Surname	Centre Number	Candidate Number
Other Names		2

GCE AS

B420U20-1

S19-B420U20-1-R1

PHYSICS – AS component 2
Electricity and Light

FRIDAY, 17 MAY 2019 – MORNING

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**9**	
3.	**6**	
4.	**16**	
5.	**14**	
6.	**10**	
7.	**10**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper, you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 75.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded to show all working. Credit is given for correct working even when the final answer is incorrect.

The assessment of the quality of extended response (QER) will take place in **Q2*(a)***.

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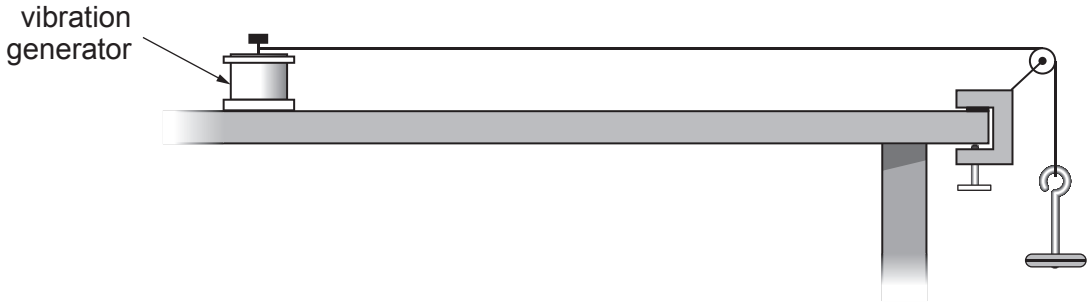
Answer **all** *questions.*

1. The apparatus below is used to demonstrate stationary waves on a string. Both the weight, and the distance between the pin and the pulley are kept constant.



The following stationary wave pattern is observed on the string.

(a) Explain why stationary waves are formed at particular frequencies only. [3]

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(b) Another stationary wave is formed when the frequency is 450 Hz and the length of each loop is 12.0 cm long.

(i) Calculate the speed of the waves on the string. [3]

(ii) At a higher frequency there are two more loops formed than at 450 Hz and each is of length 10.0 cm. Determine the number of loops observed at 450 Hz. [4]

10

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2. *(a)* Explain what properties of light from a laser can be determined using polarisation and interference. Give practical details. [6 QER]

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(b) The polarisation of light is used in Liquid Crystal Display TVs. These have been developed from research into new organic materials. Discuss the importance of research and development into new materials, in general, by giving a benefit and an issue that may arise from using new materials. [3]

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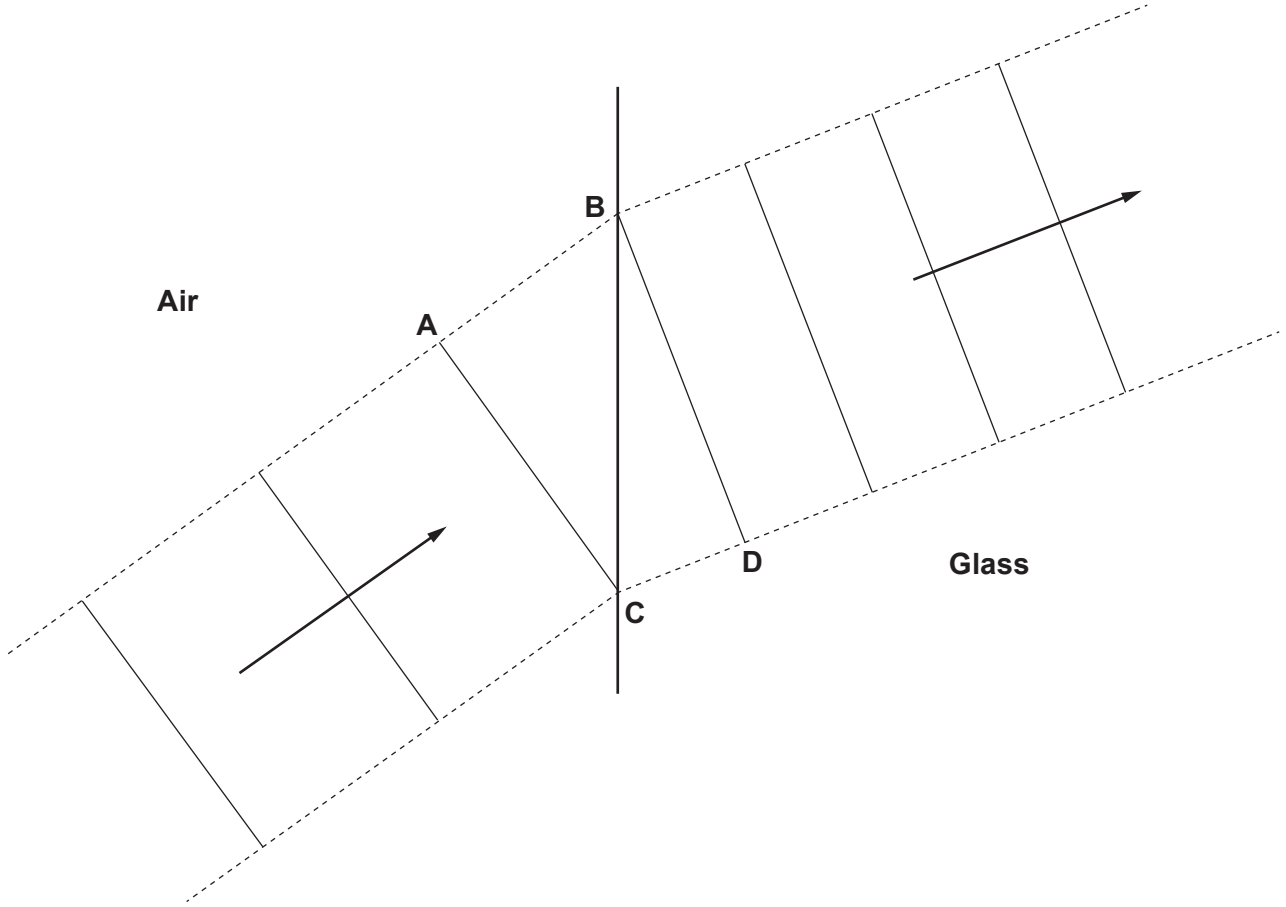
3. A light beam travelling in air hits a boundary with glass. The diagram shows wavefronts on the light beams in the air and in the glass.



(a) State what is meant by refraction and use the diagram to explain why refraction occurs. [3]

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(b) By measuring appropriate lengths from the diagram calculate the speed of light in the glass. [3]

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4. A length of wire of an unknown material is found at a crime scene. The diameter of the wire is measured as 0.28 ± 0.01 mm and its length 32.4 ± 0.1 cm. The resistance of the wire is measured as 0.085 Ω ± 5 %.

(a) (i) Calculate the resistivity of the material of the wire. [3]

(ii) Calculate the **absolute** uncertainty in the resistivity. [4]

(iii) Evaluate whether it is possible to identify the unknown material from the table below. [2]

Material	Resistivity ($10^{-8}\,\Omega$m)
Aluminium	2.65
Copper	1.68
Silver	1.59
Iron	9.71
Tungsten	5.60

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(b) Anika applies a fixed potential difference of 6.0 V across a different piece of metal wire. At a temperature of 0 °C the current is found to be 0.30 A. At 50 °C the current is 0.24 A.

(i) Explain in terms of electrons why the current is **smaller** at 50 °C than at 0 °C. [4]

(ii) Anika states that the resistance of the wire can be considered to be directly proportional to temperature in °C. Use the following table of data to determine whether Anika is correct. [3]

Temperature (°C)	Current (A)
10	0.29
30	0.26
50	0.24

16

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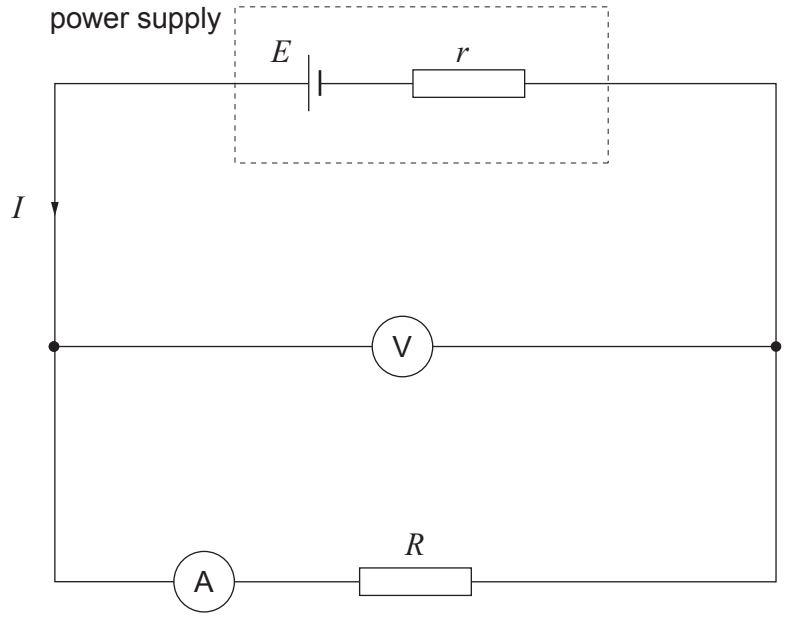
5. Zhang Li sets up the following circuit and uses a spreadsheet to analyse her data as the load resistance, R, is varied.



	A	C	D	E	F
1					
2	Emf, E	Load resistance, R	Current, I	pd across R, V	Internal resistance, r
3	V	Ω	A	V	Ω
4	1.5	1.4	0.94	1.32	0.19
5	1.5	3.3	0.43	1.42	0.19
6	1.5	4.7	0.31	1.46	0.13
7	1.5	5.6	0.26	1.46	.....
8	1.5	8.0	0.19	1.49	0.17

(a) Zhang Li uses 3 resistors of values 3.3 Ω, 4.7 Ω and 5.6 Ω, to create various load resistance values. Show clearly how the value in cell C4 (column C and row 4) is obtained. [3]

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(b) (i) Zhang Li uses the spreadsheet formula = $\frac{A4 - E4}{D4}$ to determine the internal resistance in cell F4. Explain in terms of energy why this is a valid method. [6]

(ii) Determine the internal resistance value for cell F7. [2]

(iii) Zhang Li can choose between 4.7 Ω resistors with power ratings of 0.25 W or 0.50 W. Justify, numerically, which resistor power rating she should use in the circuit. [3]

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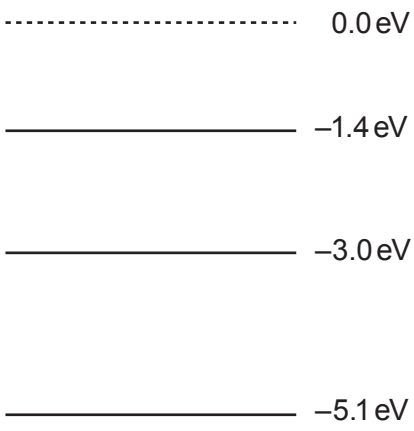
6. The diagram shows three energy levels of a sodium atom.



(a) State the ionisation energy of a sodium atom. [1]

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(b) White light passes through a cloud of sodium atoms. The light which emerges is found to have the continuous spectrum of white light but with dark lines crossing the spectrum. State briefly how the dark lines are caused and what happens to the atoms in the process. [3]

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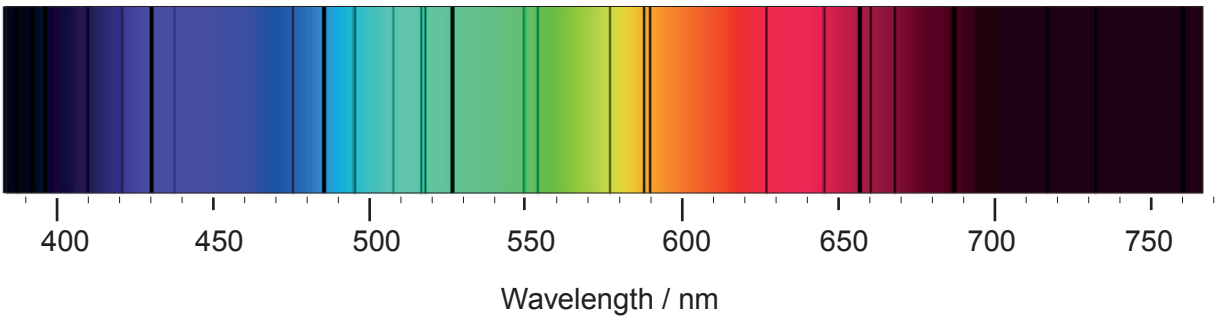
(c) (i) The spectrum of a star is shown below. The wavelength of one of the dark lines is 590 nm. Evaluate whether this is evidence for the presence of sodium in the star. [3]



(ii) The wavelength of peak emission of the star is 100 nm. Determine its surface temperature. [3]

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7. Einstein's photoelectric equation can be written as

$$E_{\mathrm{k\,max}} = hf - \phi$$

(a) Explain what is meant by the term work function, ϕ. [2]

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(b) (i) Light of frequency 7.3×10^{14} Hz is incident on a sodium surface at a rate of 2.5×10^{-10} J s^{-1}. Determine the number of photons per second incident on the sodium surface. [2]

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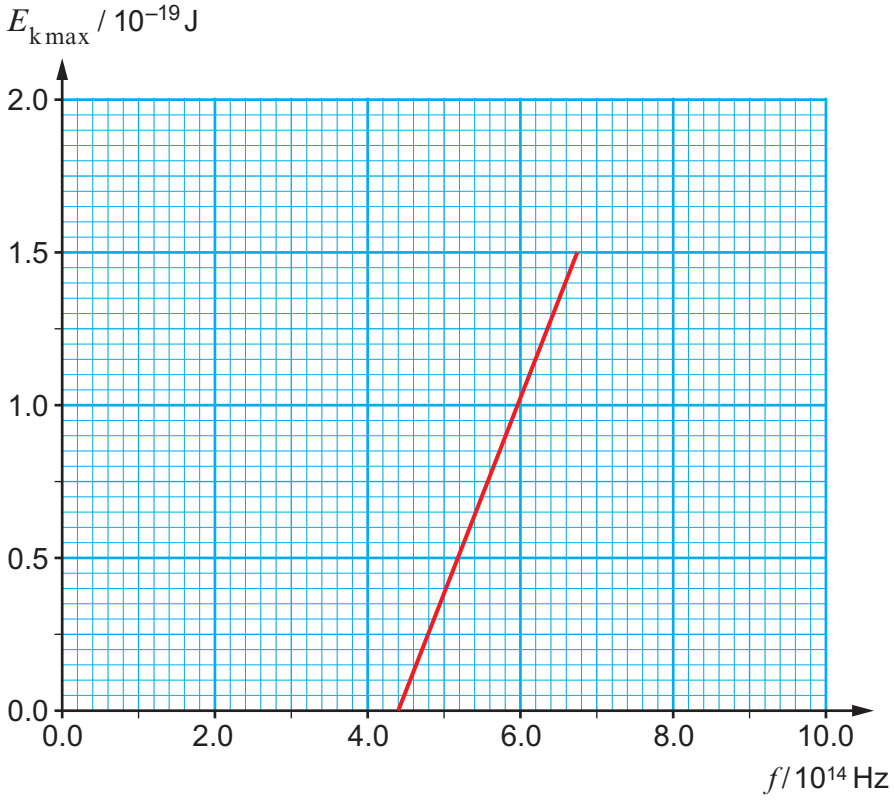
(ii) A graph of $E_{\mathrm{k\,max}}$ against f for the sodium surface is given below.



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I. Calculate the work function of sodium. [2]

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II. Draw a line on the graph to show how $E_{k\,max}$ varies with f for a metal which has a greater work function than sodium. [2]

III. The rate at which light falls on to the sodium surface is increased from $2.5 \times 10^{-10}\,J\,s^{-1}$ to $3.0 \times 10^{-10}\,J\,s^{-1}$. Explain clearly why the graph would not change. [2]

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END OF PAPER