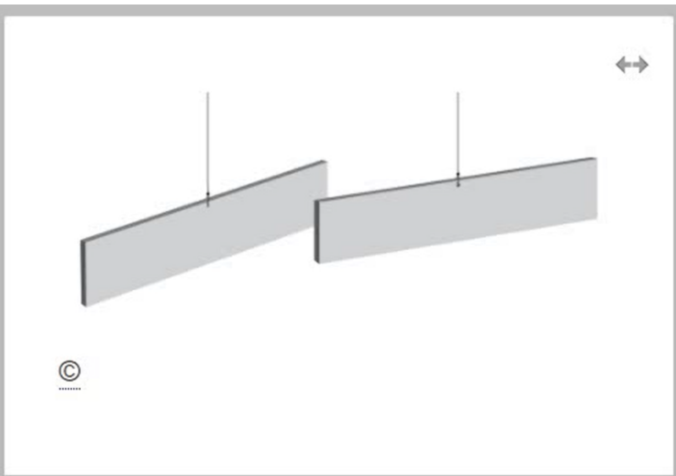
B I U Styles



Question 1c (2 marks)

Describe what will happen to one piece of charged nylon suspended by a thread if the other charged piece of nylon is brought very close to it but without touching.

B I U Styles



Question 1d (1 mark)

Justify what would happen if the nylon pieces were to touch.

B I U Styles

Question 2 (12 marks)

A raindrop falls from a cloud that is 500 m above the ground.

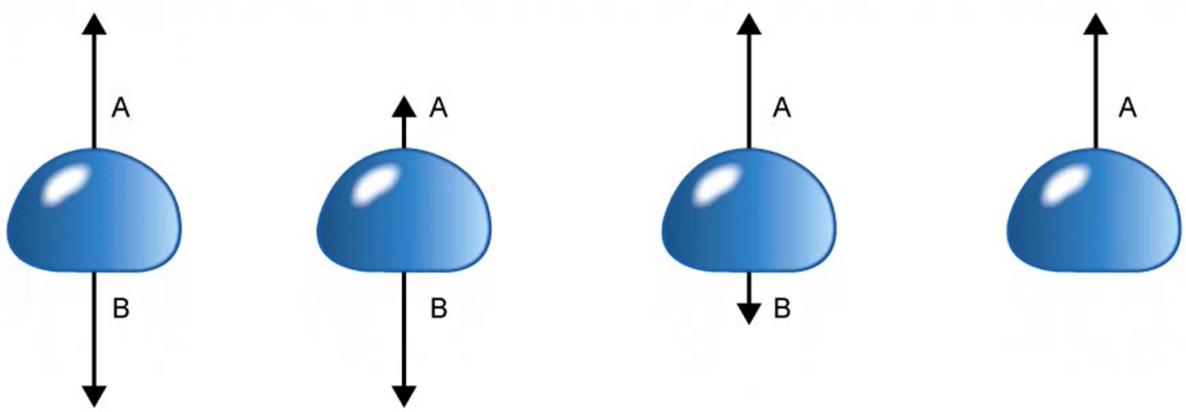
Question 2a (3 marks)

Calculate the theoretical maximum velocity of the raindrop before it hits the ground. Assume that the acceleration due to gravity, g, is equal to 10 ms^{-2}.

Question 2b (1 mark)

The raindrop does not reach this theoretical maximum speed: instead it reaches the terminal velocity.

Select the free body diagram that shows the forces acting on the raindrop when it reaches its terminal velocity.



1. ○ 2. ○ 3. ○ 4. ○

Question 2c (1 mark)

Label the forces A and B.

Force A

Force B

Question 2d (1 mark)

A typical raindrop has a mass of 3.0×10^{-5} kg.

State the mass of the raindrop in grams (g).

Question 2e (2 marks)

Use your answers to part (a) and part (d) to **calculate** the maximum final theoretical momentum of the raindrop. You should include the unit in your answer.

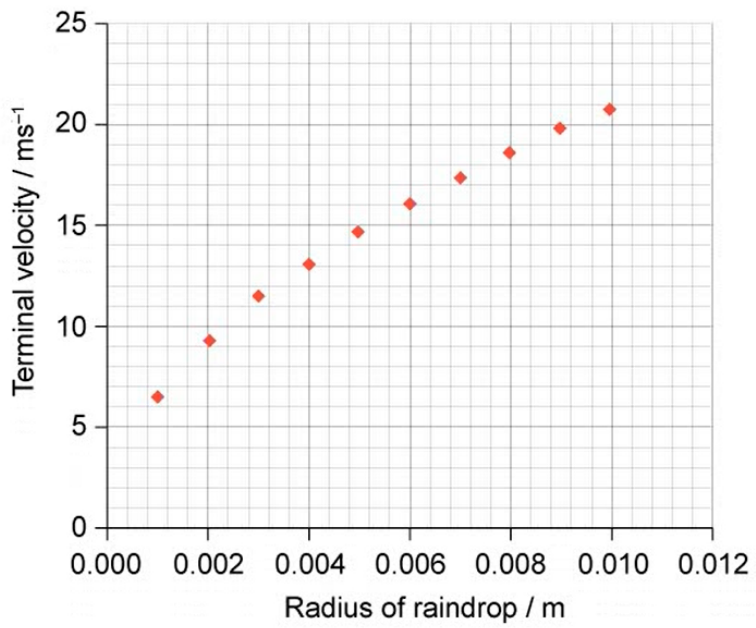
Question 2f (2 marks)

A student reads that the terminal velocity of a raindrop is determined by its radius.

To determine experimentally if this is true, the student makes the following prediction:

"The terminal velocity of a raindrop is proportional to the radius of the raindrop because the weight will be larger."

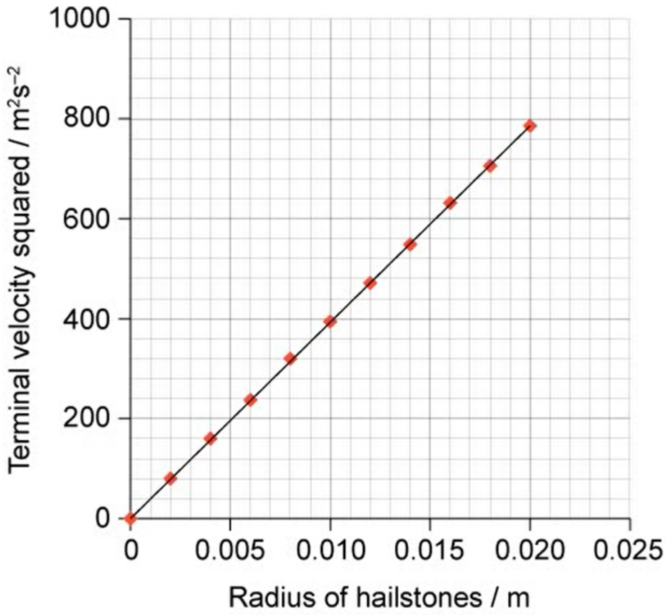
The student measures the terminal velocity of different raindrops and produces the following graph.



Use the graph to **discuss** the validity of the hypothesis.

Question 2g (2 marks)

A second student decides to complete a similar investigation to measure the terminal velocity of hailstones. He draws a different graph of the results shown below.

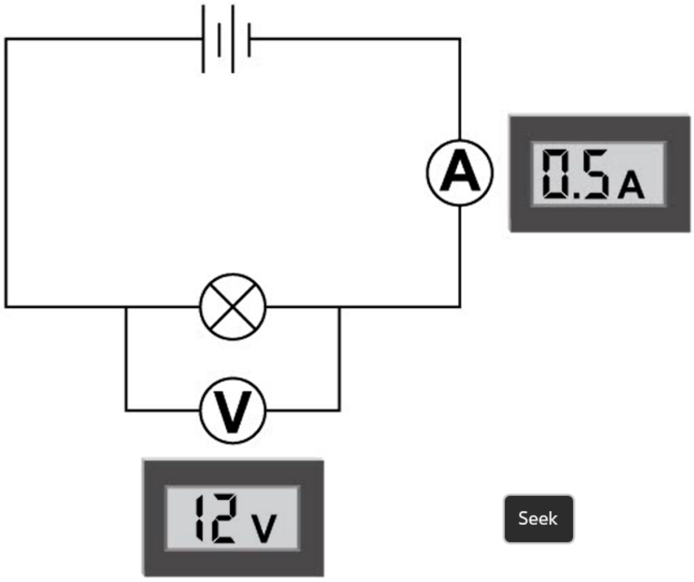


Explain what these results show about the relationship between the radius of hailstones and terminal velocity.

B I U Styles

Question 3 (14 marks)

A flow of charge around a circuit allows us to transfer energy. We often refer to this flow as a current. The circuit diagram below shows a simple circuit.



Question 3a (1 mark)

Select appropriate terms and **organize** them into a sequence to show the energy changes taking place in the circuit.

Draggable items:

nuclear | light | electrical | sound | chemical

Question 3b (2 marks)

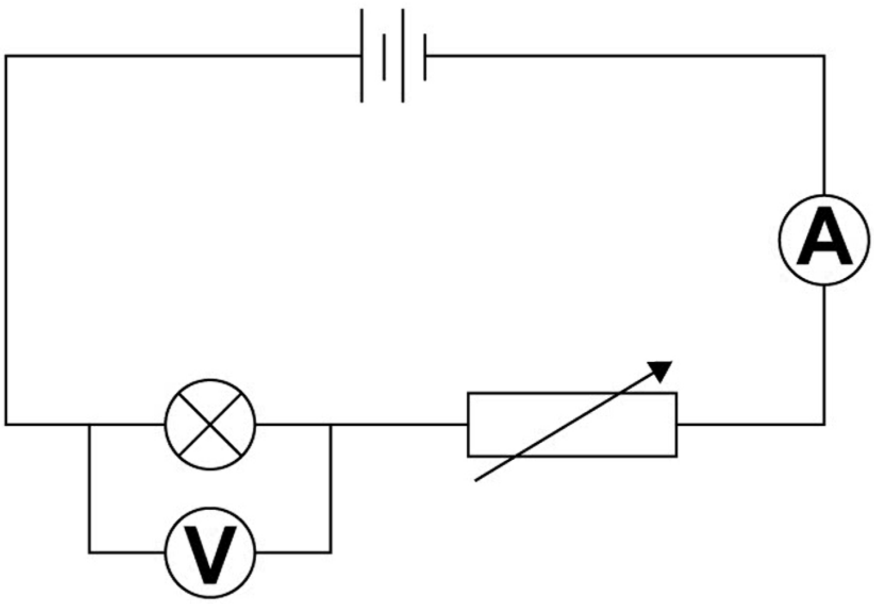
Calculate the power transferred to the bulb in the circuit diagram above. You should include the unit in your answer.

Question 3c (1 mark)

Calculate the charge which flows through the bulb in 100 seconds.

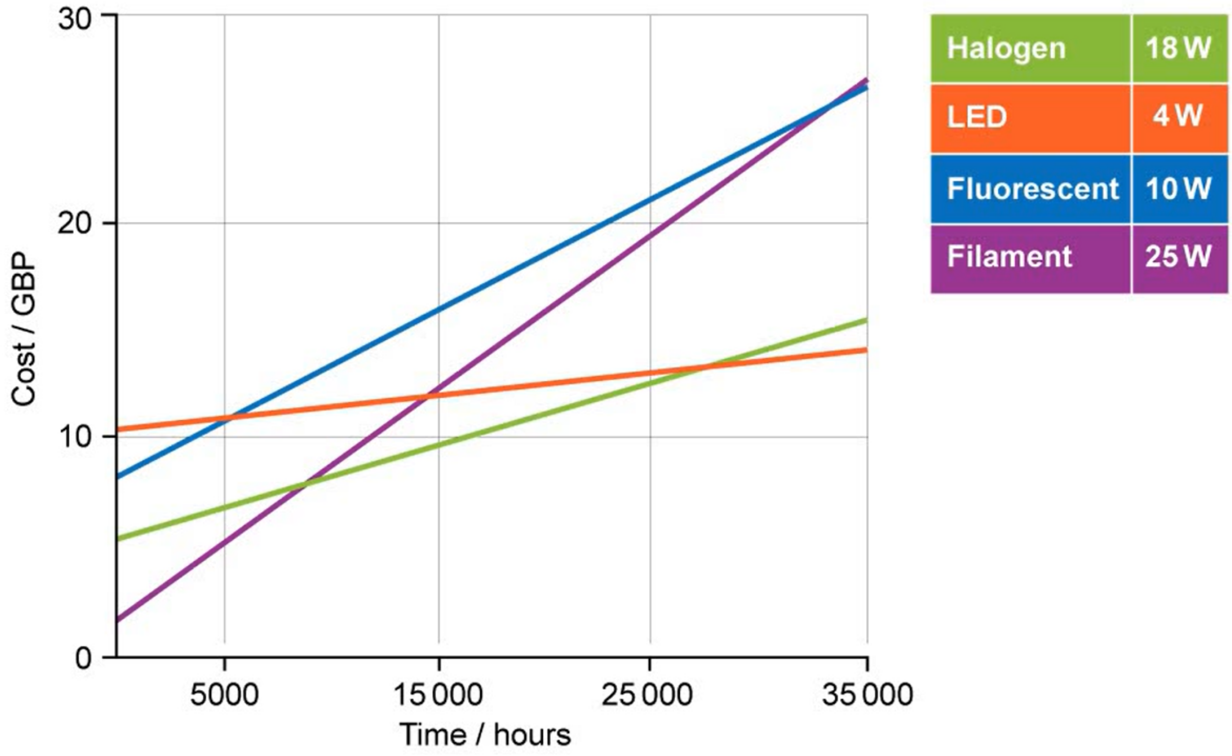
Question 3d (5 marks)

The circuit now has a variable resistor added in series. Changing the resistance of the variable resistor changes the brightness of the bulb.



Explain why changing the resistance will affect the brightness of the bulb.

The graph below shows the costs of different types of light bulbs. Each bulb produces the same level of brightness.



Use information from the table and the graph to **justify** why LED bulbs are more economical over the long term even though they are more expensive to buy. You should use data to support your answer and you should refer to:

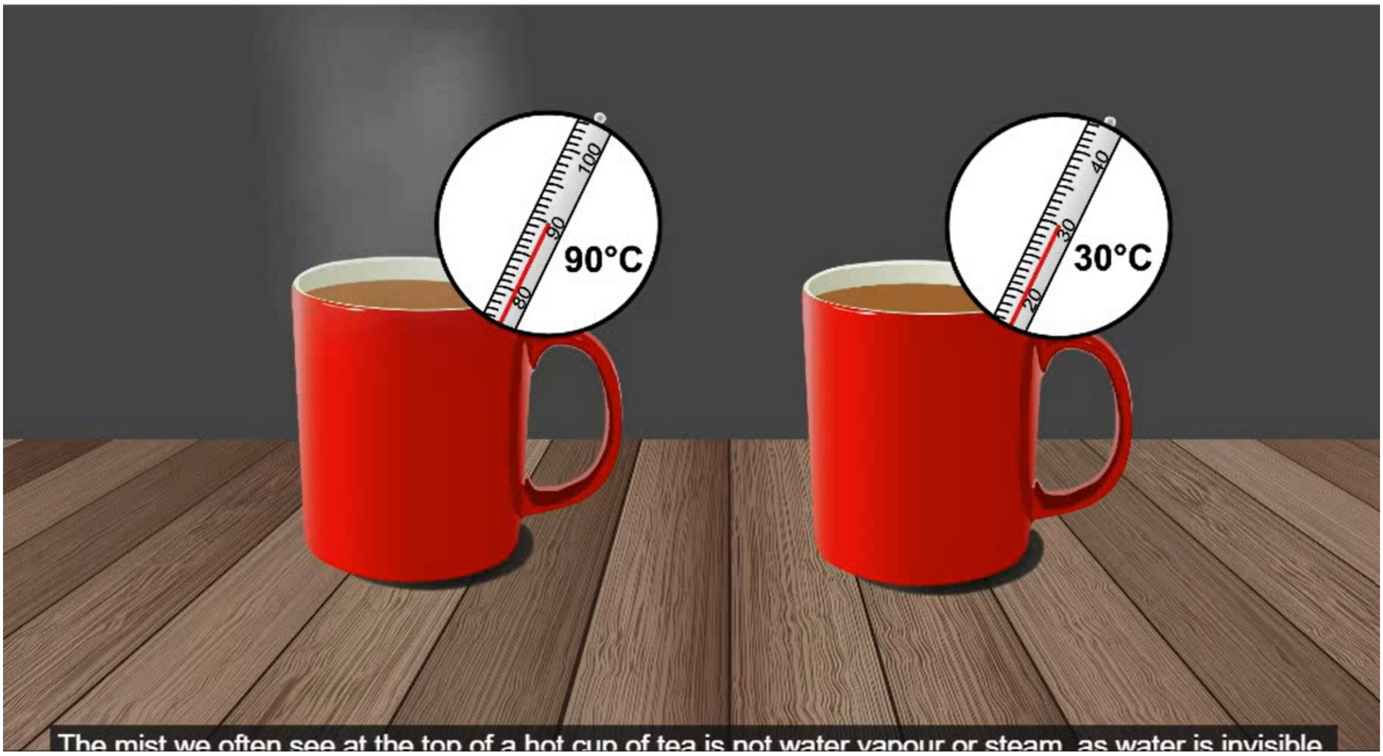
- the gradients of the lines
- the significance of the y intercept
- the significance of the intersections of lines.

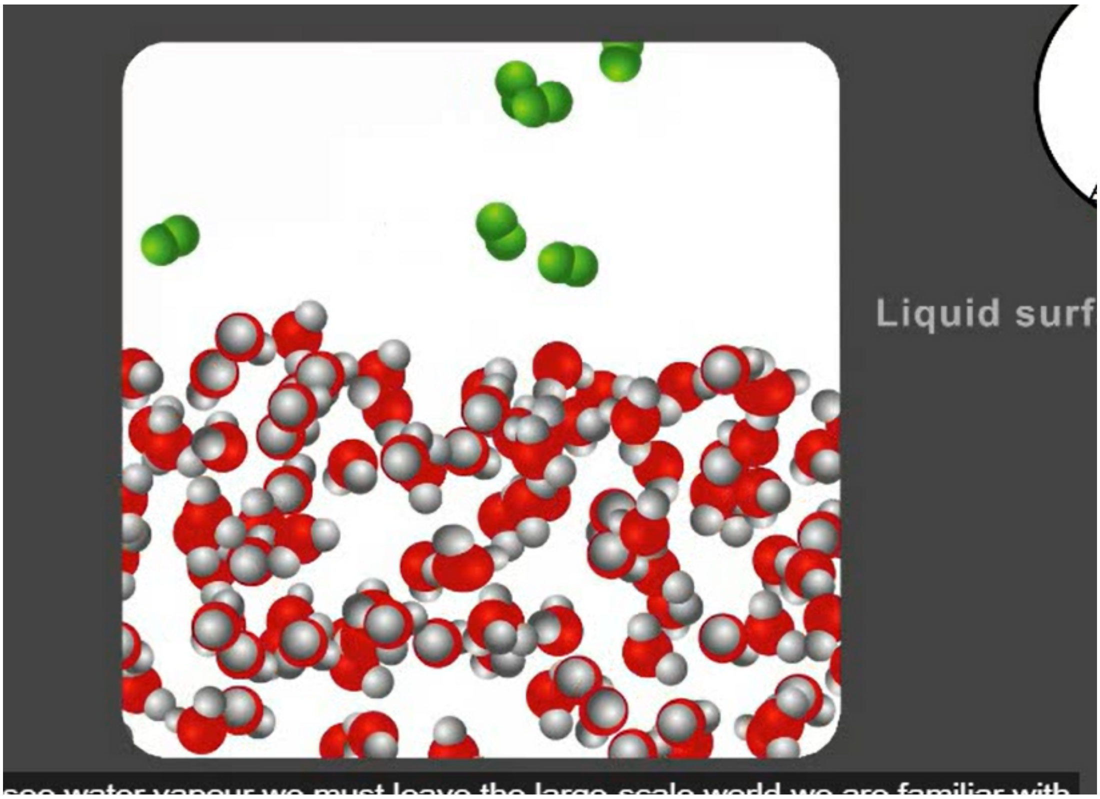
Question 3f (1 mark)

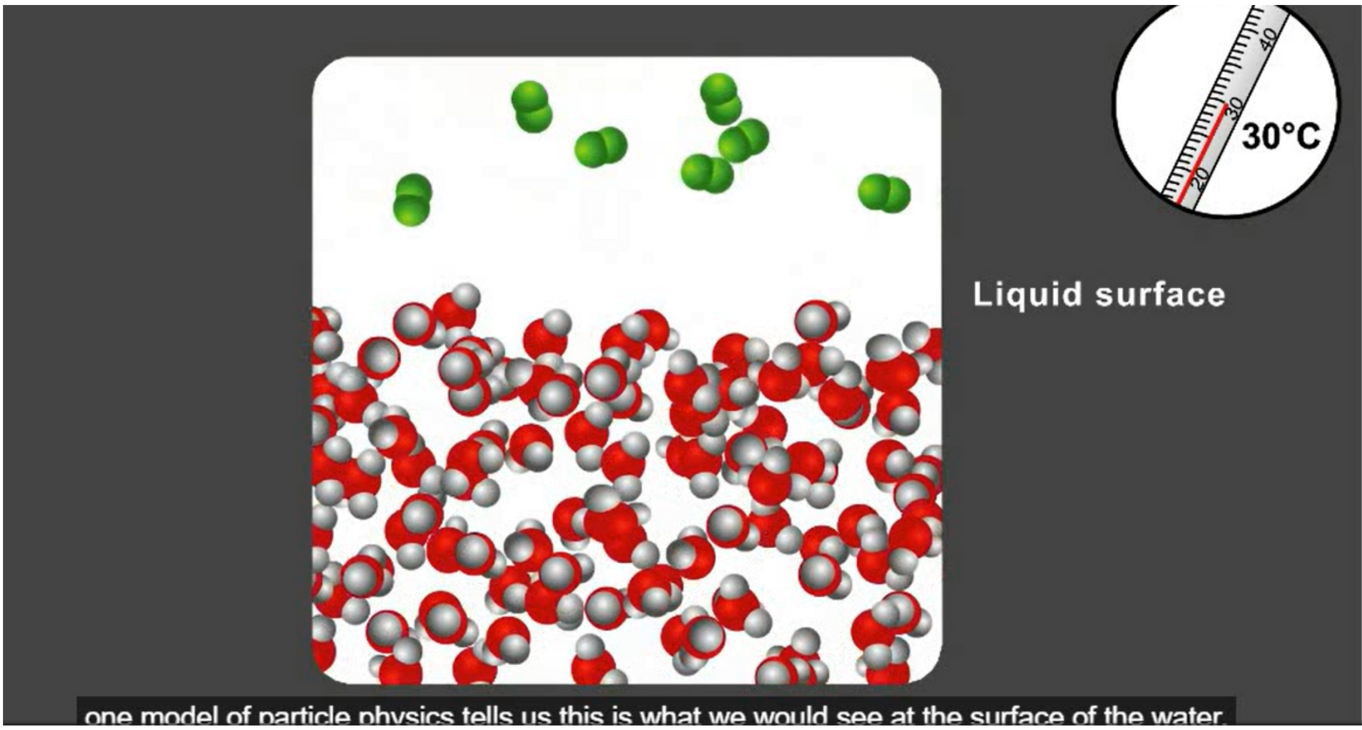
Suggest one extra piece of information not included in the graph or the table that you would need to reach a final judgment.

Question 4 (21 marks)

The video shows how the particles in a liquid leave the surface and become gas particles when the liquid evaporates.




Liquid surf
see water vapour we must leave the large scale world we are familiar with


40
30
20
30°C
Liquid surface
one model of particle physics tells us this is what we would see at the surface of the water.

Many different factors affect the rate at which a liquid evaporates. You have been asked to investigate the effect that surface area has on the mass of liquid evaporated in an hour.

Question 4a (1 mark)

State the question that could be answered in this scientific investigation.

Question 4b (3 marks)

If 0.25 g of water evaporates from a container in 12 minutes, **calculate** the rate of evaporation. Give your answer in g h^{-1}.

Question 4c (3 marks)

Formulate and **explain** the hypothesis that this question would test.

Question 4d (3 marks)

Below is a list of variables that are important in this experiment. **Select** the most appropriate description for each of the variables in this experiment.

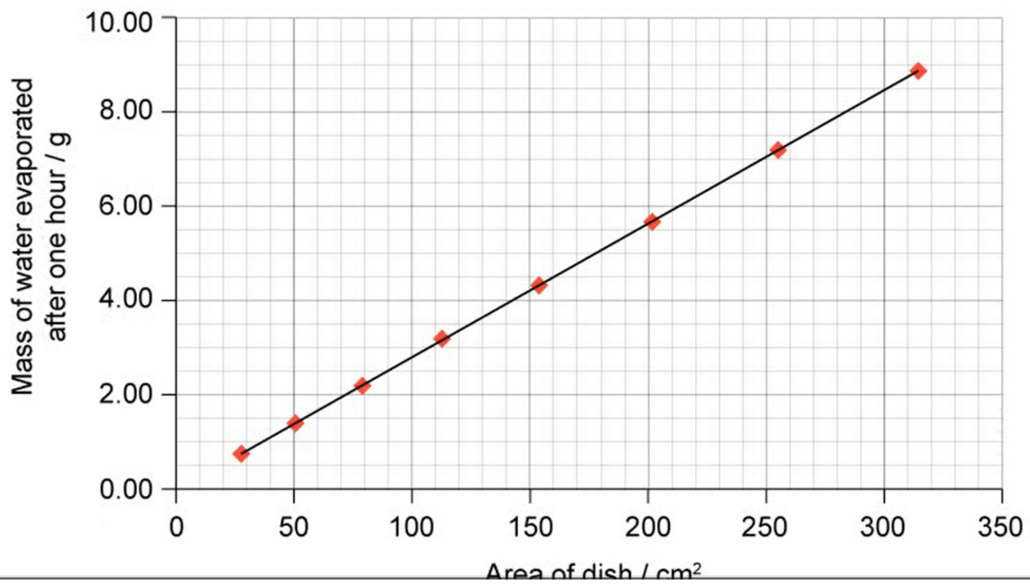
Independent variable	Dependent variable	Control variables	
☐	☐	☐	Mass of water
☐	☐	☐	Water temperature
☐	☐	☐	Air temperature
☐	☐	☐	Time
☐	☐	☐	Surface area
☐	☐	☐	Type of liquid
☐	☐	☐	Movement of air above the liquid

Question 4e (3 marks)

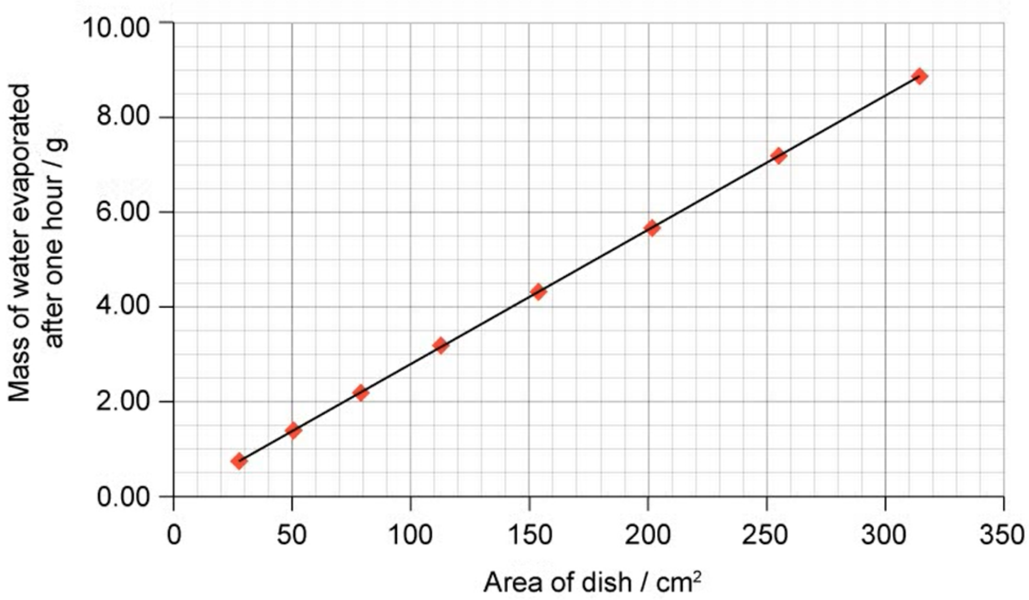
Describe how you will ensure that you collect sufficient data.

Question 4f (2 marks)

The whole class collected their data and presented it in the following graph.



The whole class collected their data and presented it in the following graph.



Describe the relationship between the two variables shown in the graph.

Question 4g (3 marks)

Determine the constant of proportionality from the graph. Give your answer in g cm^{-2}.

Question 4h (3 marks)

A pond has a surface area of 4 m^2 (40 000 cm^2). Using your answer from part (g), **calculate** the mass of water lost from this pond in an hour.

Question 5 (6 marks)

After the student investigated the effect of changing the surface area of the container, he decides to extend the investigation and to examine how a different independent variable affects the mass of liquid evaporated in an hour.

Question 5a (1 mark)

State a question that could be asked in this new investigation.

Question 5b (3 marks)

Formulate and **explain** the hypothesis that the question in part (a) would test.

Question 5c (2 marks)

Identify the variables in this experiment. The dependent variable and a first control variable are already completed.

Dependent variable:

Mass of liquid evaporated

Control variable 1:

Time

Control variable 2:

Question 6 (16 marks)

A student living in Tanzania decides to investigate if there is a relationship between the altitude (height above sea level) and the boiling point of water.

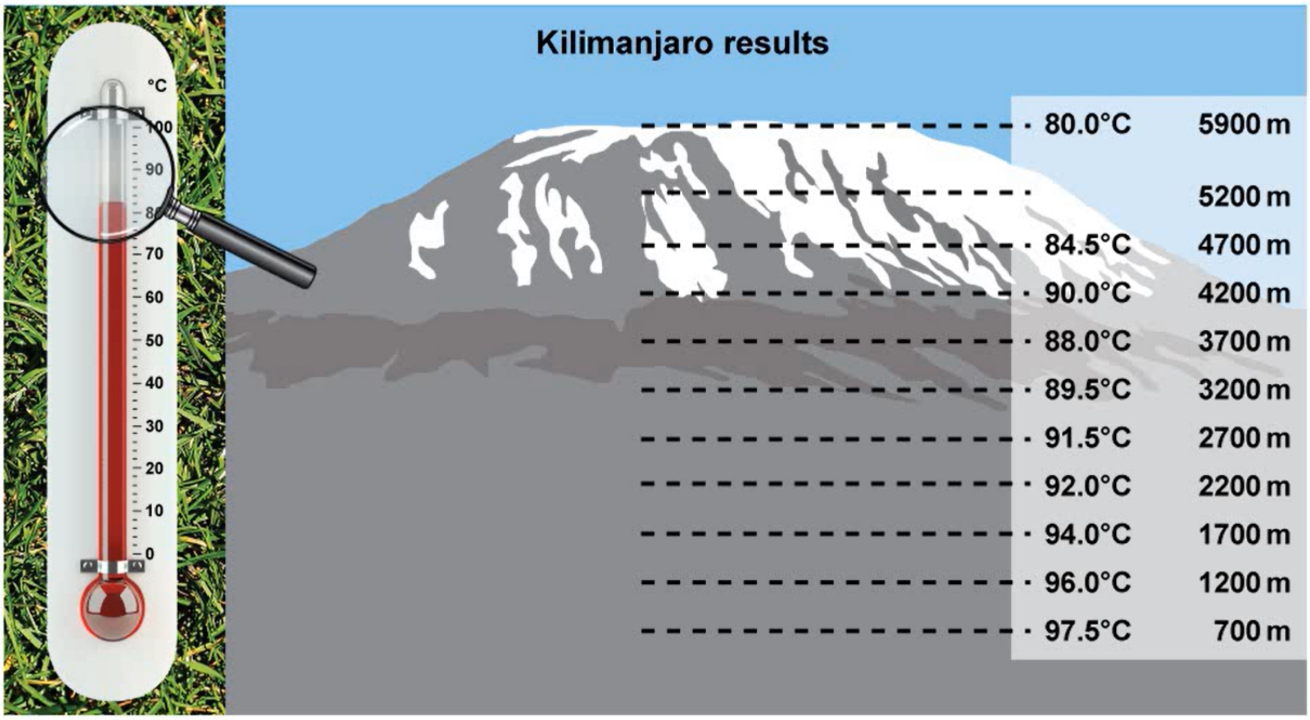
She climbs Mount Kilimanjaro recording the temperature at which water boils at different altitudes, from the bottom of the mountain to the top.

She records her results on a picture of the mountain, shown below.

Question 6a (3 marks)

The student forgot to label the table correctly. **Write down** labels for heading 1 and heading 2.
At 5200 m the student did not record a temperature, but took a photo of the thermometer.
Measure the temperature shown in the photograph and add it to the results table.

Click on the magnifying glass to enlarge the thermometer.



Heading 1	Heading 2
5900	80.0
5200	
4700	84.5
4200	90.0
3700	88.0
3200	89.5
2700	91.5
2200	92.0
1700	94.0
1200	96.0
700	97.5

Reset

Heading 1:

Styles

Heading 2:

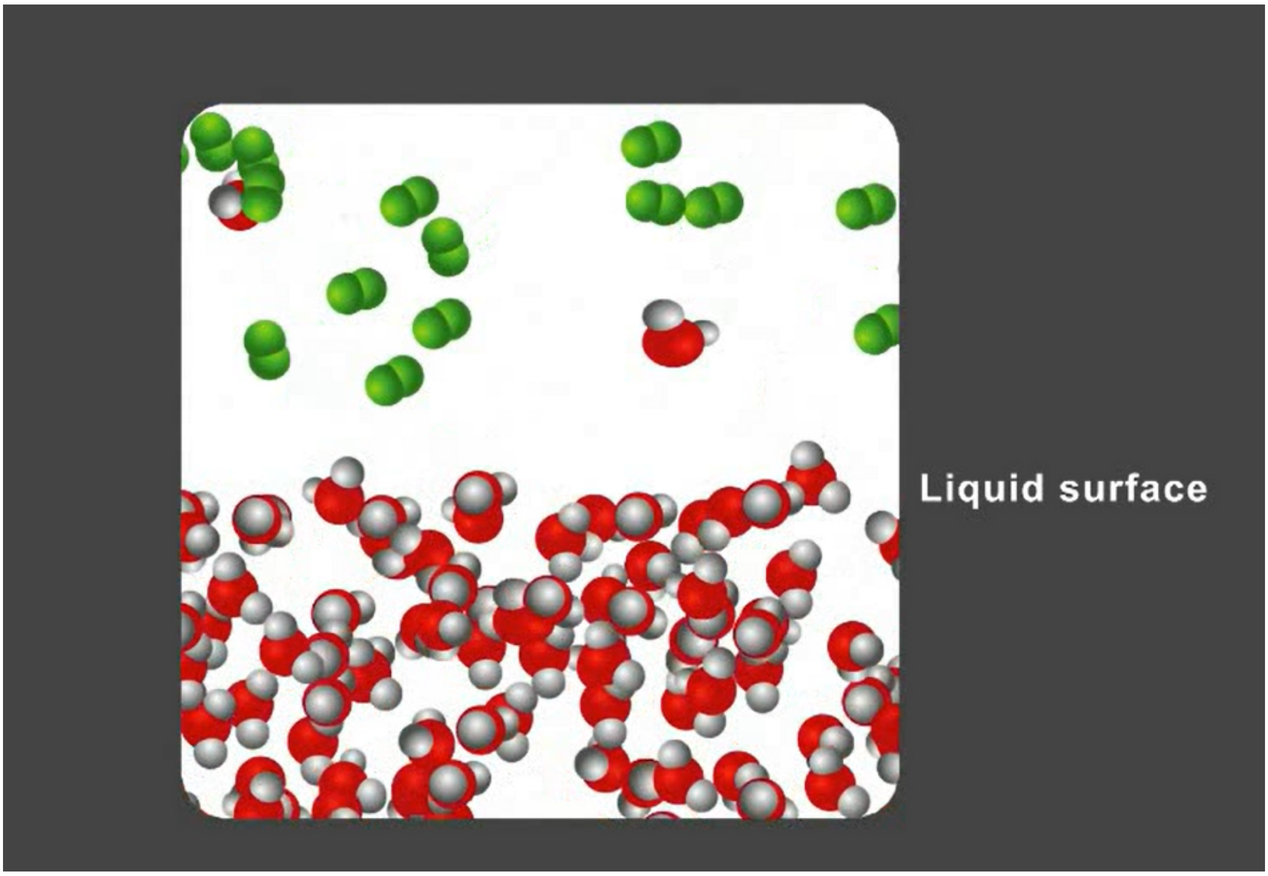
Styles

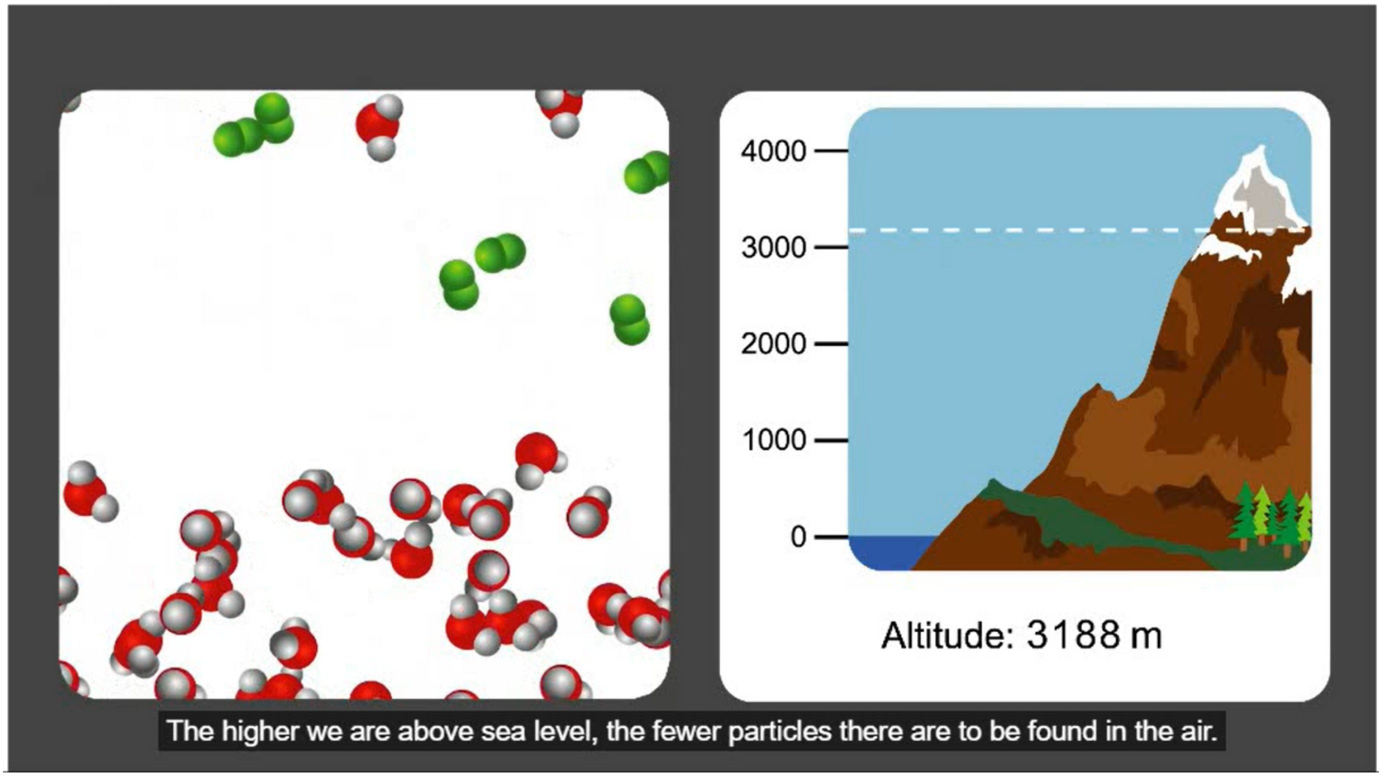
Question 6b (2 marks)

Explain why a bar chart is not appropriate to display these results.

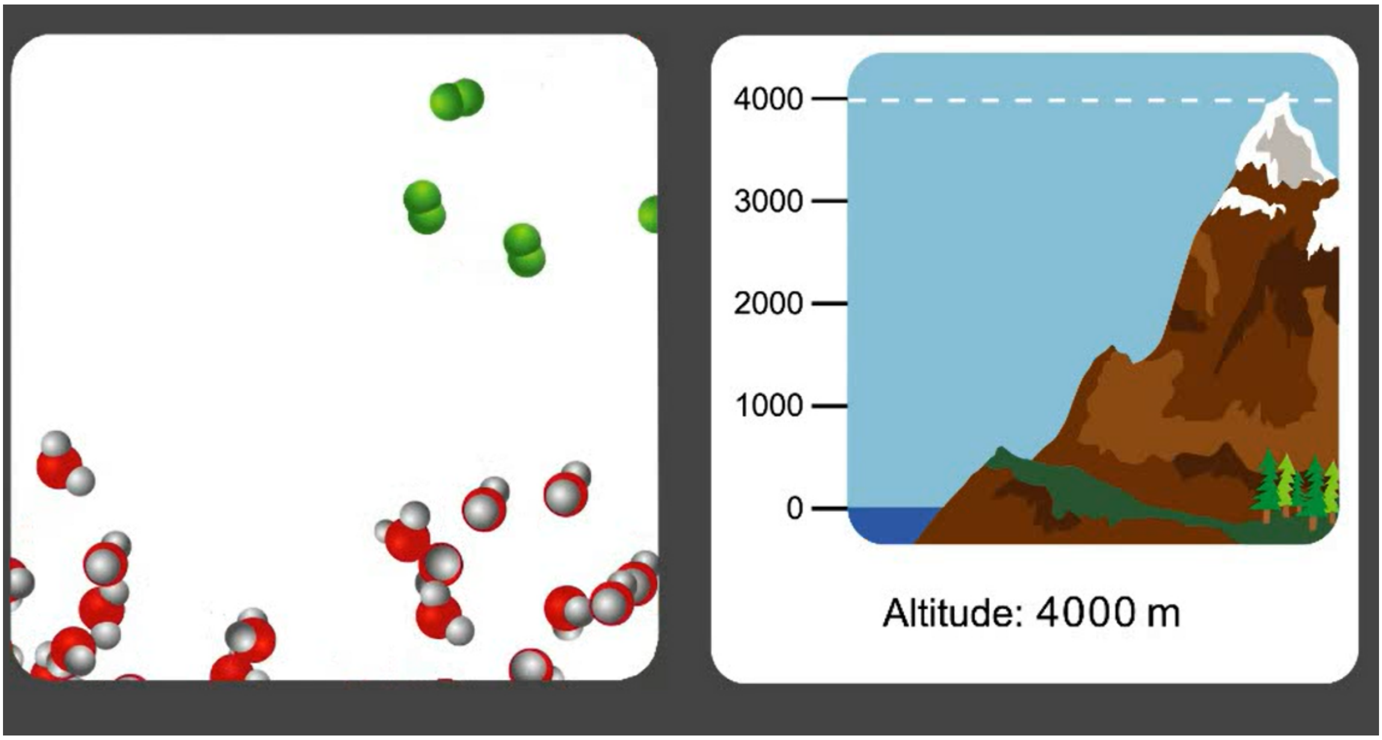
Question 6c (2 marks)

Air pressure reduces as altitude increases.





4000
3000
2000
1000
0
Altitude: 3188 m
The higher we are above sea level, the fewer particles there are to be found in the air.

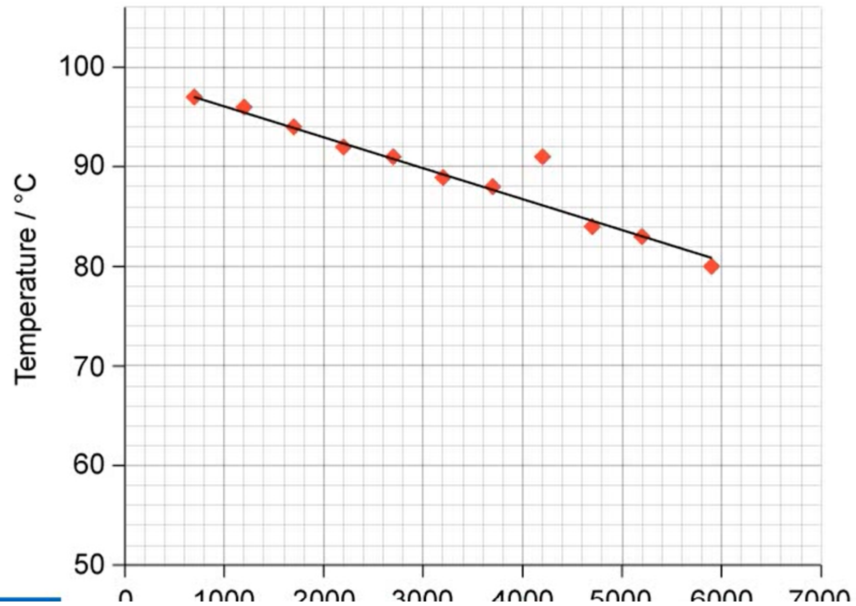


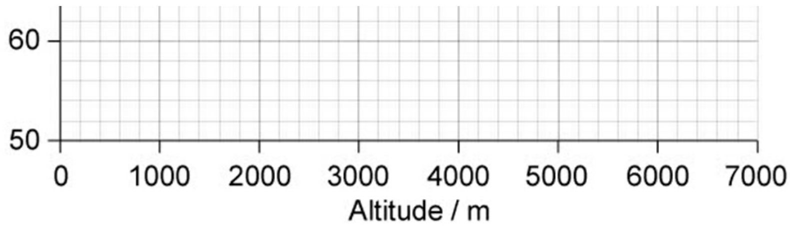
4000
3000
2000
1000
0
Altitude: 4000 m

Before starting her climb, the student writes the following hypothesis:

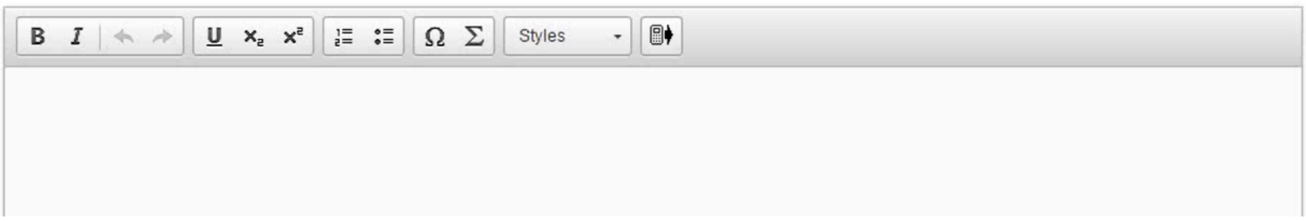
“As the altitude increases the boiling point will increase. The water molecules will find it harder to escape from the liquid because the pressure is dropping as you go up the mountain.”

Once she has completed the experiment the student presents her results on the following graph.





Identify which altitude produced an anomalous result and **justify** your answer.



Question 6d (2 marks)

Outline what this graph shows about the relationship between altitude and boiling temperature of water.

Question 6e (4 marks)

Explain the results of the investigation using particle theory.

Question 6f (2 marks)

"As the altitude increases the boiling point will increase. The water molecules will find it harder to escape from the liquid because the pressure is dropping as you go up the mountain."

Use the results shown on the graph in part (c) to **comment** on the validity of the hypothesis.

Question 6g (1 mark)

Suggest an extension to this investigation.

Question 7 (17 marks)

Another student decides to climb Mount Kilimanjaro with his friend. He decides to investigate the effect that altitude has on the volume of a balloon. He starts at the bottom of the mountain with a sealed, inflated balloon. **Design** a method that he could use to complete this investigation. In your method you should include:

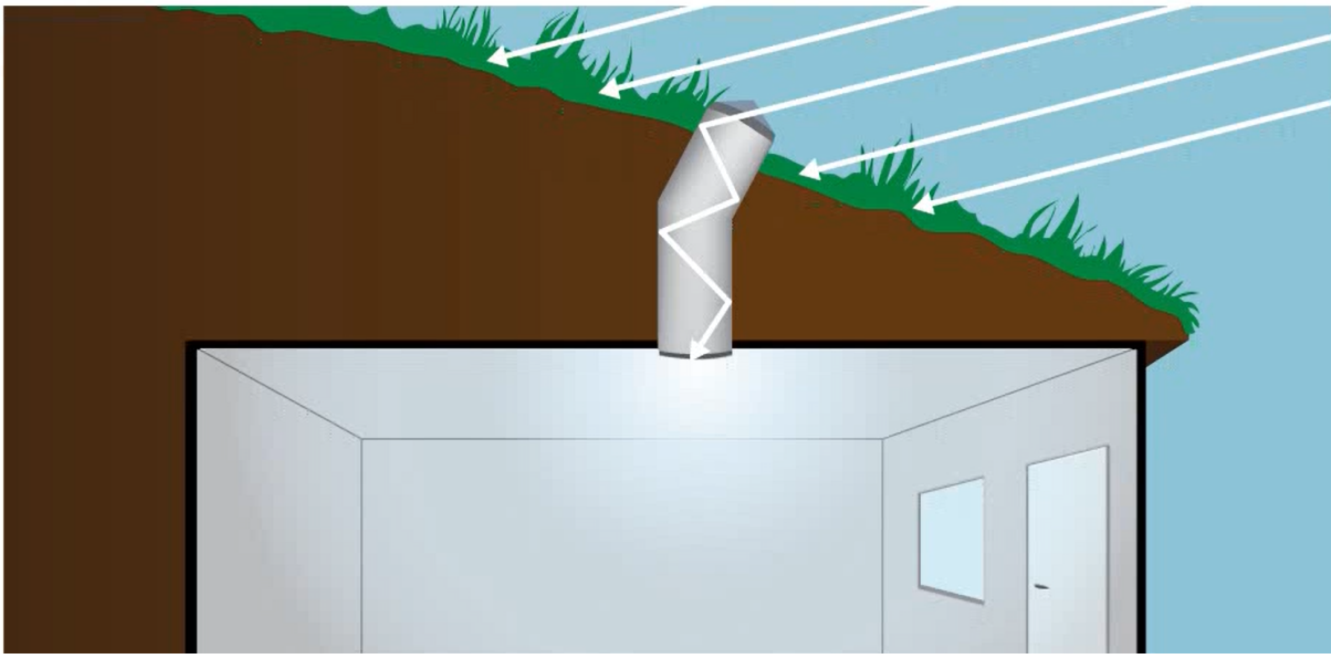
- the independent and dependent variables
- any assumptions you will make about control variables
- the equipment you will use
- the measurements you will make
- how you will collect sufficient data.

Question 8 (13 marks)

Humans need shelter every night and that means they have been looking for a temperate place to live for centuries.

Hundreds of years ago, one method of keeping houses warm in winter was to build part of the construction underground or to dig inside mountains. Iceland, Italy, Canada and the United States have examples of these constructions which are, in general, named *dugouts*.

A lack of natural light is common in dugout houses. Solar tubes can be used to redirect natural sunlight into dugout houses. Solar tubes use reflection to transmit light into the house.



Question 8a (4 marks)

Suggest two advantages and two disadvantages of using solar tubes in dugout houses.

Advantage 1	Disadvantage 1

Question 8b (9 marks)

Dugout houses and other buildings need to be built inside a large mass of rock or soil that acts as a thermal insulator. The rock or soil absorbs or retains heat as it needs a large quantity of energy to raise or lower its temperature. The temperature of dugout buildings remains constant throughout the year. In cool countries, the temperature inside the building will stay warm and in warmer countries the house will be cool.

In Coober Pedy, a town in Australia, the temperature changes between 0°C at night to over 50°C during the day.

°C during the day.

Nowadays extreme temperatures in some cities means that large quantities of energy are used in air conditioners or heaters to keep people at comfortable temperatures.

One way we could reduce the use of energy in cities is to build accommodation underground.

Discuss if underground housing could be used for inner city housing. In your answer, you should consider:

- advantages
- disadvantages
- environmental considerations
- social considerations.

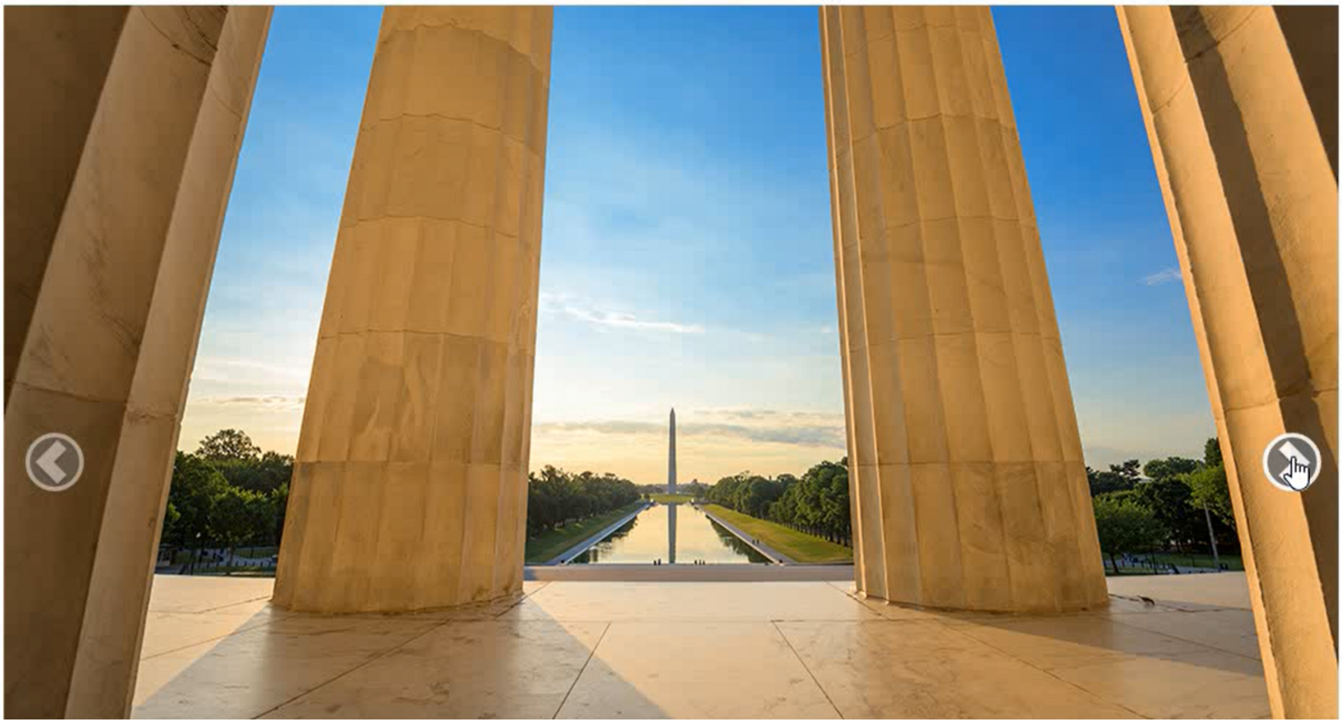
Question 9 (14 marks)

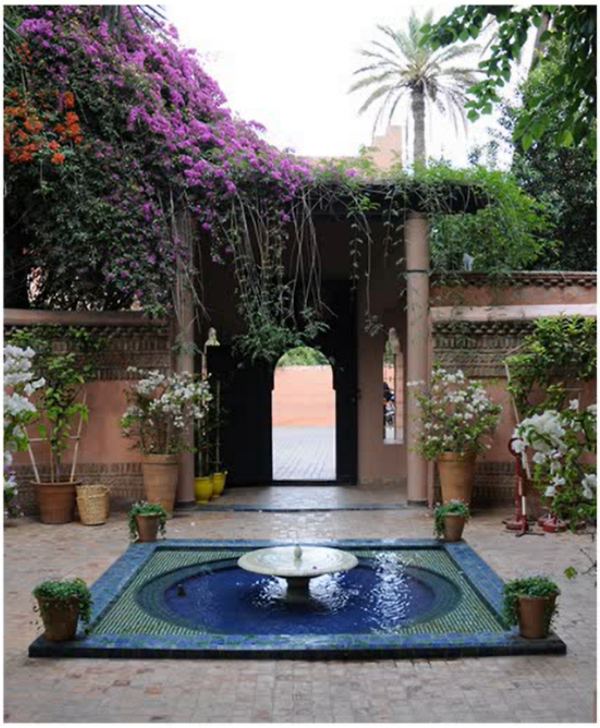
Water fountains or reflecting pools are a second method used by architects to reduce changes in temperature. These water features are added not only for their beauty but also for their advantage in controlling temperature. Water features are found in the Taj Mahal in India, in the Alhambra in Spain and in the Lincoln Memorial in Washington.

This system uses the fact that when water evaporates it causes a cooling effect.

However, in some hot countries, water is a resource with very limited availability.

Scroll through the images below.





It has been suggested that water features can also be used for air cooling in domestic houses.

You are an architect and your client wants to create an innovative and environmentally friendly house in a hot country.

Discuss and **evaluate** the implications of using water features in your design. In your answer, you should include:

- strengths of using water features in the home
- limitations of using water features in the home
- wider implications for the environment
- economic considerations
- a concluding appraisal of whether you would recommend water features.