Rewarding Learning

**ADVANCED SUBSIDIARY (AS)**
**General Certificate of Education**
**2022**

**Centre Number**

| | | | | |
|---|---|---|---|---|
| | | | | |

**Candidate Number**

| | | | |
|---|---|---|---|
| | | | |

# Physics

SPH31

## Assessment Unit AS 3A
*assessing*
Practical Techniques
and Data Analysis

## [SPH31]
## TUESDAY 10 MAY, MORNING

**TIME**

1 hour.

**INSTRUCTIONS TO CANDIDATES**

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all** the questions in this booklet. Rough work and calculations must also be done in this booklet. Except where instructed, do **not** describe the apparatus or experimental procedures. The Teacher/ Supervisor will tell you the order in which you are to answer the questions. One hour is to be spent on four short experimental tests. **After 12 minutes you must stop using the apparatus so that it can be rearranged for the next candidate.** At 14 minutes you will be instructed to move to the station for the next question.
At the end of the test a 4 minute period will be provided for you to complete your answer to any question, but you will not have access to the apparatus during this time.

**INFORMATION FOR CANDIDATES**

The total mark for this paper is 40.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You may use an electronic calculator.

| For Examiner's use only | | |
|---|---|---|
| **Question Number** | **Marks** | **Remark** |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| **Total Marks** | | |

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

**1 In this experiment you will investigate the oscillations of a magnet.**

You have been provided with a magnet suspended so that it will oscillate when it is displaced slightly and released. A second magnet is fixed to the desk directly below the first magnet's resting position.

This arrangement is shown in **Fig. 1.1**.

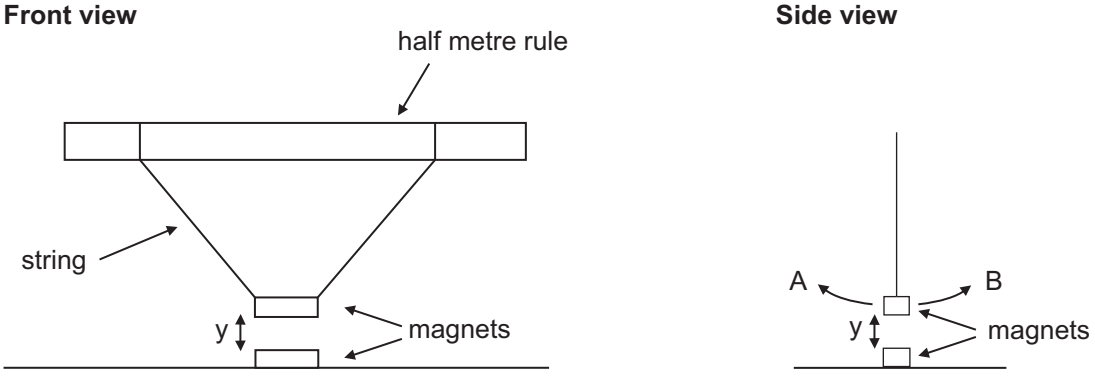



**Fig. 1.1**

The period of oscillation T is the time taken for the magnet to oscillate from A to B and back to A again.

**(a)** Measure the vertical distance y between the magnets and record the value in the first column of **Table 1.1**.

Take suitable readings from which you can calculate an accurate and reliable value for the period of oscillation of the magnet.

Record all your readings in **Table 1.1** and include suitable headings and units.

Remove the magnet that is stuck to the desk and attach it to the supplied cube using blu-tac. Place the cube so that the magnet is, again, directly below the first magnet's resting position, but now closer to the first magnet.

Measure the new distance y and find the new period of oscillation of the magnet. Record all your readings in **Table 1.1**.

**Table 1.1**

| y / mm | |
|---|---|
| | |
| | |

[7]

**(b)** Do your results show that T is proportional to $\sqrt{y}$ ?
Justify your answer with suitable calculations.

[3]

Examiner Only

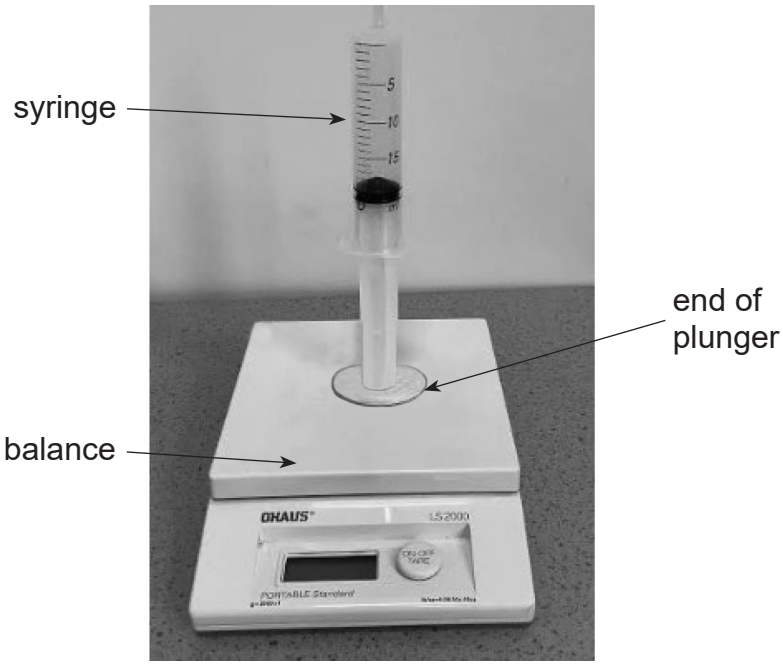
| Marks | Remark |
|---|---|
| | |

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

**2 In this experiment you will investigate the pressure exerted by a compressed gas.**

You have been provided with a sealed syringe containing 20 $cm^3$ of air.

**(a) (i)** Set the syringe with the end of the plunger on the balance as shown in **Fig. 2.1**.




*Source: Principal Examiner*

**Fig. 2.1**

When the syringe is pushed down gently, the volume of the gas will decrease and the reading on the balance will increase.

The reading on the balance **will not remain steady**, so any reading taken will be **an estimate**.

Press down on the syringe until the volume of the gas is 18 $cm^3$. Holding the syringe with the gas at this volume, record, in **Table 2.1**, the value displayed on the balance.

Press down further on the syringe until the volume decreases to 15 $cm^3$. Record, in **Table 2.1**, the new value displayed on the balance. [2]

**Table 2.1**

| Volume of gas / $cm^3$ | Reading on balance / g |
|---|---|
| 18 | |
| 15 | |

**(ii)** Calculate the change in the force on the balance when the volume of the gas decreased from 18 $cm^3$ to 15 $cm^3$.

Change in force = _____ N [2]

**(b) (i)** Use the vernier calipers to obtain a reliable value for the diameter of the end of the plunger.
Give your answer in centimetres.

Diameter = _____ cm [2]

**(ii)** Calculate the surface area of the end of the plunger.

Surface area = _____ $cm^2$ [2]

**(c)** Calculate the increase in pressure exerted on the end of the plunger when the volume of the gas in the syringe decreases from 18 $cm^3$ to 15 $cm^3$.

Give your answer in N $cm^{-2}$.

Increase in pressure = _____ N $cm^{-2}$ [2]

Examiner Only

| Marks | Remark |
|---|---|
| | |

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

**3 In this experiment you will determine the internal resistance of a cell.**

You have been provided with two cells labelled cell A and cell B, each with a different e.m.f. but the same internal resistance. The cells are connected in series and the voltmeter is connected across the cells to measure their total e.m.f.

**(a) (i)** Record the value of the total e.m.f. in **Table 3.1**. [1]

**(ii)** Remove the voltmeter and replace it with resistor R.
Now connect the voltmeter and milliammeter, to measure the potential difference V across R and the current I flowing through R.
Record your values in **Table 3.1**. [2]

**Table 3.1**

| Total e.m.f. / V | V / V | I / mA |
|---|---|---|
| | | |
| | | |

**(b)** Disconnect the circuit. Turn cell B around so that its polarity is reversed. Measure the new total e.m.f. of the cells in series and record the value in **Table 3.1**.

Reconnect the resistor R and measure the new potential difference across R and the current flowing through R. Record the values in **Table 3.1**. [2]

**(c)** The potential difference V is related to the total e.m.f. E by **Equation 3.1**.

$$V = E - Ir \qquad \textbf{Equation 3.1}$$

where r is the sum of internal resistance of the cells.

By applying **Equation 3.1** to both sets of results in **Table 3.1**, calculate a value for the internal resistance of each cell.

Internal resistance = _____ Ω [5]

| Examiner Only | |
|---|---|
| Marks | Remark |

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

**4 In this experiment you will use two methods to determine the focal length of a lens.**

The distance from the illuminated object to the screen has been set at 100 cm.
**This distance should not be adjusted.**

**(a)** Method 1

**(i)** When the lens is moved along the line between the illuminated object and the screen there are two places where a focussed image is produced on the screen. Record the position of the lens at each of these places.

Position 1 = _____ cm

Position 2 = _____ cm [2]

**(ii)** The focal length f of the lens can be calculated from **Equation 4.1**

$$f = \frac{100^2 - D^2}{400} \qquad \textbf{Equation 4.1}$$

where D is the distance between the two lens positions measured in **(a)(i)**.

Calculate f.

f = _____ cm [2]

**(b)** Method 2

| Examiner Only | |
|---|---|
| Marks | Remark |

**(i)** With the electricity supply turned off, use the 30 cm ruler to measure the external diameter d of the object, a washer, as illustrated in **Fig. 4.1**.

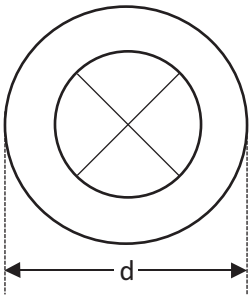



**Fig. 4.1**

diameter of the object = _____ cm [1]

**(ii)** Turn on the electricity supply. Move the lens to the position where the image is in focus and **diminished**. Measure the external diameter of the image of the washer on the screen.

diameter of the image = _____ cm [1]

**(iii)** Calculate the magnification m of the image of the washer.

m = _____ [1]

**(iv)** The focal length f of the lens is given by **Equation 4.2**

$$f = \frac{mu}{m+1} \qquad \textbf{Equation 4.2}$$

where u is the distance from the object to the lens.

Use **Equation 4.2** to calculate f.

f = _____ cm [1]

**(c)** Which method leads to the greatest uncertainty in the value of f? Explain your answer.

_____

_____

_____

_____

_____ [2]

Examiner Only

| Marks | Remark |
|---|---|
| | |

**THIS IS THE END OF THE QUESTION PAPER**

Rewarding Learning

**ADVANCED SUBSIDIARY (AS)**
**General Certificate of Education**
**2022**

# Physics

## Assessment Unit AS 3A

## Practical Techniques and Data Analysis

**[SPH31]**

**TUESDAY 10 MAY, MORNING**

# CONFIDENTIAL INSTRUCTIONS

## 1 Confidential Instructions

These instructions will give detailed guidance on setting up and testing the apparatus and materials to be used. **Again, information contained within the Confidential Instructions must not be relayed to candidates under any circumstances**. If at this point, centres find that the testing process produces results different to those specified in the Confidential Instructions, they must contact the CCEA Science Subject Officer (ggray@ccea.org.uk) immediately.

## 2 Final Apparatus Testing

The practical assessment question paper will be made available to the Head of Physics **two** working days before the timetabled starting time so that teachers and technicians can carry out a final test on the experiments. If on checking, the apparatus gives unexpected results, the CCEA Physics Subject Officer must be contacted immediately (ggray@ccea.org.uk), if the problem cannot be resolved. Then the centre must e-mail the CCEA Physics Subject Officer stating the centre name and number, the specific nature of the problem and the range of anomalous results produced. CCEA will respond by acknowledging receipt of the e-mail. If you do not receive a response within 24 hours, please contact the CCEA Physics Subject Officer by telephone (028 90261200) to confirm that CCEA has received your e-mail.

## 3 Practical Assessment AS 3A

The AS 3A Practical Techniques Assessment is a test of practical skills comprised of 4 short experimental tests. The duration of the assessment is 1 hour. Some of this time will be set aside for supervisors to re-set the apparatus ready for the next candidates. The assessment should be run as a circus of experiments with candidates moving to the next experiment at the designated time. The assessment should be timed as follows:

| **Questions** | **Time** |
|---|---|
| Q1 (Short practical test) | 12 minutes |
| Changeover and practical write-up | 2 minutes |
| Q2 (Short practical test) | 12 minutes |
| Changeover and practical write-up | 2 minutes |
| Q3 (Short practical test) | 12 minutes |
| Changeover and practical write-up | 2 minutes |
| Q4 (Short practical test) | 12 minutes |
| Changeover and practical write-up | 2 minutes |
| End of test write-up | 4 minutes |

At the end of each 12 minute period, candidates must stop using the apparatus. During each 2 minute changeover period candidates may write up anything they have not completed however they will not have access to the apparatus.

At the end of the test a 4 minute period is provided for candidates to complete their answer to any question, however they will not have access to the apparatus.

## 4 After the Practical Assessments

When the individual exam sessions have finished, please return the AS 3A practical scripts together with the corresponding advice notes to the examinations officer (EO). We will collect these by the day after the examination. If we don't, please contact us immediately to arrange another time for collection.

Where the centre finds that a candidate may have been disadvantaged because the apparatus did not function as intended, the supervising teachers should make a report to the EO. The EO will forward the confidential report on the issue and the candidates affected to the centre support section at CCEA for special consideration. Candidates should be identified by their examination number.

**IMPORTANT NOTICE**
**Centres are urged to order items needed for the Physics Practical Tests from the suppliers as soon as possible.**

**Question 1**

Requirements

- 2 × 1 ‘magnadur’ or ‘alnico’ magnets (e.g. Timstar MA10130)
- retort stand, boss and clamp
- string
- stop-clock
- half metre rule
- 30 cm ruler
- 2 cm cube block of non-magnetic material
- blu-tac
- tape

**Preparation**
Clamp the half metre rule horizontally from the retort stand. Suspend one of the magnets from the half metre rule using the string as shown in **Fig 1.1**. The magnet can be taped to the string. The magnet should be between 40–42 cm below the half metre rule. Ensure that the magnet is horizontal.

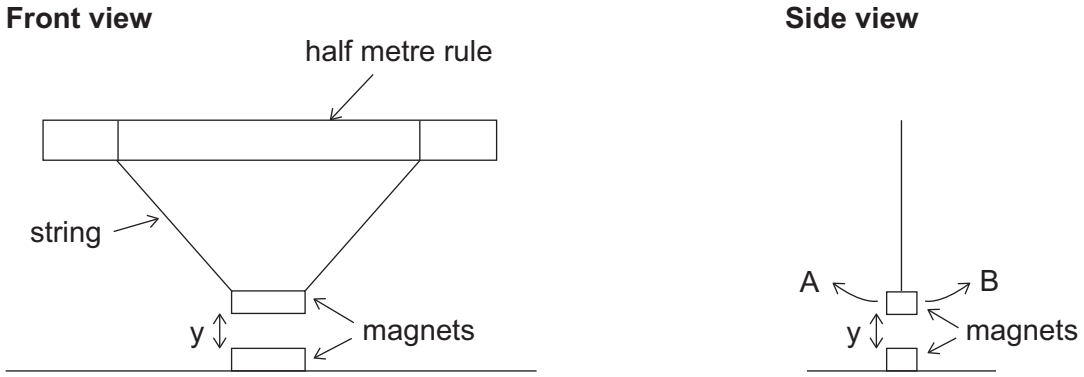



**Fig 1.1**

Use blu-tac to stick the other magnet onto the desk directly below the suspended magnet so that the two magnets attract. Adjust the clamp in the retort stand until the distance between the magnets is approx. 5.5 cm. Place a small piece of blu-tac on the cube. Set the cube and stop-clock close to the apparatus

**Action at Changeover**
Remove the magnet from the cube and stick the magnet to the desk in its original position. Set the cube close to the apparatus. Check that the height of the suspended magnet has not been adjusted.
Reset the stop-clock.

## Question 2

Requirements

- 20 ml syringe with 1 ml divisions, with a circular end on the plunger
- balance measuring to 1 g, capable of measuring up to at least 2000 g
- vernier caliper
- sealant for syringe, e.g. glue

**Preparation**
Trap 20 $cm^3$ of air in the syringe and seal the end of the syringe, (e.g. by using glue or heating the end of the syringe).
Place the apparatus on the bench.
Zero the balance.

**Action at changeover**
Rearrange apparatus on the bench.
Check that the plunger and syringe are as in original set-up.
Zero the balance.

**Question 3**

Requirements

- 3 × 1.5 V cells
- 68 Ω resistor in component holder
- 3.9 Ω resistor
- voltmeter range 0–20V, reading to 0.01 V
- milliammeter range 0–200 mA reading to 0.1 mA
- connecting wires (8, may vary depending on set up)
- 2 × opaque box capable of holding two cells in series

**Preparation**
Connect two of the cells in series and place them in a box. Connect a connecting wire to each end of the cells so they protrude from the ends of the box. Label the box 'Cell A' and clearly mark the polarity.

Connect the remaining cell in series with the 3.9 Ω resistor and place them in the other box. Connect a connecting wire to the open end of the cell and also the open end of the resistor so they protrude from the ends of the box. Label the box 'Cell B' and mark the polarity on the box.

Label the 68 Ω resistor **R**.

**Before the examination**
Connect 'Cell A' and 'Cell B' in series and connect the voltmeter across them so it is measuring the e.m.f.. Set the remainder of the apparatus on the bench.

**Action at Changeover**
Disconnect the circuit and connect the voltmeter across the cells in series as at the start of the experiment. Check that the e.m.f. is at a value of approx. 4.5 V.

**Question 4**

Requirements

- 15 cm focal length converging lens
- lens holder
- screen – plain white paper and screen holder
- metre rule
- power supply } light box
- ray box
- Constructed illuminated object (washer with internal diameter 10 ±1 mm) and crosswires, as shown in **Fig. 4.1**
  used in 2018 AS 3A

**Illuminated object (washer and cross) construction.**
Measure the height H of the centre of the lens, mounted in the lens holder above the surface of the bench. Take a sheet of stiff card and use a sharp knife to cut a square aperture of side 40 mm so that the centre of the square is a distance H from the marked edge of the card. The width W of the card depends on the dimensions of the lens holder.
Cut a piece of tracing or greaseproof paper about 60 mm square. In the centre of this square use a fine felt tip pen (or similar) to mark an "X" with the arms at least 10 mm long. Place the washer over the "X" so that the intersection of the arms is at the centre of the circular hole in the washer. Using transparent self-adhesive tape, attach the washer to the tracing paper. Avoid covering any part of the hole in the washer. Place the tracing paper on the card so that the washer is at the centre of the 40 mm square aperture, with the washer inside the opening. Tape the tracing paper to the cardboard. The completed object is illustrated in **Fig. 4.1**

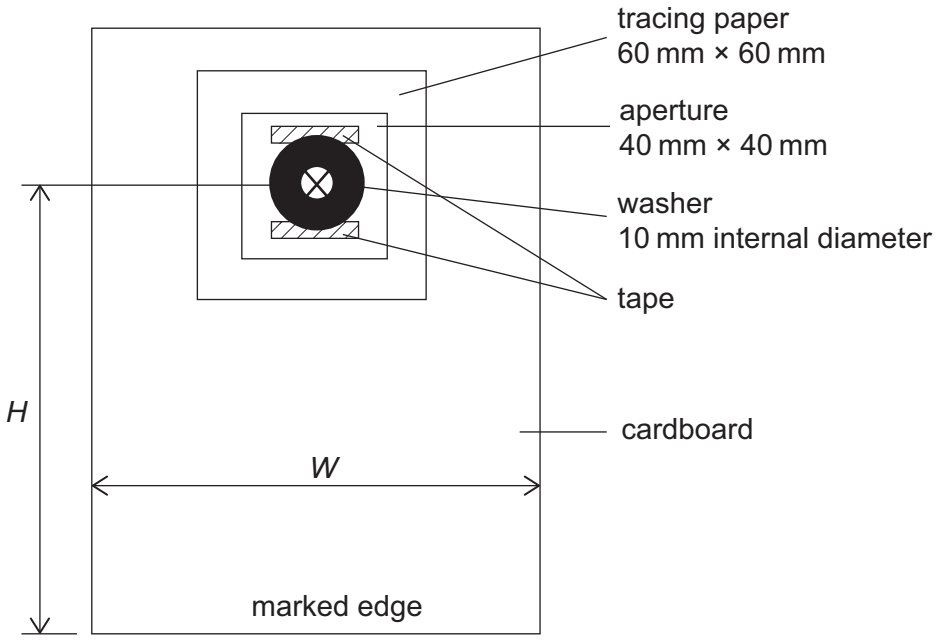



**Fig. 4.1** Washer and "X" object (not to scale)

**Preparation**
Set the metre rule on the desk and place the illuminated washer at the zero mark and the screen at the 100 cm mark. Place the lens in the lens holder and set the lens holder at the 50 cm mark.

**Action at changeover**
Reposition the lens holder to the 50 cm mark and check the object and screen are at the 0 and 100 cm marks.

Rewarding Learning

**ADVANCED SUBSIDIARY (AS)**
**General Certificate of Education**
**2022**

# Physics

Assessment Unit AS 3A

Practical Techniques and Data Analysis

**[SPH31]**

**TUESDAY 10 MAY, MORNING**

# APPARATUS AND MATERIALS LIST

**PHYSICS UNIT 3 (AS 3A)**
**APPARATUS AND MATERIALS REQUIRED FOR PRACTICAL ASSESSMENT**

**CONFIDENTIAL**

This document gives preliminary information on the apparatus and materials required for the AS Practical Assessment.

**Information about the apparatus and materials required for this assessment must NOT be communicated to students**. If apparatus/materials have their serial code and/or manufacturer specified then it is essential that centres use this exact apparatus/material.

On receipt of this APPARATUS AND MATERIALS LIST, centres must contact Gavin Gray, ggray@ccea.org.uk immediately if they have difficulty in sourcing the specified apparatus or materials.

Teachers will be given detailed instructions for setting up the experiment in the *Confidential Instructions for Physics (Advanced Subsidiary) Practical Test*, to which they will have confidential access from April 2022.

**Teachers will have confidential access to a copy of the experimental test two working days (48 hours) before the start of the assessment.**

The AS 3 Practical Techniques Assessment is a test of practical skills consisting of 4 short experimental tests (40 marks). The duration of the assessment is 1 hour.

The apparatus in the following list will allow for **one experiment** to be set up for the practical test which makes up questions 1–4. In other words, each set of apparatus (as listed on **pages 4 and 5**) will accommodate four candidates when doing the circus of experiments.

The apparatus can be used for alternative sessions according to the following schedule:

**Tuesday 10 May - Physics AS 3A (SPH31)**

(Main Session) **9.15 am–10.15 am**
(First Alternative) **10.30 am–11.30 am**
(Second Alternative) **11.45 am–12.45 pm**
(Third Alternative) **1.15 pm–2.15 pm**
(Fourth Alternative) **2.30 pm–3.30 pm**

One set of apparatus for AS 3A (SPH31) will therefore be sufficient for twenty candidates on **Tuesday 10 May** if the Main Session and all four alternatives are used. A laboratory may contain one, two, three or more sets of apparatus. This means that four, eight, twelve or more candidates can be accommodated in the same session. **To maintain the confidentiality of details of the practical tests, candidates entered for any of the alternative sessions must be segregated within the centre so that there can be no communication with candidates who have taken an earlier test in any centre.**

**IMPORTANT NOTICE**
**Centres are urged to order items needed for the Physics Practical Tests from the suppliers as soon as possible.**

**Question 1**

Requirements

- 2 × ‘magnadur’ or ‘alnico’ bar magnets (e.g. Timstar MA 10130)
- retort stand, boss and clamp
- string
- stop-clock
- half metre rule
- 30 cm ruler
- 2 cm cube block of non-magnetic material
- blu-tac
- tape

**Question 2**

Requirements

- 20 ml syringe with 1 ml divisions, with a circular end on the plunger
- balance measuring to 1 g, capable of measuring up to at least 2000 g
- vernier caliper
- sealant for syringe e.g. glue

**Question 3**

Requirements

- 3 × 1.5 V cells
- 68 Ω resistor in component holder
- 3.9 Ω resistor
- voltmeter range 0–20V, reading to 0.01V
- milliammeter range 0–200 mA, reading to 0.1 mA
- connecting wires (8, may vary depending on set-up)
- 2 × opaque boxes capable of holding two cells in series

**Question 4**

Requirements

- 15 cm focal length converging lens
- lens holder
- screen – plain white paper and screen holder
- metre rule
- power supply } light box
- ray box }
- Constructed illuminated object (washer with internal diameter 10 ± 1 mm) and crosswires, as shown in **Fig 4.1**
  (used in 2018 AS 3A)

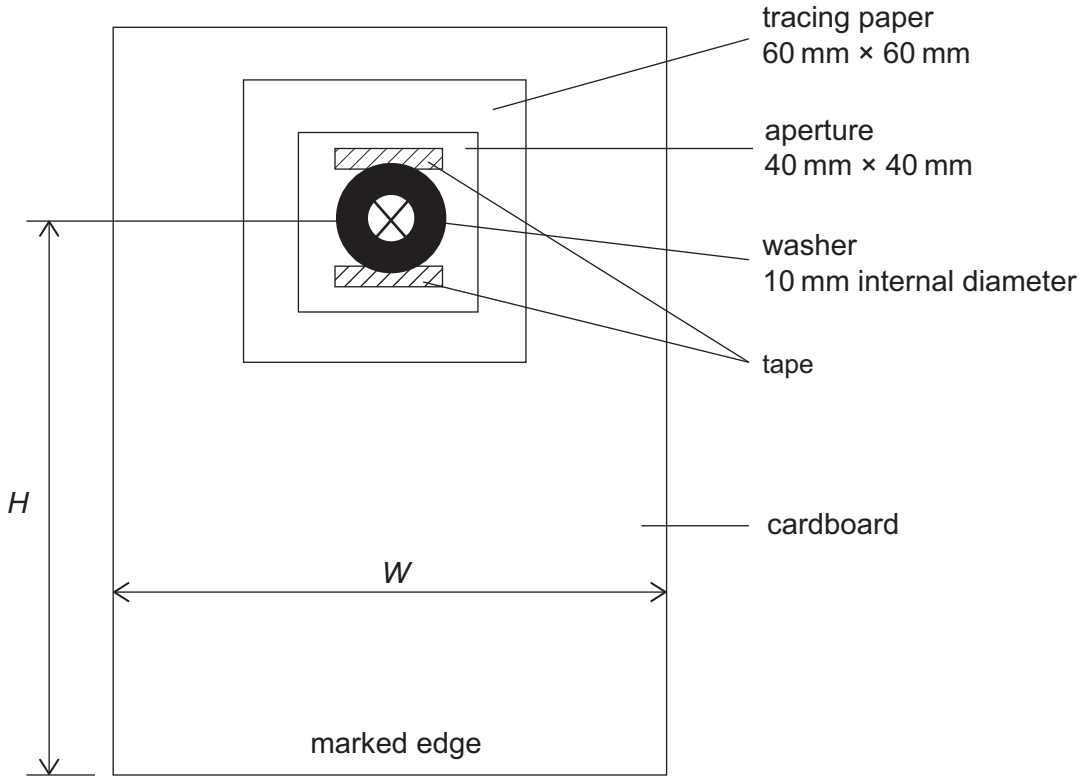



**Fig. 4.1** Washer and "X" object (not to scale)