Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Physics

Assessment Unit AS 3
assessing
Practical Techniques (Internal Assessment)
Session 1

[AY131]

FRIDAY 11 MAY, MORNING

AY131

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces
provided at the top of this page.
Turn to page 2 for further Instructions and Information.

Question Number	Marks	
	Teacher Mark	Examiner Check
1		
2		
3		
4		
5		
Total Marks		

7617

INSTRUCTIONS TO CANDIDATES

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 Section A and 30 minutes on Section B.
Section A consists of four short experimental tests. **You will have access to the apparatus for 13 minutes for each of the tests.** At the end of this 13-minute experimental period there is a 2-minute changeover to the area set aside for the next test. Any spare time before the start of the next test may be used to write up anything you have not yet completed.
At the end of your Section A work you will be told to move to the area set aside for Section B.
Section B consists of one question in which you will analyse a set of experimental results.

INFORMATION FOR CANDIDATES

The total mark for this paper is 40.
Section A and Section B carry 20 marks each.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each part question.
You may use an electronic calculator.

BLANK PAGE
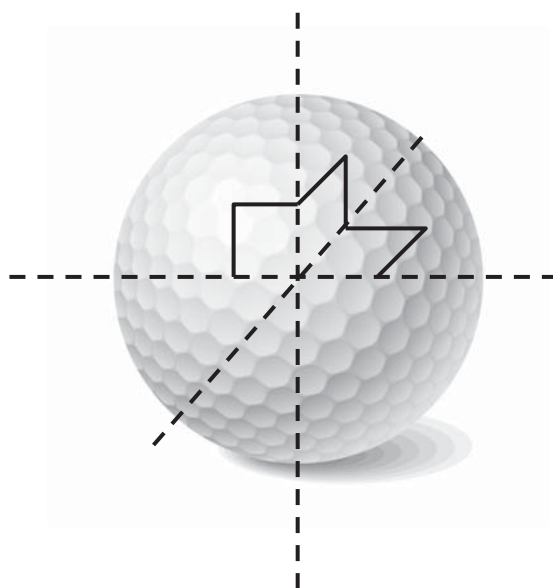
(Questions start overleaf)

1 **(a)** **(i)** Use the metre rule and blocks of wood provided to measure the diameter of the golf ball. You are only expected to take one measurement at this stage.

Diameter = _____ cm   [1]

(ii) Now use the callipers to determine the diameter of the golf ball in three different planes; an example is shown in **Fig. 1.1**. Then use your values to determine the mean diameter.

Diameter 1 = _____ cm

Diameter 2 = _____ cm

Diameter 3 = _____ cm

Mean diameter = _____ cm

**Fig. 1.1**   [3]

© iStockphoto / Thinkstock

(b) Determine the mass of the golf ball. Place the golf ball into the small beaker to prevent it rolling off the scales.

Mass = _____ g   [1]

2 You are provided with the circuit shown in **Fig. 2.1**, a third component labelled Q, a voltmeter, a milliammeter and additional connecting wires. Throughout this question, push and hold the switch closed as measurements are taken.

(a) The circuit shown in **Fig. 2.1** has been set up for you.
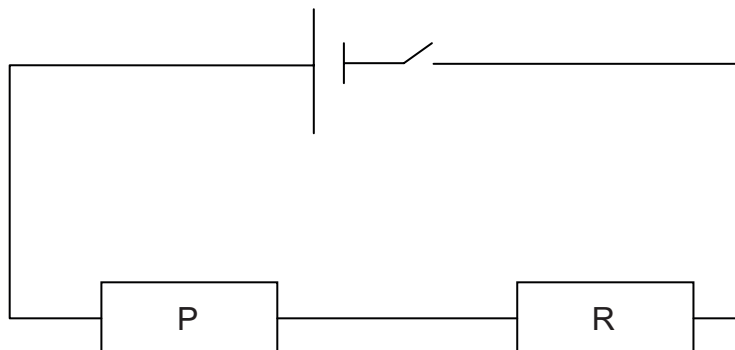
Fig. 2.1

(i) Measure the current flowing in the circuit by using the milliammeter provided.

Current = _____ mA   [1]

(ii) Measure the potential difference (P.D.) across component P by using the voltmeter provided.

P.D. = _____ V   [1]

(b) Adapt the circuit provided to set up the circuit as shown in **Fig. 2.2**. Take care to ensure the polarity of component Q is as shown.
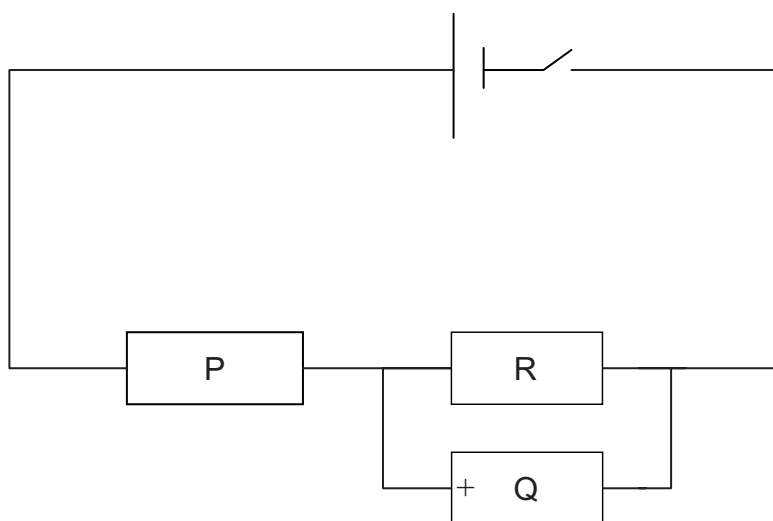
Fig. 2.2

(i) Measure the current flowing through component Q by using the milliammeter provided.

Current into Q = _____ mA   [1]

(ii) Replace component Q into the circuit the opposite way round, i.e. "reverse biased".

Measure the current flowing through component Q after reversing component Q.

Current into Q = _____ mA   [1]

(c) Adapt your circuit to allow you to measure the electromotive force (e.m.f.) of the battery. Record the value of the e.m.f. below.
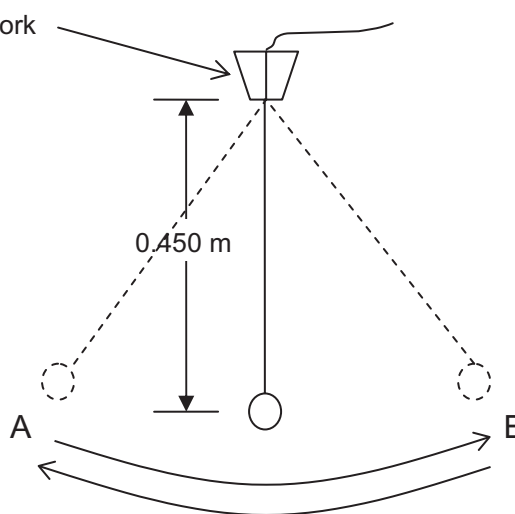
e.m.f. = _____ V   [1]

3 (a) The pendulum arrangement as shown in **Fig. 3.1a** is provided. Adjust the length of the pendulum until the centre of mass of the bob is 0.450 m from the point of suspension. Use the 90° set square to assist, see **Fig. 3.1a**. The curved arrows on **Fig. 3.1b** represent a single oscillation, i.e. A → B → A.

split cork

0.450 m

90° set square

Fig. 3.1a

split cork

0.450 m

A

B
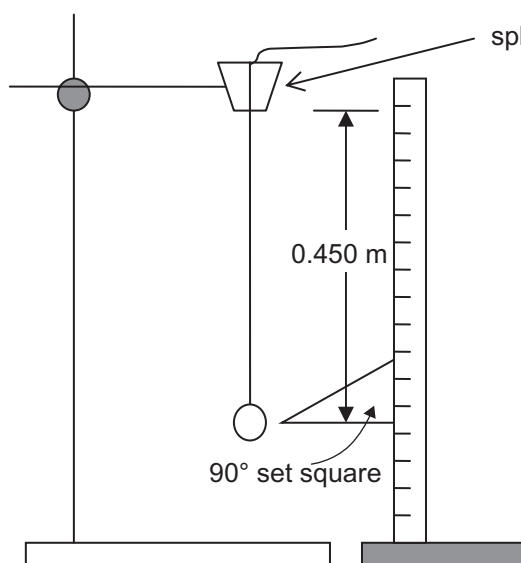
Fig. 3.1b

You are to determine an **accurate** value for the periodic time of the simple pendulum of length 0.450 m. Periodic time is defined as the time taken for one oscillation and has the S.I. unit "second" (s).

Take readings that will allow an accurate value for the periodic time of the pendulum to be determined. **Tabulate all readings** taken in the space below.

Periodic time = _____ s   [5]

www.StudentBounty.com
·Homework Help & Pastpapers

4 You have been provided with an object of unknown weight and volume. This object has been attached to a length of thread. A retort stand, boss head and clamp have also been provided for your use. The spring balance suspended from the clamp has a **systematic (zero) error**. Small height adjustments can be made by opening and closing the clamp.

(a) Taking into account the systematic error determine the **actual** weight of the object. You should place the thread attached to the object to the lower end of the spring balance and allow it to hang freely. See **Fig. 4.1**.
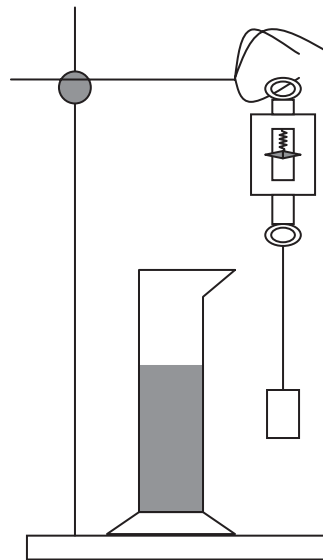
Fig. 4.1

Weight (W_1) = _____ N   [2]

(b) (i) Determine the volume of the object attached to the thread by immersing it in the water in the graduated cylinder. In the space below record the **values** you require. You must show your calculation.
N.B. 1 ml = 1 cm^3 if your cylinder is graduated in millilitres (ml)

Volume (V) = _____ cm^3 [1]

(ii) With the object still completely immersed in the water, determine the weight of the object when immersed in water.

Weight (W_2) = _____ N   [1]

(c) Use the values from **(a)** and **(b)** along with **Equation 4.1** to calculate the value of R.

$$R = \frac{W_1 - W_2}{V} \qquad \textbf{Equation 4.1}$$

R = _____ N cm^{-3} [1]

5 Many governments and private companies are sponsoring research into the generation of electrical energy from wind.

(a) The electrical power output from a wind turbine for a variety of wind speeds is recorded in **Table 5.1**.

Table 5.1

Wind speed/ ms^{-1}	Electrical Power Output/kW			
	Trial 1	Trial 2	Trial 3	Average
5.32	46.9	45.7	47.2	46.6
7.55	134	132	137	134
8.28	176	177	174	
10.7	381	383	380	381
12.6	623	621	623	622
14.4	632	932	931	932

(i) To how many significant figures are all the values given in **Table 5.1**?

Number of significant figures = _____ [1]

(ii) Complete **Table 5.1** by calculating the average electrical power output for a wind speed of $8.28\,ms^{-1}$ and inserting the value, to the correct number of significant figures, into the table. [1]

(iii) Consider the electrical power output values for wind speed $14.4\,ms^{-1}$. State whether or not a mistake has been made in calculating the average and explain your answer.
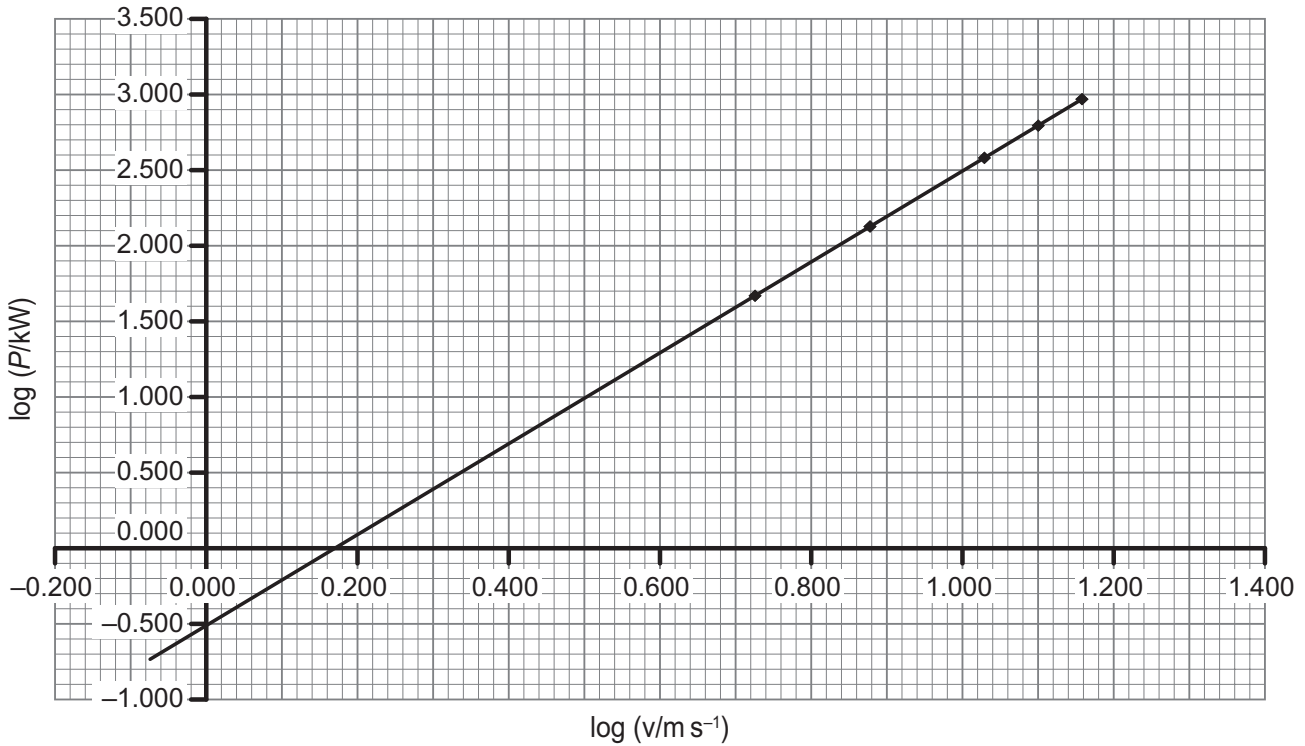
_____

_____

_____ [2]

The relationship between electrical power output (*P*) and wind speed (*v*) is given by **Equation 5.1**

$$P = kv^n \quad \textbf{Equation 5.1}$$

where *k* and *n* are constants.

In **Fig. 5.1**, logarithms (log) of *P* and *v* are plotted. You do not need to know anything about logarithms in order to complete this question.

Fig. 5.1

(iv) Does this graph indicate that log *P* and log *v* are directly proportional? Explain your answer.

_____

_____ [1]

(v) Constant *n*, in **Equation 5.1**, is equal to the gradient of this graph. Determine its value.

n = _____ [3]

(vi) Constant k may be determined using **Equation 5.2**

$$k = 10^c \qquad \textbf{Equation 5.2}$$

where c is the intercept on the vertical axis of the graph in **Fig. 5.1**.

Calculate the magnitude of constant k.

$k =$ _____ $\mathrm{kg\,m^{-1}}$ [2]

(b) The electrical power output from the wind turbine also depends on the diameter of the turbine blades. **Table 5.2** provides data on this relationship.

Table 5.2

Turbine	Blade Diameter d/m	Electrical Power P/kW
A	7.4	8.3
B	14.8	33.2
C	22.2	74.7
D	29.6	
E	37.0	208

(i) For turbines A and C:

1. Calculate the ratio $\dfrac{Blade\ diameter\ turbine\ C}{Blade\ diameter\ turbine\ A}$

   Ratio = _____ [1]

2. Calculate the ratio $\dfrac{Electrical\ power\ turbine\ C}{Electrical\ power\ turbine\ A}$

   Ratio = _____ [1]

Blade diameter and electrical power are related by **Relationship 5.3**

$$P \propto d^x \qquad \textbf{Relationship 5.3}$$

where **x** is a constant.

(ii) Use your answer to **(b)(i)** and/or by performing other calculations, establish a numerical value for **x**.

   x = _____ [1]

(iii) Calculate the electrical power *P* for turbine *D*.

Power *P* = _____ kW   [2]

(c) The maximum harvestable power P_{max} that can be extracted from the wind has a theoretical limit called the Betz Limit. **Equation 5.4** gives the relationship for the maximum harvestable power

$$P_{max} = \frac{\pi}{8}\rho B_c Z \qquad \textbf{Equation 5.4}$$

where ρ is the air density, Z is a constant and B_c is the Betz coefficient.

Table 5.3 provides values for some of the quantities in **Equation 5.4** along with the uncertainty in those values.

Table 5.3

Quantity	Value	Uncertainty	
		Absolute	**Percentage**
P_{max}	656 kW	± 33 kW	
ρ	1.29 kg m^{-3}		$\pm 3\%$
Z	2.18×10^6 m^5 s^{-3}	$\pm 5 \times 10^4$ m^5 s^{-3}	$\pm 2\%$

(i) Complete **Table 5.3** by

1. calculating the percentage uncertainty for P_{max} and entering it in **Table 5.3** [1]

2. calculating the absolute uncertainty for ρ and entering it in **Table 5.3** [1]

(ii) Calculate the value for the Betz coefficient B_c and state its percentage uncertainty.

$B_c =$ _____

Uncertainty = _____ % [3]

THIS IS THE END OF THE QUESTION PAPER

112047

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Physics

Assessment Unit AS 3

assessing

Practical Techniques (Internal Assessment)
Session 1 (pp 3–9) and 2 (10–16)

[AY131] [AY132]

FRIDAY 11 AND MONDAY 14 MAY

CONFIDENTIAL
INSTRUCTIONS
TO
TEACHERS

CONFIDENTIAL INSTRUCTIONS FOR PHYSICS (ADVANCED SUBSIDIARY) PRACTICAL TECHNIQUES (INTERNAL ASSESSMENT)

Confidentiality

To maintain the integrity of the Assessment, **no** question papers or any material pertaining to the Assessment should be publicly released until after the final session of the second day.

General

The Internal Assessment will contain five compulsory questions, of which Section A is made up of four 15-minute experimental tests and Section B is a 30-minute question testing Data Analysis. The total time allowed is 1 hour 30 minutes. The order in which candidates are to take the questions in Section A is to be decided by the Supervisor. Candidates will have access to the apparatus in each experimental task for 13 minutes each, the final two minutes being reserved for adjustment of the apparatus by the Supervisor. During this 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 Section A, candidates should be directed to an area set aside for Section B which consists of one question in which a set of experimental results will be analysed.

Question 1

Principal Requirements

Golf ball
Vernier callipers
Scales (electronic, accurate to 0.01 g)
Glass beaker (100 ml)
Wooden blocks
Metre rule

Preparation

The supervisor must record the golf ball mass for each set of scales used as **this will be required for marking purposes**.
The supervisor must also ensure the mean diameter for each golf ball used is
4.23 cm–4.29 cm.

Before Examination

Level the electronic scales and set to zero.
Close the vernier callipers.
Place the golf ball in the beaker and leave beside the scales.
Place the metre rule and blocks of wood alongside the other apparatus.

Action at changeover

Level the electronic scales and set to zero.
Close the vernier callipers.
Place the golf ball in the beaker and leave beside the scales.
Place the metre rule and blocks of wood alongside the other apparatus.

Information required by examiners

None.

SESSION 1

Question 2

Principal Requirements

Cell
Cell holder
Push-to-make switch
4 mm sockets
Component channels (boxes)
Diode
75 Ω resistor
150 Ω resistors
330 Ω resistor
4 mm leads
Voltmeter
Milliammeter
Masking tape

Preparation

(a) Drill two holes into each component channel (at either end) and fit 4 mm sockets.

(b) Solder the 75 Ω resistor into the channel and label it 'P'. Use masking tape to cover the resistor so that it cannot be seen.

(c) Solder the 330 Ω resistor into the channel and label it 'R'. Use masking tape to cover the resistor so that it cannot be seen.

(d) Solder the diode to a 150 Ω resistor so they are in series and solder both into the channel so that the diode anode is attached to the LH socket (viewed from the outside). Solder a second 150 Ω resistor in parallel with the diode and the first 150 Ω resistor. Label this component channel 'Q'. Mark the LH socket '+' and use masking tape to cover the resistors and diode so that they cannot be seen. See **Fig. 2.1**.
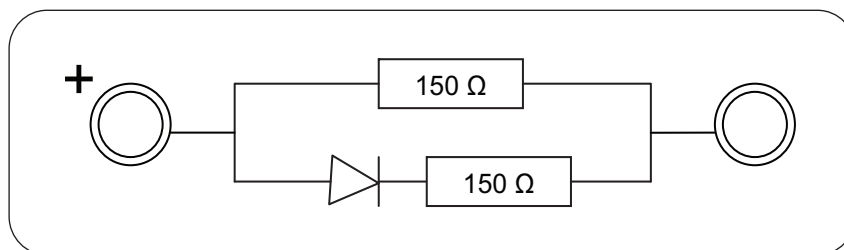
Fig. 2.1

Testing

Ensure that the cell provides a voltage of ~ 1.5 V.

Check that with the switch, component 'P' and component 'R' connected to the cell in series, the current flowing is ~ 3.7 mA and the p.d. across 'P' is ~ 0.27 V.

Connect components 'P', 'R' and 'Q' as shown in **Fig. 2.2** and record the current flowing through 'Q'. **Please note that this value will be required for marking purposes**.

Reverse component 'Q' and ensure that the current flowing through 'Q' has decreased.

Fig. 2.2

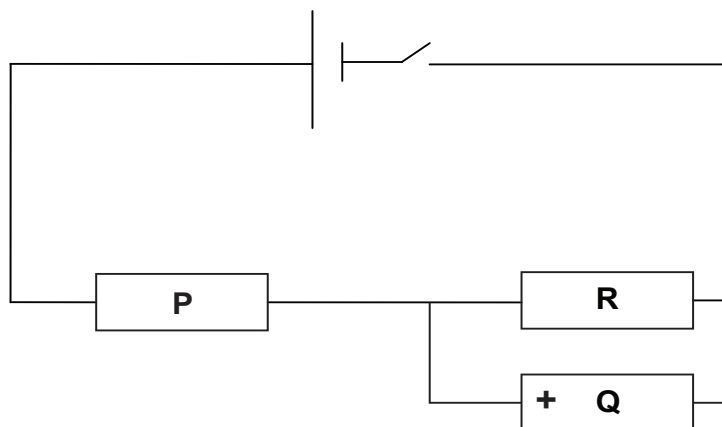**Before Examination**

Set up the circuit shown in **Fig. 2.3**.

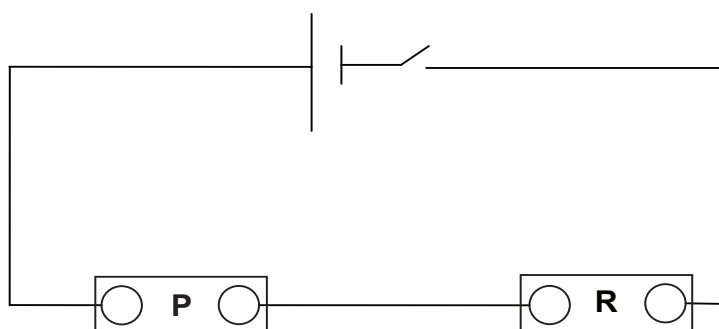**Fig. 2.3**

Leave component Q, the milliammeter, the voltmeter and five leads adjacent to the circuit.

Action at changeover

Set up the circuit shown in **Fig. 2.3**.

Leave component Q, the milliammeter, the voltmeter and five leads adjacent to the circuit.

Information required by examiners

None.

SESSION 1

Question 3

Principal Requirements

Retort stand
Boss head
Clamp
Split cork
Pendulum bob
String/thread (~ 1 m)
Stopwatch/stopclock (accurate to 0.01 s)
Metre rule
Metre rule support
90° set square
G-clamp

Preparation

Clamp the retort stand to the bench.
Ensure there is minimal movement in the retort stand when the pendulum is swinging.
Ensure the edges of the cork around the split are clean.
Arrange the cork in the clamp so that it tapers down to allow the clamp to be opened slightly without the cork falling.

Before Examination

Adjust pendulum length to between 500 mm and 550 mm.
Zero the stopwatch/stopclock.
Leave the stopwatch/stopclock, set square and metre rule in holder adjacent to the pendulum.

Action at changeover

Adjust pendulum length to between 500 mm and 550 mm.
Zero the stopwatch/stopclock.
Leave the stopwatch/stopclock, set square and metre rule in the support adjacent to the pendulum.
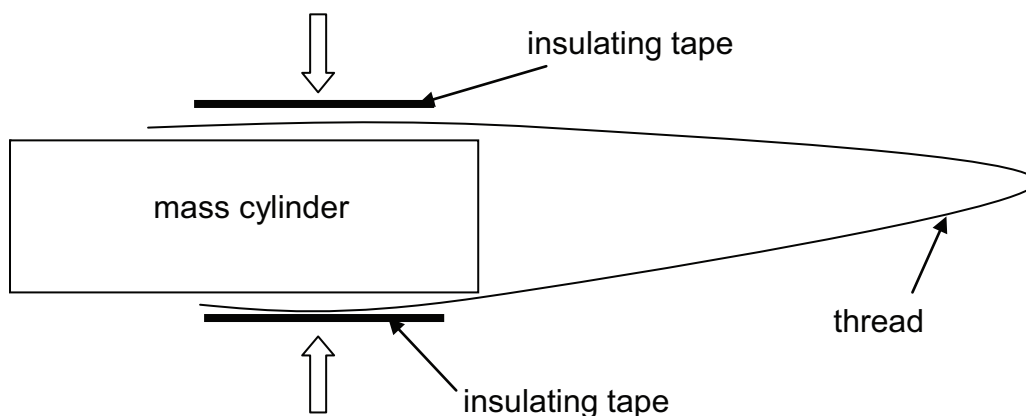
Information required by examiners

None.

Question 4

Principal Requirements

Spring balance (range to 10 N)
Graduated cylinder (200 cm^3 in 2 cm^3 intervals)
Slotted masses (50 g, diameter < 30 mm)
Thread (~ 0.5 m)
Retort stand
Boss head
Clamp
Tape (e.g. insulating tape)

Preparation

Stack the four 50 g masses and tape tightly together into a cylinder shape.
Ensure the masses are completely covered in tape.
Securely attach the thread to the mass cylinder, using more insulating tape, so that a loop exists
see **Fig. 3.1** below (to facilitate adding the cylinder to the spring balance).

insulating tape

mass cylinder

thread

insulating tape

Fig. 3.1

Before Examination

Setup the retort stand, boss head and clamp.
Adjust the spring balance so that it reads +0.5 N with no load (zero error).
Fill the graduated cylinder with water to the 94 cm^3 mark.
Place the spring balance on the clamp.
Adjust the height of the clamp so that the mass when suspended from the spring balance will be immersed in the water in the graduated cylinder.
Leave the stack of four 50 g masses on the bench beside the other apparatus.

Action at changeover

Place the spring balance on the clamp.
Ensure the spring balance has a zero error of +0.5 N
Ensure the water level in the graduated cylinder is 94 cm^3.
Leave the stack of four 50 g masses on the bench beside the other apparatus.

Information required by examiners

None.

SESSION 1

Question 5

Apart from the provision of a suitable working area, no apparatus is required for this Data Analysis Question.

Information required by examiners

None.

SESSION 2

Question 1

Principal Requirements

Table tennis ball
Vernier callipers
Scales (electronic, accurate to 0.01 g)
Glass beaker (100 ml)
Wooden blocks
Metre rule

Preparation

The supervisor must record the table tennis ball mass for each set of scales used **as this will be required for marking purposes**.
The supervisor must also ensure that the mean diameter for each table tennis ball used is 3.97 cm–4.03 cm.

Before Examination

Level the electronic scales and set to zero.
Close the vernier callipers.
Place the table tennis ball in the beaker and leave beside the scales.
Place the metre rule and blocks of wood alongside the other apparatus.

Action at changeover

Level the electronic scales and set to zero.
Close the vernier callipers.
Place the table tennis ball in the beaker and leave beside the scales.
Place the metre rule and blocks of wood alongside the other apparatus.

Information required by examiners

None.

Question 2

Principal Requirements

Cell
Cell holder
Push-to-make switch
4 mm sockets
Component channels (boxes)
Diode
75 Ω resistor
150 Ω resistor
330 Ω resistors
4 mm leads
Voltmeter
Milliammeter
Masking tape

Preparation

(a) Drill two holes into each component channel (at either end) and fit 4 mm sockets.

(b) Solder the 75 Ω resistor into the channel and label it 'P'. Use masking tape to cover the resistor so that it cannot be seen.

(c) Solder the 150 Ω resistor into the channel and label it 'R'. Use masking tape to cover the resistor so that it cannot be seen.

(d) Solder the diode to a 330 Ω resistor so they are in series and solder both into the channel so that the diode anode is attached to the LH socket (viewed from the outside). Solder a second 330 Ω resistor in parallel with the diode and the first 330 Ω resistor. Label this component channel 'Q'. Mark the LH socket '+' and use masking tape to cover the resistor and diode so that they cannot be seen. See **Fig. 4.1**.
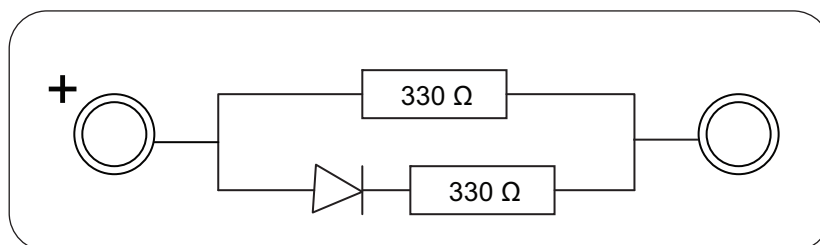

Fig. 4.1

11

Testing

Ensure that the cell provides a voltage of ~ 1.5 V.

Check that with the switch, component 'P' and component 'R' connected to the cell in series, the current flowing is ~ 6.7 mA and the p.d. across 'P' is ~ 0.5 V.

Connect components 'P', 'R' and 'Q' as shown in **Fig. 4.2** and record the current flowing through 'Q'. **Please note that this value will be required for marking purposes**.

Reverse component 'Q' and ensure that the current flowing through 'Q' has decreased.
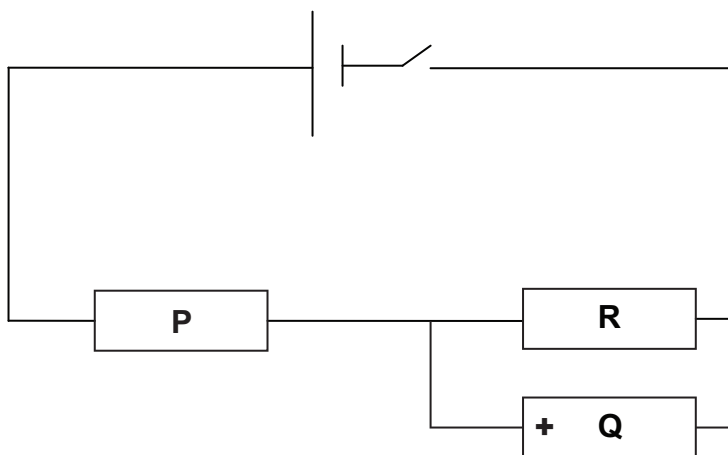
Fig. 4.2

Before Examination
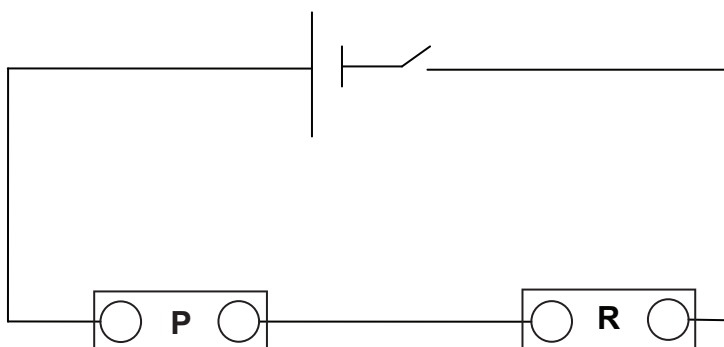
Set up the circuit shown in **Fig. 4.3**.

Fig. 4.3

Leave component Q, the milliammeter, the voltmeter and five leads adjacent to the circuit.

Action at changeover

Set up the circuit shown in **Fig. 4.3**.

Leave component Q, the milliammeter, the voltmeter and five leads adjacent to the circuit.

Information required by examiners

None.

Question 3

Principal Requirements

Retort stand
Boss head
Clamp
Split cork
Pendulum bob
String/ thread (~ 1 m)
Stopwatch/stopclock (accurate to 0.01 s)
Metre rule
Metre rule support
90° set square
G-clamp

Preparation

Clamp the retort stand to the bench.
Ensure there is minimal movement in the retort stand when the pendulum is swinging.
Ensure the edges of the cork around the split are clean.
Arrange the cork in the clamp so that it tapers down to allow the clamp to be opened slightly without the cork falling.

Before Examination

Adjust pendulum length to between 500 mm and 550 mm.
Zero the stopwatch/stopclock.
Leave the stopwatch/stopclock, set square and metre rule in holder adjacent to the pendulum.

Action at changeover

Adjust pendulum length to between 500 mm and 550 mm.
Zero the stopwatch/stopclock.
Leave the stopwatch/stopclock, set square and metre rule in the support adjacent to the pendulum.
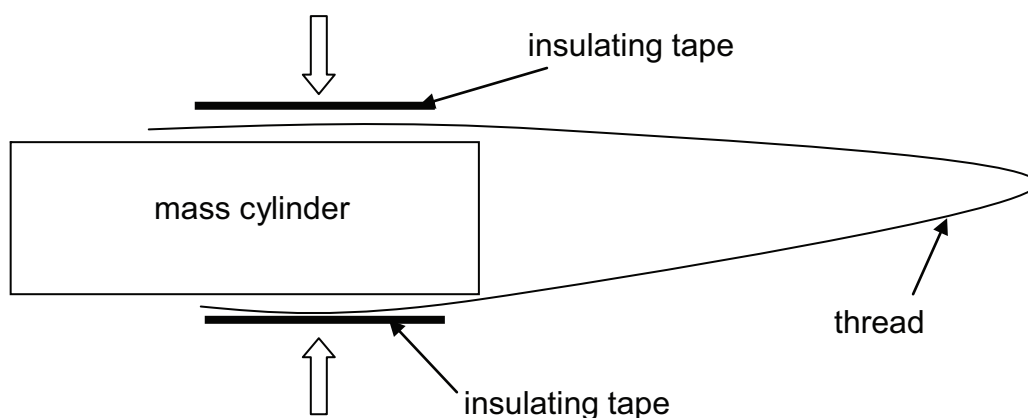
Information required by examiners

None.

Question 4

Principal Requirements

Spring balance (range to 10 N)
Graduated cylinder (200 cm^3 in 2 cm^3 intervals)
Slotted masses (50 g, diameter < 30 mm)
Thread (~ 0.5 m)
Retort stand
Boss head
Clamp
Tape (e.g. insulating tape)

Preparation

Stack the six 50 g masses and tape tightly together into a cylinder shape.
Ensure the masses are completely covered in tape.
Securely attach the thread to the mass cylinder, using more insulating tape, so that a loop exists see **Fig. 5.1** below (to facilitate adding the cylinder to the spring balance).

Fig. 5.1

Before Examination

Setup the retort stand, boss head and clamp.
Adjust the spring balance so that it reads +0.5 N with no load (zero error).
Fill the graduated cylinder with water to the 94 cm^3 mark.
Place the spring balance on the clamp.
Adjust the height of the clamp so that the mass when suspended from the spring balance will be immersed in the water in the graduated cylinder.
Leave the stack of six 50 g masses on the bench beside the other apparatus.

Action at changeover

Place the spring balance on the clamp.
Ensure the spring balance has a zero error of +0.5 N.
Ensure the water level in the graduated cylinder is 94 cm^3.
Leave the stack of six 50 g masses on the bench beside the other apparatus.

Information required by examiners

None.

7616.06

[Turn over

Question 5

Apart from the provision of a suitable working area, no apparatus is required for this Data Analysis Question.

Information required by examiners

None.

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Physics

Assessment Unit AS 3

assessing

Practical Techniques
Sessions 1 and 2

[AY131] [AY132]

FRIDAY 11 MAY AND MONDAY 14 MAY

AY131 AY132

APPARATUS
AND
MATERIALS
LIST

PHYSICS UNIT 3 (AS 3)
APPARATUS AND MATERIALS REQUIRED FOR PRACTICAL ASSESSMENTS

CONFIDENTIAL

Information about the apparatus and materials required for the AS Practical Assessments **must not** be communicated to candidates sitting the examination.

This document gives preliminary information on the apparatus and materials required for the AS Practical Assessments. The Practical Assessments will be marked by teachers as part of the internal assessment requirements for the GCE Physics Specification.

Teachers will be given detailed instructions for setting up the experiment in the *Confidential Instructions for Physics (Advanced Subsidiary) Practical Tests*, to which they will have confidential access from March 2012.

Teachers will have confidential access to a copy of the experimental tests 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 Section A and Section B. Section A is comprised of 4 short experimental tests (20 marks) and Section B consists of one question requiring the analysis of experimental results (20 marks). The duration of the assessment is 1 hour 30 minutes. Some of this time will be set aside for supervisors to re-set the apparatus ready for the next candidates. **All** candidates should attempt Section A of the AS 3 assessment first followed by Section B. Section A of 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:

Section A	Time
Q1 (Short practical test)	*13 minutes*
Changeover and practical write-up	2 minutes
Q2 (Short practical test)	*13 minutes*
Changeover and practical write-up	2 minutes
Q3 (Short practical test)	*13 minutes*
Changeover and practical write-up	2 minutes
Q4 (Short practical test)	*13 minutes*
Changeover and practical write-up	2 minutes
Section B	**Time**
Question on the analysis of experimental results	*30 minutes*

In Section A, at the end of each 13 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.

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

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

Friday 11 May 2012 Physics AS 3A (AY131)

(Main Session) **9.15 a.m. – 10.45 a.m.**
(First Alternative) **11.00 a.m. – 12.30 p.m.**
(Second Alternative) **1.15 p.m. – 2.45 p.m.**
(Third Alternative) **3.00 p.m. – 4.30 p.m.**

Monday 14 May 2012 Physics AS 3B (AY132)

(Main Session) **9.15 a.m. – 10.45 a.m.**
(First Alternative) **11.00 a.m. – 12.30 p.m.**
(Second Alternative) **1.15 p.m. – 2.45 p.m.**
(Third Alternative) **3.00 p.m. – 4.30 p.m.**

One set of apparatus for AS 3A (AY131) will therefore be sufficient for sixteen candidates on **11 May** if the Main Session and all three alternatives are used. Similarly, one set of apparatus for AS 3B (AY132) will be sufficient for sixteen candidates on **14 May** if the Main Session and all three 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. **When alternative sessions are used care must be taken to segregate candidates who have taken the examination from those who have still to sit the examination.**

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

The following list of apparatus for Questions **1–4** is sufficient to equip one experimental station.

		Session 1	**Session 2**
Question 1			
1.1	Golf ball (new and R&A and USGA approved)	1	X
1.2	Table tennis ball (new and ITTF approved)	X	1
1.3	Vernier callipers (analogue, accurate to 0.01 cm)	1	1
1.4	Scales (electronic, accurate to 0.01 g)	1	1
1.5	Glass beaker (100 ml)	1	1
1.6	Wooden block (straight edges; bigger in size than 1.1 or 1.2)	2	2
Question 2			
2.1	Cell (providing ~1.5 V)	1	1
2.2	Cell holder (suitable for cell)	1	1
2.3	Push-to-make switch (e.g. Philip Harris B8H30798)	1	1
2.4	4 mm sockets (single colour)	6	6
2.5	Component channels (boxes)	3	3
2.6	Diode (e.g. Rapid 47-3154)	1	1
2.7	75 Ω resistor (1% tolerance, 0.6 W, e.g. Rapid 62-2044)	1	1
2.8	150 Ω resistor (1% tolerance, 0.6 W, e.g. Rapid 62-2058)	2	1
2.9	330 Ω resistor (1% tolerance, 0.6 W, e.g. Rapid 62-2074)	1	2
2.10	4 mm leads (4 mm plug at each end)	9	9
2.11	Voltmeter (digital, range to ~ 5 V in intervals of 0.01 V)	1	1
2.12	Ammeter (digital, range to 100 mA in intervals of 0.1 mA)	1	1
2.13	Masking tape	✓	✓

Question 3

		Session 1	Session 2
3.1	Retort stand	1	1
3.2	Boss head	1	1
3.3	Clamp	1	1
3.4	Split cork	1	1
3.5	Pendulum bob	1	1
3.6	String/thread (~1 m)	✓	✓
3.7	Stopwatch/stopclock (accurate to 0.01 s)	1	1
3.8	Metre rule	1	1
3.9	Metre rule support (to hold metre rule vertically)	1	1
3.10	90° set square	1	1
3.11	G-clamp	1	1

Question 4

		Session 1	Session 2
4.1	Spring balance (range to 10 N in intervals of 0.1 N with zero adjustment facility)	1	1
4.2	Graduated cylinder (200 cm^3 in 2 cm^3 intervals)	1	1
4.3	Slotted masses (50 g, diameter < 30 mm so as to fit inside graduated cylinder)	4	6
4.4	Thread (~ 0.5 m)	✓	✓
4.5	Retort stand	1	1
4.6	Boss head	1	1
4.7	Clamp	1	1
4.8	Tape (opaque and waterproof, e.g. insulating tape)	✓	✓

Question 5
Apart from the provision of a suitable writing area, no apparatus is required for this Data Analysis Question.

7616.02