OCR
RECOGNISING ACHIEVEMENT

# Wednesday 18 January 2012 – Afternoon

## A2 GCE APPLIED SCIENCE

**G628** Sampling, Testing and Processing

*G611390111*

Candidates answer on the Question Paper.

**OCR supplied materials:**
- Insert (inserted)

**Other materials required:**
- Electronic calculator
- Ruler (cm/mm)

**Duration:** 1 hour 30 minutes

*G 6 2 8*

| Candidate forename | | Candidate surname | |
|---|---|---|---|

| Centre number | | | | | | Candidate number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|

**INSTRUCTIONS TO CANDIDATES**

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

**INFORMATION FOR CANDIDATES**

- Candidates may not bring the Pre-release Case Study into the examination room.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **90**.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- A calculator may be used for this paper.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** questions.

Questions 1 and 2 refer to the materials supplied to your Centre in the Pre-release Case Study. You are supplied with fresh copies in the Insert.

This question is based on the article 'Titanium and titanium dioxide – materials for the space age'.

**1** **(a)** What unusual property did the sand have that was of interest?

..... **[1]**

**(b)** State two hazards, apart from the weather, that the students need to be aware of when collecting black sand samples from a stream.

1. .....

2. ..... **[2]**

**(c)** The stream was fed by water from a high moorland area.
State why the students should not collect black sand samples after several days of heavy rain.

..... **[1]**

**(d)** What evidence, from the article, suggests that the sand can be stored, before being analysed, without taking any particular precautions?

.....

..... **[1]**

**(e)** Samples of the black sand were analysed for their iron content and the results recorded in Table 1.1.

**Table 1.1**

| **sample** | **1** | **2** | **3** |
|---|---|---|---|
| % iron | 36.9 | 36.6 | 37.0 |

Calculate the mean percentage of iron in the samples, giving your answer to three significant figures.

..... **[1]**

**(f)** **(i)** Ilmenite samples are sometimes contaminated with the iron oxide, magnetite.
Table 1.2 shows the percentage of iron in samples of ilmenite.

**Table 1.2**

| sample | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| % ilmenite | 100.0 | 90.0 | 80.0 | 70.0 | 60.0 | 50.0 |
| % magnetite | 0.0 | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 |
| % iron in the sample | 36.8 | 40.3 | ..... | ..... | 50.8 | 54.3 |

**1** Complete the table to show the percentage of iron present. **[1]**

**2** State the method you used to find your answers.

.....

..... **[1]**

**(ii)** A student suggests that the results in Table 1.2 could be better displayed if a graph is used.
Give one advantage of using a graph other than 'ease of usage'.

..... **[1]**

**(g)** In the description of the extraction of titanium, titanium tetrachloride is made from rutile by mixing it with coke and then heating it in a stream of chlorine gas.
State two problems that might be encountered if this experiment was tried in a school or college laboratory.

1. .....

2. ..... **[2]**

**(h)** The manufacture of titanium using titanium tetrachloride as an intermediate, is an example of a batch process.
State what is meant by the term 'batch process' and explain why this type of process is not as economical as a 'continuous process'.

Batch process .....

.....

Explanation .....

.....

..... **[3]**

**(i)** **(i)** A student was asked to display figures showing the percentage of titanium in aeroplanes built in different years.
He chose to display the data by use of a graph, Fig. 1.1.

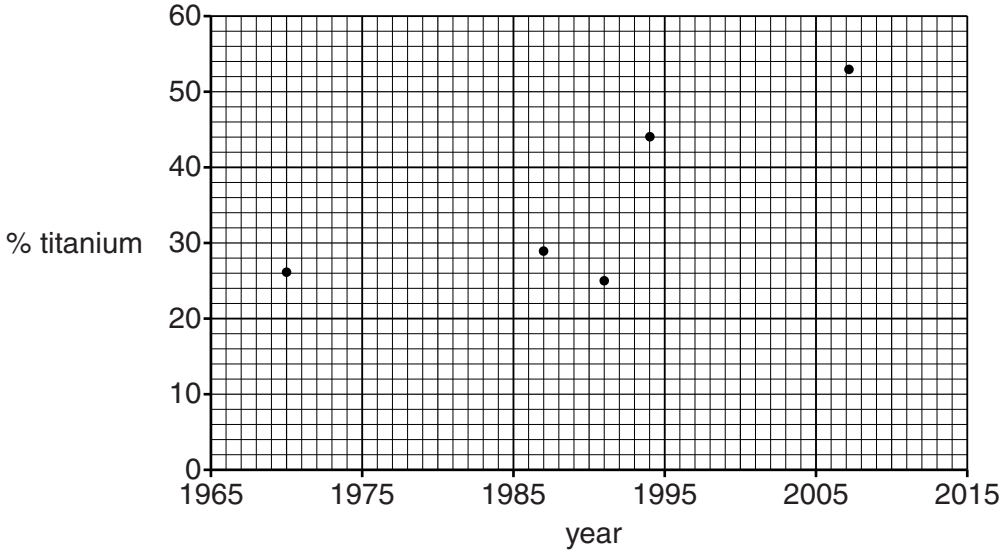


**Fig. 1.1**

State two conclusions about how the % of titanium has changed over time.

1. .....

2. ..... **[2]**

**(ii)** Suggest an alternative way of showing these data.

..... **[1]**

**(j)** An alloy used in aircraft manufacture was analysed for titanium by colorimetry.

**(i)** A known mass of the alloy was reacted with boiling concentrated sulfuric acid for one hour.
An inexperienced technician had not used boiling concentrated sulfuric acid before.
What should he have done before he used it?

..... **[1]**

**(ii)** The mixture from **(i)** was then carefully added to water, mixed well and made up to a volume of 1.00 $dm^3$.
State why it was important to ensure that the product was thoroughly mixed before further use.

..... **[1]**

**(iii)** A series of standard solutions was then prepared by dilution in the presence of hydrogen peroxide. A series of yellow solutions was produced.
The colorimeter used a blue filter.
State why this particular filter was used.

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..... **[1]**

**(iv)** Two groups of students, **A** and **B**, produced calibration graphs using standard solutions, as shown in Fig. 1.2.

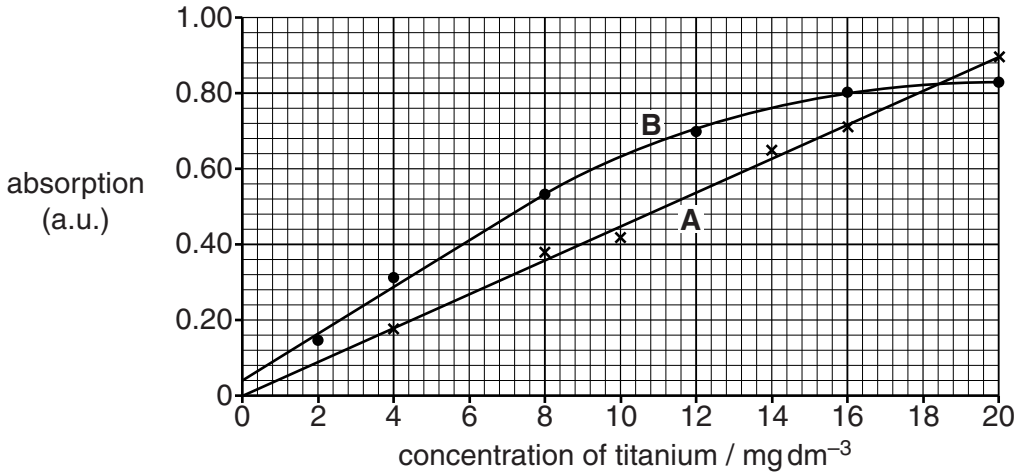


**Fig. 1.2**

State and explain why the results produced by Group **A** are more likely to be valid than those produced by Group **B**.

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..... **[3]**

**(v)** The following results were obtained in an experiment, using colorimetry, to find the percentage of titanium in an alloy.

Mass of alloy = 3.00 g

This alloy was dissolved to make 1 dm$^3$ of solution.

This titanium-containing solution was diluted in the ratio 1 : 200.

The diluted solution contained 13.5 mg of titanium per dm$^3$.

Calculate the percentage of titanium in the alloy.

% = ..... **[3]**

**(k)** The article gives details about the production of titanium dioxide by the sulfate and chloride processes.
Use this information to suggest two other factors, apart from cost, that should be considered when advising a company about which of these two processes should be used.

1. .....

2. ..... **[2]**

**(l)** The graph Fig. 1.3 (also seen in the article) shows the ultraviolet spectrum given by sunscreen **V**.

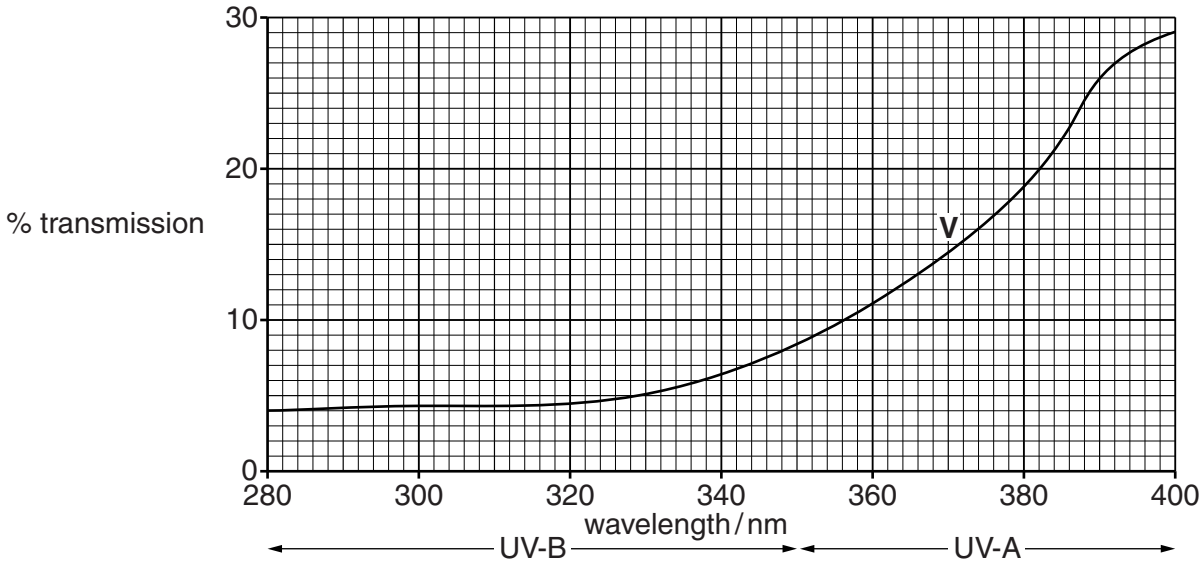


**Fig. 1.3**

A student measures the ultraviolet spectrum given by sunscreen **Y**. She finds that this sunscreen is more effective at absorption of ultraviolet light in the UV-B region than sunscreen **V** but is less effective in the UV-A region.

Sketch the ultraviolet spectrum of sunscreen **Y** on Fig. 1.3. **[1]**

**(m)** The article suggests that the ultraviolet spectrum of a sunscreen for an '*in vitro*' system might be different from the ultraviolet spectrum of the same sunscreen for an '*in vivo*' system.
Suggest what is meant by the term '*in vivo*'.

..... **[1]**

**(n)** The article mentions a possible use of titanium dioxide in 'no fat' milks.

You are asked to plan a study to see if 'no fat' milks are acceptable to the general public.

You are provided with

- a supply of three different 'no fat' milks
- a supply of skimmed milk (1% fat)
- a group of volunteers who are to take part in sampling the milks.

Outline your plan for the study below. In your answer you should describe how this study will be carried out, including factors that your volunteers should consider when making their decisions and how these results will be displayed.

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..... **[6]**

**[Total: 36]**

This question is based on the article 'Water – an essential commodity'.

**2** **(a)** Some students are asked to produce a poster that shows some facts about the Earth and its water and they have asked you for help.

**(i)** They found out that the surface area of the Earth is $5.1 \times 10^8$ km$^2$ and that two thirds of it is covered by water.
Calculate the surface area that is covered by water.

..... km$^2$ **[1]**

**(ii)** They have found that the volume of water in the oceans is $1.5 \times 10^9$ km$^3$ and used the formula

surface area × depth = volume

to state that the depth of the oceans is about 4.4 km (nearly 3 miles).
State an assumption that the students have made in this calculation.

.....

..... **[1]**

**(iii)** Seawater contains about 3% of dissolved sodium chloride (common salt).
Explain how the article implies that this figure has remained largely constant over a long time period.

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..... **[3]**

**(b)** One method for the desalination of seawater is by distillation under reduced pressure (vacuum distillation).
Some students were interested to distil some water under reduced pressure.
They found a graph, Fig. 2.1, that shows the boiling point of water at various pressures.

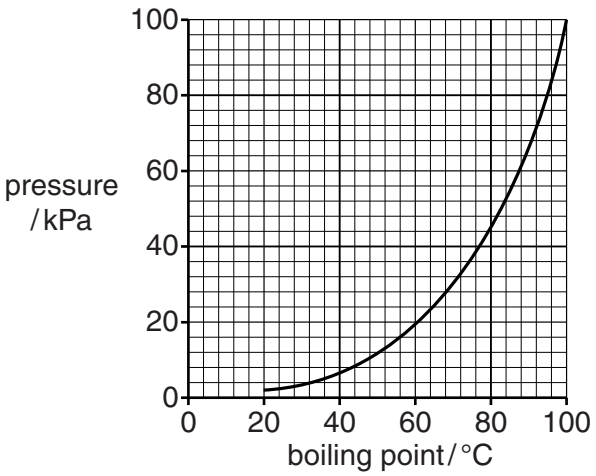


**Fig. 2.1**

**(i)** Describe what the graph shows about how the boiling point of water varies with pressure.

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..... **[2]**

**(ii)** Use Fig. 2.1 to state the boiling point of water if the vacuum gauge reads 7.0 kPa.

.....°C **[1]**

**(iii)** Suggest why the distillation of a liquid at a reduced pressure might be

**1** **more** advantageous for a company than distilling the same liquid at atmospheric pressure.

..... **[1]**

**2** **less** advantageous for a company than distilling the same liquid at atmospheric pressure.

..... **[1]**

**(c)** The students then distilled some salt water under reduced pressure using the equipment shown in Fig. 2.2.

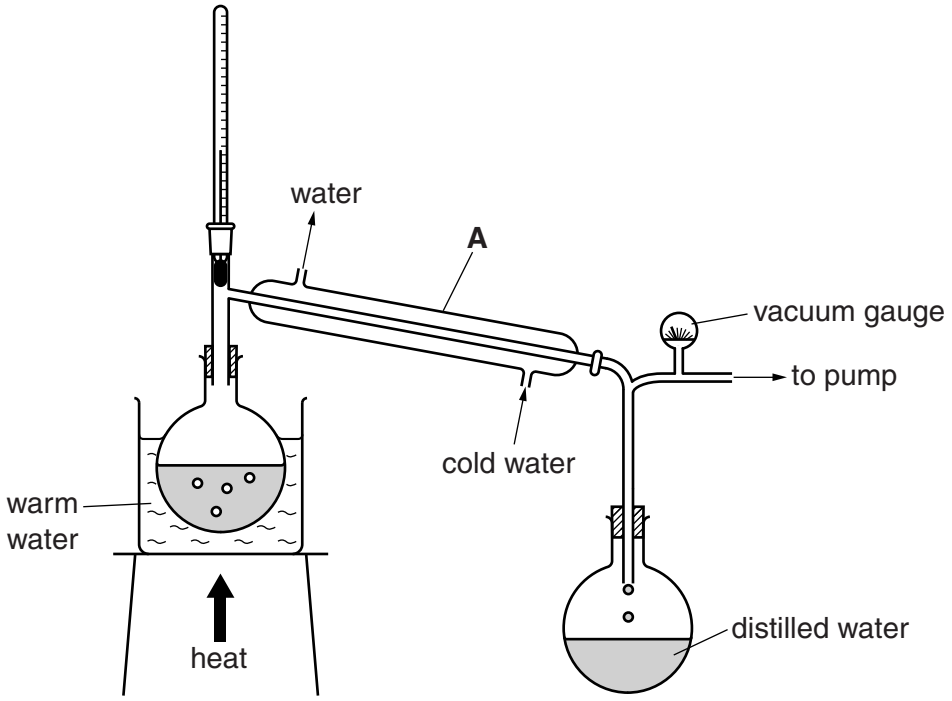


**Fig. 2.2**

**(i)** State the function of the piece of apparatus labelled **A**.

..... **[1]**

**(ii)** After a time, the salt water stopped boiling even though the vacuum gauge was still reading 7.0 kPa.
Suggest two reasons why this might occur.

1. .....

.....

2. .....

..... **[2]**

**(iii)** The students carrying out the distillation were advised to carry out this experiment behind a transparent screen for safety reasons.
Suggest why they were given this advice.

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..... **[1]**

**(d)** The article mentions reverse osmosis as another method of desalination.

**(i)** Use the diagram Fig. 2.3 to help you describe how pure water is made from salt water by this method of desalination. Label Fig. 2.3 as part of your answer.

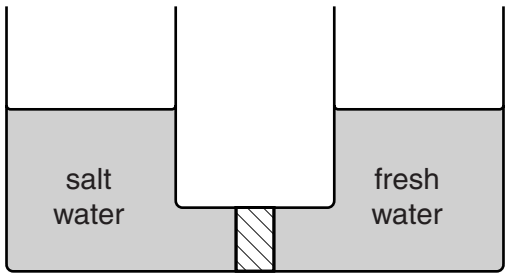


**Fig. 2.3**

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..... **[4]**

**(ii)** A student read an article about the use of reverse osmosis to desalinate seawater in the Canary Islands.

The desalination plant uses a pressure of 6787 kPa (67 atmospheres) and in a typical test the following results were obtained.

| | | |
|---|---|---|
| concentration of salt water input | = | 28000 mg $dm^{-3}$ |
| concentration of salt in the 'fresh' water output | = | 504 mg $dm^{-3}$ |

Calculate the percentage of salt remaining in the 'fresh' water to two significant figures.

..... **[1]**

**(e)** A different group of students was asked to purify and then analyse samples of river water.

**(i)** Some samples of water were collected from the local river.
State three factors that should be considered when collecting the water so that the samples were representative.

1. .....

2. .....

3. ..... **[3]**

**(ii)** The students were advised to wear plastic gloves when handling the water.
Suggest why this advice was given.

.....

..... **[1]**

**(iii)** The collected water was then poured into a number of plastic bottles.
What should the students ensure was done before using these bottles?

..... **[1]**

**(iv)** The filled bottles were then labelled.
State two things that should be written on the label, apart from a hazard warning.

1. .....

2. ..... **[2]**

**(v)** After treatment the 'purified' river water still contained some soluble compounds and possibly some pathogens.
Use the article to explain why the disinfection of water using ultraviolet light only may not produce water as safe to drink as water treated with chlorine.

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..... **[2]**

**(vi)** The students used ultraviolet light to disinfect their water samples. State two variables that they should consider that may affect the effectiveness of their procedure.

1. .....

2. ..... **[2]**

**(vii)** After the water samples had been disinfected they were analysed for the remaining soluble impurities.
This was done by taking a sample of the 'purified' river water and heating it, until only a dry solid remained.

Devise an experiment, giving full experimental details, to determine the percentage of soluble solids in this 'purified' water.

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..... **[7]**

**[Total: 37]**

**3** Rope consists of bundles of fibres, which are twisted together for strength. It has been used since prehistoric times and, until the development of synthetic materials in the 20th century, ropes were made from naturally occurring materials such as sisal.

**(a)** Sisal fibre is made from a plant that grows best in hot humid countries such as Brazil.
A group of Brazilian students were investigating the method of fibre production from sisal leaves.

They cut samples of leaves from a number of plants and stored them for a few days before treating them.

**(i)** Suggest what they should do before storing these leaf samples.

..... **[1]**

**(ii)** After storage, what should they do to the leaves before starting to crush them?

..... **[1]**

**(iii)** The students borrowed a machine that would crush the leaves and separate the fibres.
It consisted of a roller, on which were attached several knives for shredding the leaves.
Suggest two safety factors that they should consider when operating the machine.

1. .....

2. ..... **[2]**

**(iv)** The machine separated the fibres from the waste material from one sample of leaves.
State what should be done to the machine before crushing the next leaf sample.

..... **[1]**

**(v)** A sample sisal leaf had a mass of 640 g.
The dried fibres had a mass of 38.4 g.
Calculate the percentage of fibres in this leaf.

% ..... **[1]**

**(vi)** After testing several leaves the students found that the average percentage of dried fibres in a leaf was 5.4%.
A book stated that the percentage of dried fibres in the plant was around 4%.
Suggest two reasons for the difference in the two percentages.

1. .....

2. ..... **[2]**

**(vii)** There is a considerable wastage of vegetable material when the fibres are separated from the leaves.
The students were asked about possible uses for this waste material.
Give one appropriate use.

..... **[1]**

**(b)** In the 1950s, sisal rope was extensively used for fishing nets.
Tests were carried out using various waterproofing materials to test their effectiveness in preventing rotting of the ropes by seawater.

**(i)** At the start of these tests the infrared spectrum of a sample of sisal rope was taken.
State what an infrared spectrum tells you about the chemical structure of sisal.

..... **[1]**

**(ii)** Explain why untreated sisal rope was used as one of the samples in these tests.

..... **[1]**

**(iii)** All the rope samples were immersed in the same seawater.
State what else should be kept constant so that the results could be compared.

..... **[1]**

**(c)** In the Middle Ages it was important to have strong ropes because they were needed as the trigger in trebuchets. A trebuchet, shown in Fig. 3.1, was a catapult that was used to attack castles.

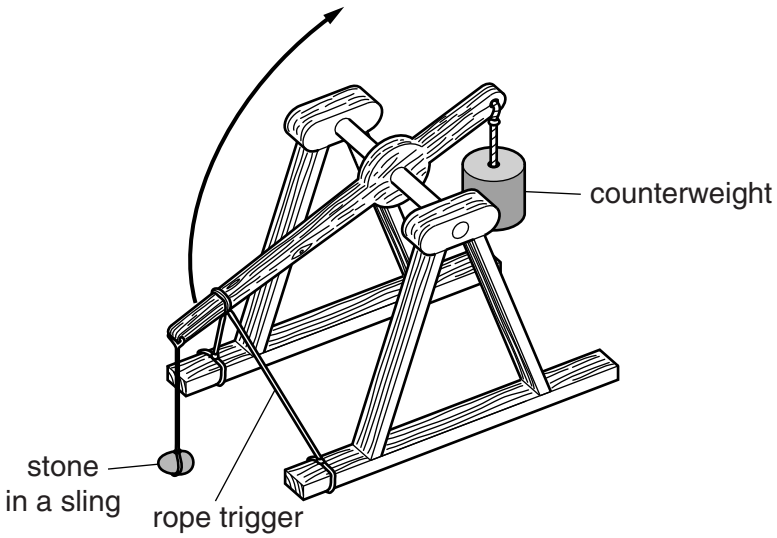


**Fig. 3.1**

When the rope trigger was released the downward movement of the counterweight enabled the projectile (a stone) to be propelled through the air.

A ballistic pendulum, Fig. 3.2, can be used to measure the velocity of the stone.

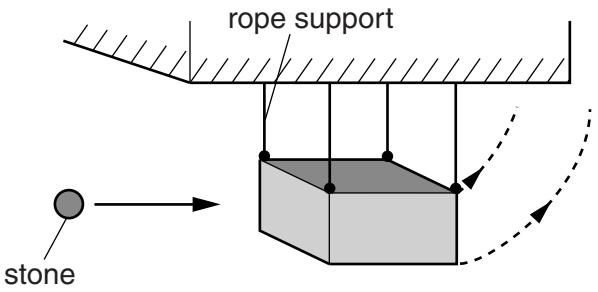


**Fig. 3.2**

**(i)** The following results were obtained in a test using a model trebuchet.

| | | |
|---|---|---|
| mass of ballistic pendulum (M) | = | 2.000 kg |
| mass of stone (m) | = | 0.200 kg |
| vertical displacement (h) | = | 0.080 m |
| acceleration due to gravity (g) | = | 9.8 m s$^{-2}$ |

Use the formula below to calculate the velocity (v) of the stone, as it strikes the ballistic pendulum.

$$v = (1 + \frac{M}{m}\sqrt{2gh})$$

..... m s$^{-1}$ **[2]**

**(ii)** Suggest how the two positions of the pendulum, the starting position and the maximum height, could be marked, so that the vertical displacement (h) can be measured.

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..... **[1]**

**(iii)** This test does not give very accurate results because the vertical displacement (h) is small.
Assuming that you use the same stone in another experiment, state and explain one way in which the experiment could be modified to give a larger value of h.
Your answer should state which variable you are changing and which one(s) you are keeping constant.

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..... **[2]**

**[Total: 17]**

**END OF QUESTION PAPER**

## ADDITIONAL PAGE

**If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.**

## ADDITIONAL PAGE

## ADDITIONAL PAGE