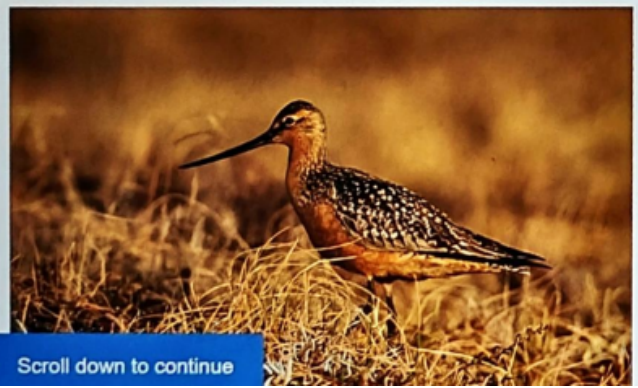
Question 1 (10 marks)

Some birds migrate every autumn, some fly to cooler countries and some fly to warmer countries. The bar-tailed godwit in the photograph can fly for nearly 11 000 km without stopping. During the eight-day journey that it takes to cover that distance, the bird doesn't stop for food or rest. This makes the bar-tailed godwit the bird with the longest recorded non-stop flight.

Question 1a (1 mark)



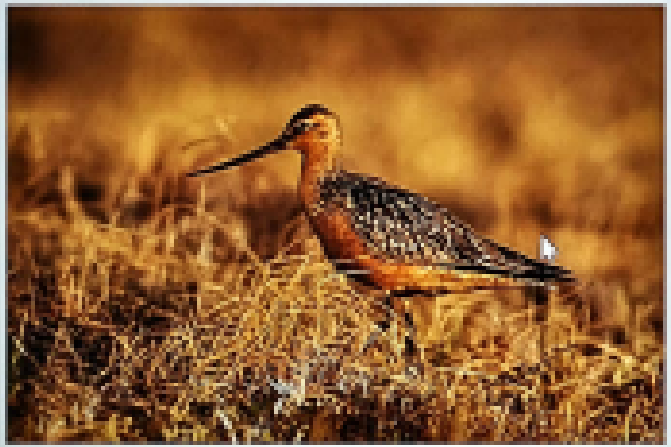
Scroll down to continue

One bar-tailed godwit flies 1200 km in a day. **Calculate** the speed in km h^{-1} (in kilometres per hour).

B I U x_2 x^2 Ω Σ

Styles

Question 1a (1 mark)



Photograph of bar-tailed godwit

One bar-tailed godwit flies 1200 km in a day. **Calculate** the speed in km h^{-1} (in kilometres per hour).

Question 1b (2 marks)

Scientists fit satellite transmitters to 16 godwits at two locations in New Zealand. Later the scientists use the information from the satellite transmitters and calculate that the average speed of the bird is 56 km h^{-1}.

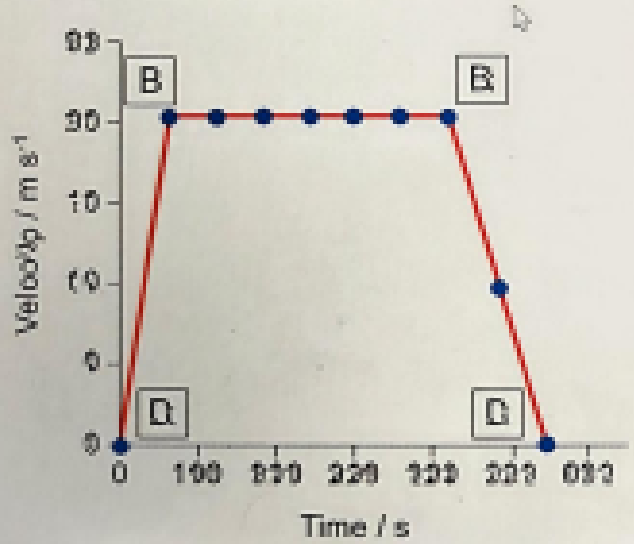
Outline two factors that may affect the average speed achieved by the bar-tailed godwit.

Question 1c (1 mark)

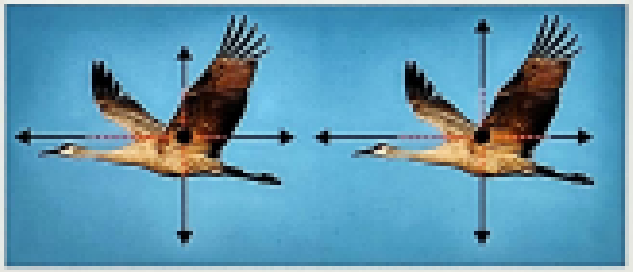
The graph below shows part of a different migrating bird's journey.

This media is interactive

Hover over the points to reveal data.

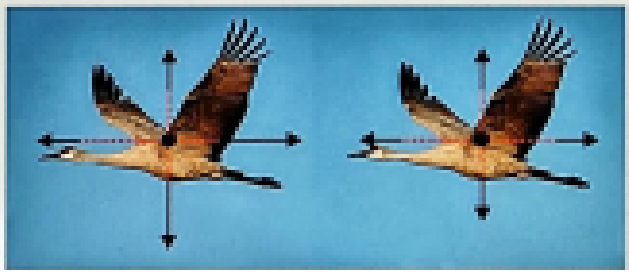


Select the appropriate diagram which represents the forces acting between points B and C on the graph.



1. ○

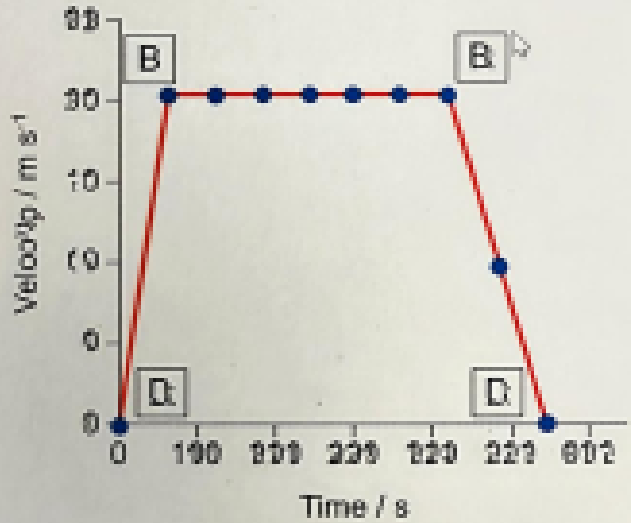
2. ○



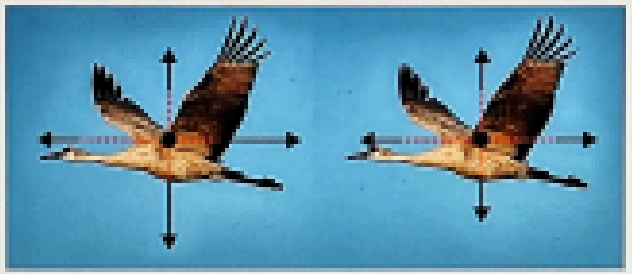
The graph below shows part of a different migrating bird's journey.

This media is interactive

Hover over the points to reveal data.



1. ○ 2. ○



3. ○ 4. ○

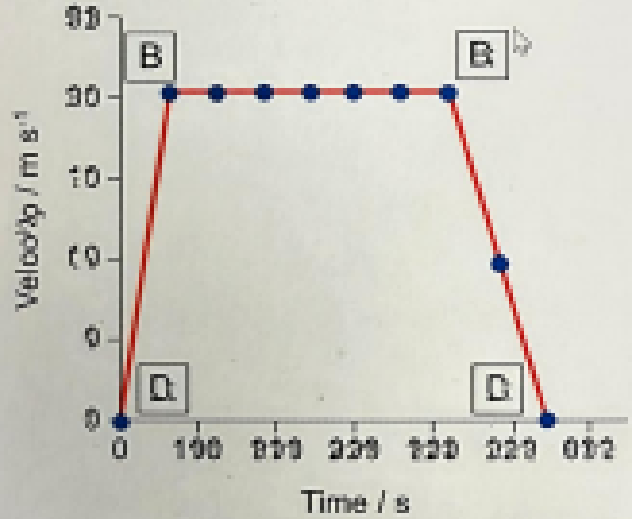
©

Question 1d (4 marks)

The graph below shows part of a different migrating bird's journey.

This media is interactive

Hover over the points to reveal data.



Question 1d (4 marks)

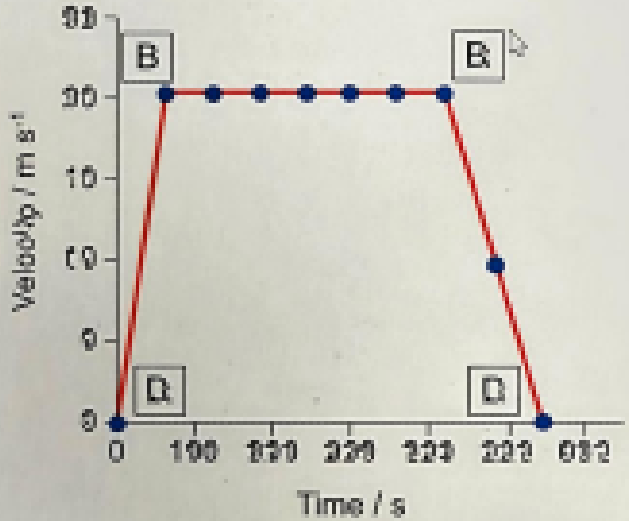
Explain what is happening with respect to the force, velocity and acceleration of the bird between points C and D on the graph. Include in your explanation which of Newton's laws is being obeyed as the graph changes.

Force

The graph below shows part of a different migrating bird's journey.

This media is interactive

Hover over the points to reveal data.



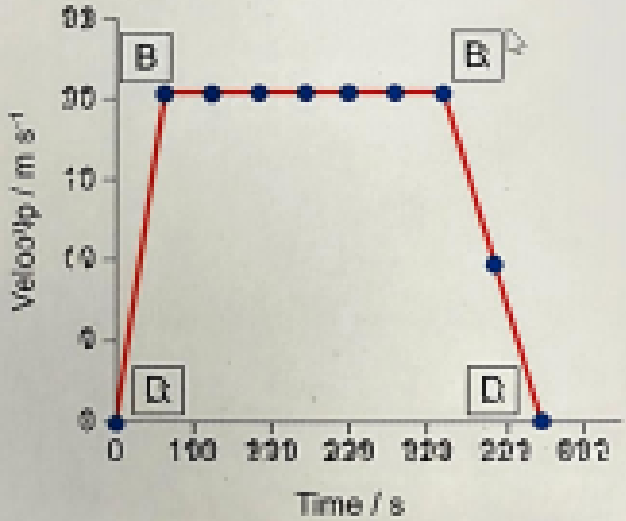
Force

Velocity

The graph below shows part of a different migrating bird's journey.

This media is interactive

Hover over the points to reveal data.



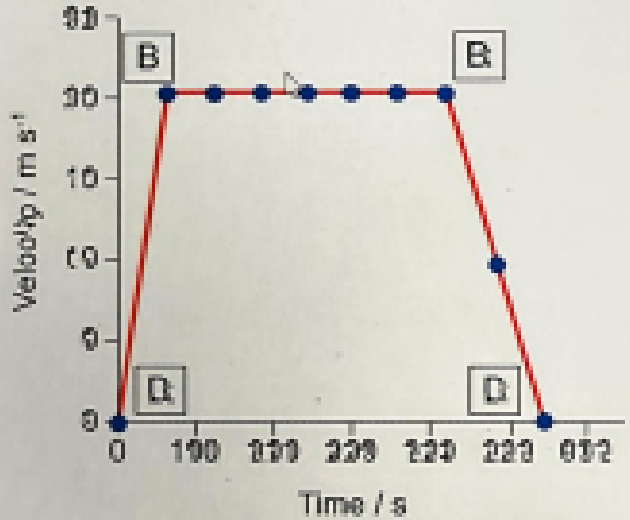
Acceleration

Newton's law

The graph below shows part of a different migrating bird's journey.

This media is interactive

Hover over the points to reveal data.



Question 1e (2 marks)

Use the graph to **calculate** the distance travelled by the bird while decelerating.

Question 2 (10 marks)

These animations show the two different types of wave moving along springs.

This media contains no audio

This media contains no audio

Question 2a (2 marks)

Label the two diagrams below to show wavelength, amplitude, compression and rarefaction.

Draggable items

- rarefaction
- amplitude
- compression
- wavelength

Diagram 1:

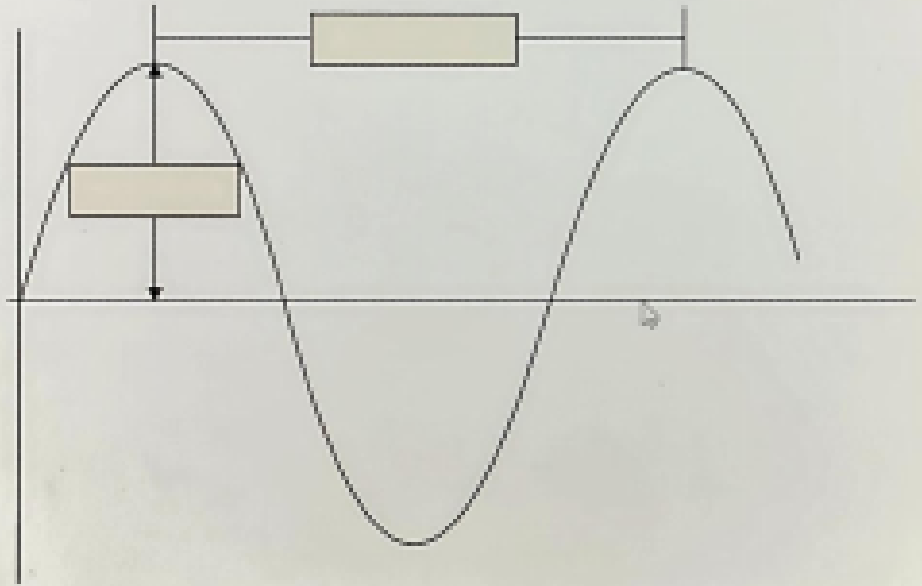
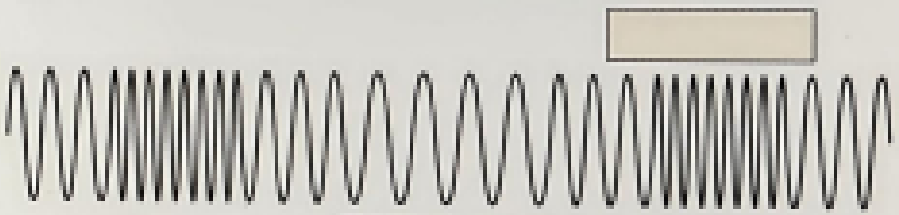


Diagram 2:



Infrasound is a low frequency longitudinal wave that elephants, whales, rhinoceros and alligators use to communicate with each other. The frequency of infrasound waves is lower than 20 Hz. Infrasound waves can travel very long distances through air at a speed of 330 m s^{-1}.

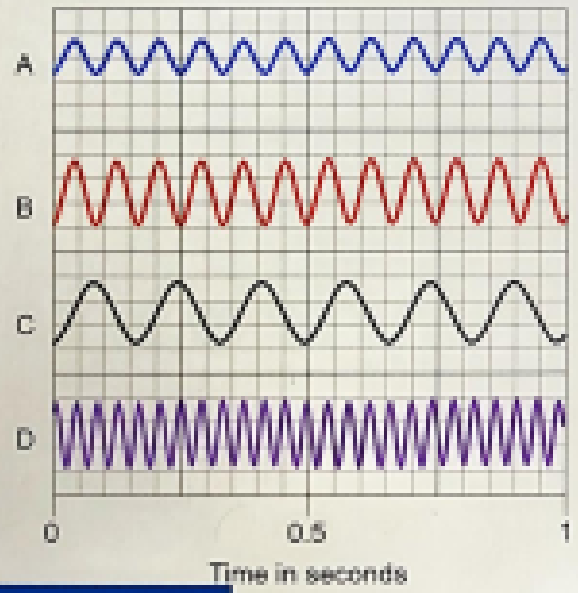
Sound waves can be represented on a computer. Below are some waves recorded on a computer from four different sources.

A 

Question 2b (1 mark)

Calculate the frequency of wave A.

Sound waves can be represented on a computer. Below are some waves recorded on a computer from four different sources.



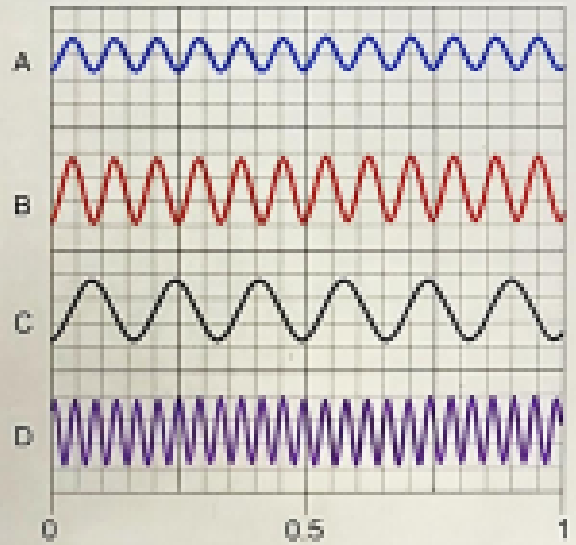
Question 2b (1 mark)

Calculate the frequency of wave A.

Question 2c (1 mark)

Identify which **two** waves have the same frequency.

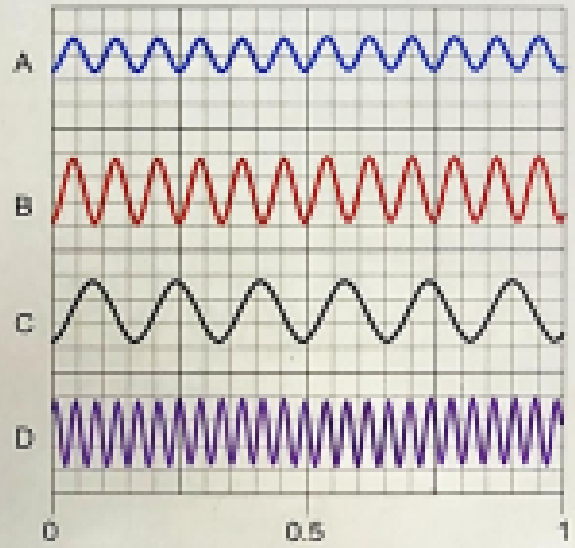
Sound waves can be represented on a computer. Below are some waves recorded on a computer from four different sources.



Question 2c (1 mark)

Identify which **two** waves have the same frequency.

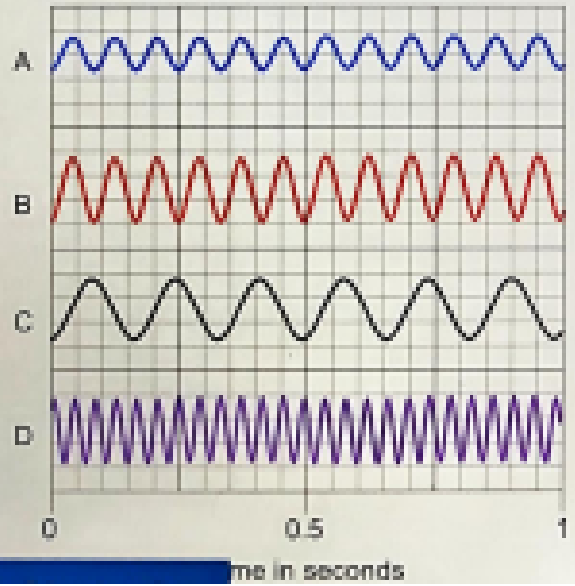
Sound waves can be represented on a computer. Below are some waves recorded on a computer from four different sources.



Question 2d (2 marks)

Calculate the wavelength of wave C.

Sound waves can be represented on a computer. Below are some waves recorded on a computer from four different sources.



Question 2e (1 mark)

Infrasound waves have a frequency of less than 20 Hz. Use your answers above to **identify** which wave does not show infrasound.

Question 2f (3 marks)

Animals use infrasound as the waves travel long distances. This is because low frequency, long wavelength infrasound waves lose little energy in transmission.

Elephants can communicate with each other using infrasound. **Explain** how the group of elephants on the other side of the hill can hear the elephant.

Question 3b (3 marks)

Explain your answer to part (a).

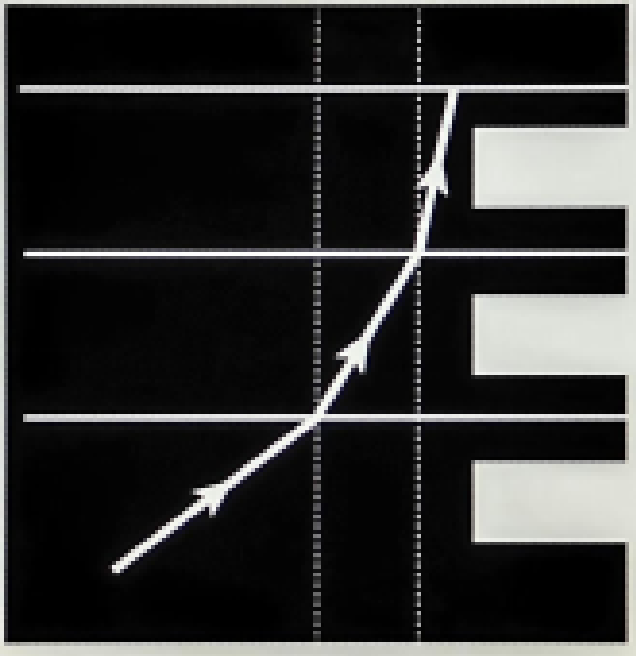
Question 3a (2 marks)

Use the data and diagram to **identify** each of the materials the ray passes through. Drag and drop the label to the correct layer.

Material	Refractive index (n)
Air	1.00
Glass	1.50
Water	1.33

Draggable items

Water Glass Air



Question 4 (8 marks)

Question 4a (1 mark)

Select an appropriate charge for each particle below.

Electron: Select charge ▾ Proton: Select charge ▾ Neutron: Select charge ▾

Select charge
+1
0
-1

Question 4b (3 marks)

Most materials are electrically neutral; they contain equal numbers of charged particles. The animation shows that if a cloth is used to rub a plastic rod, the rod becomes positively charged.

Use the animation to **explain** the process

This media is interactive

Start

Question 4b (3 marks)

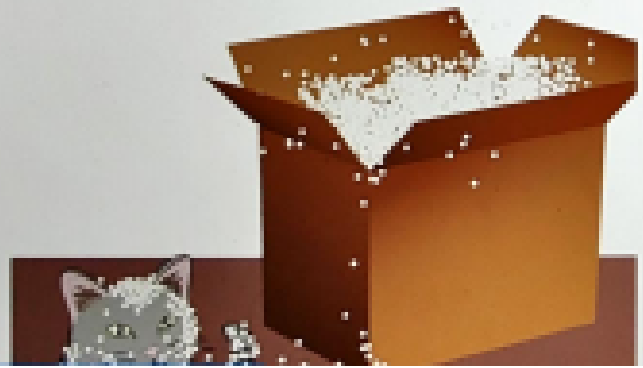
Most materials are electrically neutral; they contain equal numbers of charged particles. The animation shows that if a cloth is used to rub a plastic rod, the rod becomes positively charged.

Use the animation to **explain** the process that has occurred between the cloth and the rod, leaving the rod positively charged.

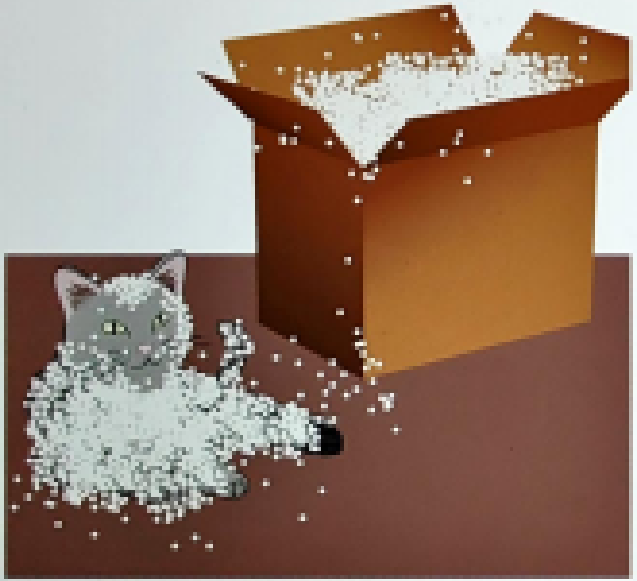
This media is interactive

Question 4c (4 marks)

Harry the cat is rolling around on the carpet on a very dry day when he notices a cardboard box nearby full of polystyrene. Wanting to play, he jumps into the box! When Harry is pulled out of the box, the polystyrene pellets are stuck to his fur.



Using the concept of induction, **suggest** why the polystyrene pellets stick to Harry.



Using the concept of induction, **suggest** why the polystyrene pellets stick to Harry.

Question 5 (13 marks)

Question 5a (3 marks)

This question is about heat transfer.

List the **three** ways that heat is transferred.

1.

2.

3.

Question 5b (2 marks)

Zaina carries ice cream home from the shops. On hot days, she finds that much of the ice cream has melted before she gets home. She lives 15 minutes away from the shops. Zaina decides to investigate a solution to this problem. In many countries, wrapping ice cream in thick paper is an environmentally friendly alternative to insulated bags.

Zaina uses standard blocks of ice, each with mass of 100 g, to model the melting of the ice cream. She decides to investigate how the number of sheets of paper wrapped around the block affects the mass of ice that has melted.

Other than ice and paper, **suggest** and **justify one** additional piece of equipment that Zaina will need to perform this experiment.

Equipment:

Justification:

Question 5c (2 marks)

Suggest and **justify** a hypothesis for this experiment.

Question 5d (3 marks)

State one variable that Zaina needs to control. **Describe** how and why this variable should be controlled.

Variable

How the variable should be controlled

Why the variable should be controlled

Question 5e (3 marks)

Explain what results Zaina needs to collect to ensure that she has sufficient relevant data.

Question 6 (9 marks)

Another student, Gareth, finds that his cup of coffee cools down too quickly when taking it home from his local coffee shop. He wonders if the thin cardboard cup is the reason for the coffee cooling down too quickly.

Gareth formulates the hypothesis: "The thicker the coffee cup, the longer the coffee will take to cool down because the heat will take longer to transfer through the thicker material of the cup". He finds cups of different thicknesses in his kitchen.

He fills each cup with coffee to the same level and times how long it takes for the coffee to cool down from 75 °C to 50 °C in each cup.

Question 6a (1 mark)

Thickness of coffee cup / mm	Time taken to cool from 75 °C to 50 °C / min
1	18
2	25
3	8
3	16
4	10

State and **justify** whether the results of Gareth's investigation support his hypothesis.

Styles

Question 6b (8 marks)

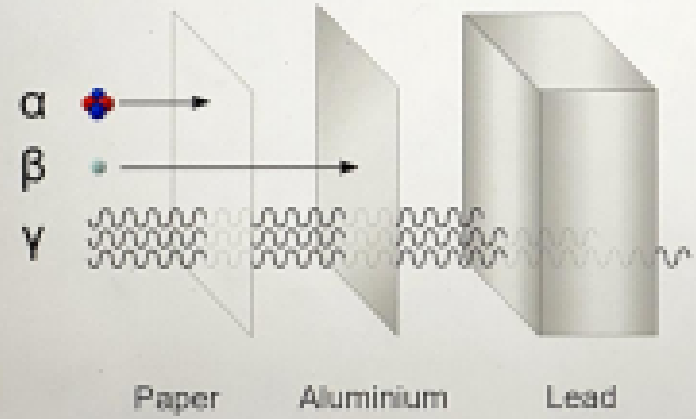
Identify four weaknesses in Gareth's method. For each of the weaknesses, **explain** how his investigation was affected. Use scientific knowledge and understanding in your answer.

Question 7 (21 marks)

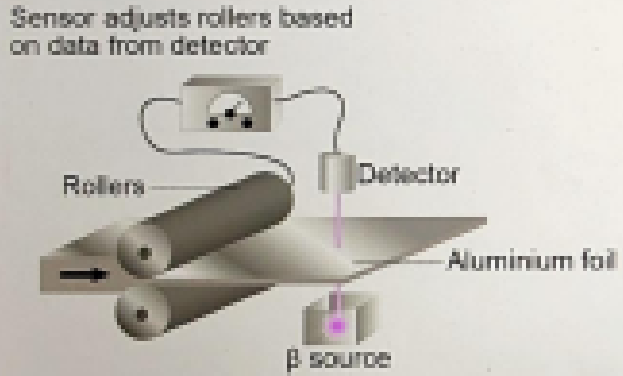
Developments in the understanding of atomic physics have led to many useful applications in industry, medicine and technology.

Through understanding patterns in the properties of alpha (α), beta (β) and gamma (γ) radiation, scientists have developed ways in which the specific properties may be used.

One useful property is the difference in the penetration of alpha, beta and gamma radiation. The diagram compares the penetration of the three types of radiation.



The amount of beta radiation absorbed depends on the thickness of the materials. This property of beta radiation is used to monitor the thickness of aluminium foil produced in an aluminium factory.



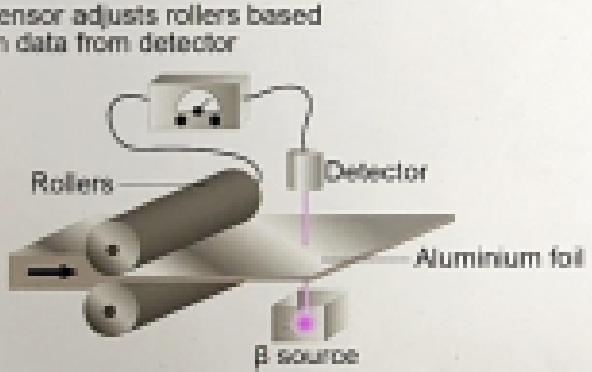
Question 7a (2 marks)

Your task is to design an investigation to determine how the thickness of aluminium foil affects the amount of beta radiation absorbed.

State the independent and dependent variables in your investigation.

Independent variable

The amount of beta radiation absorbed depends on the thickness of the materials. This property of beta radiation is used to monitor the thickness of aluminium foil produced in an aluminium factory.



Dependent variable

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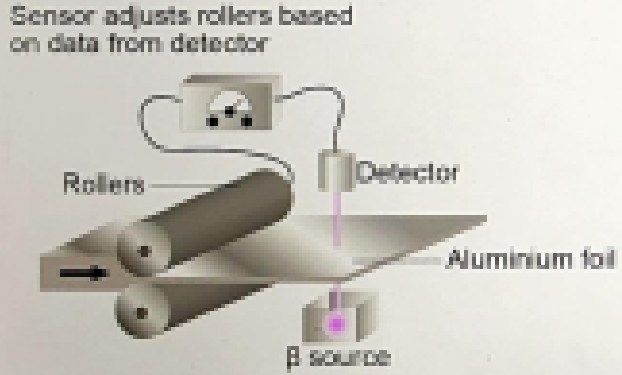


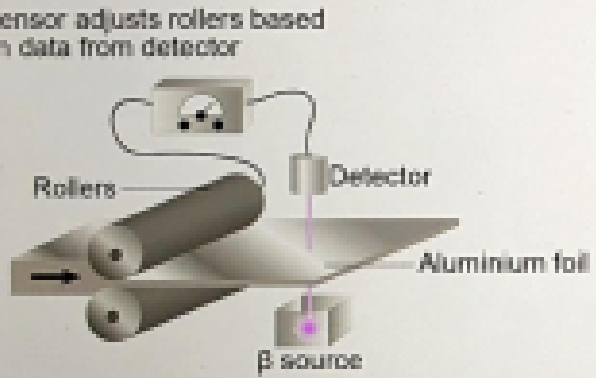
Question 7b (2 marks)

Outline the nature of beta radiation.

Question 7c (2 marks)

Formulate a hypothesis that would be

The amount of beta radiation absorbed depends on the thickness of the materials. This property of beta radiation is used to monitor the thickness of aluminium foil produced in an aluminium factory.

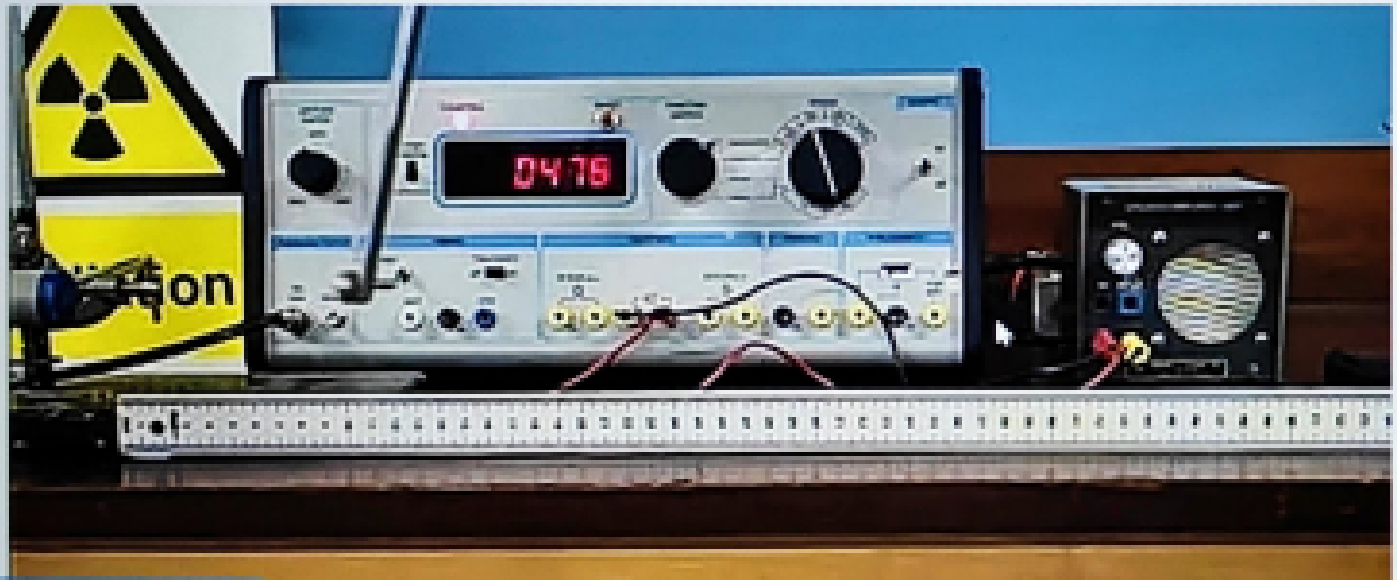


Question 7c (2 marks)

Formulate a hypothesis that would be tested by your investigation using scientific knowledge and understanding.

The following video shows how the absorption of radiation can be measured with a Geiger-Muller tube.

The Geiger-Muller tube is linked to a digital rate meter. The rate meter gives readings in counts per second, which is a measure of the number of ionizations detected by the Geiger-Muller tube each second.



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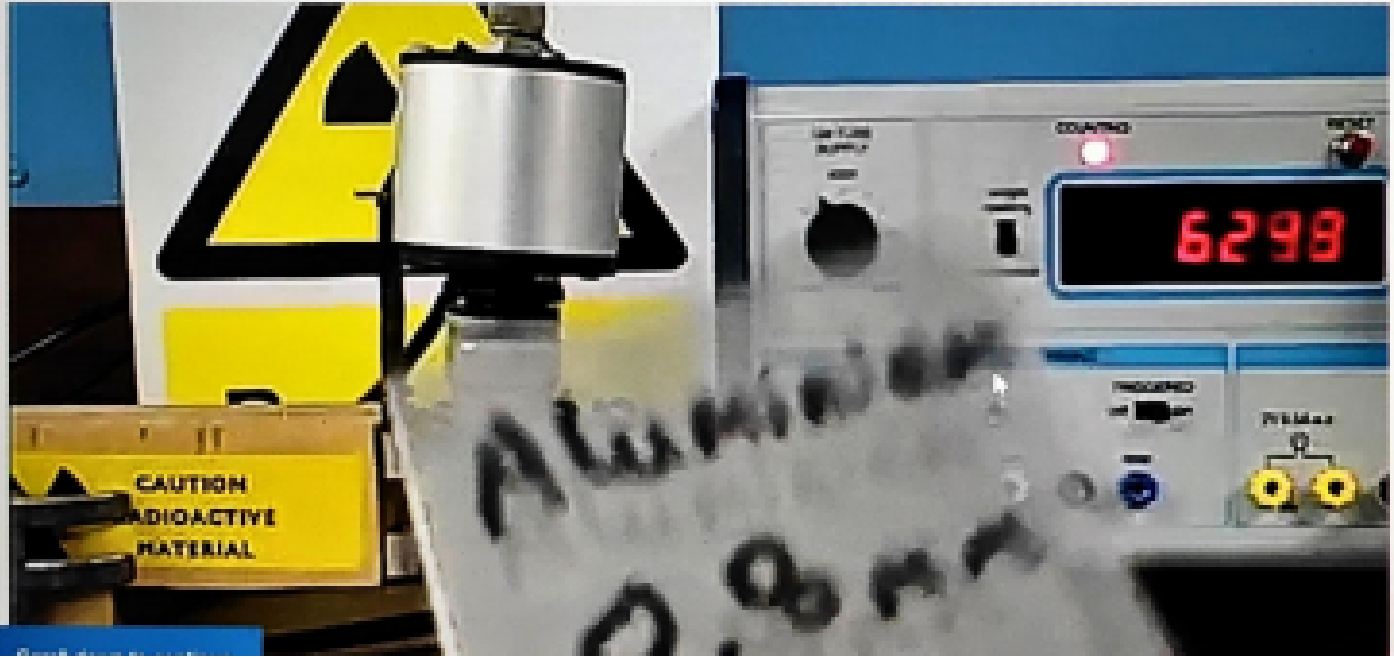


You are provided with the following equipment:

- A source of beta radiation. In this case strontium-90 will be used. The radioactive source is in a sealed lead-lined container and produces a beam of beta radiation.
- A number of sheets of aluminium foil, with a thickness of 0.04 mm
- Standard laboratory equipment (metre rules, clamps and clamp stands, etc.).

Question 7d (6 marks)

Explain the method you would use to collect data to test your hypothesis from part (c).

Question 7e (1 mark)

Background radiation is all around us. Background radiation does not come from the source; it is naturally occurring.

State one origin of the background radiation.

Question 7f (2 marks)

Describe how the data collected could be corrected for the possible effects of background radiation.

Question 7g (4 marks)

State and **justify** two precautions you would take to ensure that the method was carried out safely.

Precaution	Justification

Reset

Question 7h (2 marks)

Imagine that you perform exactly the same experimental method as the one you planned but this time, you use an alpha source instead of the beta source.

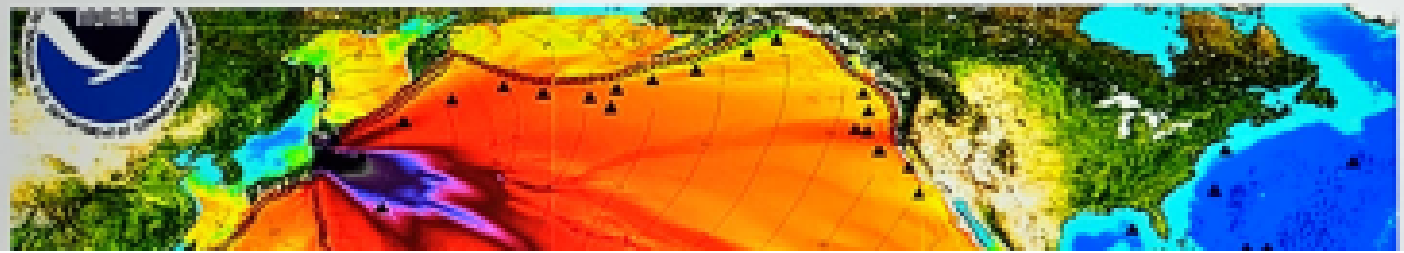
Formulate a hypothesis for this second experiment using scientific knowledge and understanding in your answer.

Question 8 (12 marks)

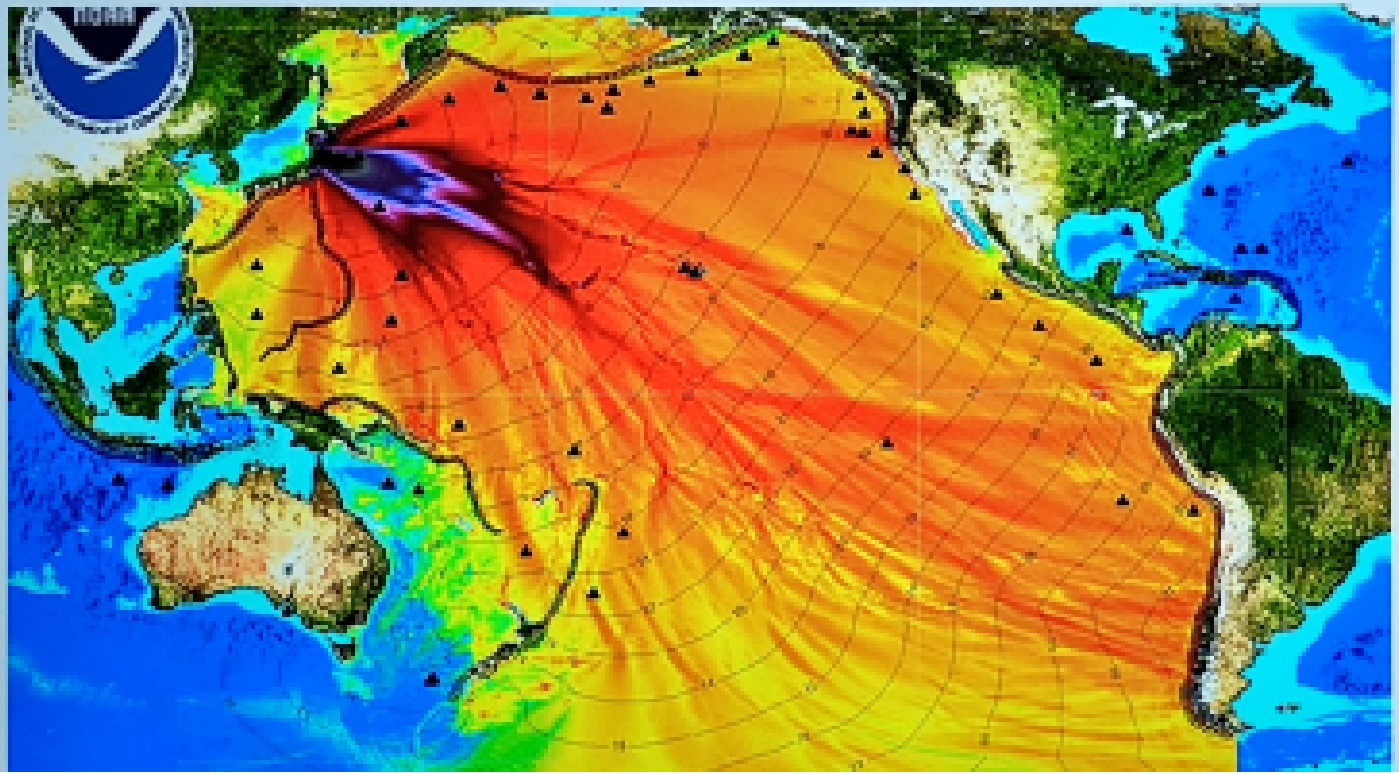
We have seen that strontium-90 has useful applications in industry but uncontrolled release of strontium-90 into the environment has negative consequences.

In 2011, there was a disaster at the Fukushima Daiichi nuclear power plant in Japan. This disaster resulted in the release of large amounts of radioactive water into the local environment; scientists think that this process is still occurring. The water contains many different radioisotopes including strontium-90. Some of this material made its way into the sea and has been spread globally as a result.

The map below shows a model of how the radioactive material released from Fukushima might spread across the world in seawater. The darker colour shows where the readings of radiation are predicted to be the highest.



The map below shows a model of how the radioactive material released from Fukushima might spread across the world in seawater. The darker colour shows where the readings of radiation are predicted to be the highest.



The negative environmental effects of strontium-90 are clear, but to understand how long-lasting these effects will be, scientists must know the half-life of the radioisotope. The half-life is the time taken for the number of radioactive nuclei to decrease by half.

Radioactive decay is a random process. Strontium-90 decays to yttrium-90 by beta decay.

$$^{90}_{38}Sr \rightarrow {}^{90}_{39}Y + {}^{0}_{-1}\beta$$

Two years after the Fukushima Daiichi disaster, scientists wanted to investigate what was happening inside the reactor. Radiation levels inside the reactor were too high for humans to investigate directly so the scientists used a probe specially designed to work in radioactive conditions. The scientists found evidence of highly radioactive water leaking from the reactor.

decay.

$$^{90}_{38}Sr \rightarrow ^{90}_{39}Y + ^{0}_{-1}\beta$$

designed to work in radioactive conditions. The scientists found evidence of highly radioactive water leaking from the reactor.

Question 8a (6 marks)

The simulation below shows what could happen to a sample of 100 strontium-90 nuclei over a period of 100 years.

You are going to collect data to enable you to plot a decay curve. You need to know how the number of strontium-90 nuclei varies with time. Time is your independent variable and number of strontium-90 nuclei is your dependent variable.

The table on the left below shows the data that you will record during the simulation.

This media is interactive

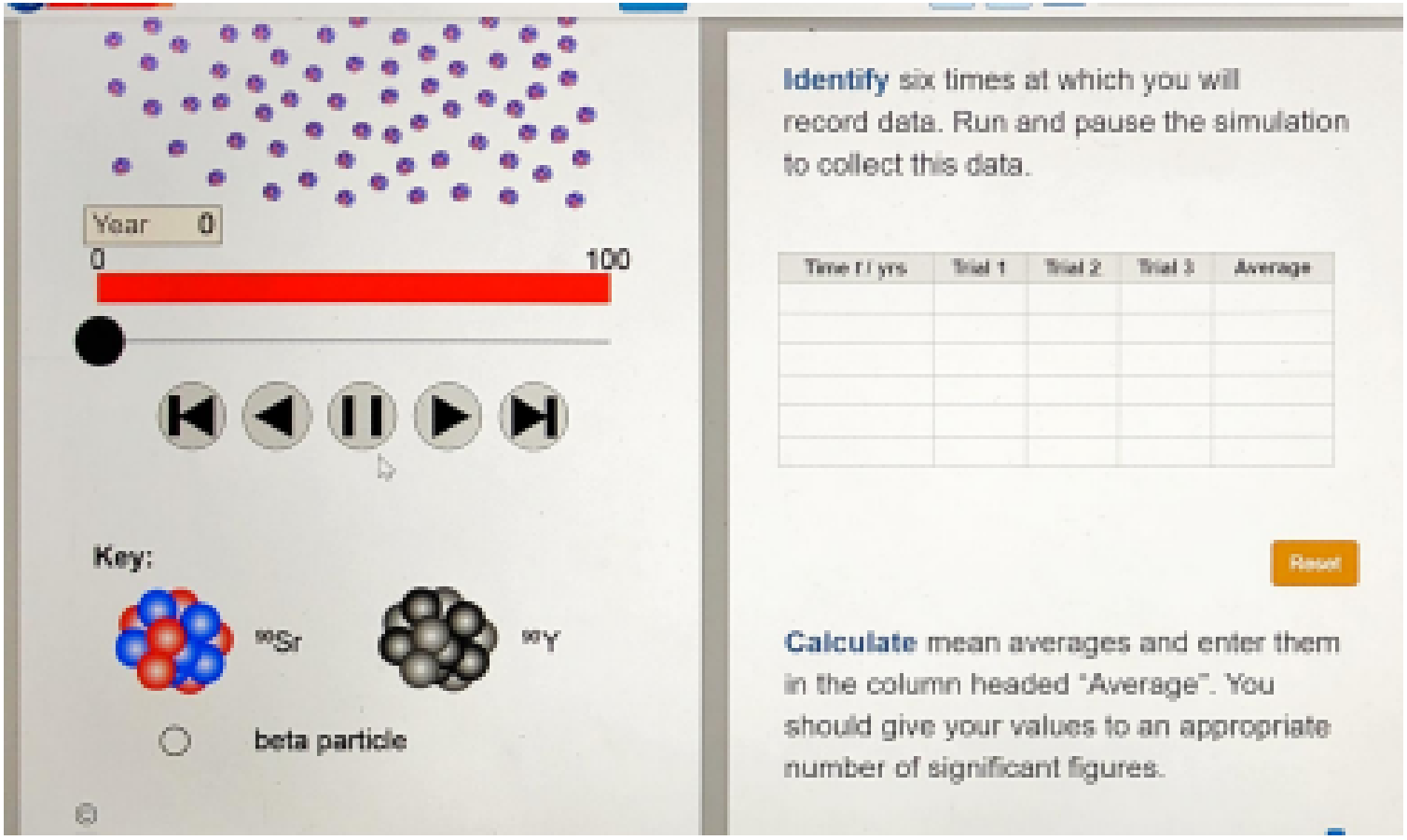
Nuclei numbers	Trial 1	Trial 2	Trial 3
^{90}Sr	100	100	100
^{90}Y	0	0	0

Identify six times at which you will record data. Run and pause the simulation to collect this data.

Time t / yrs	Trial 1	Trial 2	Trial 3	Average

Reset

Calculate mean averages and enter them in the column headed "Average". You should give your values to an appropriate number of significant figures.

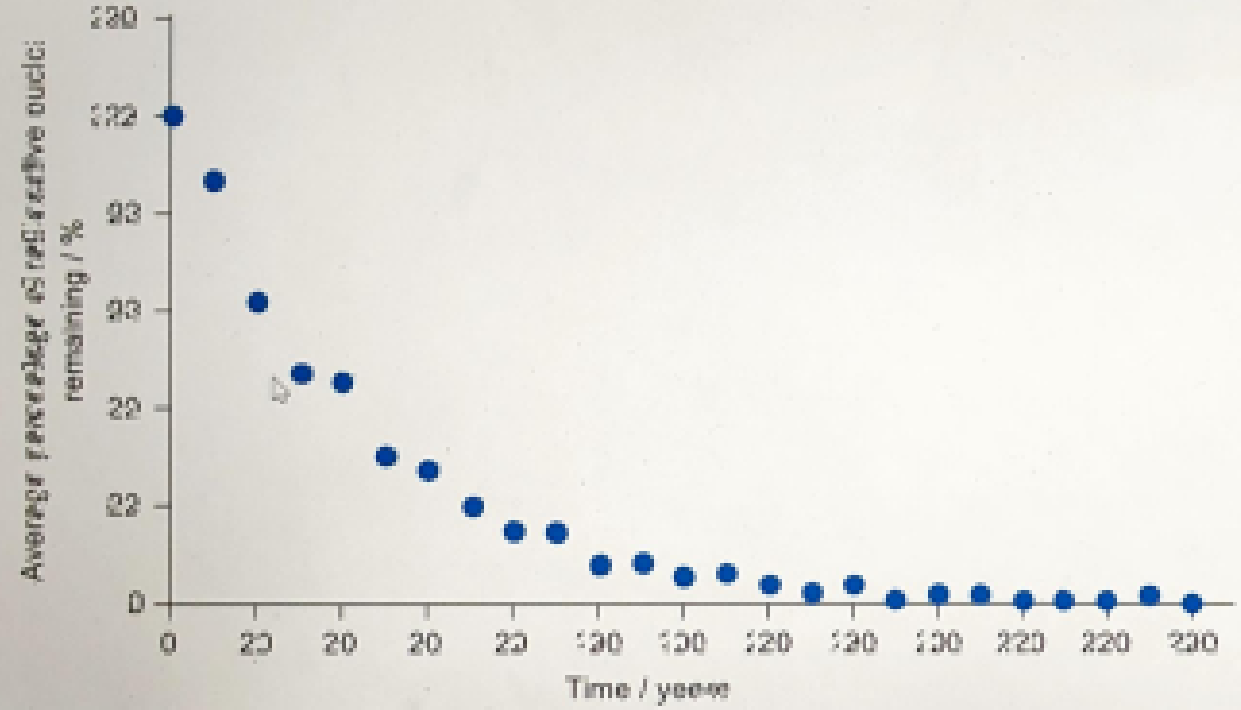

Year 0
0
100
Key:
^{90}Sr
^{90}Y
beta particle
Identify six times at which you will record data. Run and pause the simulation to collect this data.
Time t / yrs
Trial 1
Trial 2
Trial 3
Average
Reset
Calculate mean averages and enter them in the column headed "Average". You should give your values to an appropriate number of significant figures.

Another radioisotope that was released in the Fukushima Daiichi nuclear disaster was caesium-137. Another student used a simulation to collect decay data for caesium-137. Their data is presented in the graph below where time is on the *x*-axis and average percentage of caesium-137 remaining is on the *y*-axis.

This media is interactive

Hover over the points to reveal data.

Hover over the points to reveal data.

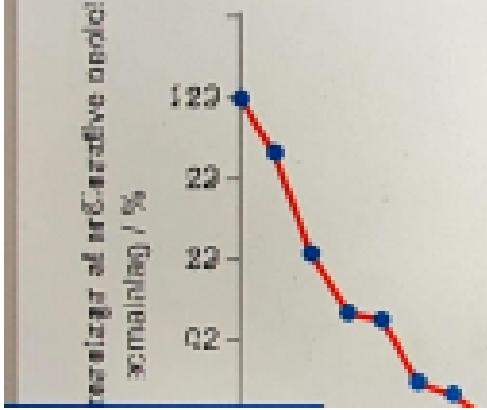


Question 8b (1 mark)

Some of the data is also presented in the graphs below. Click on the tabs to view the different graphs.

Point-to-point | Straight line | Smooth curve

This media is interactive



Select the most appropriate graph to present the data.

Select
Select
Point-to-point
Straight line
Smooth curve

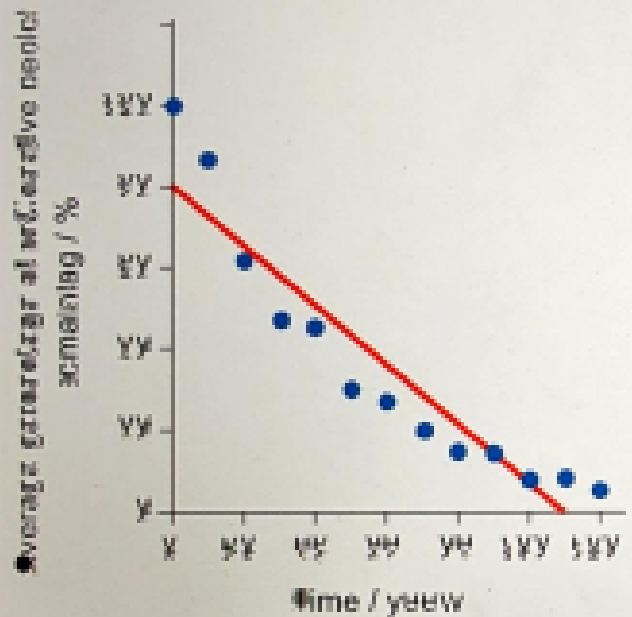
Question 8c (3 marks)

The half-life is characteristic of a particular isotope.

Using the graph, **calculate** the average

Point-to-point | Straight line | Smooth curve

This media is interactive



Select the most appropriate graph to present the data.

Select

Question 8c (3 marks)

The half-life is characteristic of a particular isotope.

Using the graph, **calculate** the average half-life for caesium-137. You should use **at least three** data points in your calculation.

Point-to-point | Straight line | Smooth curve

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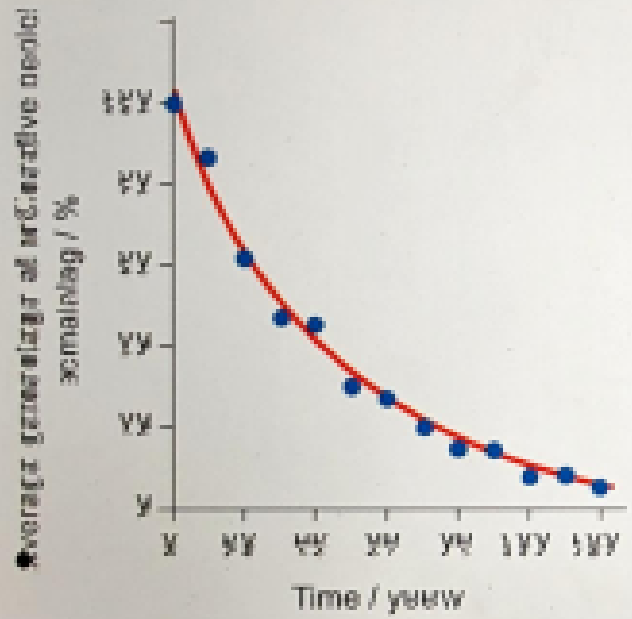

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B I Styles

Point-to-point | Straight line | Smooth curve

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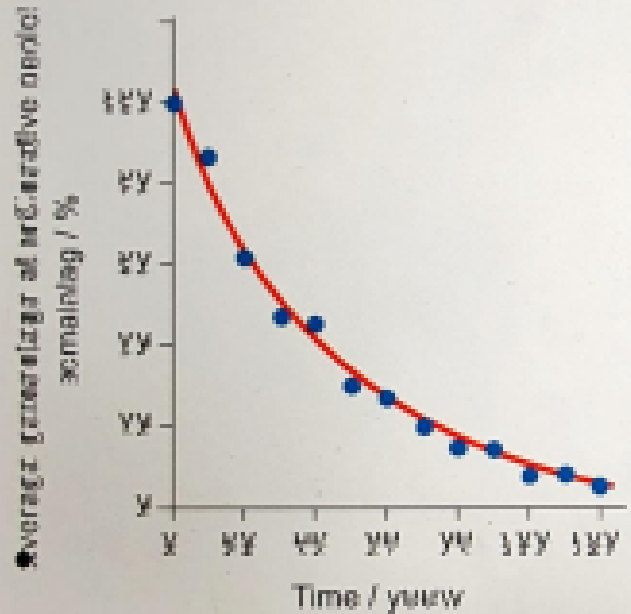

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Point-to-point | Straight line | Smooth curve

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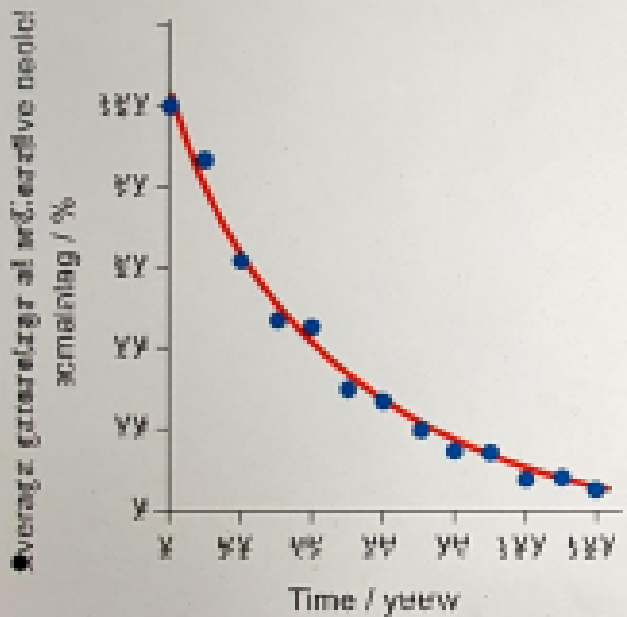
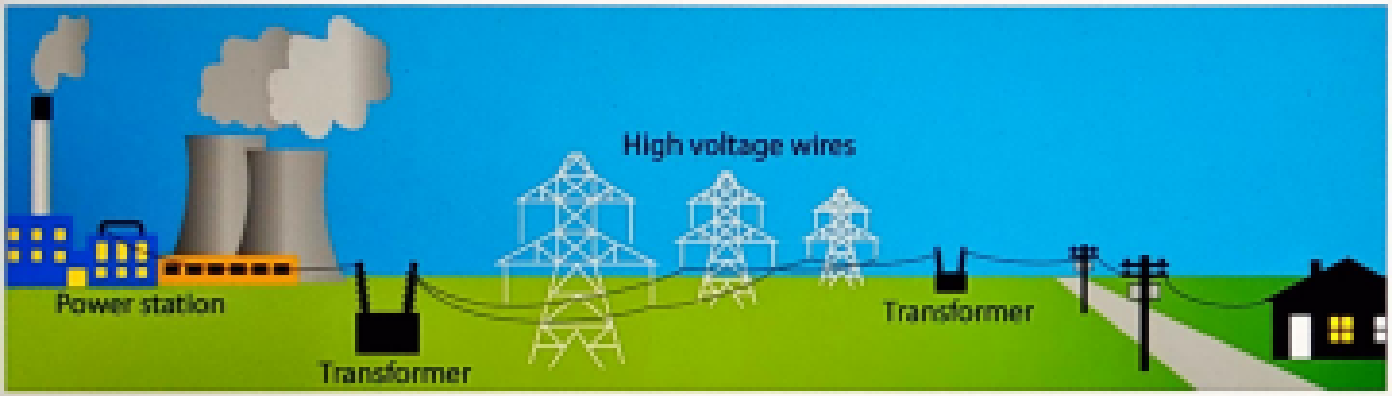


Question 8d (2 marks)

A different isotope of caesium, caesium-134 was also released. Caesium-134 has a half-life of two years. If the Fukushima Daiichi disaster released 1 600 000 atoms of caesium-134 into the ocean, **calculate** how long it would take for this number to decrease to 100 000.

Question 9 (16 marks)

This question is about the generation and transmission of electricity. In many developed countries, electricity is generated in large power stations, far away from where the people who use the electricity live and work.



The energy sources that power the generators in large industrial countries are coal, gas and nuclear (fission) reactors, or a mix of these.

Question 9a (2 marks)

Suggest two reasons why people would not want a coal-fired power station in or near their city.

Reason 1:

Reason 2:

Question 9b (1 mark)

Outline a reason why coal-fired and nuclear power stations are built near large rivers or the sea.

Question 9c (1 mark)

The cables lose some electrical power as it transfers from the power station to the city. One solution is to reduce this power loss by increasing the voltage of the electricity in the cables when the energy travels long distances.

A transformer converts current and voltage.

If $P = IV$, when the secondary voltage doubles, **state** what happens to the secondary current.

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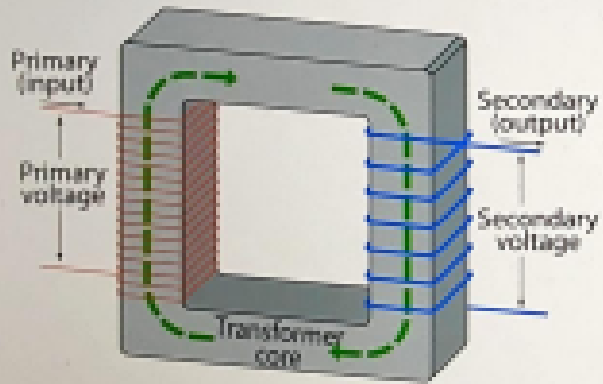

For an ideal transformer, the primary

If $P = IV$, when the secondary voltage doubles, **state** what happens to the secondary current.

Question 9d (3 marks)

Describe why increasing the voltage reduces the power lost during transmission.

Question 9e (6 marks)

Coal is a source of energy that is found in many parts of the world. When coal is burned, it produces three gases: water vapour (H_2O), carbon dioxide (CO_2) and sulfur dioxide (SO_2).

Choose any two of the gases listed above and **describe** a problem associated with each.

Select gas

Select gas
water vapour
carbon dioxide
sulfur dioxide

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Problem

How does this gas cause this problem?

Select gas

Select gas
water vapour
carbon dioxide
sulfur dioxide

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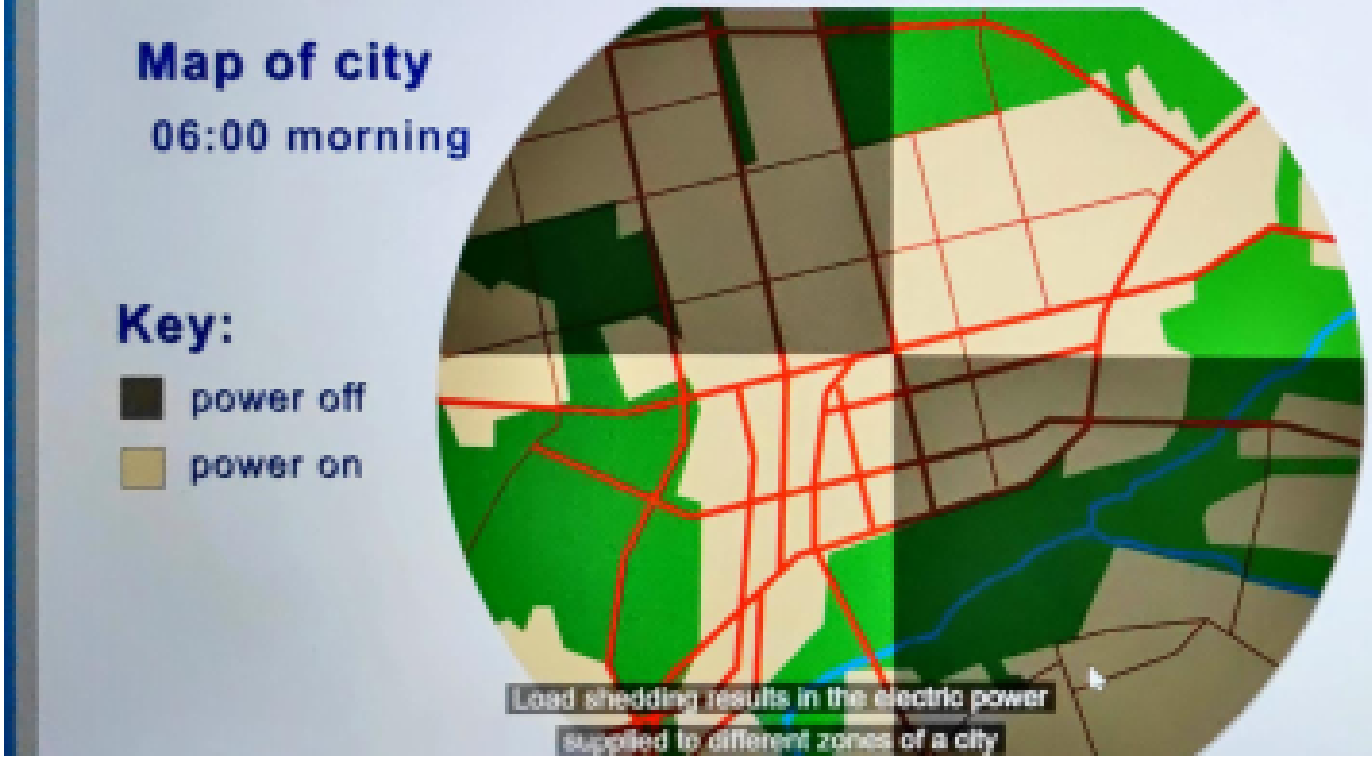
Question 9f (3 marks)

Large power stations operate continuously, 24 hours a day, and it often takes many days to turn them on and off.

Suggest why a power generation company might sell electricity more cheaply at night than during the day.

Question 10 (16 marks)

The animation below shows a sustainable solution to traffic management in an African city.



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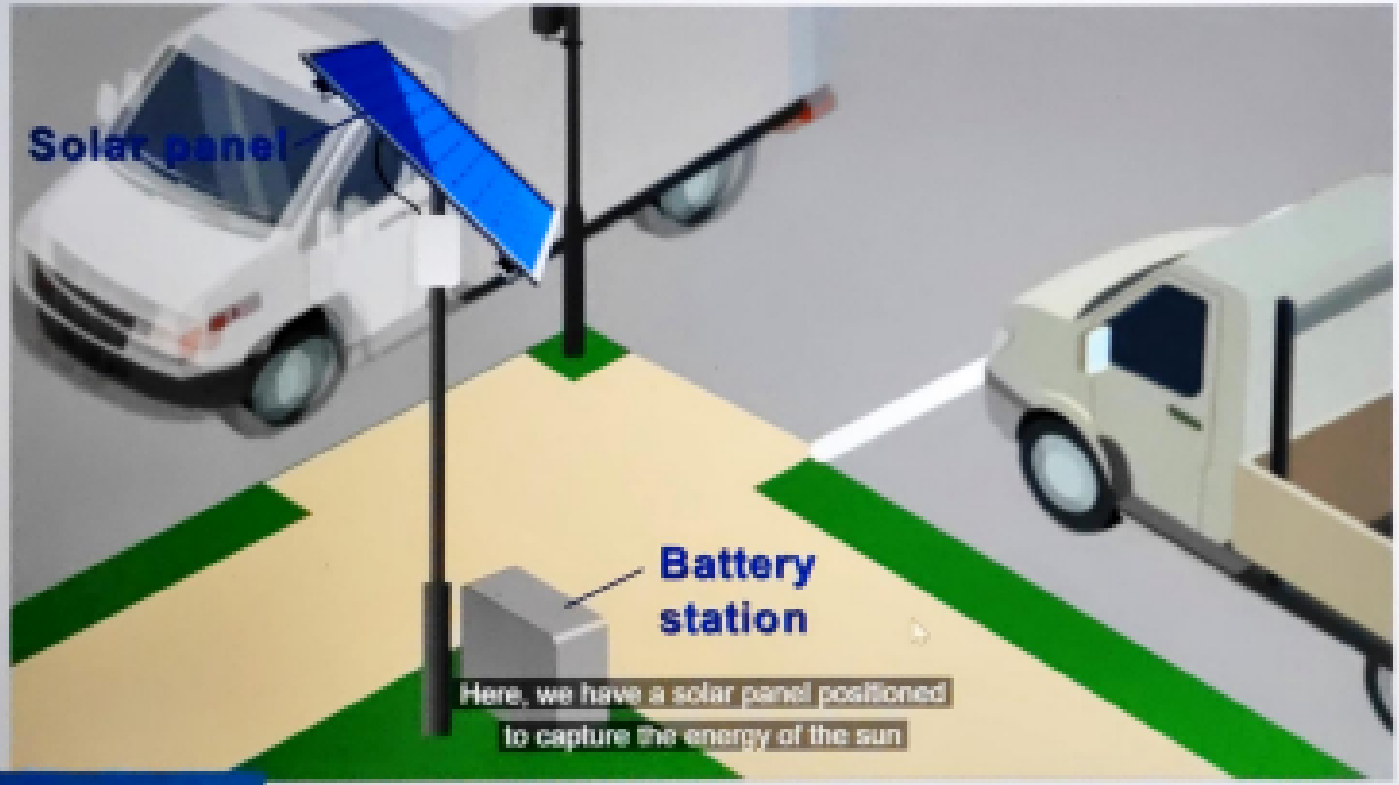

Question 10a (1 mark)

Apart from traffic lights, **suggest** a different application where a constant source of electricity is necessary.

Question 10b (15 marks)

Using information from the animation and your wider MYP studies, **discuss** and **evaluate** the use of a small-scale solar electrical power supply to solve the problem identified in part (a). In your answer you should consider:

- why a constant source of electricity is important in your application
- the advantage of using a small-scale power supply in this situation
- the disadvantage of using a small-scale power supply in this situation
- economic factors
- social factors.