Candidate Name	Centre Number					Candidate Number				

AS PHYSICS

COMPONENT 2

Electricity and light

SPECIMEN PAPER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	5	
2.	13	
3.	10	
4.	14	
5.	10	
6.	15	
7.	8	
Total	75	

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Answer **all** questions.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question 6*(b).*
No certificate will be awarded to a candidate detected in any unfair practice during the examination.

*Answer **all** questions*

1. The current (I) in a metal conductor of cross-sectional area (A) is given by the equation:

$$I = nAve$$

(a) A wire of cross-sectional area 1.20 mm^2 and length 5.00 m carries a current of 2.00 A. Calculate the time it takes for a free electron in the wire to travel from one end of the wire to the other given that the wire has 8×10^{28} free electrons per m^3. [3]

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(b) The same current (2.00 A) is now passed through a thinner wire of the same length and material. State and explain what effect this change would have on the time for an electron to travel from one end to the other. [2]

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2. *(a)* X and Y are two lamps.

(i) Lamp X is labelled 12 V, 24 W. Calculate the current in the lamp when it operates at its rated voltage. [1]

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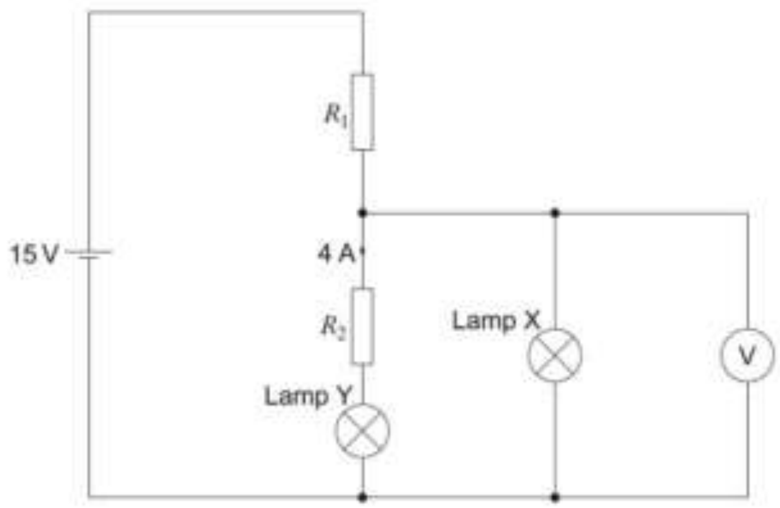
Lamp Y is labelled 6 V, 4 A. In the following circuit, the values of R_1 and R_2 are chosen so that both the lamps operate at their rated voltages.



(ii) Calculate R_1 and R_2. [6]

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(iii) The supply potential difference is now increased so it is greater than 15 V. Without further calculations, state and explain how, if at all, R_1 and R_2 should be changed if both lamps are to remain at their rated voltages. [3]

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(b) Lamp X (12 V, 24 W) is now powered using hydroelectricity. Water turns a turbine and a generator provides electrical energy to the lamp. If the water drops from rest from a height of 1.10 m, calculate the mass of water per second required to provide the power to the bulb. [3]

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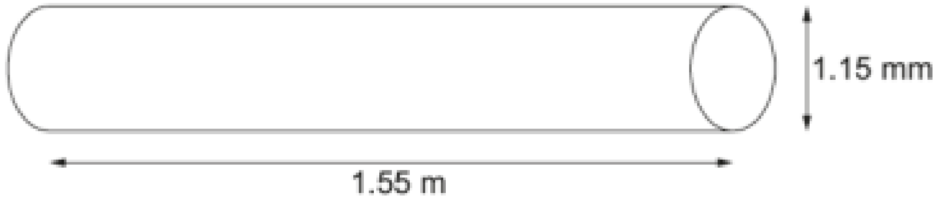
3. The metal wire shown has a resistance of 2.27 Ω.



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

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(b) Explain why the resistance of the wire increases as its temperature rises. [3]

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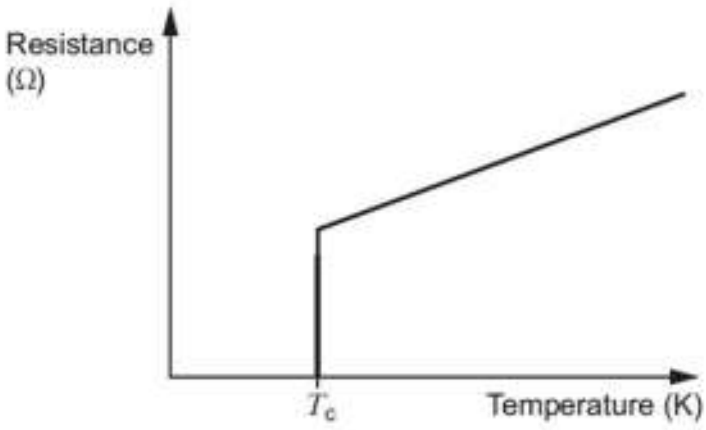
(c) The metal of the wire is cooled to a very low temperature using liquid helium and the following results obtained.



(i) What is the name of the quantity represented by T_C? [1]

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(ii) What is the resistivity of the metal at temperatures below T_C? [1]

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(iii) What potential difference is required to maintain a current in the metal when its temperature is below T_C? [1]

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(iv) Liquid helium is relatively expensive per litre. How can high temperature superconductors be cooled more cheaply? [1]

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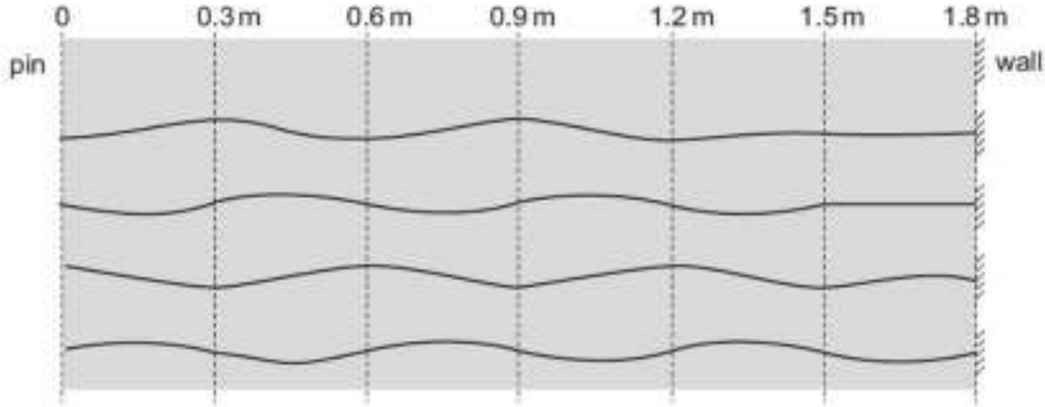
4. *(a)* A piece of string 1.8 m long is attached at one end to the pin of a vibration generator and, at the other end, to a rigid wall. The diagrams show the string at intervals of 0.0030 s, starting from shortly after the string has been connected to the signal generator (so the wave has not yet reached the wall).



Calculate:

(i) the speed of the waves; [2]

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(ii) the frequency. [3]

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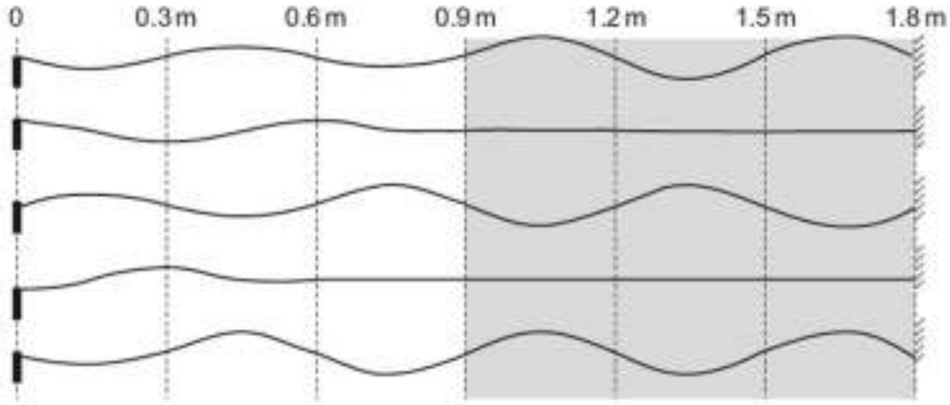
(b) The diagrams below show the set-up of part *(a)* after a stationary wave has started to develop in the string. **Refer only to the shaded area where the stationary wave has started to develop.**



(i) Describe how the amplitude of the stationary wave varies with distance along the string. [2]

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(ii) Explain whether or not the same description applies to the amplitude of the progressive wave in part *(a)*. [1]

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(iii) Explain in terms of interference how the stationary wave is formed. [2]

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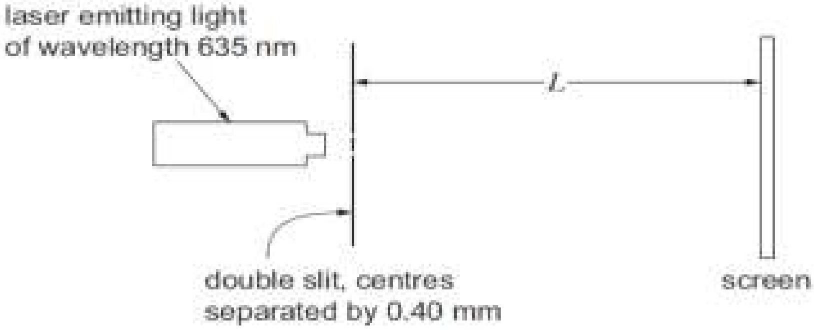
(c) A student attempts to demonstrate the interference of light using the set-up shown.



(i) At first the student places the screen a distance L from the slits of 0.080 m. Calculate the separation of the bright fringes on the screen. [2]

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(ii) Explain why this would not provide a clear demonstration of interference fringes, and by estimating relevant quantities suggest a suitable value for L. [2]

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5. *(a)* Complete in **words** the following version of Einstein's photoelectric equation. [2]

{Maximum KE of emitted electron} = {……………………………..} – {work function of surface}

(b) When violet light falls on a sheet of barium metal held in an insulating stand, the barium acquires a charge.

(i) Explain clearly which sign of charge would be acquired. [3]

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(ii) Explain, in terms of photons, why this effect does not occur if red light is shone on to the same surface. [2]

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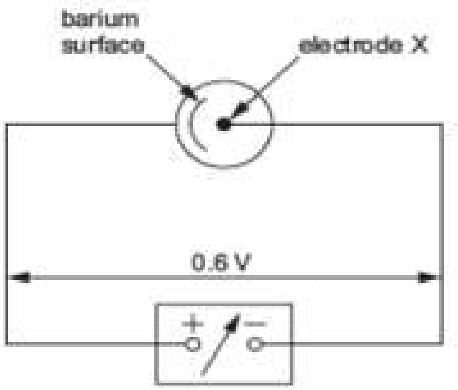
(c) The work function of barium is 4.0×10^{-19} J. Violet light of frequency 7.0×10^{14} Hz is shone on to a barium surface. Determine whether or not electrons would be able to reach the electrode **X** in the circuit below. [3]



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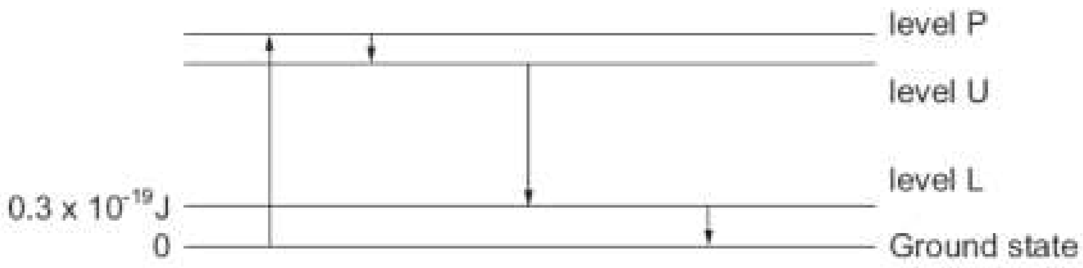
6. *(a)* A simplified energy level diagram is shown for a 4-level laser system. The arrows show the sequence of transitions which electrons make between leaving the ground state and returning to it.



(i) Label the transitions associated with (I) *pumping* and (II) *stimulated emission*. [2]

(ii) The wavelength of the output radiation from the laser is 1.05×10^{-6} m. Calculate the energy **above the ground state** of level U. [2]

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(b) Explain in detail how light amplification takes place for the above laser system. [6 QER]

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(c) (i) The force exerted by a beam of light is given by:

$$\text{force} = \frac{\text{power}}{\text{speed of light}}$$

Explain briefly why a laser of power 1.3×10^{15} W would experience a large recoil. [2]

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(ii) High power lasers can be used as weapons. A scientist developing such a system is assured that it will only be used for medical use. However, the company later sells her laser system for military applications. Discuss whether or not the scientist was treated ethically. [3]

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7. *(a)* A student directs a narrow beam of light on to one end of a glass block, as shown.

(i) Referring to the diagram, calculate the angle of incidence, x.
[Refractive index of air = 1.00; refractive index of the glass = 1.52.][2]

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(ii) Calculate the angle y. [1]

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(iii) Determine whether or not any light refracts into the air at point **P**. [2]

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(b) (i) Explain how multimode *dispersion* arises in an optical fibre. [2]

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(ii) What is the main difference in the dimensions of a monomode fibre compared with a multimode fibre? [1]

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