Candidate Name	Centre Number					Candidate Number				
						0				

AS PHYSICS

AS UNIT 2
Electricity and Light

SPECIMEN PAPER

(1 hour 30 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	13	
2.	12	
3.	10	
4.	11	
5.	12	
6.	10	
7.	12	
Total	80	

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 7*(c).*

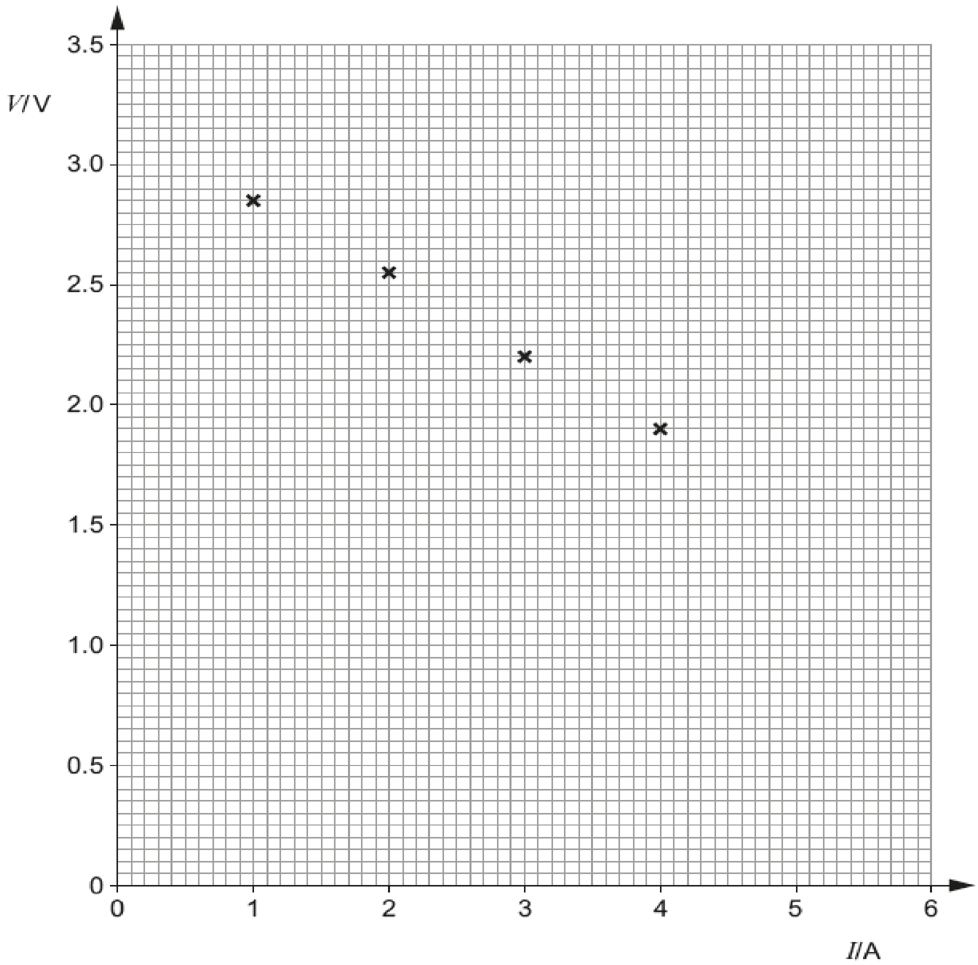
*Answer **all** questions.*

1. (*a*) A student wishes to investigate how the potential difference, V, across a battery depends on the current, I, it is supplying. In effect, she is investigating the equation: $E = V + Ir$. Draw a diagram of a circuit she might use. [2]

(*b*) The student's measurements are plotted on the graph below.
Describe briefly what the student did to obtain the measurements. [1]

....

....



(*c*) (i) Draw a line of best fit on the graph on page 22 and determine the y-intercept and gradient. [3]

....

....

....

(ii) State what properties of the battery these represent: [2]

(I) gradient;

....

(II) y-intercept.

....

(*d*) Comment on the quality and adequacy of the data obtained. [2]

....

....

....

(e) In a separate experiment the student connects a voltmeter across the battery and measures a pd of 3.20 V. She then connects a 1.50 Ω resistor across the battery and measures the pd to be 2.62 V. Investigate whether or not these readings are consistent with your results from part (*c*). [3]

....

....

....

....

....

....

....

....

13

2. *(a)* State Ohm's law in terms of current and potential difference. [2]

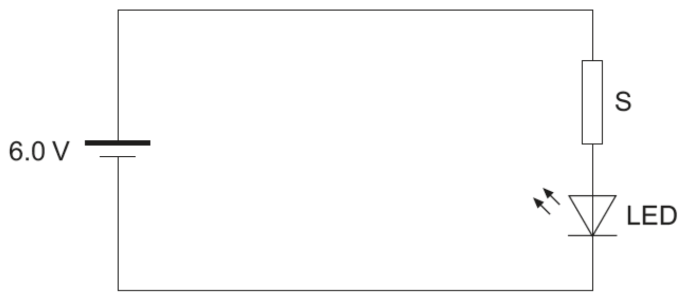
....

....

....

(b) To operate correctly, a light emitting diode (LED) requires a pd of 1.8 V across it. The current through it is then 15 mA.

In order to run the LED correctly using a 6.0 V supply, a series resistor, S, is needed. Calculate the resistance of S. [3]



....

....

....

....

....

....

(c) (i) Calculate the drift velocity of free electrons through an aluminium wire of **diameter** 1.80 mm when there is a current of 3.00 A through the wire. [Note: 1.00 m^3 of aluminium contains 6.02×10^{28} aluminium atoms, each of which contributes 3 free electrons.] [3]

....

....

....

....

....

....

(ii) State what current there would have to be in an aluminium wire of diameter 3.60 mm, for the drift velocity to be the same. [1]

....

....

....

(d) Calculate the pd which must be applied across a 70.0 m length of aluminium wire of diameter 1.80 mm in order to produce a current of 3.00 A. [Resistivity of aluminium = $28.2 \times 10^{-9}\ \Omega\,\text{m}$] [3]

....

....

....

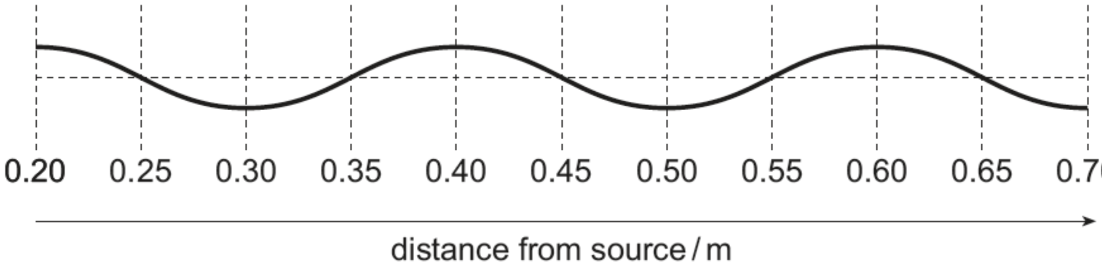
....

....

....

12

3. *(a)* A transverse wave is travelling from left to right along a stretched string. The diagram shows part of the string at one instant.



(i) The frequency is 50 Hz.

(I) Calculate the speed of the waves. [2]

....

....

(II) Calculate the time taken for 1 cycle of oscillation. [1]

....

....

(III) **On the diagram above**, draw the string at a time of 0.005 s later. [2]

(ii) Explain why the waves are called transverse. [2]

....

....

(b) It is also possible to set up a stationary wave on a stretched string. Describe how progressive waves and standing waves differ in regard to:

(i) transfer of energy along the string; [1]

....

....

(ii) **variation** of amplitude with distance along the string. [2]

....

....

....

....

10

4. *(a)* In the set-up shown below, the in-phase sources, $\mathbf{S_1}$ and $\mathbf{S_2}$, are emitting, in all directions, microwaves of wavelength 12 mm.

(i) State what is meant by *in-phase sources*. [1]

....

....

(ii) Justify whether there is constructive interference, destructive interference or neither at **X**. [2]

....

....

....

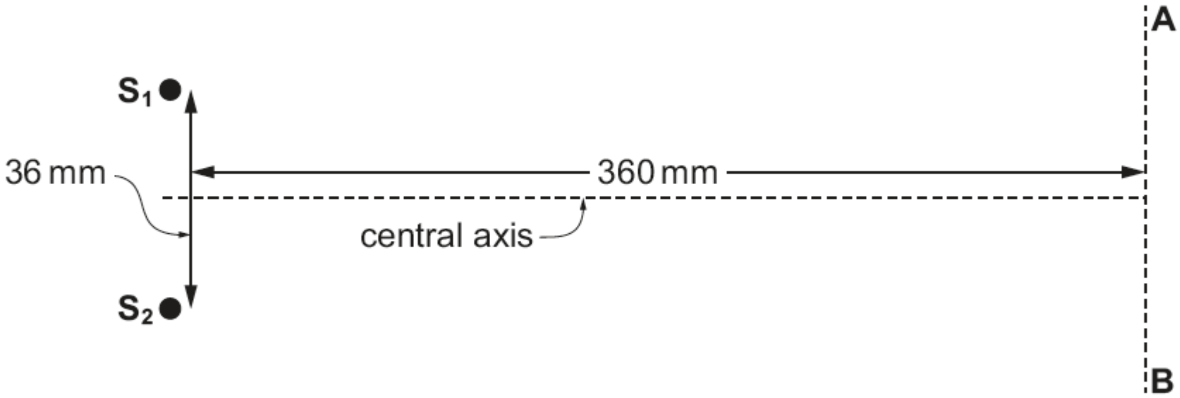
(iii) Discuss whether or not the observed signal strength would change if a microwave detector were moved to the right, from point **X**. [2]

....

....

....

(b) The same microwave sources are now arranged as shown, and the detector is moved along the line **AB**.



Use the equation for double slit interference to determine the approximate spacing between points of maximum microwave intensity. [2]

....

....

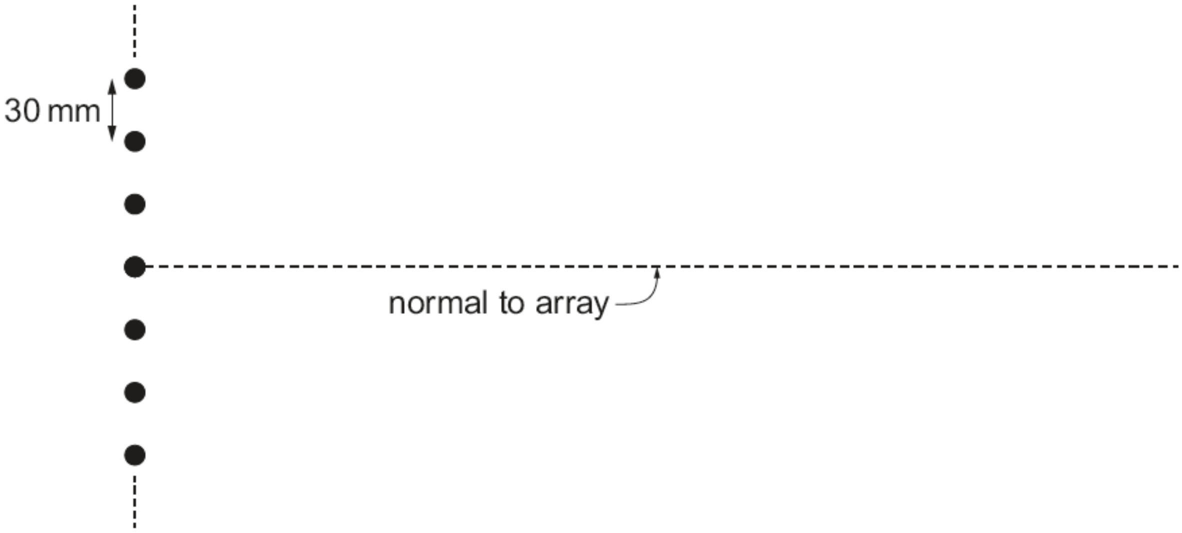
....

....

....

(c) An 'array' of regularly spaced, in-phase wave sources produces an interference pattern similar to that of a diffraction grating, that is sharply defined beams (maxima) of waves at specific angles to the normal.

In the array shown the sources emit waves of wavelength 12 mm.



Determine all the angles to the normal at which beams (maxima) occur. [4]

....

....

....

....

....

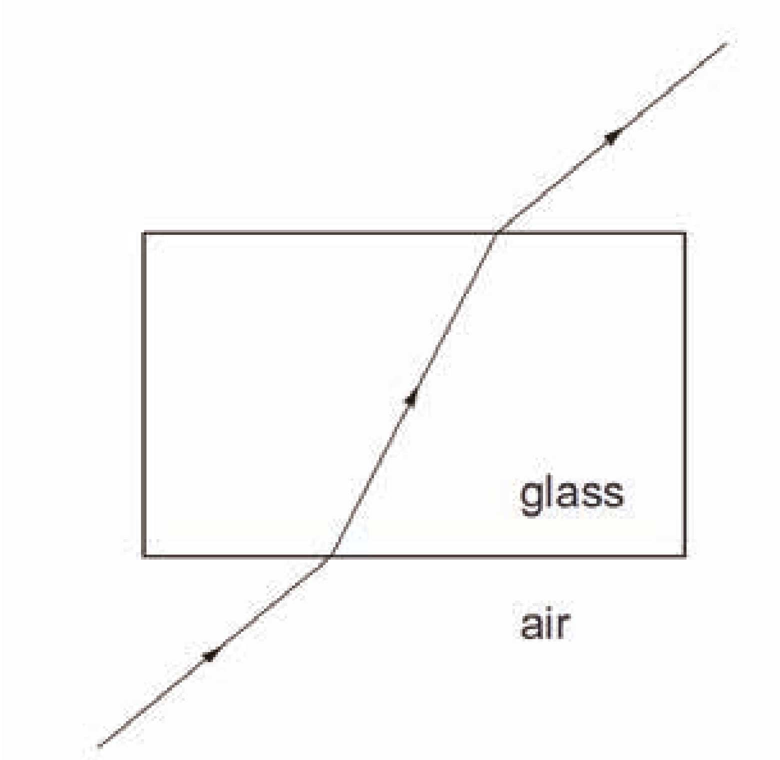
....

....

....

11

5. The diagram shows the path of a narrow beam of light through a glass block.



(a) The diagram shown is drawn to scale. By measuring suitable angles, calculate the refractive index of the block. [3]

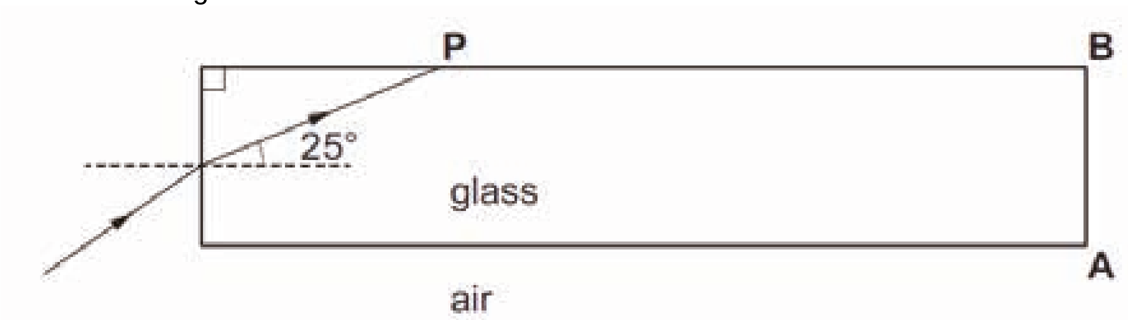
....

....

....

....

(b) The diagram shows a narrow beam of light entering a solid block of glass of refractive index 1.52.



(i) The beam does not emerge into the air at **P**. Justify this statement. [3]

....

....

....

....

....

(ii) Carefully **complete the path** of the beam, showing it eventually reaching the face **AB**, emerging into the air and travelling through the air. [1]

(iii) **Indicate clearly on the diagram** sections of the **whole** path that are parallel to each other. [2]

(c) (i) Explain what is meant by *multimode dispersion* in optical fibres, and what causes it. [2]

....

....

....

....

....

(ii) Explain why multimode dispersion prevents the accurate transmission of data as a rapid stream of pulses through a long 'thick' fibre. [1]

....

....

....

12

6. *(a)* (i) The work function of caesium is 3.0×10^{-19} J. Explain what this statement means. [1]

....

....

(ii) Calculate the frequency of radiation needed to eject electrons of maximum kinetic energy 6.0×10^{-19} J from a caesium surface. [2]

....

....

....

....

(iii) **Explain** in terms of photons what effect, if any, increasing the intensity of this radiation would have on the number of electrons ejected per second, and on their maximum kinetic energy. [3]

....

....

....

....

....

....

....

(b) In 1902, Einstein's equation: $E_{k\,\max} = hf - \phi$ was revolutionary because it gave strong evidence for light behaving as particles. Explain why this theory was controversial in 1902, but is now accepted as standard pre-university physics. [4]

....

....

....

....

....

....

....

....

10

7. *(a)* A laser emits light with a photon energy of 3.14×10^{-19} J.

(i) Calculate the wavelength of the light. [2]

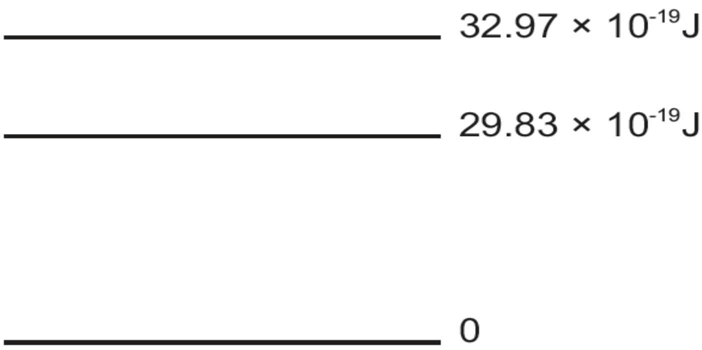
....

....

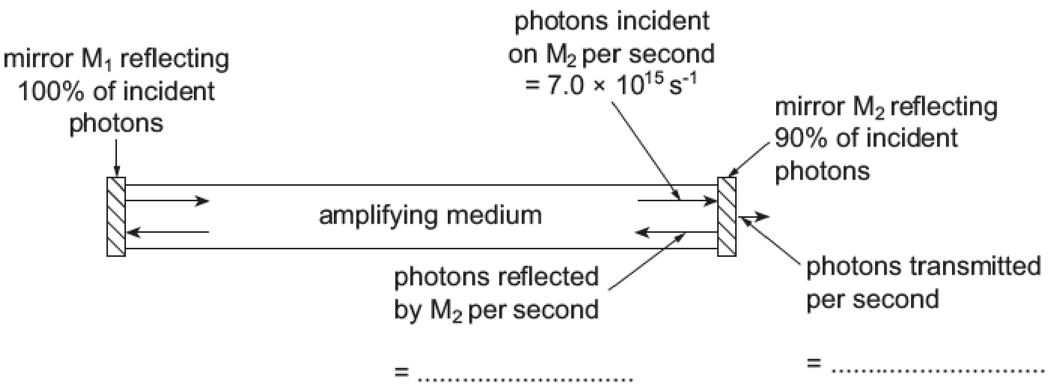
....

....

(ii) A simplified energy level diagram for the amplifying medium of the laser is given. **Add an arrow** to show the transition giving rise to these photons. [1]



(b) The (simplified) diagram shows the cavity of the laser.



(i) Mirror M_2 is only partially reflecting. The light that it does not reflect is transmitted through it.
Complete the diagram to show the numbers of photons per second reflected and transmitted. [1]

(ii) Calculate the power output of the laser. [2]

....

....

....

(c) Explain how a laser works. [6 QER]

....

....

....

....

....

....

....

....

....

....

....

....

12