Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Friday 17 May 2019

Morning (Time: 1 hour 30 minutes) | Paper Reference **WPH12/01**

Physics

International Advanced Subsidiary Level
Unit 2: Waves and Electricity

You must have:
Scientific calculator, 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.*
- **Show all your working out in calculations and include units where appropriate.**

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

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

Turn over ▶

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SECTION A

Answer ALL questions.

For questions 1–10 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 Which of the following is an SI unit for electromotive force (e.m.f)?

☒ **A** coulomb

☒ **B** joule

☒ **C** newton

☒ **D** volt

(Total for Question 1 = 1 mark)

2 A filament lamp is a source of unpolarised light.

A polarising filter is placed between a filament lamp and an observer. The filter is rotated in the plane perpendicular to the direction of travel of the light.

Which of the following is observed as the filter is rotated through an angle of 90°?

☒ **A** The light intensity changes from maximum to minimum.

☒ **B** The light intensity changes from minimum to maximum.

☒ **C** The light intensity does not change.

☒ **D** The light intensity is zero throughout the rotation.

(Total for Question 2 = 1 mark)

3 When a guitar string is plucked, a sound of constant frequency is heard.

The wave produced on the vibrating guitar string is

☒ **A** longitudinal and progressive.

☒ **B** longitudinal and stationary.

☒ **C** transverse and progressive.

☒ **D** transverse and stationary.

(Total for Question 3 = 1 mark)

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4 Which of the following has the largest de Broglie wavelength?

☒ **A** an electron travelling at $3.0 \times 10^5\,m\,s^{-1}$

☒ **B** an electron travelling at $4.0 \times 10^5\,m\,s^{-1}$

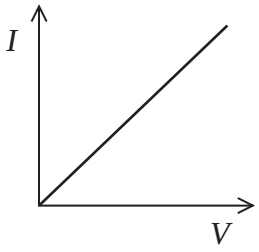
☒ **C** a neutron travelling at $3.0 \times 10^5\,m\,s^{-1}$

☒ **D** a neutron travelling at $4.0 \times 10^5\,m\,s^{-1}$

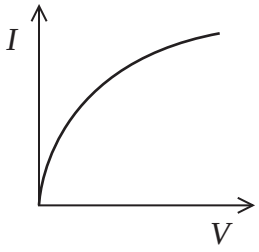
(Total for Question 4 = 1 mark)

5 Which of the following graphs shows how current *I* varies with potential difference *V* for a negative temperature coefficient thermistor?

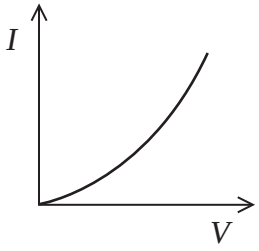
☒ **A**



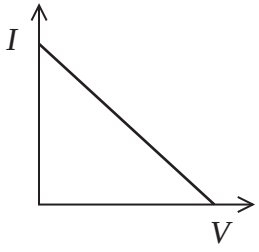
☒ **B**



☒ **C**



☒ **D**



(Total for Question 5 = 1 mark)

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6 A string is stretched between two fixed points and set into oscillation.

The frequency of the vibrating string is **not** dependent on

☒ **A** the amplitude of the string's vibration.

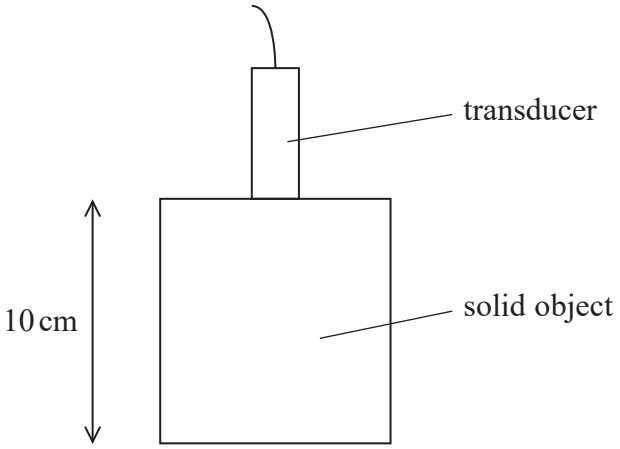
☒ **B** the length of the string.

☒ **C** the mass per unit length of the string.

☒ **D** the tension in the string.

(Total for Question 6 = 1 mark)

7 An ultrasound transducer is placed on the surface of a solid object as shown.



A pulse of ultrasound is transmitted into the object. The pulse is received at the transducer 50 μs after it is emitted.

Which of the following can be used to calculate the speed of sound in this object?

☒ **A** $\frac{0.10}{50 \times 10^{-6}}$

☒ **B** $\frac{0.10}{25 \times 10^{-6}}$

☒ **C** $\frac{0.10}{100 \times 10^{-6}}$

☒ **D** $\frac{0.20}{25 \times 10^{-6}}$

(Total for Question 7 = 1 mark)

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8 Two copper wires of identical cross-sectional area are placed in series in a circuit.

Which of the following could be different for the two wires?

☒ **A** charge carrier density

☒ **B** current

☒ **C** drift velocity

☒ **D** potential difference

(Total for Question 8 = 1 mark)

9 The definitions for current and potential difference both include

☒ **A** charge.

☒ **B** resistance.

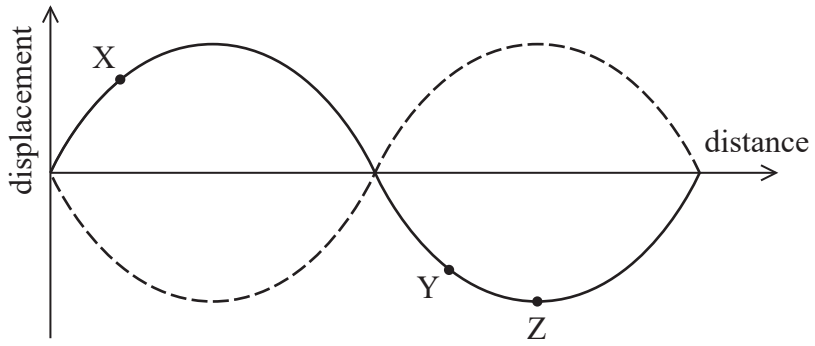
☒ **C** time.

☒ **D** work done.

(Total for Question 9 = 1 mark)

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10 The diagram shows how the displacement varies with distance along a stationary wave at two instants of time.



Which of the following statements is **not** correct?

☒ **A** Points X and Z are in antiphase with each other.

☒ **B** Points Y and Z have the same amplitude of vibration.

☒ **C** Points Y and Z have the same frequency of vibration.

☒ **D** Point Z is an antinode.

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

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SECTION B

Answer ALL questions.

11 A student carried out an experiment to determine the resistivity of a metal in the form of a wire. She made the following measurements:

length of wire = 0.20 m
resistance of wire = 50 mΩ
diameter of wire = 0.36 mm

Determine the metal of the wire using information from the table below.

Metal	Resistivity / Ω m
aluminium	2.7×10^{-8}
tungsten	5.6×10^{-8}
iron	1.0×10^{-7}

(3)

(Total for Question 11 = 3 marks)

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12 The equation $I = nqvA$ can be used to establish the drift velocity v of electrons in a copper wire.

(a) State what is meant by drift velocity.

(1)

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.....

(b) A copper wire has a cross-sectional area of $2.64 \times 10^{-7}\,m^2$ and carries a current of 1.31 A. Calculate the drift velocity of the electrons in this copper wire.

$n = 8.49 \times 10^{28}\,m^{-3}$

(2)

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Drift velocity = ...

(Total for Question 12 = 3 marks)

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13 The orbits of planets around the Sun are elliptical.

The intensity of radiation received at the top of the Earth's atmosphere is monitored during one orbit of the Earth around the Sun.

The following data is recorded:

maximum intensity of radiation = $1.41\,kW\,m^{-2}$
minimum intensity of radiation = $1.32\,kW\,m^{-2}$

(a) Calculate the minimum distance between the Earth and the Sun.

power of the Sun = $3.83 \times 10^{26}\,W$

(3)

Minimum distance = ...

(b) As Mars orbits the Sun, the intensity of radiation received at the top of its atmosphere varies from $491\,W\,m^{-2}$ to $711\,W\,m^{-2}$.

Explain two differences between the orbits of Mars and Earth that can be deduced from this data.

(3)

(Total for Question 13 = 6 marks)

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***14** In 1921, Albert Einstein was awarded the Nobel Prize for Physics "for his discovery of the law of the photoelectric effect".

To explain this effect, Einstein proposed that electromagnetic radiation should be modelled as a particle rather than as a wave.

Explain why, when considering the photoelectric effect, treating electromagnetic radiation as a particle is a more successful model than treating electromagnetic radiation as a wave.

(6)

(Total for Question 14 = 6 marks)

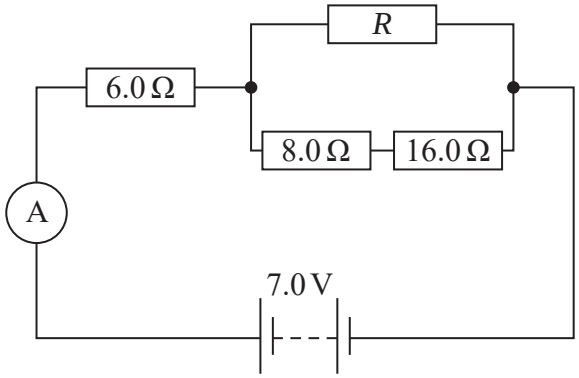
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15 Resistors are included in circuits that are used as potential dividers.

(a) Derive an equation for the combined resistance R_T for two resistors, R_1 and R_2, in series.

(3)

(b) The diagram shows a circuit that includes a resistor combination. The battery has negligible internal resistance.



The ammeter displays a current of 0.50 A.

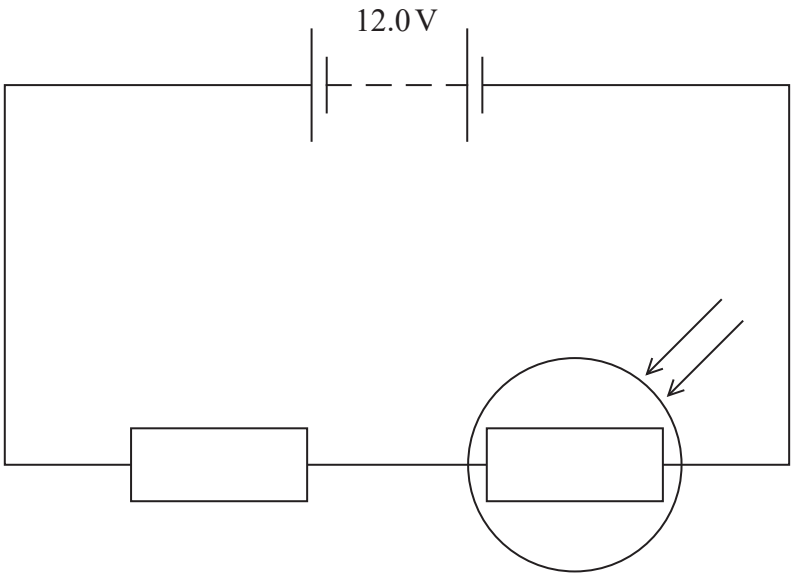
Calculate the resistance R.

(3)

Resistance R = ...

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(c) The circuit shown below includes a light dependent resistor (LDR). The battery has no internal resistance.



(i) In normal daylight, this particular type of LDR has a resistance of 670 Ω.

Calculate the power dissipated in the fixed resistor in normal daylight.

resistance of fixed resistor = 8.00 kΩ

(3)

Power = ...

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(ii) As the light intensity incident upon the LDR decreases, the power dissipated in the fixed resistor decreases.

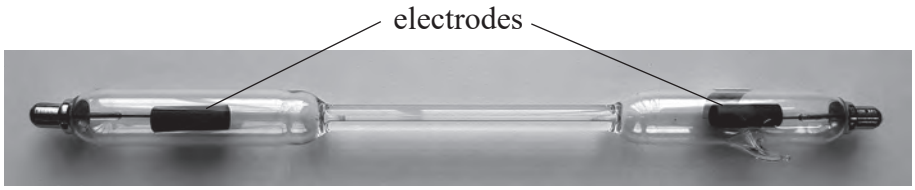
Explain why the power in the fixed resistor decreases. Your answer should include reference to the electrons in the LDR.

(4)

(Total for Question 15 = 13 marks)

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16 In 1857, Heinrich Geissler invented the first gas discharge tube. A sodium gas discharge tube is shown.



When a high potential difference is applied between the electrodes, electrons move through the sodium gas in the tube. The electrons collide with the sodium atoms. The tube then gives out visible light with a wavelength of 589 nm.

(a) Describe the process by which visible light is emitted from the sodium atoms.

(3)

(b) Calculate the energy, in eV, of a photon of visible light with a wavelength of 589 nm.

(3)

Photon energy = ... eV

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(c) Light from the tube was directed through a diffraction grating, labelled as having 300 lines per mm. The diffraction pattern produced was displayed on a flat screen. The student measured the distance s between the central maximum and the first-order maximum on the screen. He also measured the distance D from the diffraction grating to the screen.

Determine whether the labelling of the diffraction grating as having 300 lines per mm was correct.

$s = 0.234$ m
$D = 1.30$ m
$\lambda = 589$ nm

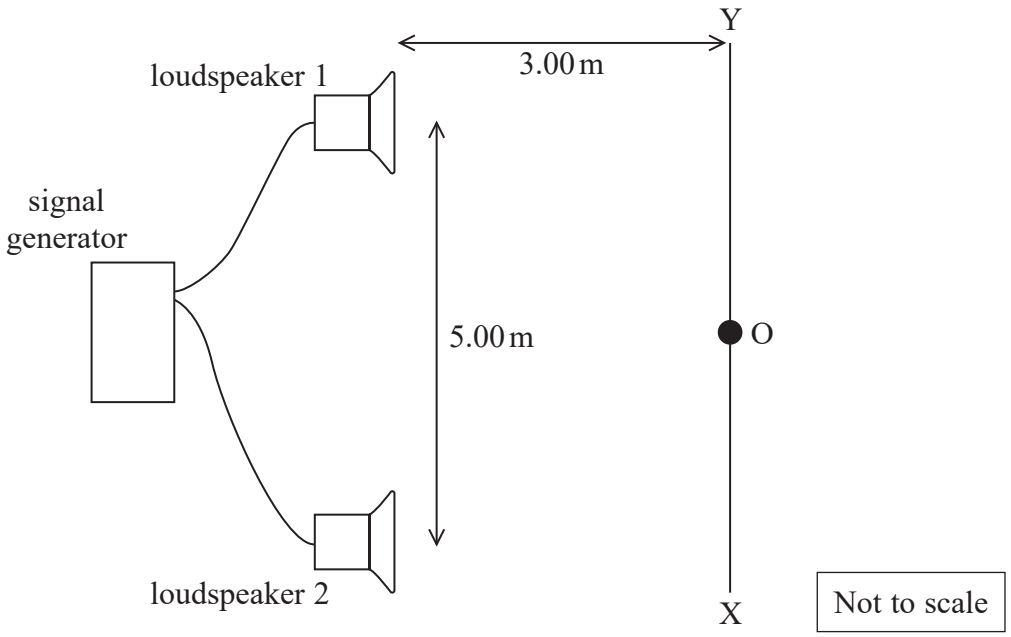
(3)

(Total for Question 16 = 9 marks)

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17 A teacher set up a signal generator connected to two loudspeakers as shown.
This apparatus was used to determine the speed of sound in air in an open space.

A measuring tape was positioned along the ground at XY, which was a perpendicular distance of 3.00 m from the two loudspeakers.



The signal generator was set to a frequency of 160 Hz. The students walked along the line XY. As they walked, they heard a series of loud and quiet sounds. At O the students heard a loud sound.

(a) Explain why the students heard a loud sound at O.

(3)

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(b) As the students moved from O towards Y, the sound became quieter until a minimum was reached. One student stood still at the minimum point while another student recorded from the measuring tape the distance from O at which this occurred. He recorded this as 84 cm.

(i) Determine the speed of sound in air.

(5)

Speed of sound in air = ...

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(ii) The teacher suggested using a microphone connected to an oscilloscope to determine where the loud and quiet zones were located along the line XY. She said that this method would result in much less uncertainty than when students walked along the line XY.

Explain one reason why this is a suitable suggestion.

(2)

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(c) A student suggested that equally valid results would be obtained if the experiment was performed in the classroom.

Criticise this suggestion.

(2)

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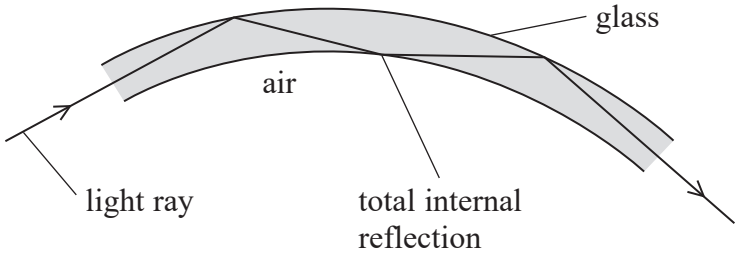
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(Total for Question 17 = 12 marks)

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18 An endoscope is a medical device that can be used to see inside the digestive system. The endoscope contains bundles of very fine glass fibres. Light is directed into the fibres to illuminate the part of the digestive system being investigated.

Light travels along the glass fibres by total internal reflection.



(a) State the conditions required for total internal reflection to occur.

(2)

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(b) A ray of light is incident on the end of a glass fibre and refracts as it enters the glass.

Explain why the light refracts as it enters the glass.

(2)

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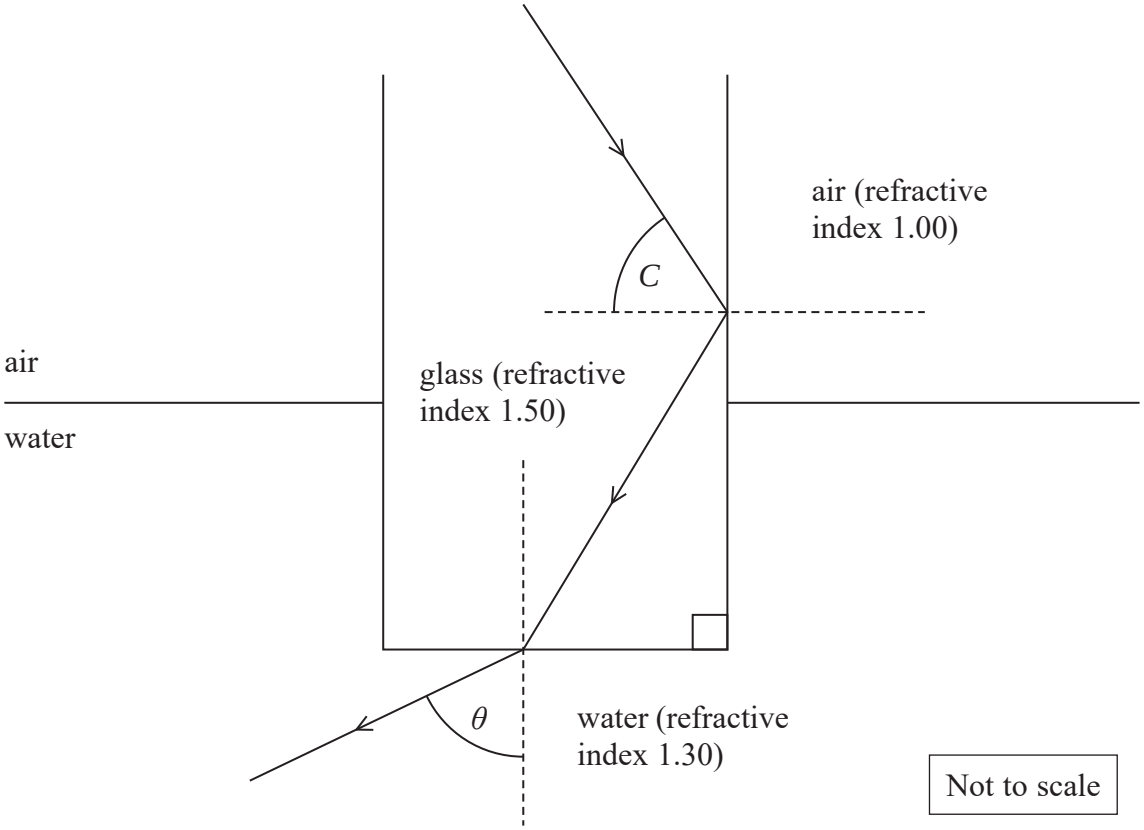
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(c) The diagram shows a ray of light being totally internally reflected at one side of a glass fibre and then refracting as it leaves the end of the fibre. The angle of incidence at the boundary between the glass fibre and air is equal to the critical angle C for the glass-air interface. The ray enters water as it leaves the glass fibre.



Determine the angle θ between the emerging ray and the normal.

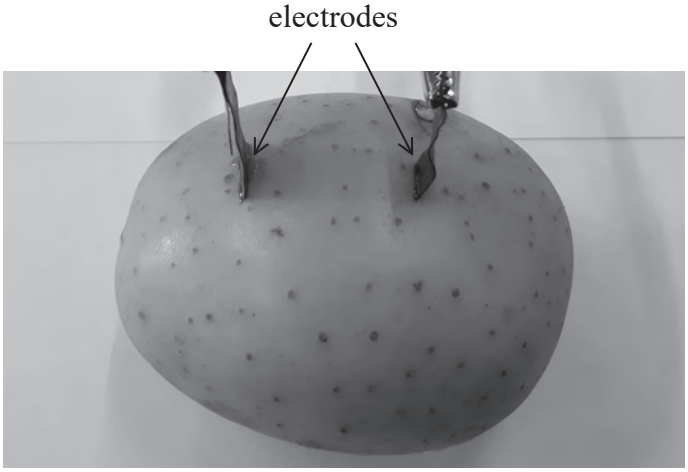
(4)

$\theta =$ .....

(Total for Question 18 = 8 marks)

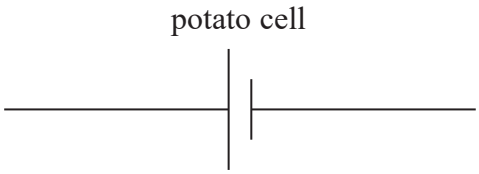
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19 A student carried out an experiment to determine the e.m.f. ε and internal resistance r of a potato cell. The potato used in the experiment was connected to the rest of the circuit using electrodes of two different metals as shown.



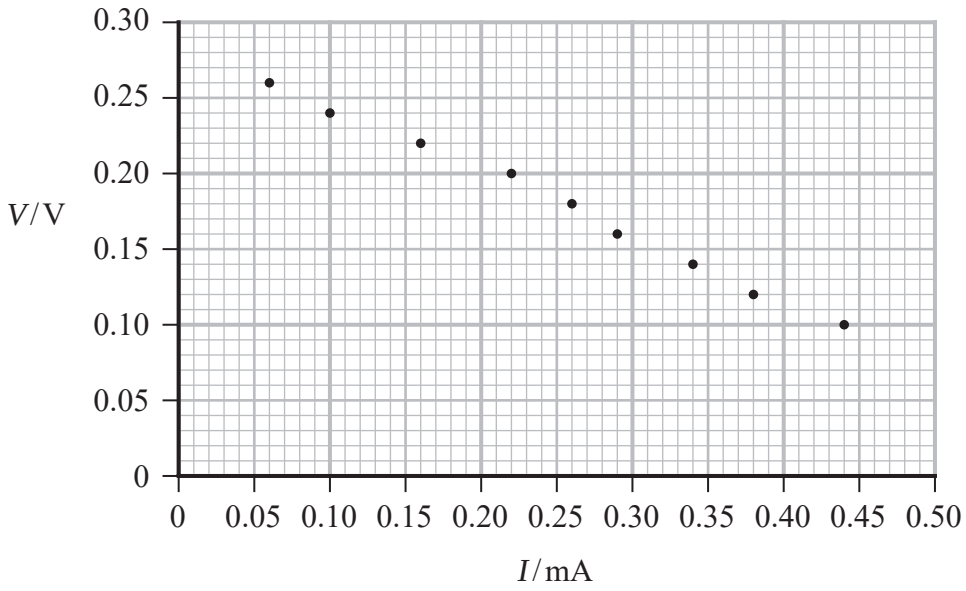
(a) Complete the diagram below to show a circuit that could be used in order to determine ε and r for the potato cell.

(2)



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(b) The student completed the experiment and plotted a graph showing the relationship between potential difference V and current I as shown.



Use the graph to determine values for ε and r.

(4)

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ε = ...

r = ...

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(c) In a separate experiment two resistors, with equal resistance R, are connected to a battery (with internal resistance r) with the two resistors firstly in a series arrangement (diagram A) and then in a parallel arrangement (diagram B).

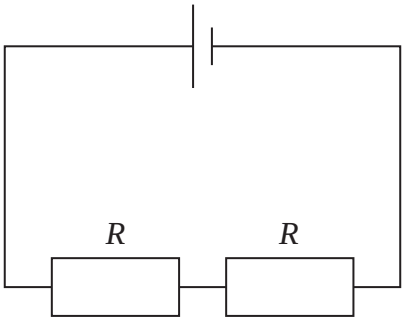


Diagram A

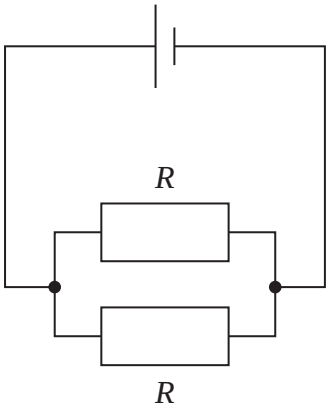


Diagram B

Explain which, if either, of the two arrangements would lead to a greater value for the terminal potential difference.

(4)

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(Total for Question 19 = 10 marks)

TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS

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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

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$= Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

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

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

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Materials

Density $\rho = \frac{m}{V}$

Stokes' law $F = 6\pi\eta rv$

Hooke's law $\Delta F = k\Delta x$

Elastic strain energy $\Delta E_{el} = \frac{1}{2} F\Delta x$

Young modulus $E = \frac{\sigma}{\varepsilon}$ where

Stress $\sigma = \frac{F}{A}$

Strain $\varepsilon = \frac{\Delta x}{x}$

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Unit 2

Waves

Wave speed	$v = f\lambda$
Speed of a transverse wave on a string	$v = \sqrt{\frac{T}{\mu}}$
Intensity of radiation	$I = \frac{P}{A}$
Refractive index	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
	$n = \frac{c}{v}$
Critical angle	$\sin C = \frac{1}{n}$
Diffraction grating	$n\lambda = d\sin\theta$

Electricity

Potential difference	$V = \frac{W}{Q}$
Resistance	$R = \frac{V}{I}$
Electrical power, energy	$P = VI$
	$P = I^2R$
	$P = \frac{V^2}{R}$
	$W = VIt$
Resistivity	$R = \frac{\rho l}{A}$
Current	$I = \frac{\Delta Q}{\Delta t}$
	$I = nqvA$
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	$hf = \phi + \frac{1}{2}mv^2_{max}$
de Broglie wavelength	$\lambda = \frac{h}{p}$

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