

Write your name here

Surname

Other names

**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number

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Candidate Number

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# Physics

**Advanced Subsidiary**  
**Unit 3: Exploring Physics**

Thursday 8 May 2014 – Morning  
**Time: 1 hour 20 minutes**

Paper Reference

**WPH03/01**

**You must have:**

Ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

## Information

- The total mark for this paper is 40.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

## Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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**PEARSON**

## SECTION A

Answer ALL questions.

For questions 1–5, in Section A, select one answer from A to D and put a cross in the box ☐.  
If you change your mind put a line through the box ☒ and then  
mark your new answer with a cross ☐.

- 1 A student is measuring the length of a wire. He takes the following readings.

1000 mm, 1002 mm, 999 mm, 998 mm

How should he record the mean length in his results table?

- ☐ A 1.0 m  
☐ B 1.00 m  
☐ C 1.000 m  
☐ D 0.999 m

(Total for Question 1 = 1 mark)

- 2 Which of the following could **not** be a unit for pressure?

- ☐ A  $\text{kN m}^2$   
☐ B  $\text{N mm}^{-2}$   
☐ C  $\text{N m}^{-2}$   
☐ D Pa

(Total for Question 2 = 1 mark)

- 3 A wire is stretched by a constant force.

The extension will be directly proportional to the

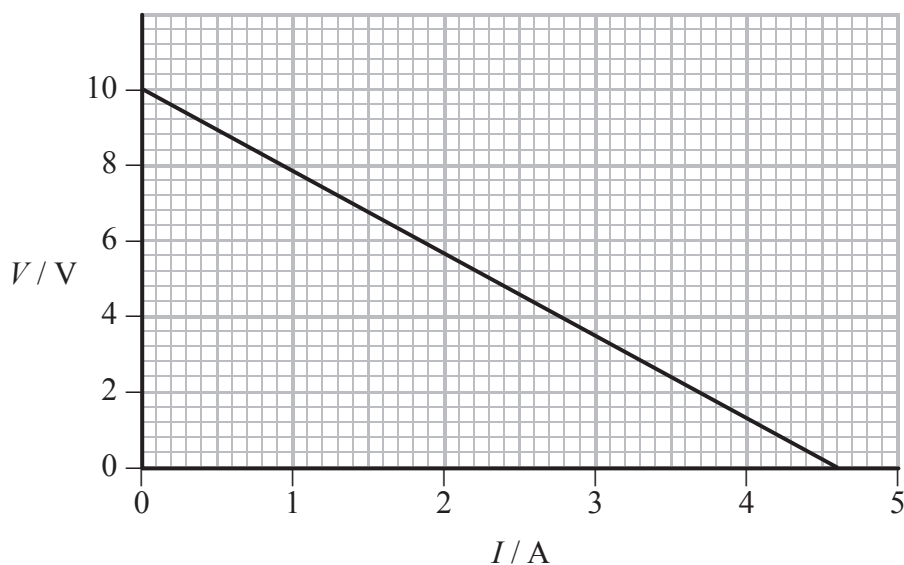
- ☐ A Young modulus of the wire.  
☐ B length of the wire.  
☐ C diameter of the wire.  
☐ D area of cross-section of the wire.

(Total for Question 3 = 1 mark)



**Questions 4 and 5 refer to the graph below.**

The graph shows how the potential difference  $V$ , across a power supply, varies with the current  $I$ , in an electric circuit.



**4** Which of the following is the correct description of the relationship between  $V$  and  $I$ ?

- ☐ **A** They are directly proportional.
- ☐ **B** They are inversely proportional.
- ☐ **C** There is a linear relationship.
- ☐ **D** There is a positive correlation.

(Total for Question 4 = 1 mark)

**5** Which of the following is the magnitude of the gradient of the graph?

- ☐ **A** 10
- ☐ **B** 4.6
- ☐ **C** 2.2
- ☐ **D** 0.46

(Total for Question 5 = 1 mark)

**TOTAL FOR SECTION A = 5 MARKS**



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## SECTION B

Answer ALL questions in the spaces provided.

- 6 Today's internationally accepted value for the speed  $c$  of electromagnetic radiation in a vacuum is  $299\,792.458 \pm 0.001 \text{ km s}^{-1}$ .

- (a) In 1883 Newcomb determined a value for  $c$  which he stated as  $299\,850 \pm 30 \text{ km s}^{-1}$ .

Explain how his stated uncertainty shows that Newcomb must have underestimated the uncertainties in his measurements.

(2)

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- (b) In 1926 Michelson determined a value for  $c$  which he stated as  $299\,796 \pm 4 \text{ km s}^{-1}$ .

Comment on the value determined by Michelson.

(2)

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- (c) Calculate the percentage uncertainty claimed for today's internationally accepted value for  $c$ .

(2)

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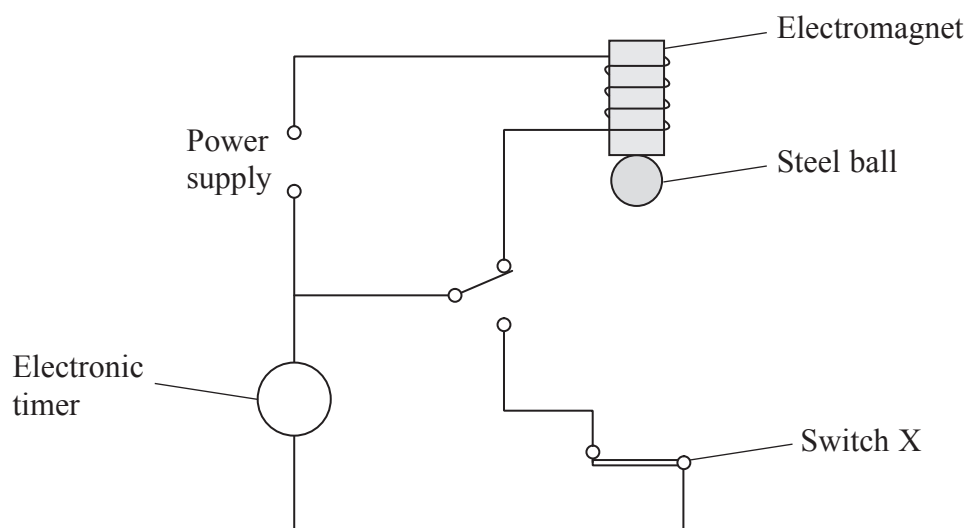
Percentage uncertainty = .....

(Total for Question 6 = 6 marks)



- 7 A student is asked to determine a value for the acceleration of free fall  $g$  by timing a falling steel ball.

The diagram below shows the apparatus to be used. The steel ball falls a distance  $s$  from the electromagnet to switch X. The electronic timer records the time taken  $t$ .



The student is told to plot a graph of  $s$  against  $t^2$ .

Write a plan for an experiment to determine  $g$  using this method.

You should:

- (a) draw on the diagram the distance  $s$  to be measured, (1)
- (b) state the apparatus required to measure  $s$  and explain your choice, (2)
- (c) explain why an electronic timer is used to measure  $t$ , (1)
- (d) comment on whether repeat readings are appropriate in this case, (1)
- (e) explain what data will be collected and how it will be used to determine  $g$ , (5)
- (f) identify the main sources of uncertainty and/or systematic error, (2)
- (g) comment on safety. (1)



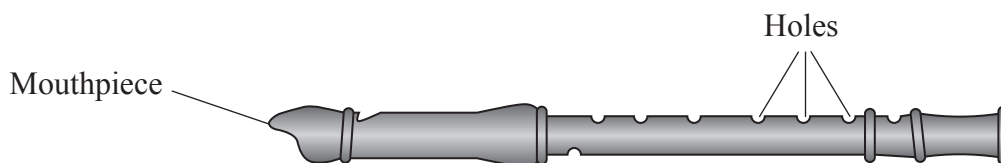
Handwriting practice area with 20 sets of three horizontal lines (top, middle, bottom) for letter formation.



(Total for Question 7 = 13 marks)



- 8 A student carried out an experiment to determine the speed  $v$  of sound in air. She used the musical instrument shown, in which standing waves are produced by blowing into the instrument to vibrate the air inside.



The length  $l$  of the vibrating air column is changed by covering the holes. This changes the frequency  $f$  of the sound produced.

She measured  $f$  for different values of  $l$ . Her results are shown in the table.

| $l$ / cm | $f$ / Hz |
|----------|----------|
| 10       | 1719     |
| 12.5     | 1375     |
| 14.5     | 1185     |
| 16.5     | 1042     |
| 19       | 904      |

- (a) Criticise her results.

(2)

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(b) Complete the last column of the table below.

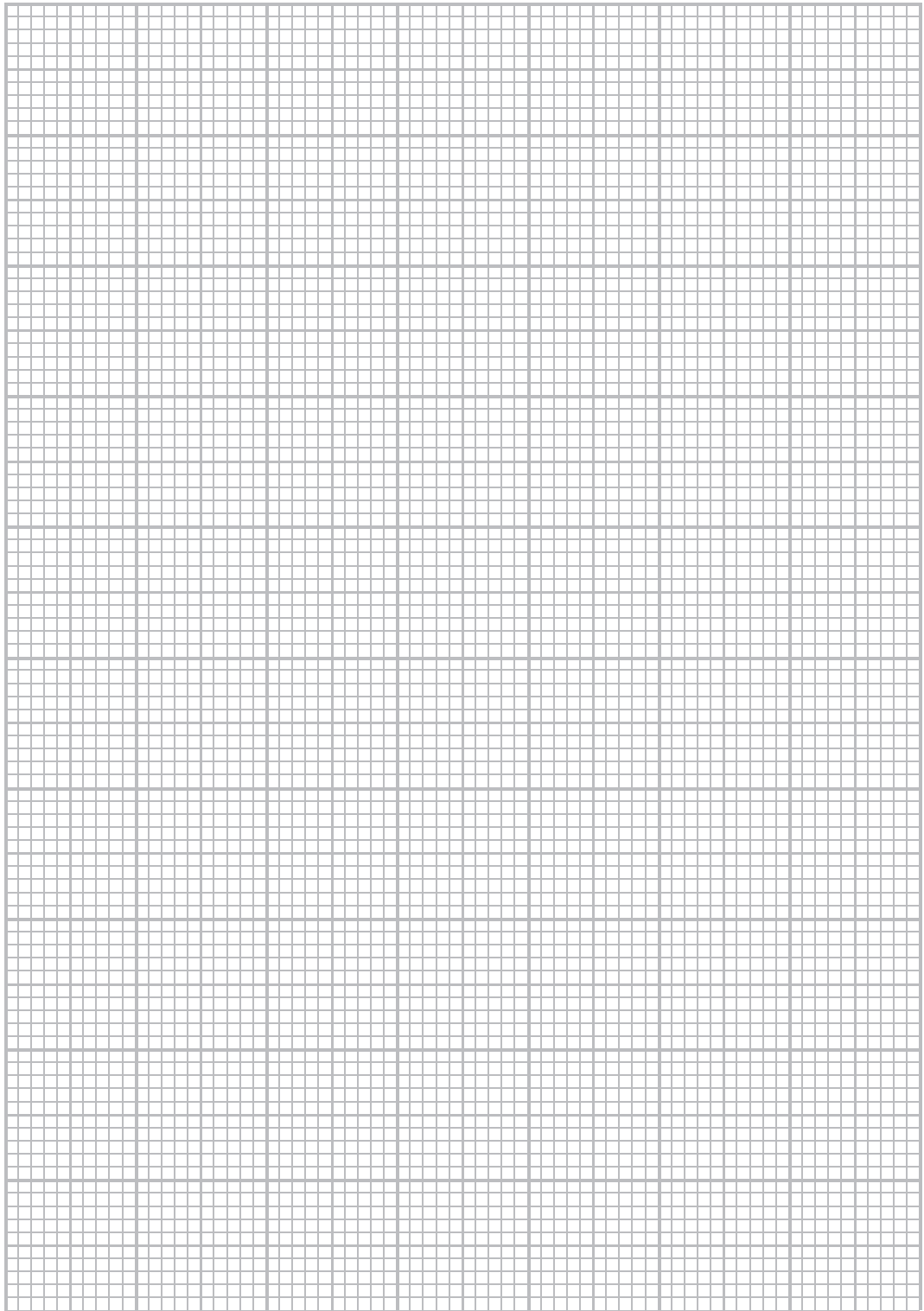
(3)

| $l/\text{cm}$ | $f/\text{Hz}$ | $\frac{1}{l}/$ |
|---------------|---------------|----------------|
| 10            | 1719          |                |
| 12.5          | 1375          |                |
| 14.5          | 1185          |                |
| 16.5          | 1042          |                |
| 19            | 904           |                |

(c) Plot a graph of  $f$  on the  $y$ -axis against  $\frac{1}{l}$  on the  $x$ -axis on the grid provided and draw a line of best fit.

(4)





(d) Determine the gradient of your graph.

(3)

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Gradient = .....

(e) The equation for the graph is  $f = \frac{v}{2l}$ . Calculate a value for  $v$ .

(3)

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$v =$  .....

(f) The accepted value for  $v$  is  $330 \text{ m s}^{-1}$ .

Assuming your calculations are correct, suggest why there is a difference between your value for  $v$  and the accepted value.

(1)

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(Total for Question 8 = 16 marks)

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**TOTAL FOR SECTION B = 35 MARKS**

**TOTAL FOR PAPER = 40 MARKS**



## List of data, formulae and relationships

|                              |                                                 |                            |
|------------------------------|-------------------------------------------------|----------------------------|
| Acceleration of free fall    | $g = 9.81 \text{ m s}^{-2}$                     | (close to Earth's surface) |
| Electron charge              | $e = -1.60 \times 10^{-19} \text{ C}$           |                            |
| Electron mass                | $m_e = 9.11 \times 10^{-31} \text{ kg}$         |                            |
| Electronvolt                 | $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$ |                            |
| Gravitational field strength | $g = 9.81 \text{ N kg}^{-1}$                    | (close to Earth's surface) |
| Planck constant              | $h = 6.63 \times 10^{-34} \text{ J s}$          |                            |
| Speed of light in a vacuum   | $c = 3.00 \times 10^8 \text{ m s}^{-1}$         |                            |

### Unit 1

#### Mechanics

|                               |                                                                                            |
|-------------------------------|--------------------------------------------------------------------------------------------|
| Kinematic equations of motion | $v = u + at$<br>$s = ut + \frac{1}{2}at^2$<br>$v^2 = u^2 + 2as$                            |
| Forces                        | $\Sigma F = ma$<br>$g = F/m$<br>$W = mg$                                                   |
| Work and energy               | $\Delta W = F\Delta s$<br>$E_k = \frac{1}{2}mv^2$<br>$\Delta E_{\text{grav}} = mg\Delta h$ |

#### Materials

|                       |                                                                                        |
|-----------------------|----------------------------------------------------------------------------------------|
| Stokes' law           | $F = 6\pi\eta r v$                                                                     |
| Hooke's law           | $F = k\Delta x$                                                                        |
| Density               | $\rho = m/V$                                                                           |
| Pressure              | $p = F/A$                                                                              |
| Young modulus         | $E = \sigma/\epsilon$ where<br>Stress $\sigma = F/A$<br>Strain $\epsilon = \Delta x/x$ |
| Elastic strain energy | $E_{\text{el}} = \frac{1}{2}F\Delta x$                                                 |



## Unit 2

### Waves

Wave speed

$$v = f\lambda$$

Refractive index

$${}_1\mu_2 = \sin i / \sin r = v_1 / v_2$$

### Electricity

Potential difference

$$V = W/Q$$

Resistance

$$R = V/I$$

Electrical power, energy and efficiency

$$P = VI$$

$$P = I^2R$$

$$P = V^2/R$$

$$W = VIt$$

$$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

Resistivity

$$R = \rho l/A$$

Current

$$I = \Delta Q / \Delta t$$

$$I = nqvA$$

Resistors in series

$$R = R_1 + R_2 + R_3$$

Resistors in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

### Quantum physics

Photon model

$$E = hf$$

Einstein's photoelectric equation

$$hf = \phi + \frac{1}{2}mv_{\max}^2$$



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