Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2018

Centre Number

Candidate Number

Physics

Assessment Unit AS 3B
(Theory)
assessing
Practical Techniques
and Data Analysis

[SPH32]

SPH32

THURSDAY 14 JUNE, MORNING

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all five** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 50.
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.

1 An experiment is carried out to investigate how the resistance of a piece of wire varies as the cross-sectional area of the wire is altered. The results from the experiment are shown in **Table 1.1**.

Table 1.1

Resistance / μΩ	0.095	0.069	0.046	0.025	0.012	0.006	0.005
Cross-sectional area / mm^2	0.08	0.12	0.16	0.30	0.65	1.10	1.32

On **Fig. 1.1** plot a graph of resistance against cross-sectional area and draw a line of best fit for the data. [8]

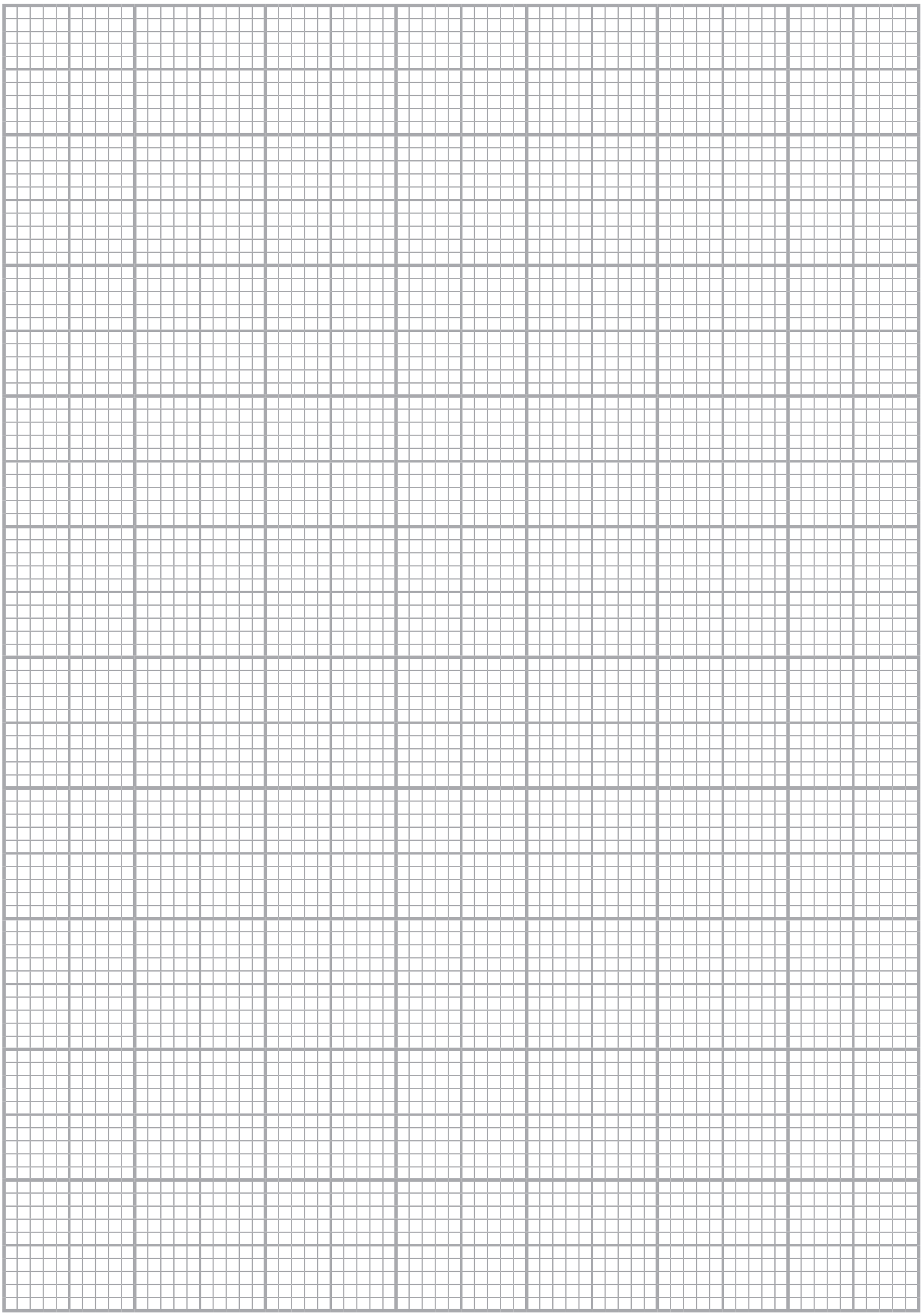

Fig. 1.1

2 **Fig. 2.1** shows a graph of the length L of a spring and the mass M added to the spring.

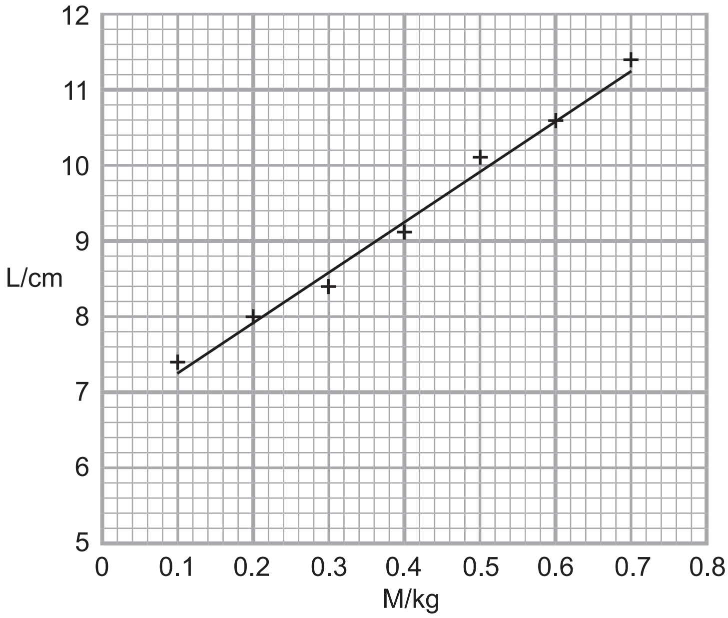

Fig. 2.1

(a) Determine the original length of the spring.

Length = ______________ cm [1]

(b) **(i)** Draw an extreme fit line for the points shown on **Fig. 2.1**. [1]

(ii) Determine the uncertainty in the original length of the spring.

Uncertainty = ______________ cm [2]

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(Questions continue overleaf)

[Turn over

3 A student performs an experiment to find the internal resistance and the e.m.f. of a cell. The cell is placed in series with a variable resistor and readings are taken of the current I and terminal potential difference V for different variable resistor values.

Fig. 3.1 shows a graph of current against the terminal potential difference.

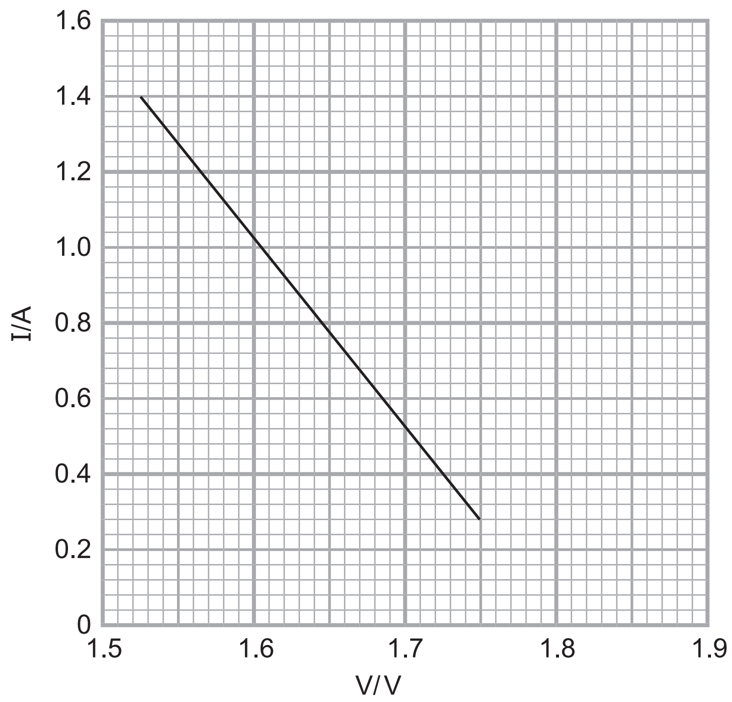

Fig. 3.1

Equation 3.1 links the e.m.f. E and the internal resistance r.

$E = V + Ir$ **Equation 3.1**

(a) **(i)** Determine the gradient of the graph in **Fig. 3.1** and state its unit.

Gradient = ________________

Unit = ____________________ [4]

(ii) Show how **Equation 3.1** can be mapped to the general equation for the straight line graph shown in **Fig. 3.1**.

[3]

(iii) Determine a value for the internal resistance of the cell.

Internal resistance = _______________ Ω [2]

(iv) (1) Explain how the e.m.f. of the cell can be found from the graph.

____

____ [2]

(2) Determine a value for the e.m.f. of the cell.

e.m.f. = _______________ V [1]

(b) Why should the experiment be started with the variable resistor at a high resistance value rather than a low resistance value?

____

____

______________________________________ [2]

4 An experiment was carried out to investigate how the speed v of a wave travelling through water depends on the wavelength λ of the wave. The time t for the wave to travel a distance 5.00 m was measured and the results recorded in **Table 4.1**.

Table 4.1

λ/m	t/s	v/m s^{-1}
0.45	5.97	0.838
0.70	4.78	1.05
0.95	4.14	1.21
1.20	3.73	
1.45	3.3	1.52

The relationship between v and λ is given by **Equation 4.1**, where K is a constant.

$$v = \sqrt{\frac{K\lambda}{2\pi}}$$ **Equation 4.1**

(a) The same measuring device was used to measure all the wavelength values. Explain why some of the values are quoted to two significant figures yet others to three significant figures.

____

____

____ [2]

(b) All of the times were measured correctly using the same stopclock. One result has been recorded incorrectly. Write down how it should be recorded and explain your answer.

____

____ [2]

(c) The speed of the wave for each wavelength, except $\lambda = 1.20$ m, was calculated and recorded in the table. Calculate the speed for wavelength $\lambda = 1.20$ m.

Speed = ______________ $m\ s^{-1}$ [3]

(d) What is the unit of the constant K?

Unit of K = ______________ [3]

5 A basic experiment is performed to measure the acceleration of free fall. The only apparatus available is: a ball bearing, a stopclock and a tape measure. The stopclock reads to one hundredth of a second and the tape measure to the nearest centimetre.

(a) Explain how the results of distance dropped and time taken can be used to obtain a value for the acceleration of free fall.

____

____

____ [3]

(b) In one experiment the distance the ball bearing is dropped is measured as 1.95 m and the time of fall 0.66 s.

(i) Calculate the percentage uncertainty in the measurement of distance.

Percentage uncertainty = ______________ % [2]

(ii) Assume the percentage uncertainty in the time of fall to be 8%. Calculate the absolute uncertainty in the value of the acceleration of free fall.

Absolute uncertainty = ± ______________ m s^{-2} [4]

(c) (i) Find the percentage difference in the experimental value of acceleration of free fall compared to the accepted value of 9.81 m s^{-2}.

Percentage difference = ______________ % [2]

(ii) Suggest ways in which the experiment could be adapted to give a result closer to the accepted value of 9.81 m s^{-2}.

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____

____ [3]

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
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Total Marks	

Examiner Number

Rewarding Learning

ADVANCED SUBSIDIARY
General Certificate of Education

Physics

Assessment Units AS 1 and AS 2

[SPH11/SPH21]

DATA AND FORMULAE SHEET

for use from 2017 onwards

Data and Formulae Sheet for AS 1 and AS 2

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall on the Earth's surface	$g = 9.81$ m s^{-2}
electron volt	1 eV $= 1.60 \times 10^{-19}$ J
the Hubble constant	$H_0 \approx 2.4 \times 10^{-18}$ s^{-1}

Useful formulae

The following equations may be useful in answering some of the questions in the examination:

Mechanics

conservation of energy	$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force

Waves

two-source interference	$\lambda = \frac{ay}{d}$
diffraction grating	$d \sin\theta = n\lambda$

Light

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

Electricity

terminal potential difference $V = E - Ir$ (e.m.f., E; Internal Resistance, r)

potential divider $V_{out} = \frac{R_1 V_{in}}{R_1 + R_2}$

Particles and photons

Einstein's equation $\frac{1}{2} m v_{max}^2 = hf - hf_0$

de Broglie equation $\lambda = \frac{h}{p}$

Astronomy

red shift $z = \frac{\Delta\lambda}{\lambda}$

recession speed $z = \frac{v}{c}$

Hubble's law $v = H_0 d$