OXFORD
INTERNATIONAL AQA EXAMINATIONS

INTERNATIONAL A-LEVEL

PHYSICS

(9630)

PAPER 2

Specimen 2018 | Morning | Time allowed: 2 hours

Materials

For this paper you must have:

- a pencil
- a ruler
- a calculator
- a data and formula booklet.

Instructions

- use black ink or ball-point pen
- answer **all** questions
- show all your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80 marks.

Please write clearly in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname

Forename(s)

Candidate signature ____________________

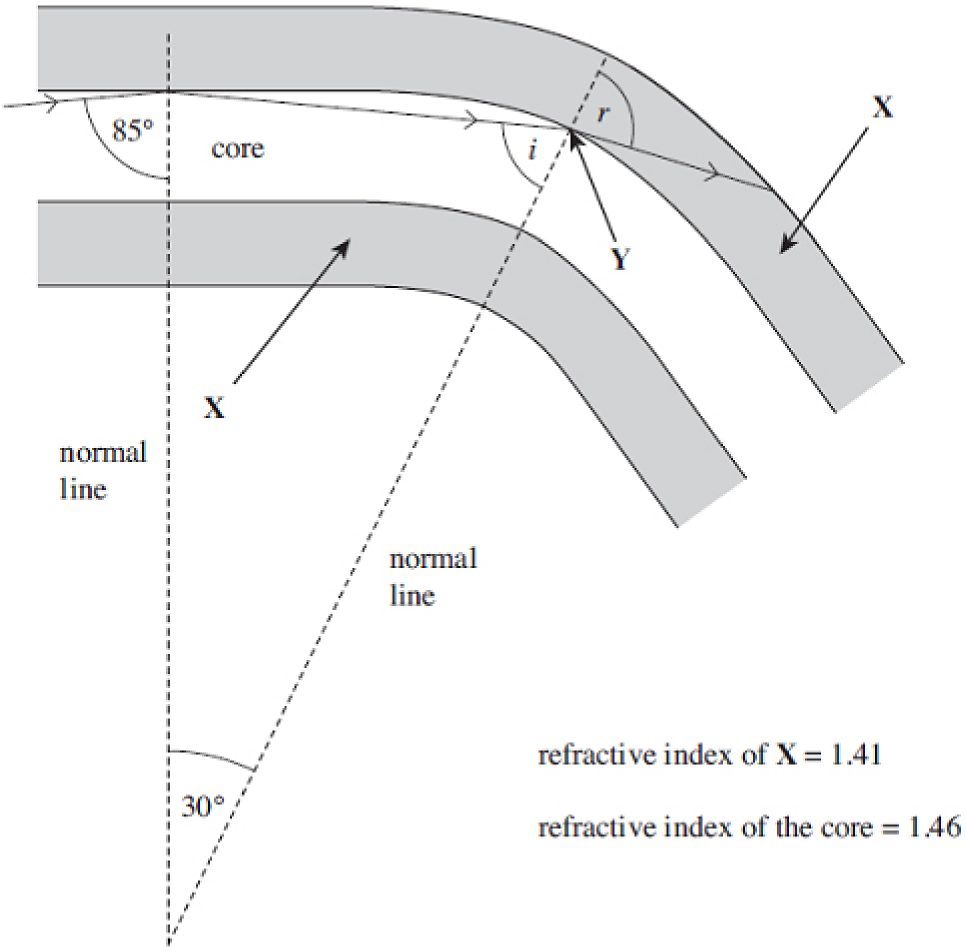
V1.1

Section A

Answer **all** questions in this section.

0 1 **Figure 1** shows a cross-section through an optical fibre used for communications.

Figure 1



0 1 . 1 Identify the part of the fibre labelled **X**.

[1 mark]

____

0 1 . 2 Calculate the critical angle for the boundary between the core and **X**.

[2 marks]

angle = ________________ degrees

0 1 . 3 The ray leaves the core at **Y**. At this point the fibre has been bent through an angle of 30° as shown in **Figure 1**.

Calculate the value of angle i.

[1 mark]

angle = ________________ degrees

0 2 . 1 A metal wire of length 1.4 m has a uniform cross-sectional area of $7.8 \times 10^{-7}\ \mathrm{m}^2$.

Calculate the resistance, R, of the wire.
Resistivity of the metal = $1.7 \times 10^{-8}\ \Omega\ \mathrm{m}$

[2 marks]

resistance = ________________ Ω

0 2 . 2 The wire is now stretched to twice its original length by a process that keeps its volume constant. The resistivity of the metal of the wire remains constant.

Show that the resistance increases to $4R$.

[2 marks]

____

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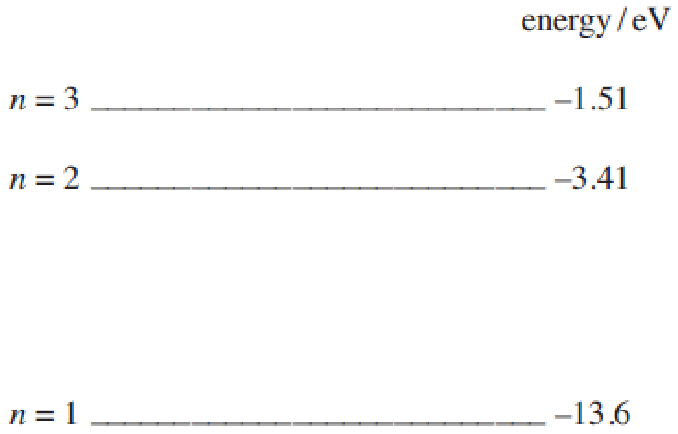
____

0 3 **Figure 2** shows the lowest three energy levels of a hydrogen atom.

Figure 2



An electron is incident on a hydrogen atom. As a result an electron in the ground state of the hydrogen atom is excited to the n = 2 energy level. The atom then emits a photon of a characteristic frequency.

Explain how the electron in the ground state becomes excited to the n = 2 energy level.

[2 marks]

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____

0 4 A battery in a laptop computer has an electromotive force (emf) of 14.8 V and can store a maximum charge of 15.5×10^{3} C. The battery has negligible internal resistance.

Calculate the maximum amount of energy this battery can deliver.

[2 marks]

maximum energy = ______________________ J

0 5 When a mass M attached to a spring X, as shown in **Figure 3**, is displaced downwards and released it oscillates with time period 1.5 s.

In **Figure 4**, a second identical spring is connected as shown and the same mass M is attached.

Figure 3

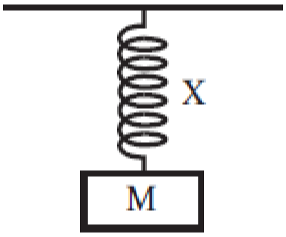
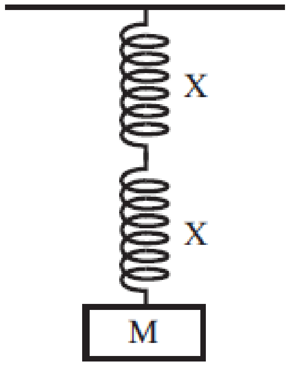


Figure 4



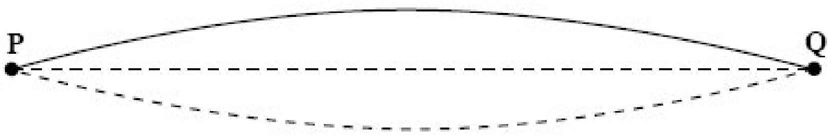
Calculate the time period of the mass in **Figure 4** when it is displaced downwards and released.

[2 marks]

time period = ____________________ s

0 6 **Figure 5** represents a stationary wave formed on a steel string fixed at **P** and **Q** when it is plucked at its centre.

Figure 5



The stationary wave in **Figure 5** has a frequency of 150 Hz. The string **PQ** has a length of 1.2 m.

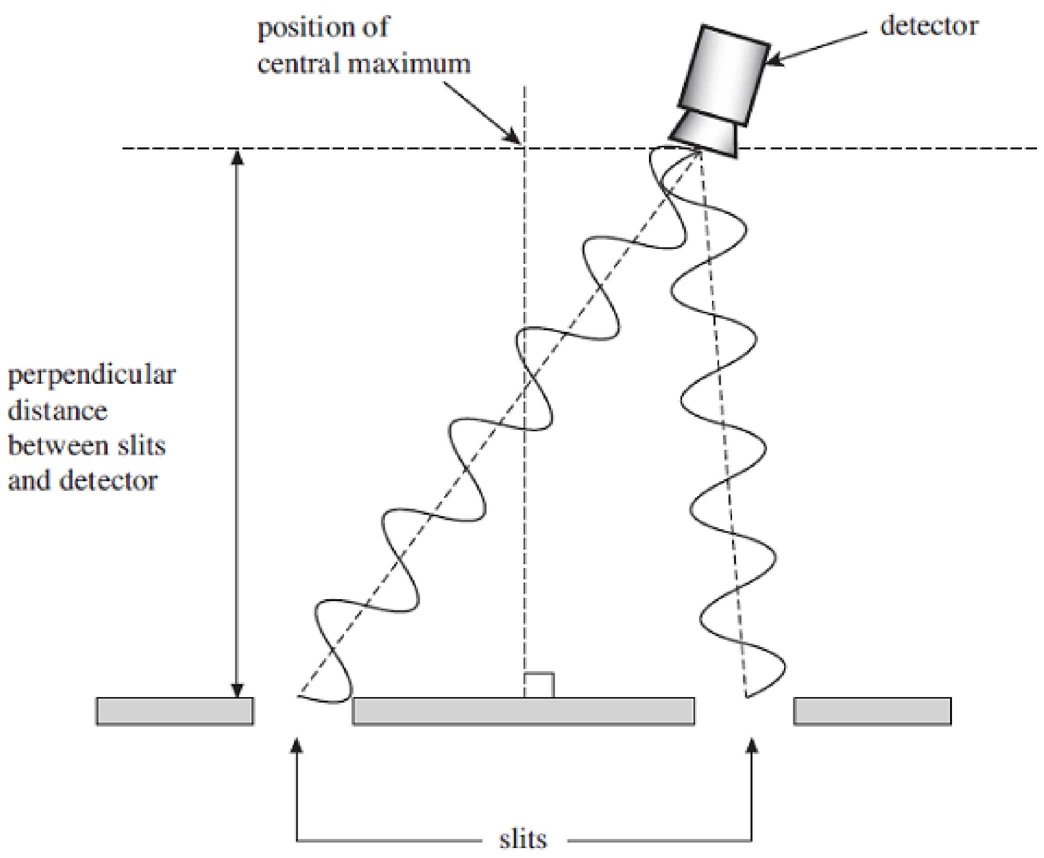
Calculate the wave speed of the waves forming the stationary wave.

[2 marks]

wave speed = ____________________ $m\ s^{-1}$

0 7 **Figure 6** shows the paths of microwaves from two narrow slits through a vacuum to a detector. The slits act as coherent sources.

Figure 6



0 7 . 1 Explain what is meant by **coherent sources**.

[2 marks]

____

____

____

____

0 7 . 2 The frequency of the microwaves is 9.4 GHz.

Determine the wavelength of the waves.

[2 marks]

wavelength = ____________________ m

V1.1

0 7 . 3 Calculate the path difference between the two waves arriving at the detector.
Use the information on **Figure 6** and your answer to **7.2**.

[1 mark]

path difference = ____________________ m

0 7 . 4 Explain whether a maximum or minimum is detected at the position shown in **Figure 6**.

[3 marks]

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0 7 . 5 The experiment is now rearranged so that the perpendicular distance from the slits to the detector is 0.42 m. The interference fringe spacing changes to 0.11 m.

Calculate the slit separation.
Give your answer to an appropriate number of significant figures.

[3 marks]

slit separation = ____________________ m

0 7 . 6 With the detector at the position of a maximum, the frequency of the microwaves is now doubled.

Explain what would now be detected by the detector in the same position.

[2 marks]

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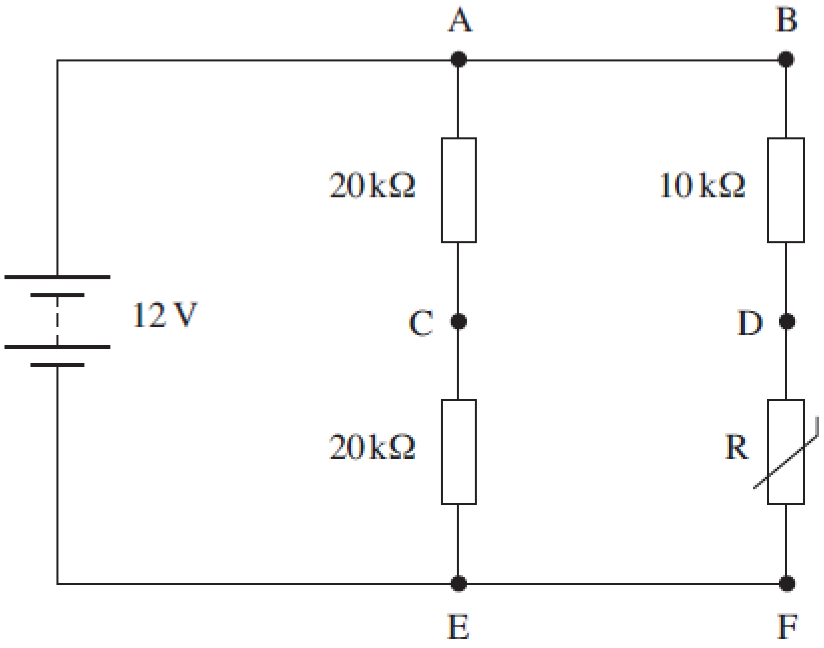
0 8 **Figure 7** shows a 12 V battery of negligible internal resistance connected to a combination of three resistors and a thermistor.

Figure 7



0 8 . 1 At room temperature, the resistance of the thermistor is 5.0 kΩ.

Calculate the total resistance of the circuit.

[2 marks]

total resistance = ____________________ kΩ

0 8 . 2 Calculate the current in the battery at the same temperature.

[1 mark]

current = ____________________ A

0 8 . 3 A high-resistance voltmeter is used to measure the potential difference (pd) between points **A–C**, **D–F** and **C–D** in turn.

Complete **Table 1** indicating the reading of the voltmeter at each of the three positions.

[3 marks]

Table 1

Voltmeter position	pd / V
A–C	
D–F	
C–D	

0 8 . 4 The thermistor is heated so that its resistance decreases.
State and explain the effect this has on the voltmeter reading in the following positions.

[4 marks]

A–C ______________________________

____

____

D–F ______________________________

____

____

Turn over for the next question

0 9 Experiments based on the photoelectric effect support the particle nature of light. In such experiments, light is directed at a metal surface. A threshold frequency for this light occurs. Below this frequency, no photoelectric effect is observed.

0 9 . 1 Explain why the photoelectric effect is **not** observed below the threshold frequency.

[2 marks]

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0 9 . 2 Monochromatic light of wavelength 5.40×10^{-7} m is incident on a metal surface which has a work function of 1.40×10^{-19} J.

Calculate the energy of a single photon of this light.

[2 marks]

energy = ____________ J

0 9 . 3 Calculate the maximum kinetic energy of an electron emitted from the surface.

[1 mark]

energy = ____________ J

0 9 . 4 Calculate the maximum speed of the emitted electron.

[2 marks]

maximum speed = ____________ m s^{-1}

0 9 . 5 Calculate the de Broglie wavelength of the fastest electrons.

[2 marks]

wavelength = ____________ m

0 9 . 6 The intensity of light incident on the metal is increased without changing the frequency.

Describe and explain the change which takes place.

[2 marks]

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____

Turn over for the next question

Section B

Answer **all** questions in this section.

1 0 A student carries out an experiment to determine the emf ε and internal resistance r of a cell. The cell is connected to a variable resistor R. The current through the cell and the terminal pd of the cell are measured as the resistance of R is decreased. The voltmeter used had a very high resistance. The circuit is shown in **Figure 8**.

Figure 8

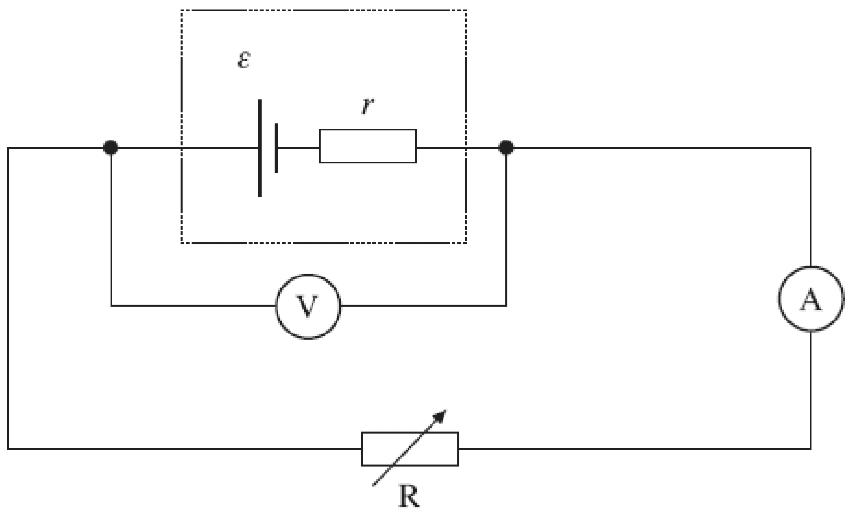
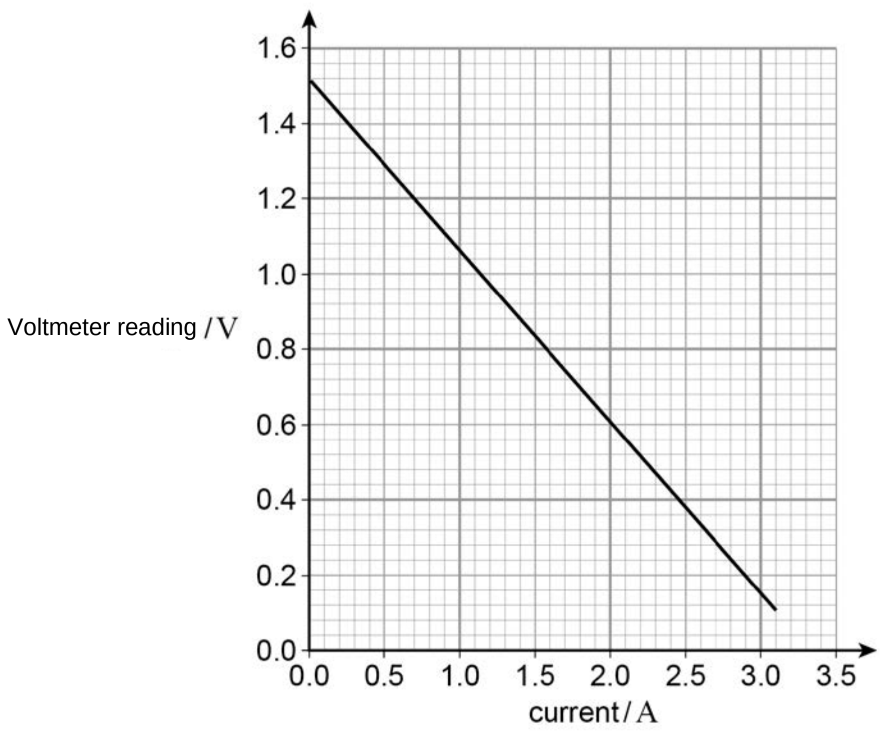


Figure 9 shows a graph drawn from the results from the experiment.

Figure 9



1 0 . 1 Determine the emf ε of the cell using **Figure 9**.

[1 mark]

emf of cell = ____________ V

1 0 . 2 Determine the internal resistance r of the cell by using **Figure 9**.

[3 marks]

internal resistance = ____________ Ω

1 0 . 3 Another student checks the emf of the cell by disconnecting the cell from the circuit and connecting a voltmeter across it. The voltmeter used has a low resistance.

State and explain how this value compares with the value determined in **10.1**.

[2 marks]

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____

____

Turn over for the next question

1 1 Read through the following information and answer the questions that follow.

Measuring the speed of sound in air

Sound travels as a longitudinal wave. The first attempt to measure its speed in air was made by the scientist Gassendi. The procedure involved timing the interval between seeing the flash of a gun and hearing the bang from some distance away. Gassendi assumed that the speed of light is infinite compared to the speed of sound. The value he obtained for the speed of sound was 480 $\mathrm{m\ s^{-1}}$. He also realised that the speed of sound does not depend on frequency.

1 1 . 1 Suggest an experiment that will demonstrate the wave nature of sound (line 1).

[1 mark]

___

___

___

1 1 . 2 Using Gassendi's value for the speed of sound (line 5), calculate the time between seeing the flash of a gun and hearing its bang over a distance of 2.5 km.

[1 mark]

time = ____________________ s

1 1 . 3 Explain why it was necessary to assume that 'the speed of light is infinite' (line 4).

[1 mark]

___

___

___

1 1 . 4 Explain **one** observation that could have led Gassendi to conclude that ‘the speed of sound does not depend on frequency’ (line 6).

[2 marks]

Question 11 continues on the next page

Read through the following information and answer the questions that follow.

Using the same method as Gassendi, a much better value of 350 $\mathrm{m\,s^{-1}}$ was obtained by the Italian physicists Borelli and Viviani. In 1740 another Italian, Bianconi, showed that sound travels faster when the temperature of the air is greater. In 1738 a value of 332 $\mathrm{m\,s^{-1}}$ was obtained by scientists in Paris. This is very close to the currently accepted value considering the measuring equipment available to the scientists at that time. Since 1986 the accepted value has been 331.29 $\mathrm{m\,s^{-1}}$ at 0 °C.

1 1 . 5 Explain how the value obtained by Borelli and Viviani was 'much better' than that obtained by Gassendi (line 1).

[1 mark]

1 1 . 6 The speed of sound c in dry air is given by

$$c = k\sqrt{(\theta + 273.15)}$$

where θ is the temperature in °C, and k is a constant.

Calculate a value for k using data from the passage.

[2 marks]

k = ____________________ $\mathrm{m\,s^{-1}\,K^{-1/2}}$

1 1 . 7 State the steps taken by the scientific community for the value of a quantity to be 'accepted' (line 5).

[2 marks]

Section C

Each of the questions in this section is followed by four responses, **A**, **B**, **C**, and **D**. For each question select the best response.

Only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD WRONG METHODS

If you want to change your answer you must cross out your original answer as shown.

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.

1 2 Two points on a progressive wave are one-eighth of a wavelength apart.
The distance between them is 0.5 m, and the frequency of the oscillation is 10 Hz.
What is the minimum speed of the wave?

[1 mark]

A 0.2 $m\ s^{-1}$

B 10 $m\ s^{-1}$

C 20 $m\ s^{-1}$

D 40 $m\ s^{-1}$

1 3 Which of the following waves **cannot** be polarised?

[1 mark]

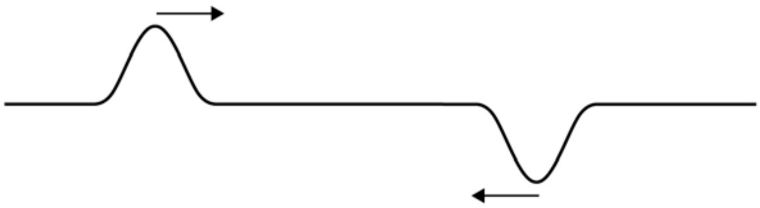
A microwave

B radio

C ultrasonic

D ultraviolet

1 4 The diagram shows two pulses on a string travelling towards each other.

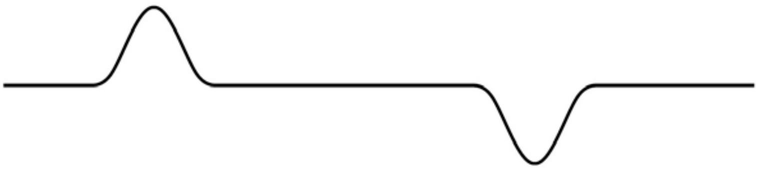


Which of the following diagrams shows the shape of the string when the pulses have passed through each other?

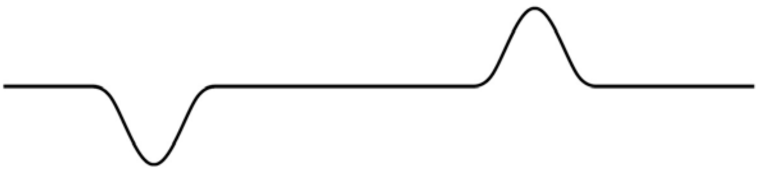
[1 mark]

A ⬭

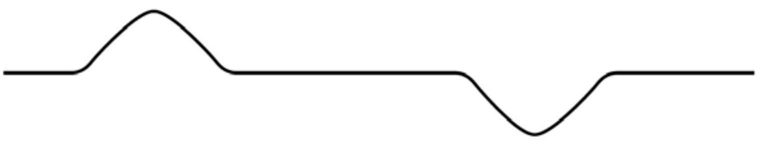
B ⬭



C ⬭



D ⬭



1 5 Monochromatic light of wavelength 590 nm is incident normally on a plane diffraction grating having 4×10^5 lines m^{-1}. An interference pattern is produced. What is the highest order visible in this interference pattern?

[1 mark]

A 2 ○

B 3 ○

C 4 ○

D 5 ○

1 6 Sound waves cross a boundary between two media X and Y. The frequency of the waves in X is 400 Hz. The speed of the waves in X is 330 $m\,s^{-1}$ and the speed of the waves in Y is 1320 $m\,s^{-1}$. What are the correct frequency and wavelength in Y?

[1 mark]

	Frequency / Hz	Wavelength / m	
A	100	0.825	○
B	400	0.825	○
C	400	3.30	○
D	1600	3.30	○

1 7 Which of the following is correct for a stationary wave?

[1 mark]

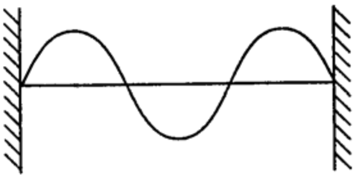
A Between two nodes the amplitude of the wave is constant. ○

B The two waves producing the stationary wave must always be 180° out of phase. ○

C The separation of the nodes for the second harmonic is double the separation of nodes for the first harmonic. ○

D Between two nodes all parts of the wave vibrate in phase. ○

1 8

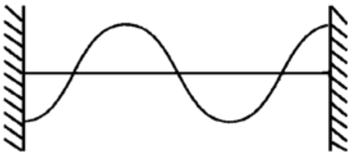


frequency of vibration = 50 Hz

The diagram above shows a stationary wave on a stretched string at a time t = 0. Which one of the diagrams, A to D, correctly shows the position of the string a time t = 0.010 s?

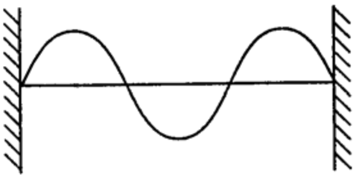
[1 mark]

A



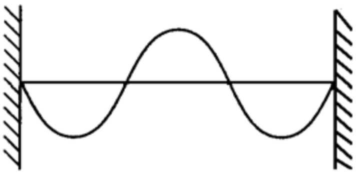
○

B



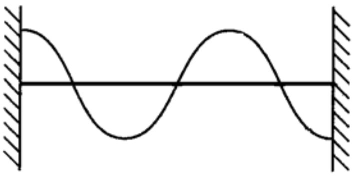
○

C



○

D



○

1 9 In a cathode ray tube 7.5×10^{15} electrons strike the screen in 40 s.
What current does this represent?
Charge of the electron is 1.6×10^{-19} C.

[1 mark]

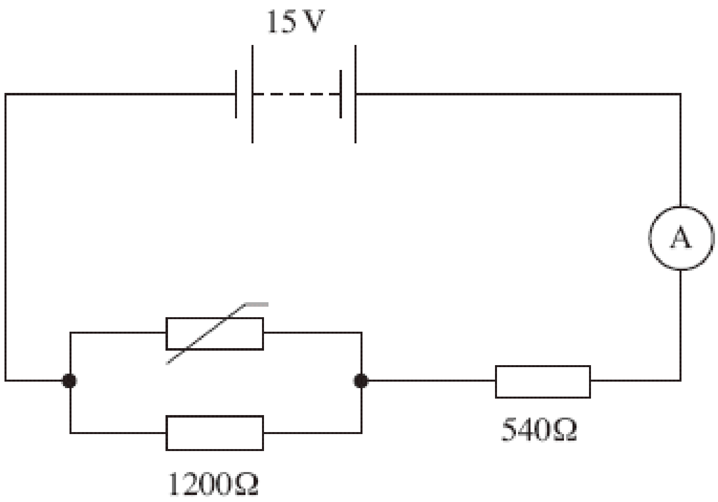
A 1.3×10^{-16} A ⬭

B 5.3×10^{-15} A ⬭

C 3.0×10^{-5} A ⬭

D 1.2×10^{-3} A ⬭

2 0 The circuit shown below shows a thermistor connected in a circuit with two resistors, an ammeter and a battery of emf 15 V and negligible internal resistance.



When the thermistor is at a certain temperature the current through the ammeter is 10.0 mA.

Calculate the pd across the 1200 Ω resistor.

[1 mark]

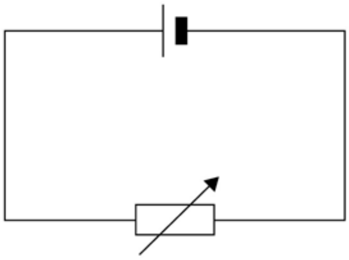
A 4.8 V ⬭

B 5.4 V ⬭

C 7.5 V ⬭

D 9.6 V ⬭

2 1 The cell in the circuit has an emf of 2.0 V. When the variable resistor has a resistance of 4.0 Ω, the potential difference (pd) across the terminals of the cell is 1.0 V.



What is the pd across the terminals of the cell when the resistance of the variable resistor is 12 Ω?

[1 mark]

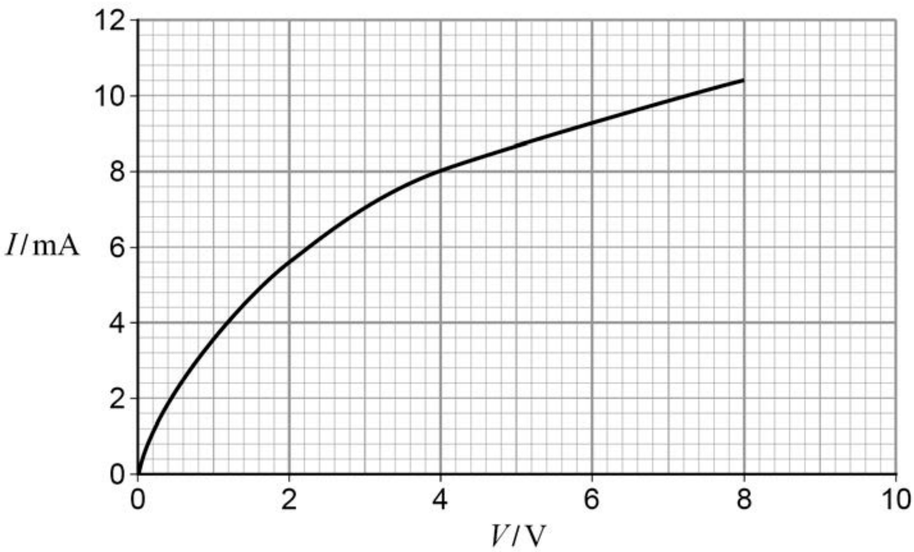
A 0.25 V

B 0.75 V

C 1.33 V

D 1.50 V

2 2 The graph shows the current–voltage (*I*–*V*) characteristics of a filament lamp.



What is the resistance of the filament when the potential difference (pd) across it is 4.0 V?

[1 mark]

A 500 Ω

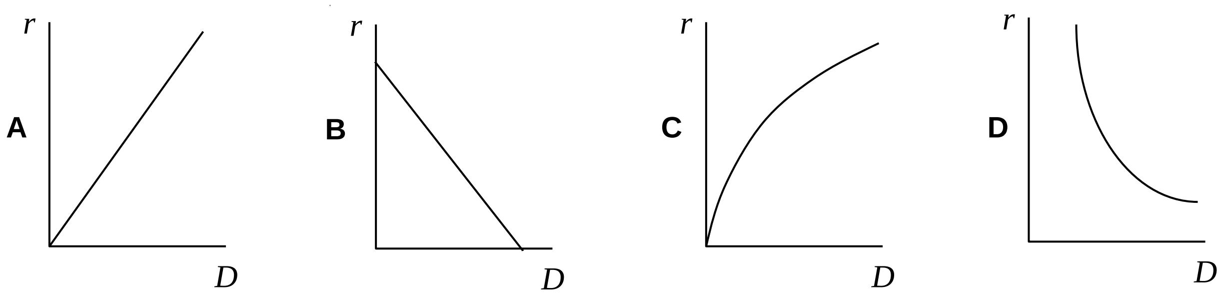
B 1700 Ω

C 2000 Ω

D 6000 Ω

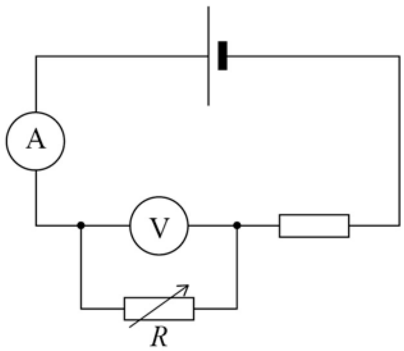
2 3 Which graph shows how the resistance per unit length r of a wire varies with diameter D of the wire?

[1 mark]



A ⬭
B ⬭
C ⬭
D ⬭

2 4 In the circuit shown in the diagram, the cell has negligible internal resistance.

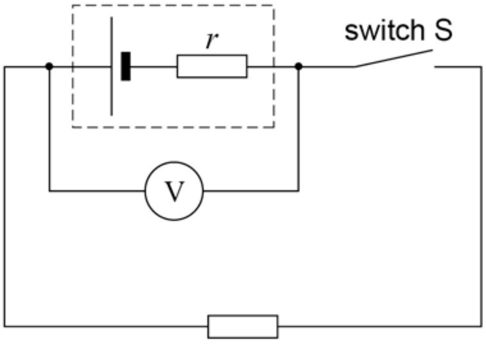


What happens to the reading of both meters when the resistance of R is decreased?

[1 mark]

	Reading of ammeter	Reading of voltmeter	
A	increases	increases	⬭
B	increases	decreases	⬭
C	decreases	increases	⬭
D	unchanged	decreases	⬭

2 5 In the circuit shown, V is a voltmeter with a very high resistance. The internal resistance of the cell, r, is equal to the external resistance in the circuit.



Which of the following is **not** equal to the emf of the cell?

[1 mark]

A the reading of the voltmeter when the switch S is open ⬭

B the chemical energy changed to electrical energy when unit charge passes through the cell ⬭

C twice the reading of the voltmeter when the switch S is closed ⬭

D the electrical energy produced when unit current passes through the cell ⬭

END OF QUESTIONS