Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number | Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Monday 9 June 2014 – Morning
Time: 1 hour 30 minutes

Paper Reference
6PH02/01R

You do not need any other materials.

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.*

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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

Advice

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

Turn over ▶

1/1/1/1/

P 4 3 2 7 0 A 0 1 2 8

PEARSON

SECTION A

Answer ALL questions.

For questions 1–10, in Section A, 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 The wave and particle models of light have both contributed to our understanding of light.

Which row of the table correctly matches properties of light to the model that best explains them?

	Wave model	Particle model
☐ **A**	photoelectric effect	refraction
☐ **B**	diffraction	atomic line spectra
☐ **C**	atomic line spectra	photoelectric effect
☐ **D**	refraction	diffraction

(Total for Question 1 = 1 mark)

2 A glass tube, closed at one end, has a loudspeaker placed at the other end. This is used to create a vibrating column of air, producing sound.

The wave in the tube is best described as

☐ **A** longitudinal and progressive.

☐ **B** longitudinal and standing.

☐ **C** transverse and progressive.

☐ **D** transverse and standing.

(Total for Question 2 = 1 mark)

3 The current through a wire of cross-sectional area *A* is *I* when the drift velocity of the electrons in the wire is *v* and the charge carrier density is *n*.

The wire is replaced with a wire of a different metal with half the charge carrier density but the same cross-sectional area *A*.

If the current in the new wire is 2*I*, the drift velocity is

☒ **A** *v*/2

☒ **B** *v*

☒ **C** 2*v*

☒ **D** 4*v*

(Total for Question 3 = 1 mark)

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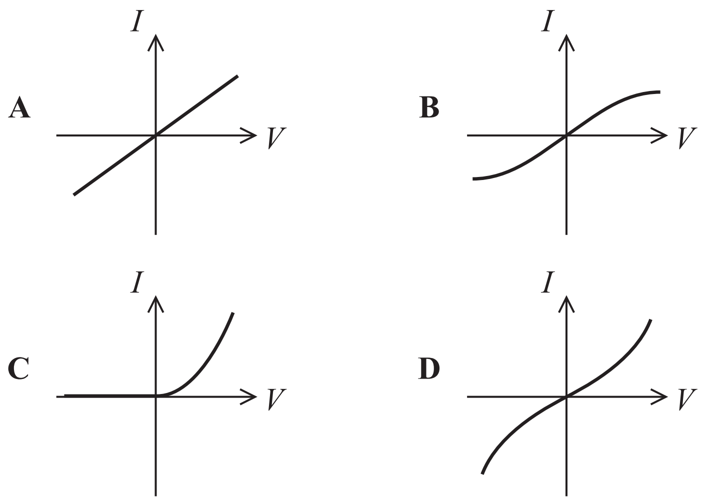
4 Which of the following current-potential difference (*I*-*V*) graphs correctly shows the behaviour of a diode?



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 1 mark)

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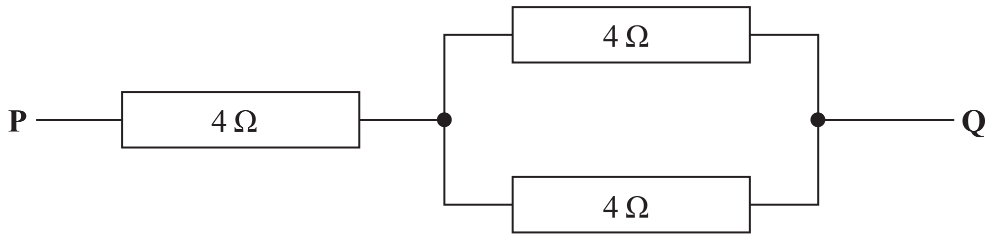
5 The diagram shows a combination of three identical resistors.



What is the combined resistance between P and Q?

☒ **A** 4 Ω

☒ **B** 6 Ω

☒ **C** 8 Ω

☒ **D** 12 Ω

(Total for Question 5 = 1 mark)

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6 Which of the following is a correct unit for resistance?

☒ **A** $J\ C^{-1}$

☒ **B** $V\ C^{-1}\ s^{-1}$

☒ **C** $J\ C^{-2}\ s$

☒ **D** $J\ C^{-2}\ s^{-1}$

(Total for Question 6 = 1 mark)

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7 Which of the following does **not** apply to longitudinal waves?

☒ **A** coherence

☒ **B** polarisation

☒ **C** superposition

☒ **D** transmission

(Total for Question 7 = 1 mark)

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8 Waves from a point light source follow separate paths and recombine at a point after travelling different distances.

When the waves recombine the path difference is $\lambda/2$. The corresponding phase difference is

☒ **A** 360°

☒ **B** $\pi/2$ radians

☒ **C** 180°

☒ **D** 2π radians

(Total for Question 8 = 1 mark)

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9 A copper wire of length 2.5 m and cross-sectional area 2.4×10^{-7} m^2 has a resistivity of 1.7×10^{-8} Ω m.

What is the resistance of the wire?

☒ **A** 1.6×10^{-15} Ω

☒ **B** 1.0×10^{-14} Ω

☒ **C** 0.18 Ω

☒ **D** 5.6 Ω

(Total for Question 9 = 1 mark)

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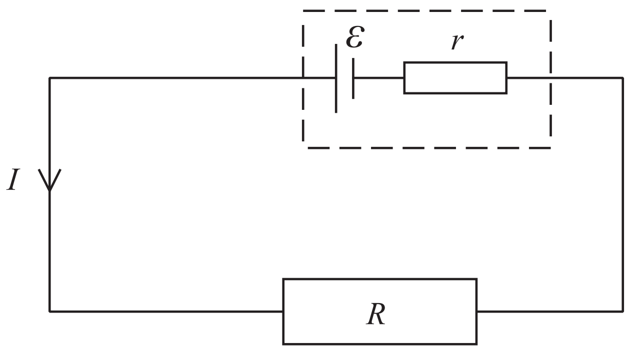
10 The diagram shows a resistor of resistance *R* across a cell of e.m.f. ε and internal resistance *r*.



Which of the following is a correct expression for the current *I* ?

☒ **A** $I = \varepsilon / r$

☒ **B** $I = \varepsilon / R$

☒ **C** $I = \varepsilon / (R + r)$

☒ **D** $I = \varepsilon / (R - r)$

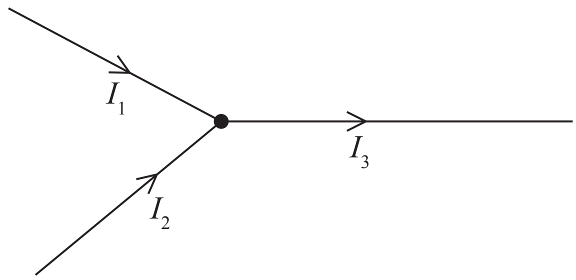
(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 The diagram shows the current in part of an electrical circuit.



State the relationship between I_1, I_2 and I_3 and explain it in terms of charge.

(3)

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(Total for Question 11 = 3 marks)

12 The photograph shows a projector with an automatic focusing system that detects the distance to the screen so it can adjust the position of the lens to produce a clear image.

X 

The part of the projector labelled X emits a pulse of infrared radiation and detects the pulse after it is reflected from a screen.

(a) The screen is 2.5 m from the projector.

Calculate the time taken between the emission and detection of the pulse.

(2)

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Time taken = ...

(b) State why the infrared radiation is emitted in pulses rather than as a continuous beam.

(1)

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(c) Suggest why infrared radiation is used rather than visible light.

(1)

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(Total for Question 12 = 4 marks)

13 In the late 1880s it was discovered that a negatively-charged zinc plate loses its charge when exposed to ultraviolet radiation.

Explain why this happens, but only with ultraviolet radiation and not white light. You are expected to complete a calculation to support your answer.

work function of zinc = 6.9×10^{-19} J

(6)

(Total for Question 13 = 6 marks)

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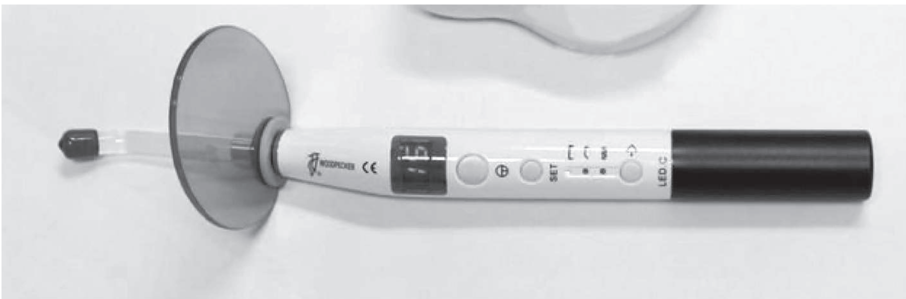
14 Dentists often use a white composite material for fillings for teeth. This material is applied as a liquid and then hardened using blue light.

The photograph shows a light gun, used by dentists, that emits the blue light.



© Zhengzhou Smile Dental Equipment Co., Ltd.

(a) The light gun emits light of radiation flux 8000 W m^{-2}.

A particular tooth needs a filling of cross-sectional area 1.5×10^{-5} m^2. It requires 2.3 J of incident light energy to harden the filling.

Calculate the time for which the light must be applied.

(3)

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Time = ...

(b) The light gun is supplied with a rechargeable battery of capacity 1.4 amp hours. When in use, the output potential difference of the battery is 3.7 V.

(i) Assuming the potential difference is constant, show that the maximum energy supplied by the battery is about 20 000 J.

(2)

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(ii) Assuming each filling requires 2.3 J of incident light energy, a fully charged battery can be used to power the light gun to harden 210 fillings.

Calculate the efficiency of the light gun at supplying the energy stored in the battery to the fillings.

(3)

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Efficiency = ...

(Total for Question 14 = 8 marks)

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15 A student has the equipment shown in Figure 1:

- protractor
- 15 cm ruler
- laser light source
- pencil
- sheet of paper
- rectangular block of plastic.

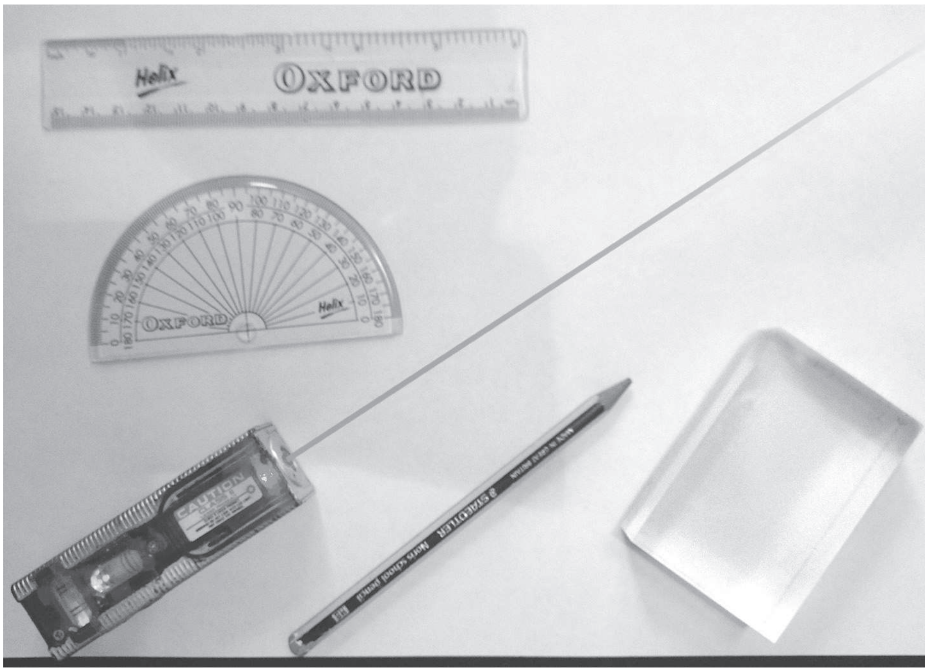

Figure 1

(a) The student uses the equipment shown in Figure 1 to take the measurements needed to determine the refractive index for light travelling from air into the plastic.

Explain **one** limitation of this equipment when used to obtain the measurements.

(2)

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(b) The value of refractive index obtained by the student was 1.52.

(i) Calculate the speed of light in the plastic.

(2)

Speed of light in the plastic = ...

(ii) Calculate the critical angle for the plastic.

(2)

Critical angle = ...

*(c) The student was given the shape shown in Figure 2 made from the same plastic.

Figure 3 shows what happens when light from a laser was directed at one end of the shape.

Figure 2

Figure 3

Explain the path of the laser light through the plastic as shown in Figure 3.

(4)

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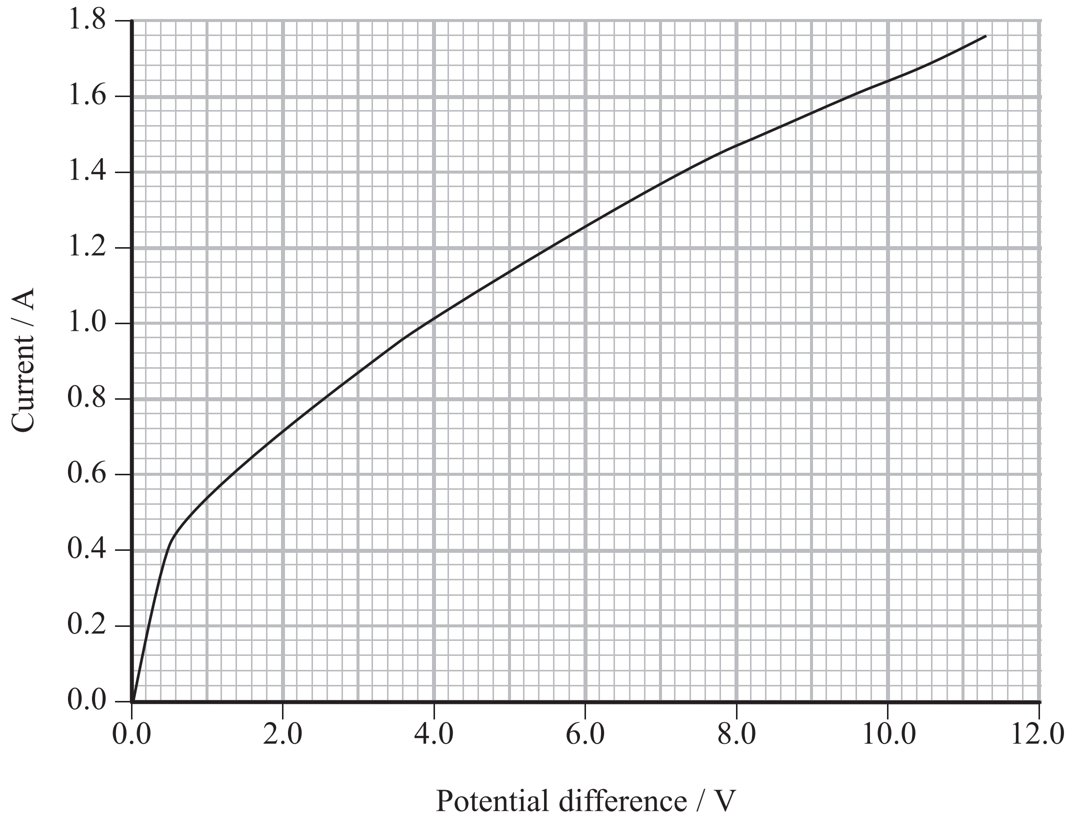
(Total for Question 15 = 10 marks)

16 A student investigates how the current through a filament light bulb varies with the potential difference across it.

(a) Draw a diagram of a circuit the student could use to obtain suitable measurements for a range of potential difference from 0 V to 12 V.

(3)

(b) The student's results are shown on the graph.



P 4 3 2 7 0 A 0 1 6 2 8

The student decides to draw a tangent to the curve at a potential difference of 6 V and use the gradient of the tangent to determine the resistance of the bulb.

(i) Explain why this is **not** a correct method to determine the resistance.

(2)

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(ii) Calculate the resistance of the bulb when the potential difference across it is 6 V.

(2)

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Resistance = ...

*(c) Describe and explain the change in the resistance of the bulb as the potential difference across it is increased.

(4)

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(Total for Question 16 = 11 marks)

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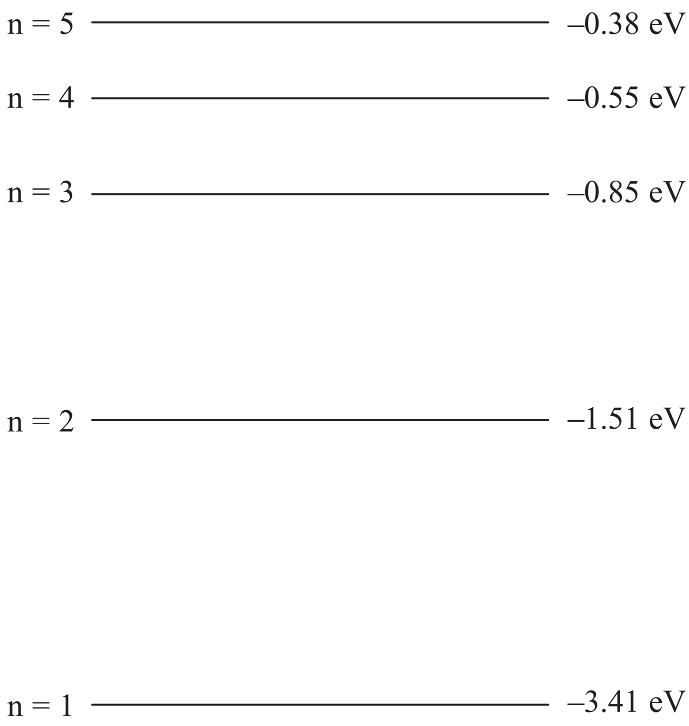
17 Helium was first discovered because of dark lines observed in the continuous spectrum of light from the Sun. The lines were caused by a few specific frequencies of light in the spectrum being present at very much lower intensity than the rest.

Scientists deduced that this was due to an unknown element in the Sun's atmosphere.

(a) Explain how helium in the Sun's atmosphere caused this set of dark lines.

(5)

(b) The diagram shows some of the energy levels for an atom of another element.



(i) Determine which energy levels are associated with photons of frequency 4.6×10^{14} Hz.

(4)

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(ii) Suggest why the energy levels all have a negative value.

(2)

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(c) Lines such as those described in (a) can be used to determine the motion of stars relative to the Earth.

Suggest how these lines may be used to determine the motion of stars.

(3)

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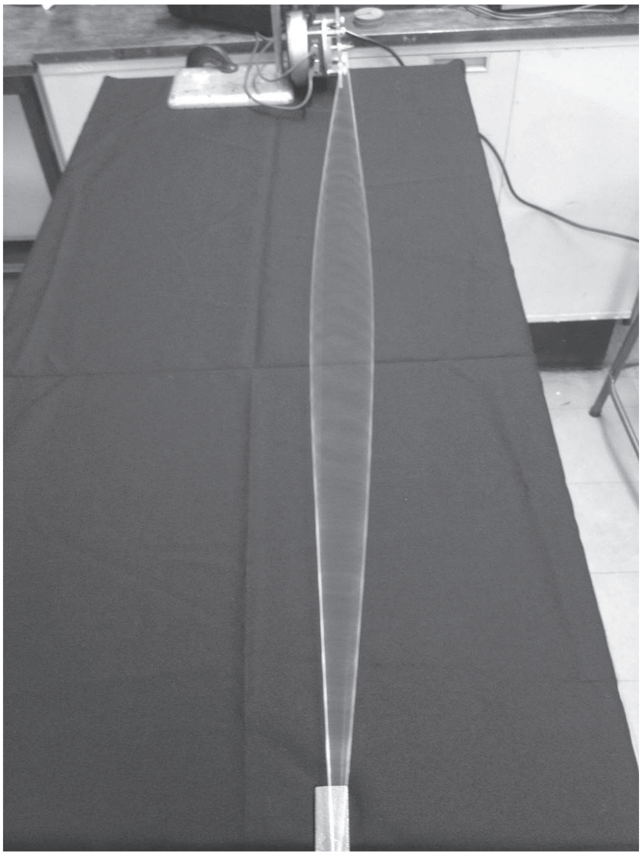
(Total for Question 17 = 14 marks)

18 A student investigates the effect of changing the frequency of waves on a string held in tension.

The string is fixed at one end and has a vibration generator attached to the other end. When the vibration generator is switched on a wave is produced on the string as shown in the photograph.



(a) Name the type of wave produced on the string and explain how it has been formed.

(4)

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(b) The length of string between the vibration generator and the fixed end is 1.8 m. The string is vibrating with a frequency of 330 Hz.

Calculate the speed of the waves on the string.

(3)

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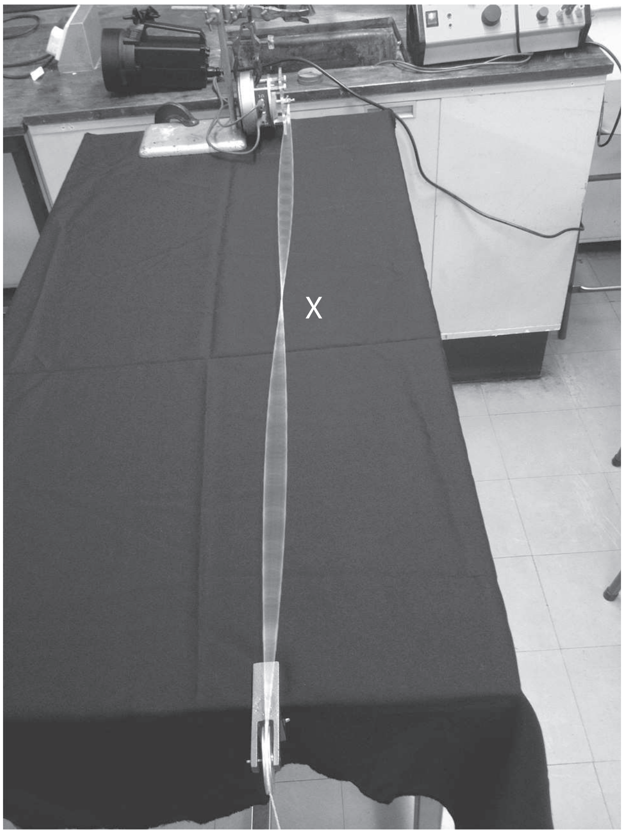
Speed of the waves = ...

(c) The frequency of the vibration generator is changed from 330 Hz. The new wave produced on the string is shown in the photograph below.



(i) The student is able to touch the string at point X without disturbing the pattern.

Explain why.

(2)

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(ii) Calculate the new frequency of the vibration generator.

(1)

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Frequency = ...

(iii) The vibrating string is now illuminated using a strobe lamp without adjusting the frequency of the vibration generator. The lamp flashes on and off many times a second at a frequency which may be varied by the student. The picture below shows a section of the string that now appears to be two separate strands.

Calculate the maximum possible frequency of the strobe lamp which will cause the appearance of two separate strands and explain why this is a maximum frequency.

(2)

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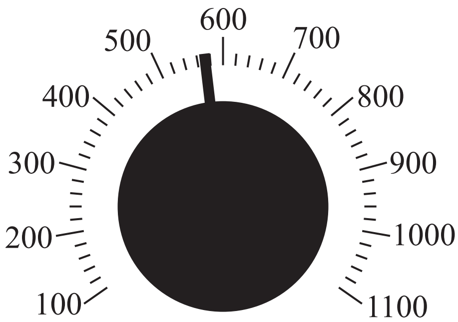
(d) The frequency of the vibration generator is adjusted by turning the dial shown below. The student measures the frequency of vibration by reading from the scale shown on the dial.



Explain a disadvantage of this method of measuring the frequency.

(2)

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(Total for Question 18 = 14 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

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
$$v = u + at$$
$$s = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Forces
$$\Sigma F = ma$$
$$g = F/m$$
$$W = mg$$

Work and energy
$$\Delta W = F\Delta s$$
$$E_k = \tfrac{1}{2}mv^2$$
$$\Delta E_{grav} = mg\Delta h$$

Materials

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

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

Density $\rho = m/V$

Pressure $p = F/A$

Young modulus $E = \sigma/\varepsilon$ where
Stress $\sigma = F/A$
Strain $\varepsilon = \Delta x/x$

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

P 4 3 2 7 0 A 0 2 6 2 8

Unit 2

Waves

Wave speed	$v = f\lambda$
Refractive index	${}_1\mu_2 = \sin i/\sin r = v_1/v_2$

Electricity

Potential difference	$V = W/Q$
Resistance	$R = V/I$
Electrical power, energy and efficiency	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$

$$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

Resistivity	$R = \rho l/A$
Current	$I = \Delta Q/\Delta t$ $I = nqvA$
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	$hf = \phi + ½mv^2_{max}$

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