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ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Centre Number

Candidate Number

Physics

Assessment Unit AS 3
assessing
Practical Techniques
Session 2

AY132

[AY132]
MONDAY 18 MAY, MORNING

TIME

1 hour 30 minutes.

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	Remark
1		
2		
3		
4		
5		
Total Marks		

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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 question or part question.
You may use an electronic calculator.

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(Questions start overleaf)

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Section A

1 In this experiment you will take measurements to enable you to find the increase in length of a stretched rubber band and find the associated uncertainty in your answer.

The apparatus has been set up for you and is shown in **Fig. 1.1**.

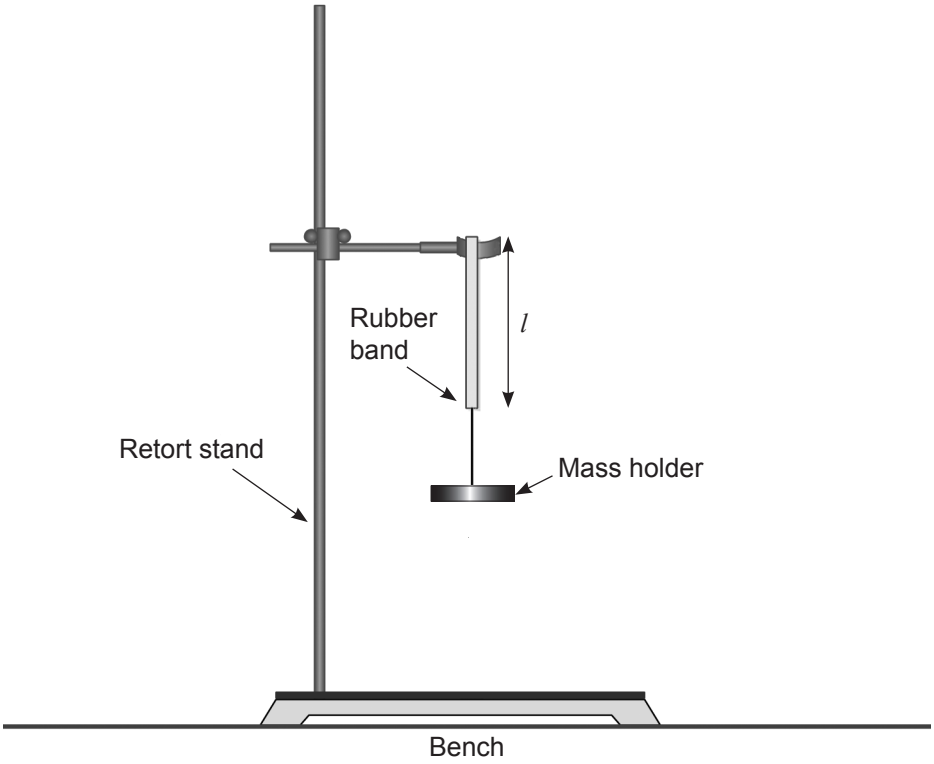

Fig. 1.1

One end of the rubber band has been placed over the limb of the clamp and a 100 g mass holder has been attached to the other end of the rubber band.

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Examiner Only

Marks	Remark

(a) (i) Using the ruler provided, measure the length, l, of the rubber band with the mass holder attached.

Length = _____ cm [1]

(ii) Increase the total mass to 200 g and measure the new length of the rubber band. Calculate the increase in length from that in **(i)** and record your answer in **Table 1.1**. Repeat this procedure for total masses of 400 g and 500 g.

Table 1.1

Total Mass/g	New length/cm	Increase in length/cm
200		
400		
500		

[1]

(b) (i) Based on the results you have recorded in **Table 1.1**, state whether or not the force on the rubber band is directly proportional to the increase in the length of the rubber band. Explain your answer.

_____

_____

_____ [1]

(ii) State the uncertainty in the increase in length. Explain your answer.

Uncertainty = ± _____ cm

Explanation _____

_____

_____ [2]

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Examiner Only	
Marks	Remark

2 In this experiment you will find the focal length of a converging lens by two different methods. The apparatus is shown in **Fig. 2.1**.

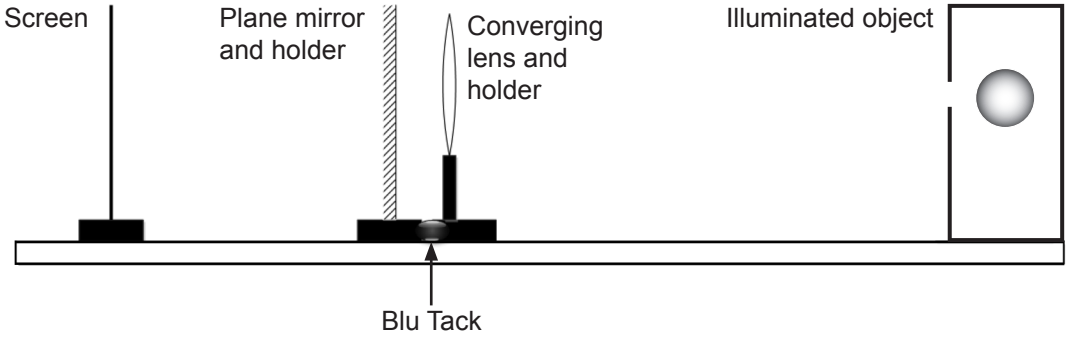

Fig. 2.1

(a) (i) The lens and mirror combination has been placed at the 50 cm mark on the ruler. Slowly move the lens and mirror combination towards the illuminated object until an image is formed **beside** the illuminated object. The distance between the lens and the illuminated object is the focal length. Record this distance.

Focal length = _____ cm [1]

(ii) Remove the plane mirror and holder. Move the lens slowly towards the screen until a sharp **magnified** image is seen on the screen. Measure the object distance, **u**, and the image distance, **v**, and use the formula

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

to calculate the focal length of the lens.

Focal length = _____ cm [2]

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(b) Find the percentage difference between the calculated and the directly measured values of the focal length.

Examiner Only

Marks	Remark

Percentage difference = _____ % [2]

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Marks	Remark

3 In this experiment you will measure the period of oscillation of an extended loaded spiral spring when three different masses are attached to the spring. The apparatus is as shown in **Fig. 3.1**. The mass of 200 g has been attached to the spring.

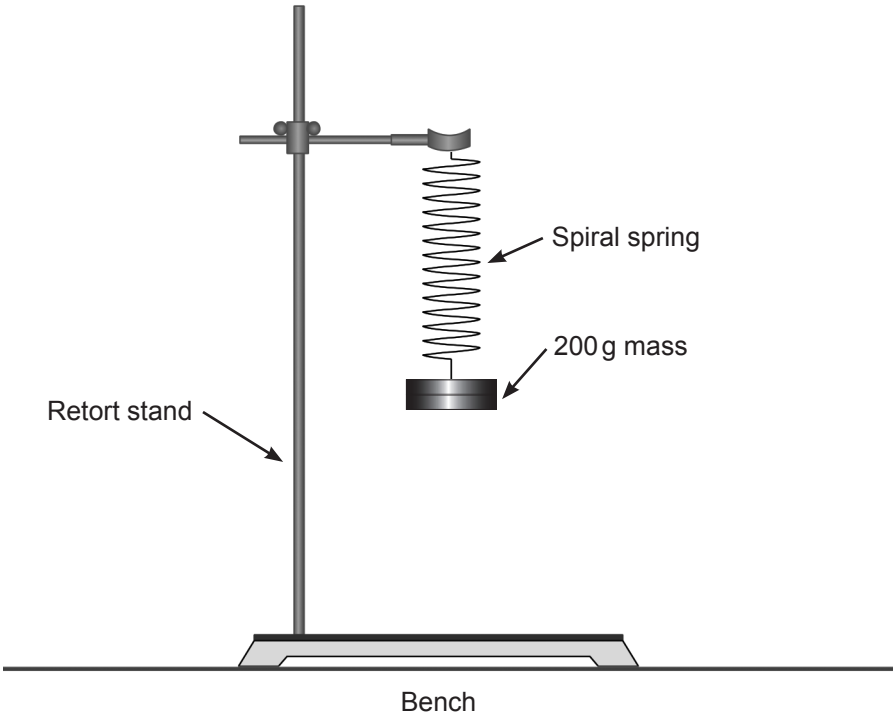

Fig. 3.1

(a) (i) Head the blank columns in **Table 3.1** to indicate the readings you intend to take to enable you to find the period T for each of the masses. Set the spring into small amplitude oscillations by displacing the mass a small vertical distance. Record your readings in the **Table 3.1**.

(ii) Increase the mass to 400 g and repeat the timings to find the new period.

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(iii) Increase the mass to 500 g and repeat the timings again to find the new period.

Examiner Only

Marks	Remark

Table 3.1

Mass/g		
200		
400		
500		

[3]

(b) One of the three equations below gives the correct relationship between the period of oscillation T and the mass m. A is a constant.

$T = Am$ **Equation 1** ☐

$T = \frac{A}{m}$ **Equation 2** ☐

$T = Am^{\frac{1}{2}}$ **Equation 3** ☐

(i) By analysing the results you recorded in **Table 3.1** decide which of the equations best describes the relationship between T and m. Indicate your answer by placing a tick in the appropriate box. [1]

(ii) Explain your choice.

_____

_____

_____ [1]

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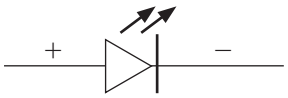
Examiner Only	
Marks	Remark

4 In this experiment you are provided with a circuit to enable you to measure the voltage across and the current through a light emitting diode (LED).

(a) (i) In the space below, draw a circuit diagram for the circuit provided. The symbol for, and the polarity of, the LED is given. In your diagram, indicate the polarity of each component.



[1]

(ii) Slowly increase the voltage of the power supply and record the current for the voltages given in **Table 4.1**.

Table 4.1

Voltage/V	Current/mA
0.0	
0.2	
0.6	
1.0	
1.3	
1.8	

[2]

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(b) The current–voltage characteristic for an LED of this type is shown in **Fig. 4.1**.

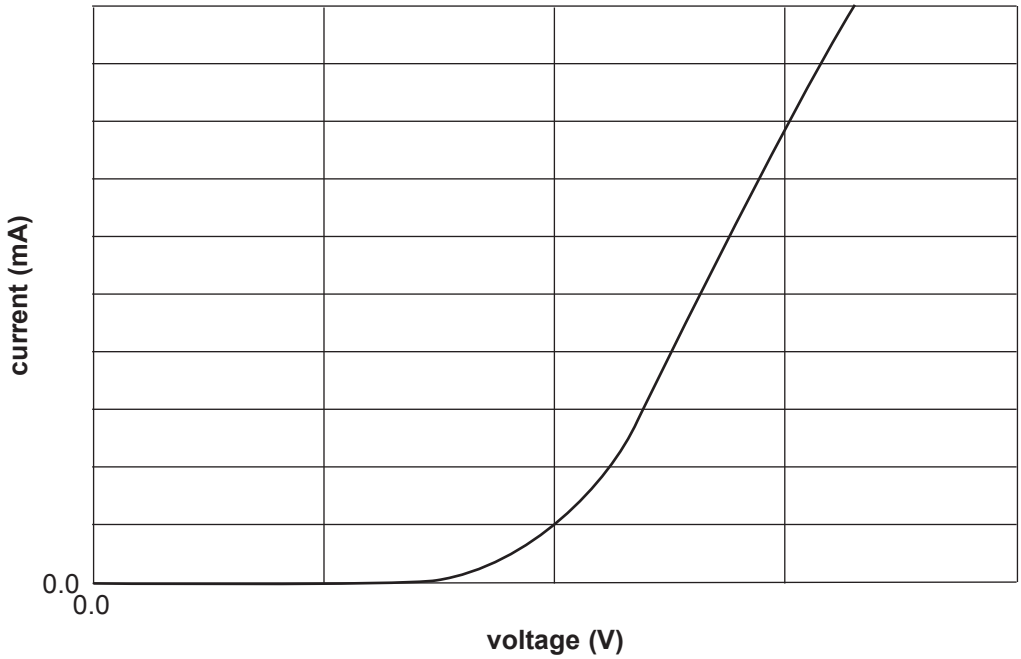

Fig. 4.1

(i) When the voltage reaches a certain value the LED switches on and the current starts to rise. Describe how you would find more accurately this switch-on voltage for the LED used in your experiment.

_____

_____

_____ [1]

(ii) Follow your described method to find a value for the switch-on voltage.

Switch-on voltage = _____ V [1]

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Marks	Remark

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Section B

Bicycle gearing

5 Most bicycles sold today have several gears. Some bicycles have five gears on the rear wheel and two or three gears at the front on the pedal crank. This leads to them being referred to as a “ten gear” or “fifteen gear” bicycle.

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Fig. 5.1

A particular bicycle has five gears on the rear wheel and two gears at the front as shown in **Fig. 5.1**. The front set of gears have 44 and 52 teeth while the rear gears have 14, 17, 20, 24 and 28 teeth.

The **GEAR SIZE, G,** (in units gear-metre, written gear-m) is defined as

$$G = \frac{DF}{R} \qquad \textbf{Equation 5.1}$$

where D is the wheel diameter in metres, F is the number of teeth in the front gear and R is the number of teeth in the rear gear. A low value of G means many turns of the pedals but low speed whereas a high value of G means few turns of the pedal but high speed.

The diameter of the bicycle wheel is 0.69 m.

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Marks	Remark

(a) (i) Complete **Table 5.1** by finding the gear size G for each combination of gears for this wheel of diameter 0.69 m. Give G to 2 significant figures.

Table 5.1

Rear Gear R	G when F = 44/gear-m	G when F = 52/gear-m
14		
17		
20		
24		
28		

[2]

(ii) A cyclist looks at a correctly completed table and says "This bicycle can be described as having only six gears."

Explain why he is correct to make this statement.

_____

_____

_____ [2]

(b) The relationship between s, in km h^{-1}, the speed at which the bicycle is travelling and G, the gear size, in gear-m is given by Equation 5.2,

$$s = \frac{\pi}{16.94} G\omega \qquad \textbf{Equation 5.2}$$

where ω is called the cadence and is the number of revolutions of the pedals per minute.

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Examiner Only	
Marks	Remark

Table 5.2 shows the speed of the bicycle for different gear sizes, G, when the cadence is constant.

Table 5.2

s/km h^{-1}	G/gear-m
16.0	1.1
18.6	1.3
22.0	1.5
26.4	1.8
30.8	2.1
38.1	2.6

(i) On the grid of **Fig. 5.2**, draw the graph of s against G using the data in **Table 5.2**. Choose suitable scales to allow you to determine the value of the cadence. Plot the points and draw the best fit line. [5]

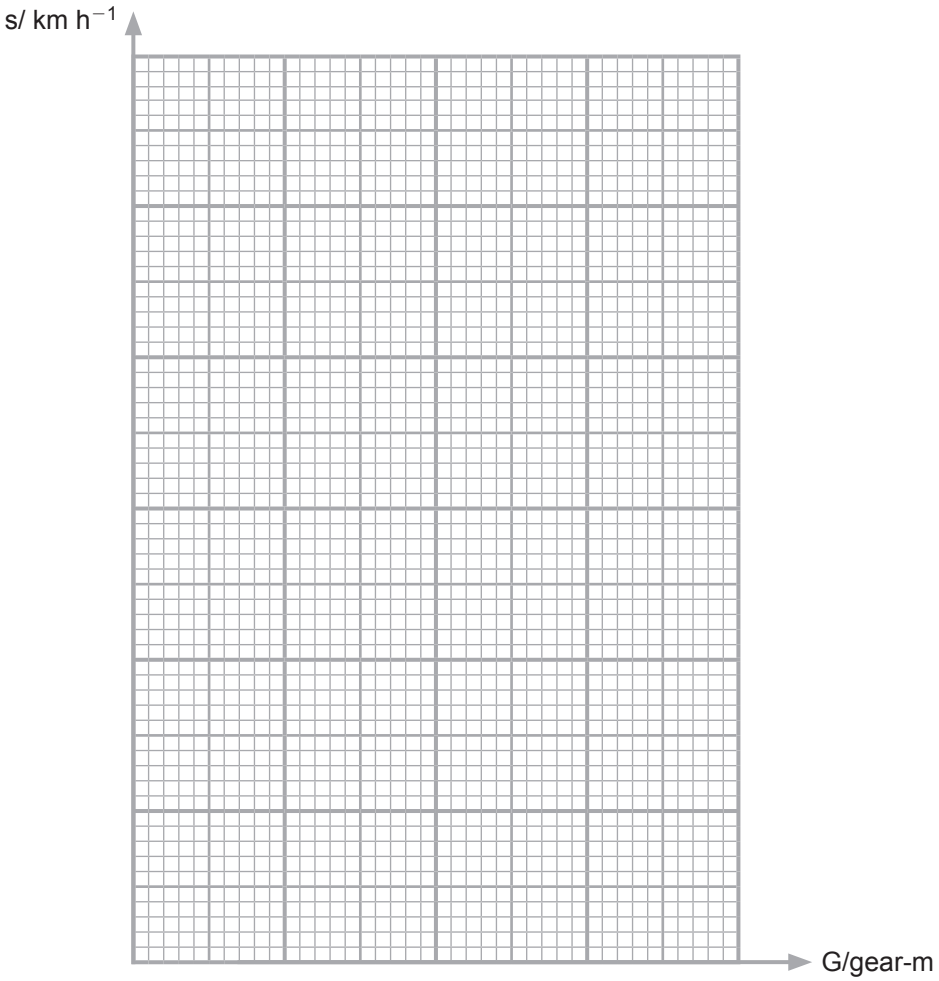

Fig. 5.2

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(ii) Determine the gradient of the graph.

Gradient = _____ units [2]

(iii) Use your value of the gradient to calculate a value for the cadence ω.

ω =_____ rev min^{-1} [2]

(c) **(i)** What is the highest gear size available for a similar bicycle with the same values of F and R but with wheels of diameter 0.48 m?

G = _____ gear-m [2]

(ii) If this bicycle, with wheels of diameter 0.48 m, is pedalled with the cadence of the bicycle in part **(b)**, what is its top speed?

Top speed = _____ km h^{-1} [1]

(iii) If the two bicycles are to be ridden side by side at a speed of 38.1 km h^{-1}, what is the cadence value of the second (smaller) bicycle?

ω =_____ rev min^{-1} [2]

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Marks	Remark

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(d) How long will it take, in minutes, for a cyclist travelling at 38.1 km h^{-1}, to travel 2.5 km?

Time = _____ min [2]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

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ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Physics

Assessment Unit AS 3

assessing

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

[AY131] [AY132]

FRIDAY 15 MAY AND MONDAY 18 MAY

CONFIDENTIAL INSTRUCTIONS TO TEACHERS

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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.

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SESSION 1

Question 1

Principal Requirements

Rubber Band	length 150 mm	width 2 or 3 mm	(e.g. size 38)	1
100 g mass holder				1
100 g mass				3
Metre rule				1
Retort stand and clamp				1

Preparation

Set up the apparatus on a bench as shown in **Fig. 1.1**.

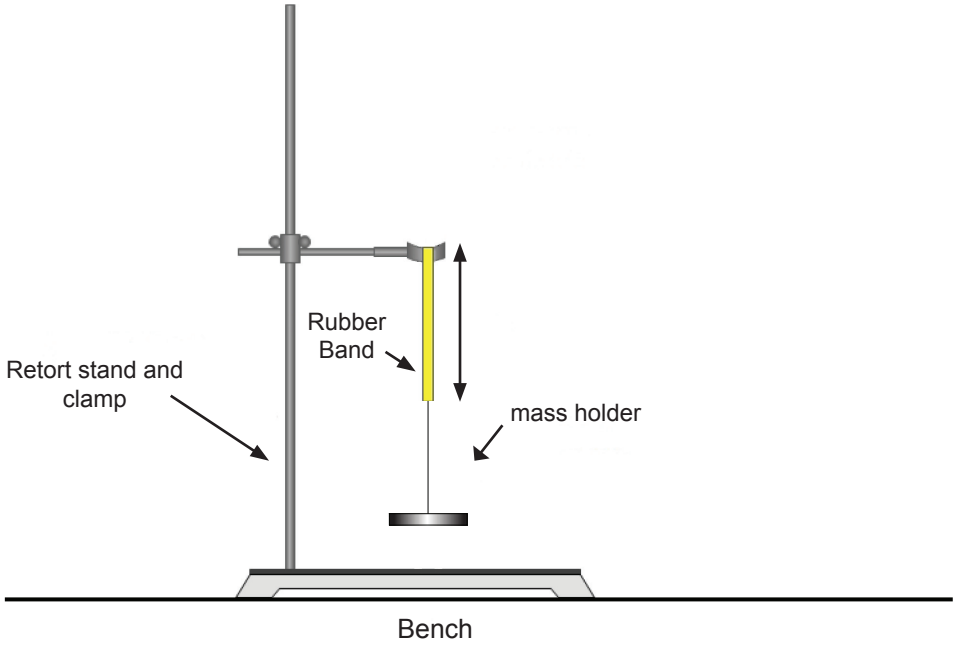

Fig. 1.1

Before the examination

Leave the three 100 g masses and the metre rule at a convenient place close to the apparatus. Check that when loaded to 400 g, the apparatus is steady and the masses do not touch the bench.

Action at changeover

Remove the 3 × 100 g masses and leave them on the bench beside the apparatus.

Information required by examiners

None

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Question 2

Principal Requirements

metre rule/optical bench	1
lens of focal length 10 cm with holder	1
plane mirror and holder	1
illuminated object and light source	1
screen	1

Preparation

The illuminated object can be a set of cross wires or mesh which can be held in place in front of the light source. If one is to be made then the following steps can be followed.

(i) Select a piece of wood to act as a holder.
(ii) Cut a piece of white card the width of the holder and about 15 cm long.
(iii) At the top of the card cut a hole the width of which is slightly smaller than the diameter of a washer as shown in **Fig. 2.1**.

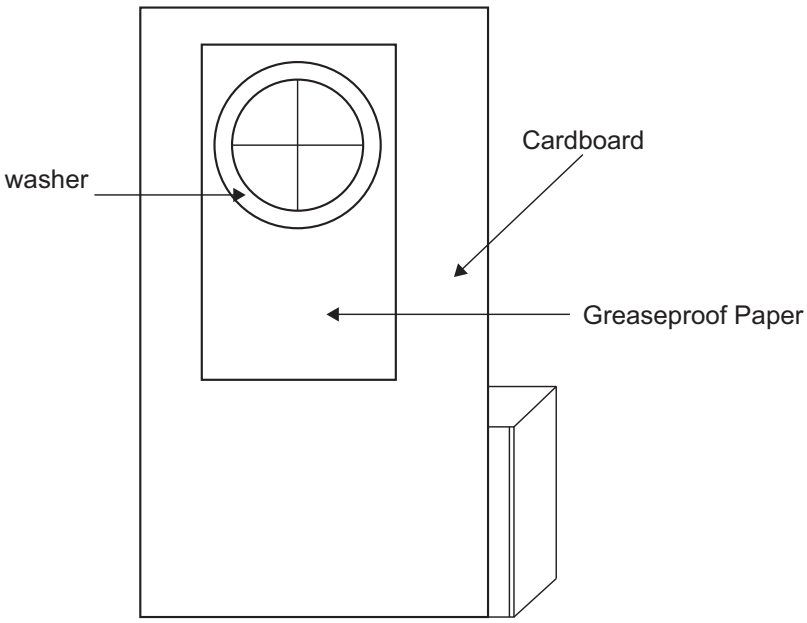

Fig. 2.1

(iv) Cut a piece of greaseproof paper so that it fits over the hole.
(v) Draw a cross in black ink on the greaseproof paper.
(vi) Stick the the greaseproof paper over the hole in the card.

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Before the examination

Set up the apparatus as shown in **Fig. 3**.

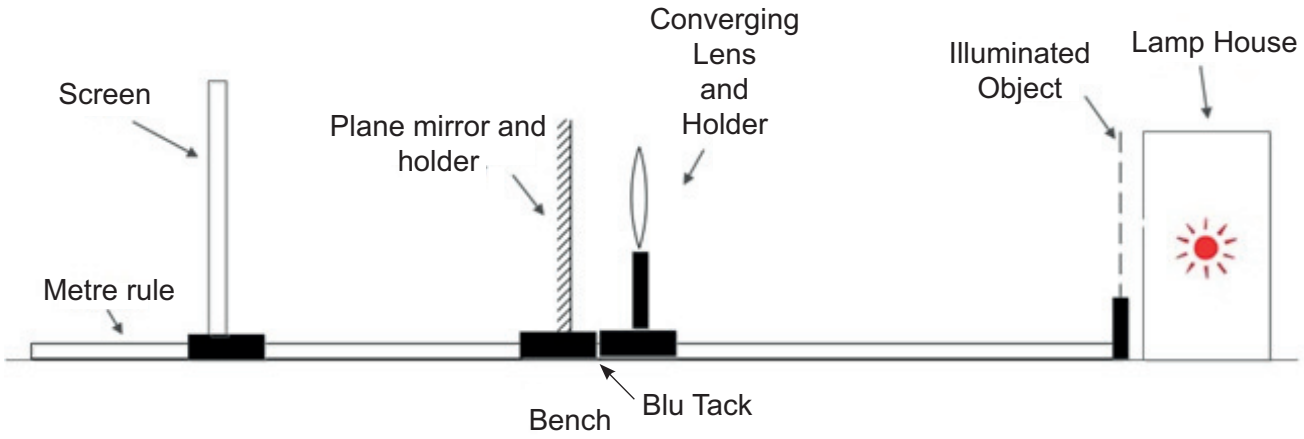

Fig. 3

Push the holders of the mirror and lens together using Blu Tack.
Set the lens at the 50 cm mark and the screen at the 70 cm mark on the metre rule scale. Place the illuminated object and light source at the zero mark on the metre rule.
Test the apparatus by moving the plane mirror/lens towards the illuminated object until a sharp image is obtained beside the illuminated object. Remove the plane mirror and move the lens toward the screen until a sharp magnified image is obtained on the screen. Reset the apparatus as at the start.

Action at changeover

Replace the plane mirror and set it with the lens at the 50 cm mark.

Information required by examiners

None

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Question 3

Principal Requirements

extension (disposable) spring unextended length 20 mm (Scientific & Technical XPS050010)	1
100 g mass holder	1
100 g mass	3
retort stand and clamp	1
stopclock	1

Preparation

Securely attach the retort stand and clamp to the edge of the bench. Suspend the spring from the clamp and attach one of the 100 g masses to the 100 g mass holder as shown in **Fig. 3.1**.

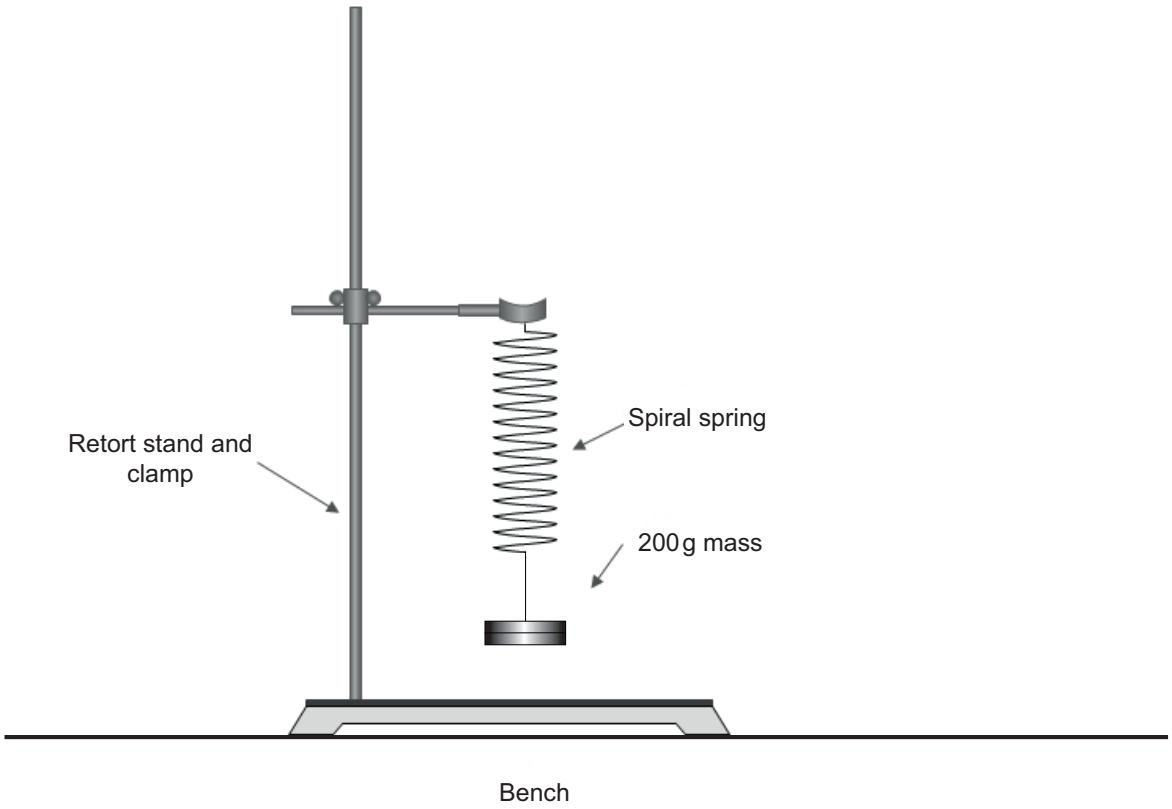

Fig. 3.1

Check that the period of oscillation is approximately 0.56 sec.
Leave the other two 100 g masses and the stopclock on the bench near the apparatus.
Check the mass doesn't hit the bench when the spring is under maximum load.

Before the examination

Assemble the apparatus as described in "Preparation" above.

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Action at changeover

Remove two of the 100 g masses and zero the stopclock.

Information required by examiners

None

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Question 4

Principal Requirements

red led (e.g. RS 826 509)	1
milliammeter to read up to 100 mA	1
digital voltmeter to read up to 3 V	1
Stabilised d.c. power supply to give steady output at 2 V	1
Connecting wires with fitted plug	5
Component holder for led	1
Label	1

Preparation

Label the positive terminal of the led and attach it to the component holder. Set up the circuit as shown in **Fig. 4.1**.

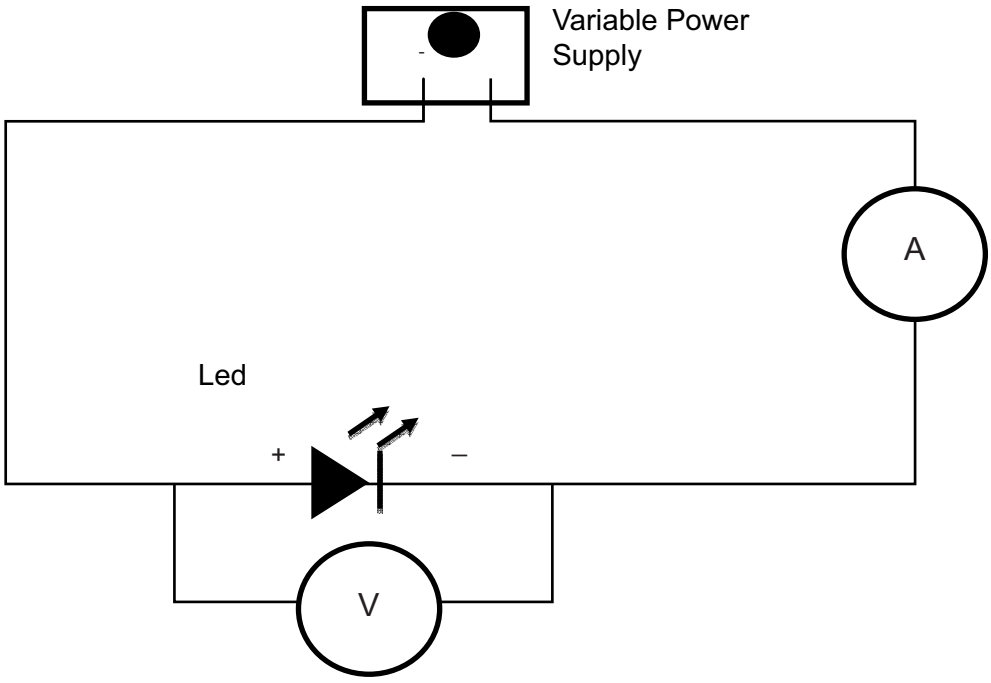

Fig. 4.1

Vary the voltage and check that the led switches on at about 1.7–1.8 V.
Reset the voltage to zero.

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Before the examination

Leave the circuit of **Fig. 4.1** connected on the bench, turn the voltage to zero.

Action at changeover

Check that the led illuminates at approximately 1.7–1.8 V and return the voltage to 0 V.

Information required by examiners

None

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SESSION 2

Question 1

Principal Requirements

Rubber Band	length 150 mm	width 2 or 3 mm	(e.g. size 38)	1
100 g mass holder				1
100 g mass				4
Metre rule				1
Retort stand and clamp				1

Preparation

Set up the apparatus on a bench as shown in **Fig. 1.1**.

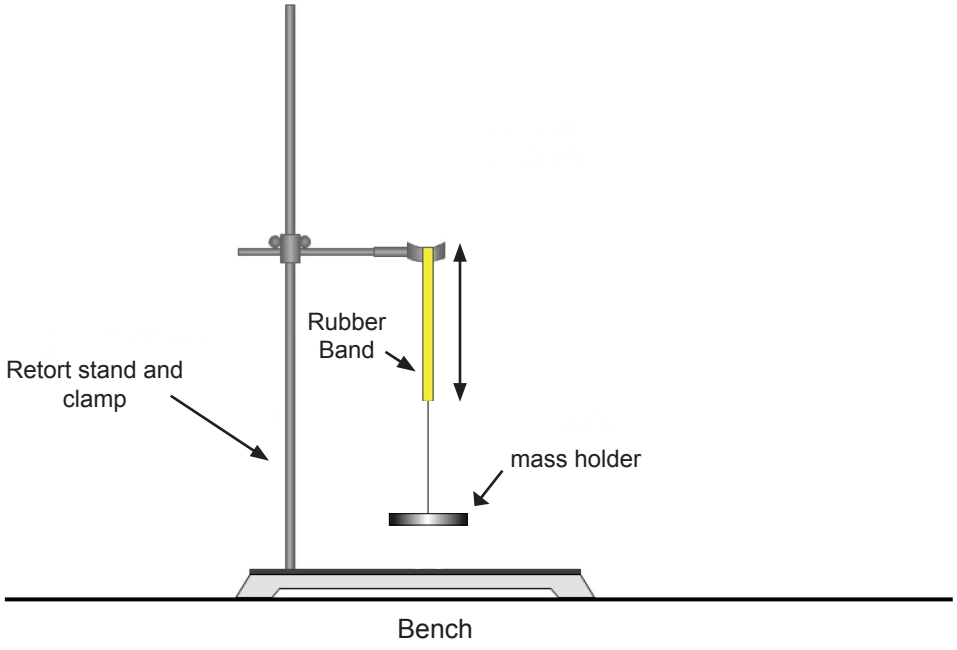

Fig. 1.1

Before the examination

Leave the four 100 g masses and the metre rule at a convenient place close to the apparatus. Check that when loaded to 500 g, the apparatus is steady and the masses do not touch the bench.

Action at changeover

Remove the 4 × 100 g masses and leave them on the bench beside the apparatus.

Information required by examiners

None

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Question 2

Principal Requirements

metre rule/optical bench	1
lens of focal length 15 cm with holder	1
plane mirror and holder	1
illuminated object and light source	1
screen	1

Preparation

The illuminated object can be a set of cross wires or mesh which can be held in place in front of the light source. If one is to be made then the following steps can be followed.

(i) Select a piece of wood to act as a holder.
(ii) Cut a piece of white card the width of the holder and about 15 cm long.
(iii) At the top of the card cut a hole the width of which is slightly smaller than the diameter of a washer as shown in **Fig. 2.1**.

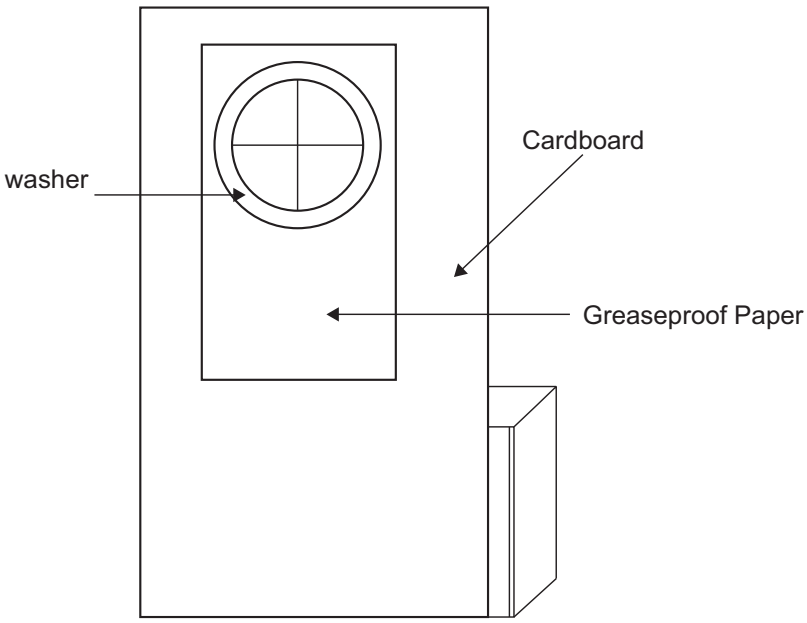

Fig. 2.1

(iv) Cut a piece of greaseproof paper so that it fits over the hole.
(v) Draw a cross in black ink on the greaseproof paper.
(vi) Stick the the greaseproof paper over the hole in the card.

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Before the examination

Set up the apparatus as shown in **Fig. 3**.

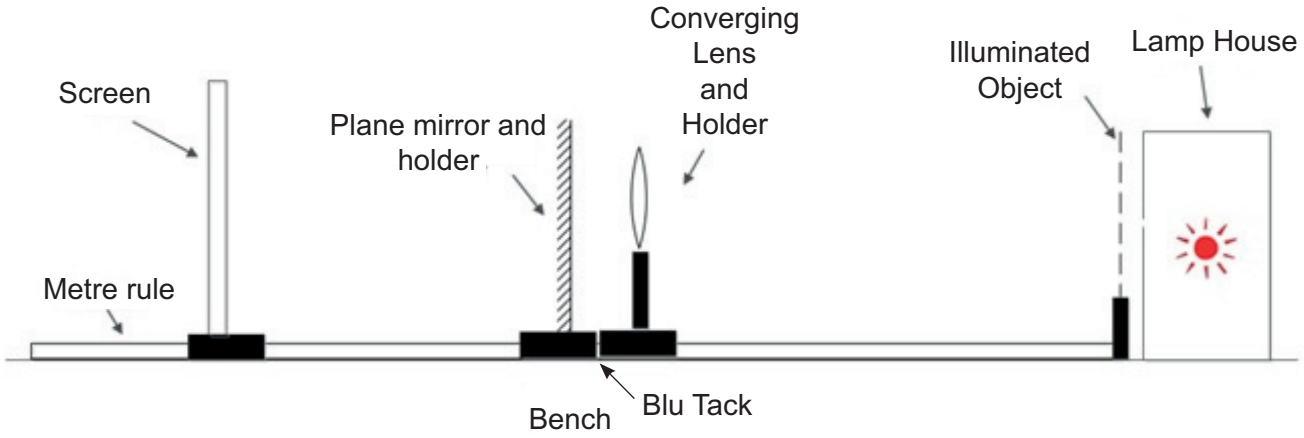

Fig. 3

Push the holders of the mirror and lens together using Blu Tack.
Set the lens at the 50 cm mark and the screen at the 70 cm mark on the metre rule scale. Place the illuminated object and light source at the zero mark on the metre rule.
Test the apparatus by moving the plane mirror/lens towards the illuminated object until a sharp image is obtained beside the illuminated object. Remove the plane mirror and move the lens toward the screen until a sharp magnified image is obtained on the screen. Reset the apparatus as at the start.

Action at changeover

Replace the plane mirror and set it with the lens at the 50 cm mark.

Information required by examiners

None

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Question 3

Principal Requirements

extension (disposable) spring unextended length 20 mm (Scientific & Technical XPS050010)	1
100 g mass holder	1
100 g mass	4
retort stand and clamp	1
stopclock	1

Preparation

Securely attach the retort stand and clamp to the edge of the bench. Suspend the spring from the clamp and attach one of the 100 g masses to the 100 g mass holder as shown in **Fig. 3.1**.

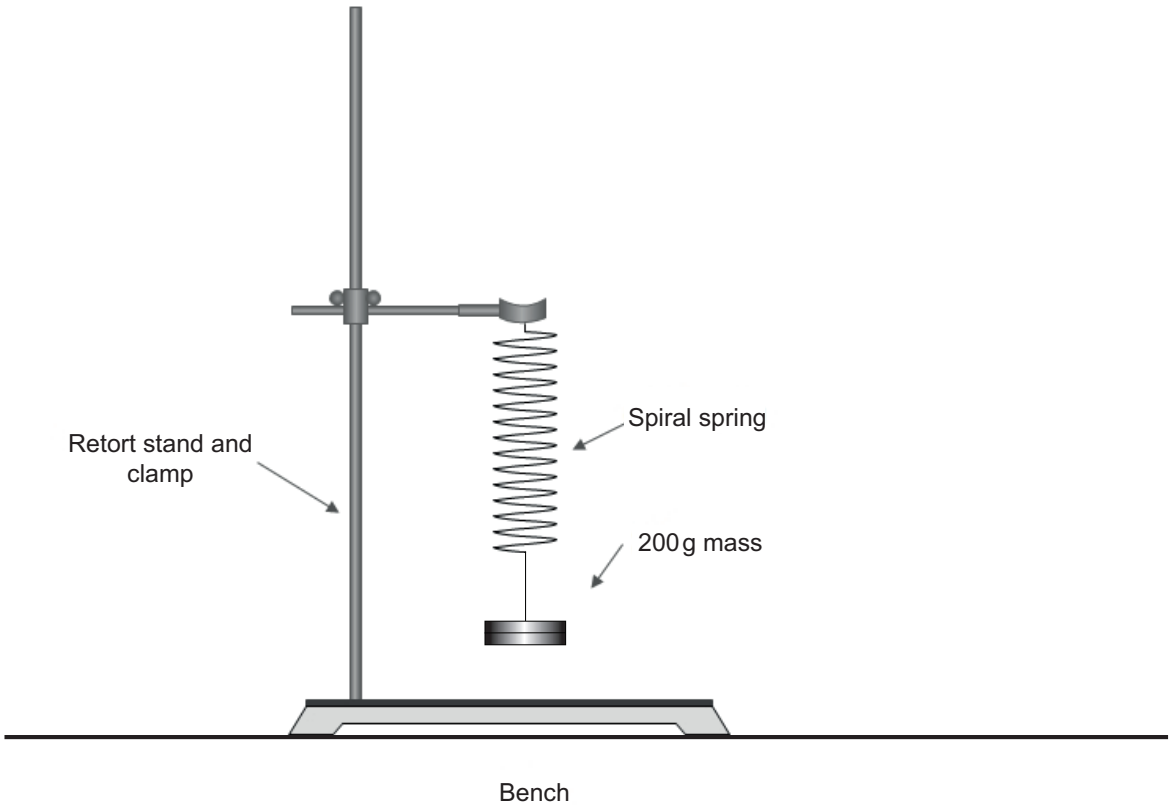

Fig. 3.1

Check that the period of oscillation is approximately 0.56 sec.
Leave the other three 100 g masses and the stop clock on the bench near the apparatus.
Check the mass doesn't hit the bench when the spring is under maximum load.

Before the examination

Assemble the apparatus as described in "Preparation" above.

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Action at changeover

Remove three of the 100 g masses and zero the stopclock.

Information required by examiners

None

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Question 4

Principal Requirements

red led (e.g. RS 826 509)	1
milliammeter to read up to 100 mA	1
digital voltmeter to read up to 3 V	1
Stabilised d.c. power supply to give steady output at 2 V	1
Connecting wires with fitted plug	5
Component holder for led	1
Label	1

Preparation

Label the positive terminal of the led and attach it to the component holder. Set up the circuit as shown in **Fig. 4.1**.

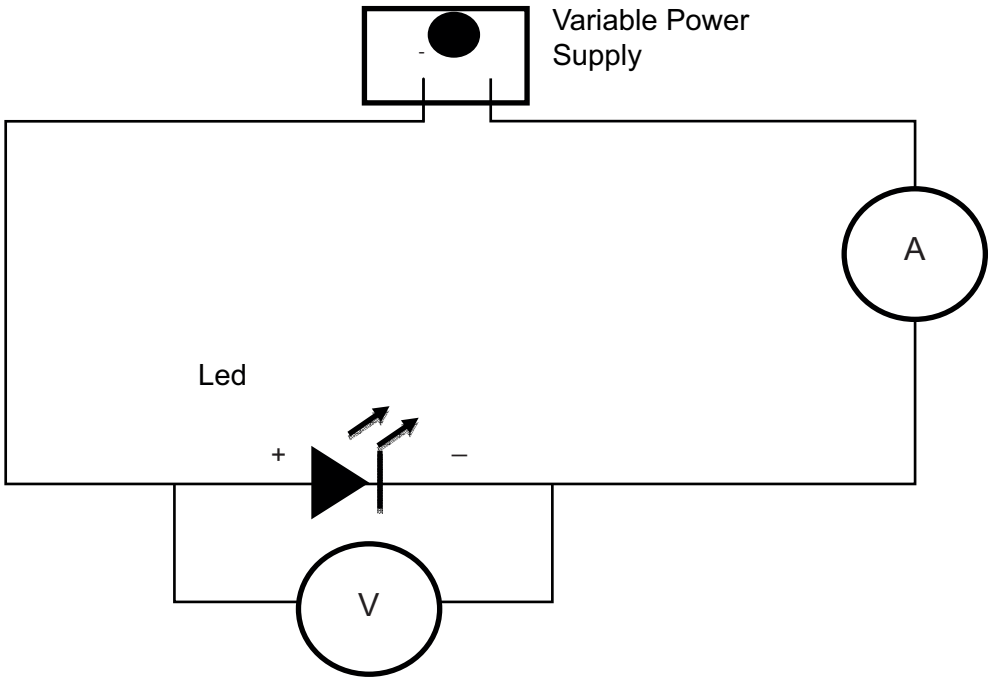

Fig. 4.1

Vary the voltage and check that the led switches on at about 1.7–1.8 V.
Reset the voltage to zero.

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Before the examination

Leave the circuit of **Fig. 4.1** connected on the bench.

Action at changeover

Check that the led illuminates at approximately 1.7–1.8 V and return the voltage to 0 V.

Information required by examiners

None

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Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Physics

Assessment Unit AS 3

assessing

Practical Techniques
Sessions 1 and 2

[AY131] [AY132]

FRIDAY 15 MAY AND MONDAY 18 MAY

AY131 AY132

APPARATUS AND MATERIALS LIST

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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.

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 2015.

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.

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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:

15 May 2014 Physics AS 3A (AY131)

(Main Session) **9.15 am–10.45 am**
(First Alternative) **11.00 am–12.30 pm**
(Second Alternative) **1.15 pm–2.45 pm**
(Third Alternative) **3.00 pm–4.30 pm**

18 May 2014 Physics AS 3B (AY132)

(Main Session) **9.15 am–10.45 am**
(First Alternative) **11.00 am–12.30 pm**
(Second Alternative) **1.15 pm–2.45 pm**
(Third Alternative) **3.00 pm–4.30 pm**

One set of apparatus for AS 3A (AY131) will therefore be sufficient for sixteen candidates on **15 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 **18 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.

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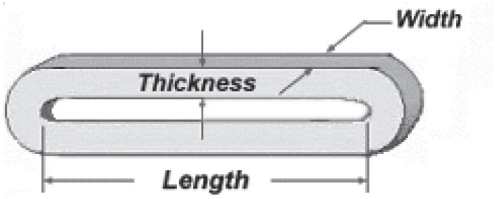
Apparatus and Materials List

Question 1

Ref.	Component	Session 1	Session 2
1.1	Rubber Band length 150 mm width 2 or 3 mm (e.g. size 38) 	1	1
1.2	100 g mass holder	1	1
1.3	100 g mass	3	4
1.4	Metre rule	1	1
1.5	Retort stand and clamp	1	1

Question 2

Ref.	Component	Session 1	Session 2
2.1	Metre rule/optical bench	1	1
2.2	Lens of focal length 10 cm with holder	1	0
2.3	Lens of focal length 15 cm with holder	0	1
2.4	Plane mirror and holder	1	1
2.5	Illuminated object and light source	1	1
2.6	Screen	1	1

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Question 3

Ref.	Component	Session 1	Session 2
3.1	Extension (disposable) spring unextended length 20 mm (Scientific & Technical XPS050010)	1	1
3.2	100 g mass holder	1	1
3.3	100 g mass	3	4
3.4	Retort stand and clamp	1	1
3.5	Stopclock (accurate to 0.01s)	1	1

Question 4

Ref.	Component	Session 1	Session 2
4.1	Red led (e.g. RS 826 509)	1	1
4.2	Milliammeter to read up to 100 mA (digital)	1	1
4.3	Digital voltmeter to read up to 3 V	1	1
4.4	Stabilised dc power supply to give steady output $\leqslant$ 2 V	1	1
4.5	Connecting wires with fitted plug	5	5
4.6	Component holder for led	1	1
4.7	Label	1	1

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