Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number	Candidate Number

Physics
Advanced Subsidiary
Unit 2: Physics at Work

Wednesday 22 January 2014 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
WPH02/01

You must have:
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.*

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 ▶

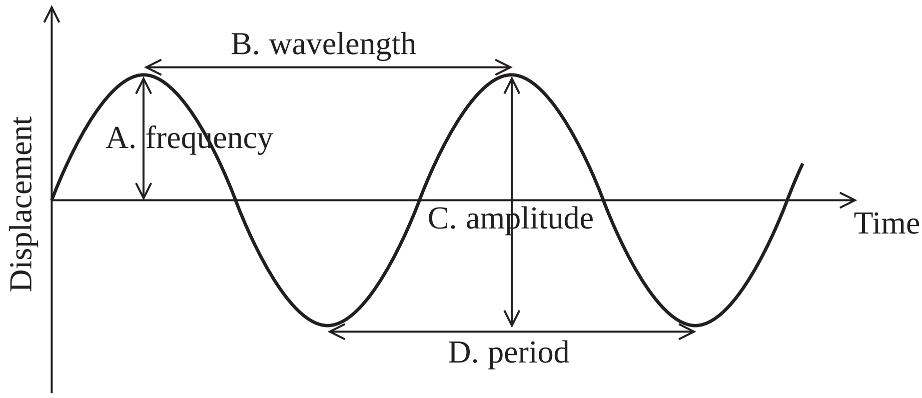
PEARSON

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 diagram shows a displacement-time graph for a wave.



Which label is correct?

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(Total for Question 1 = 1 mark)

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2 Light of radiation flux 80 W m^{-2} shines perpendicularly onto a solar heating panel of area 6 m^2.

In one hour the incident energy is

☐ **A** 80 J

☐ **B** 480 J

☐ **C** 29 000 J

☐ **D** 1 700 000 J

(Total for Question 2 = 1 mark)

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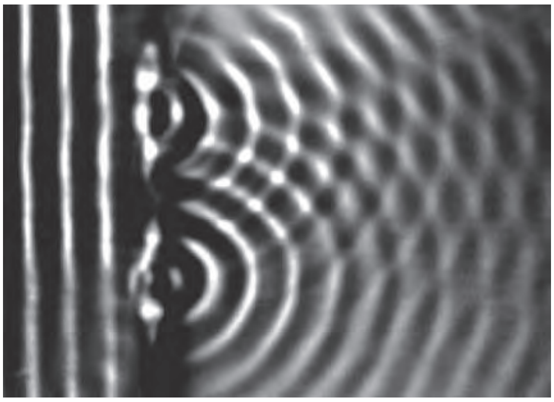
3 The photograph shows a demonstration with a ripple tank.



Plane waves travelling from the left strike a barrier with two gaps.

This demonstration does **not** involve

☒ **A** diffraction

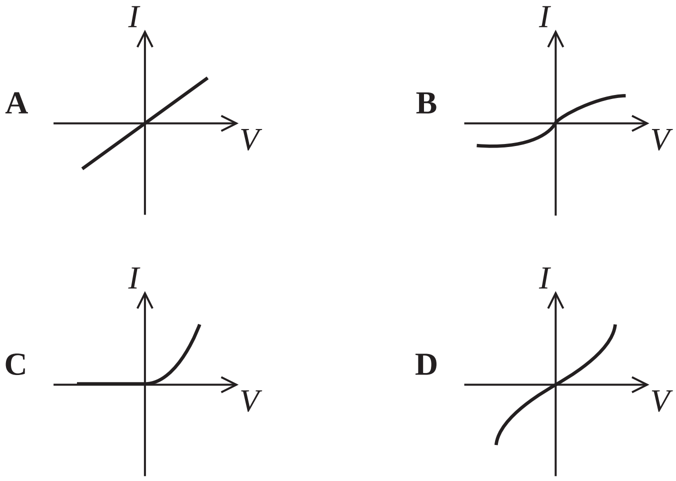
☒ **B** interference

☒ **C** refraction

☒ **D** superposition

(Total for Question 3 = 1 mark)

4 Which of the following current-potential difference (I-V) graphs shows the correct behaviour for a negative temperature coefficient thermistor?



☒ **A**

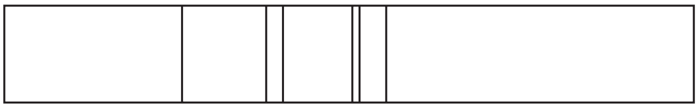
☒ **B**

☒ **C**

☒ **D**

(Total for Question 4 = 1 mark)

5 The diagram shows the line spectrum produced by a particular element as viewed in a laboratory.

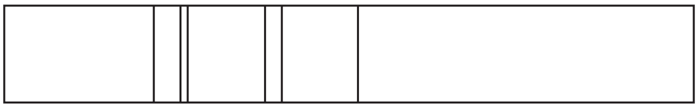


red violet

A star containing the element is moving away from the Earth.

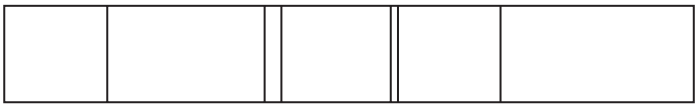
Which of the following spectra could be obtained for light from the star?

☒ **A**



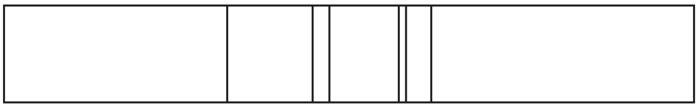
red violet

☒ **B**



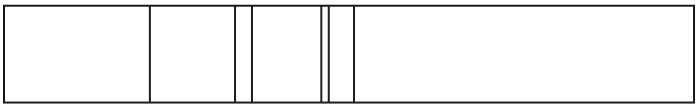
red violet

☒ **C**



red violet

☒ **D**



red violet

(Total for Question 5 = 1 mark)

6 Which table correctly shows the wavelength and frequency of light at each end of the visible spectrum?

☒ **A**

	wavelength / 10^{-9} m	**frequency / 10^{12} Hz**
red	390	400
violet	750	770

☒ **B**

	wavelength / 10^{-9} m	**frequency / 10^{12} Hz**
red	750	400
violet	390	770

☒ **C**

	wavelength / 10^{-9} m	**frequency / 10^{12} Hz**
red	390	770
violet	750	400

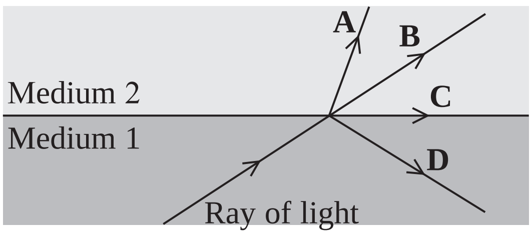
☒ **D**

	wavelength / 10^{-9} m	**frequency / 10^{12} Hz**
red	750	770
violet	390	400

(Total for Question 6 = 1 mark)

7 A ray of light in medium 1 is directed towards medium 2, in which the speed of light is different.

Identify the path the ray of light **cannot** take.



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 7 = 1 mark)

8 The waves, of wavelength λ, from a source divide along two paths and recombine having travelled different distances. At the point where they recombine, which line of the table could show the corresponding path difference and phase difference for the two waves?

	Path difference	**Phase difference / radians**
☒ **A**	λ	π
☒ **B**	$\lambda/2$	2π
☒ **C**	$\lambda/2$	π
☒ **D**	λ	$\pi/2$

(Total for Question 8 = 1 mark)

9 A potential difference of 6 V is applied to a component to provide a current of 3 A for 2 minutes.

In this time the charge flowing through the component is

☒ **A** 6 C

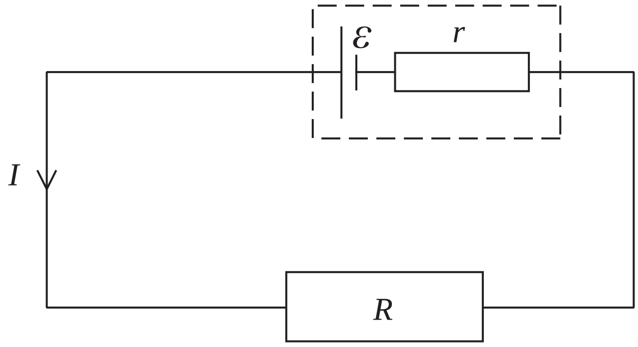
☒ **B** 36 C

☒ **C** 360 C

☒ **D** 2160 C

(Total for Question 9 = 1 mark)

10 The diagram shows a resistor of resistance R connected to a cell of e.m.f. $\mathcal{E}$ and internal resistance r.



Which of the following correctly shows the potential difference V across the terminals of the cell?

☒ **A** $V = \dfrac{\mathcal{E}(R + r)}{r}$

☒ **B** $V = \dfrac{\mathcal{E}R}{(R + r)}$

☒ **C** $V = \dfrac{\mathcal{E}(R + r)}{R}$

☒ **D** $V = \dfrac{\mathcal{E}r}{(R + r)}$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 The e.m.f. of an alkaline cell marked 1.5 V is measured with a high resistance voltmeter and found to be 1.54 V.

Explain why the voltmeter used must have a high resistance.

(2)

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(Total for Question 11 = 2 marks)

12 A student is asked to take measurements to determine the refractive index of a transparent plastic block.

The student uses a ray box and a protractor to obtain the following measurements:

angle of incidence in air = 40°

angle of refraction in plastic = 25°

(a) Calculate the refractive index of the plastic from which the block is made.

(2)

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Refractive index = ...

*(b) The student compares his value of refractive index with the values in the table to identify the type of plastic from which the block is made.

Type of plastic	Refractive index
A	1.494
B	1.498
C	1.509
D	1.519
E	1.531

Comment on the limitations of using this method to identify the type of plastic and suggest how the method may be improved.

(4)

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(Total for Question 12 = 6 marks)

13 It is often difficult to see below the surface of a pond because of glare. This is when the intensity of light from the sky reflected from the surface is much greater than that of light from below the surface.

Sunglasses with polarising lenses can reduce the effect of glare, allowing the observer to see clearly what is below the surface of the water. This is because light from the sky becomes plane polarised when it is reflected.

(a) Explain the difference between plane polarised and unpolarised light.

(3)

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(b) Explain how a polarising lens may be used to remove the glare but still allow light from below the surface of the pond to reach the observer.

(3)

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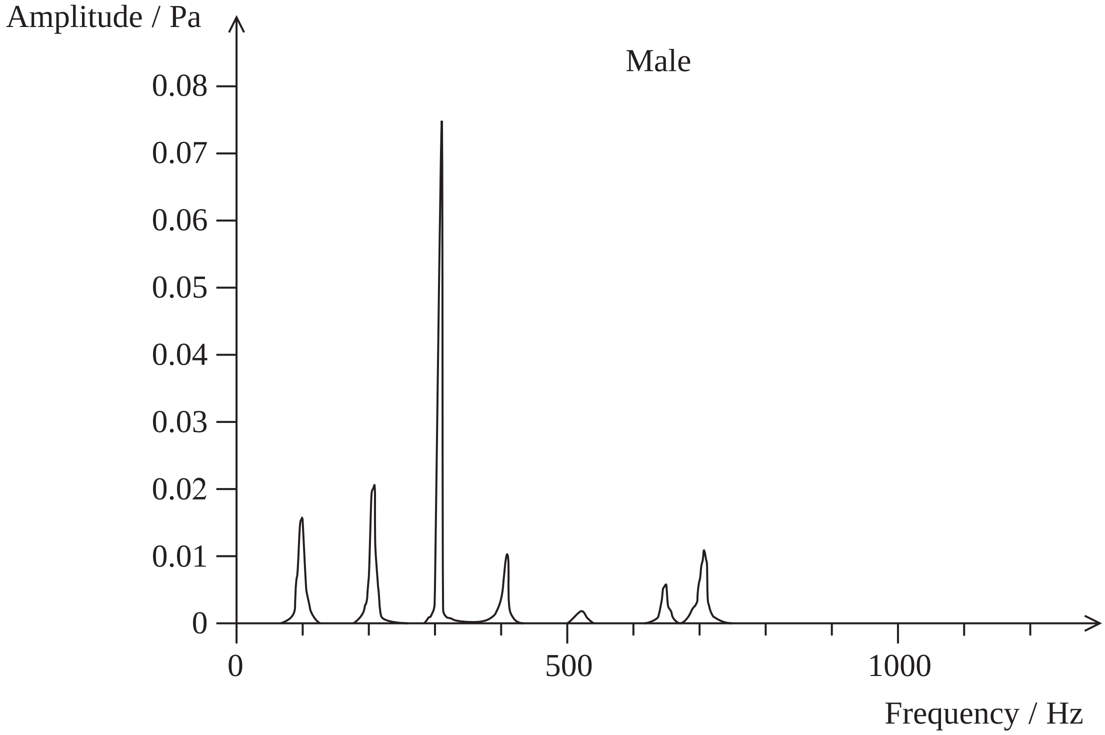
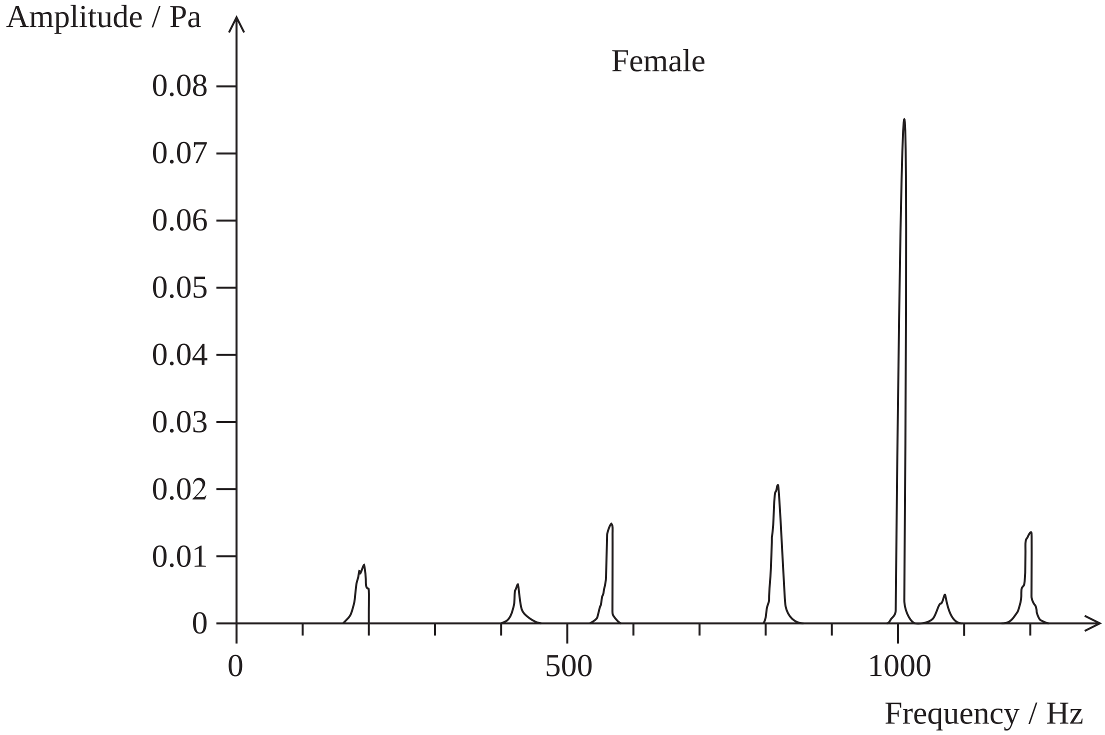
(Total for Question 13 = 6 marks)

14 The following frequency spectra are for a female and a male voice saying "how".





(a) The peak wavelength for the male is about 1 m.

Show that the peak wavelength for the female is about 0.3 m.

speed of sound in air = 330 m s^{-1}

(3)

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(b) It is possible to hear someone talking from the other side of an open door because of diffraction, even when they are not in the line of sight.

(i) Describe what is meant by diffraction.

(2)

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(ii) It is suggested that a male voice may be heard in this way more effectively than a female voice.

Comment on this suggestion for a doorway of width 90 cm.

(2)

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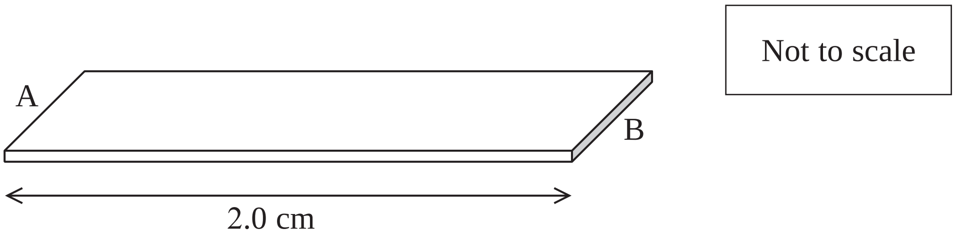
(Total for Question 14 = 7 marks)

15 A student investigates the resistance of the 'lead' in a pencil. A pencil is used to draw a rectangle, of length 2.0 cm and width 6.0 mm, on paper, creating a strip of unknown thickness *t*.



(a) The resistance of the strip between ends A and B is measured with an ohmmeter.

resistance = 55 000 Ω

resistivity of this pencil lead = 3.5×10^{-5} Ωm

Show that the cross-sectional area of the strip of pencil lead is about 1×10^{-11} m^2.

(2)

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(b) The pencil lead is made of a mixture of graphite and clay. This pencil has 50% graphite and 50% clay.

charge carrier density *n* for pure graphite is 3.5×10^{24} m^{-3}

Calculate the drift velocity for the charge carriers in the pencil lead when a potential difference of 6.0 V is applied across the strip from A to B.

Assume that the clay contributes no charge carriers.

(4)

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Drift velocity = ...

(c) Pencil leads are made with a hardness range from 9H (very hard) to 9B (very soft). Hard pencil leads have a higher proportion of clay.

Explain how the resistance of the strip would be affected if it were drawn with a softer pencil.

(2)

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(Total for Question 15 = 8 marks)

16 (a) State what is meant by a photon.

(2)

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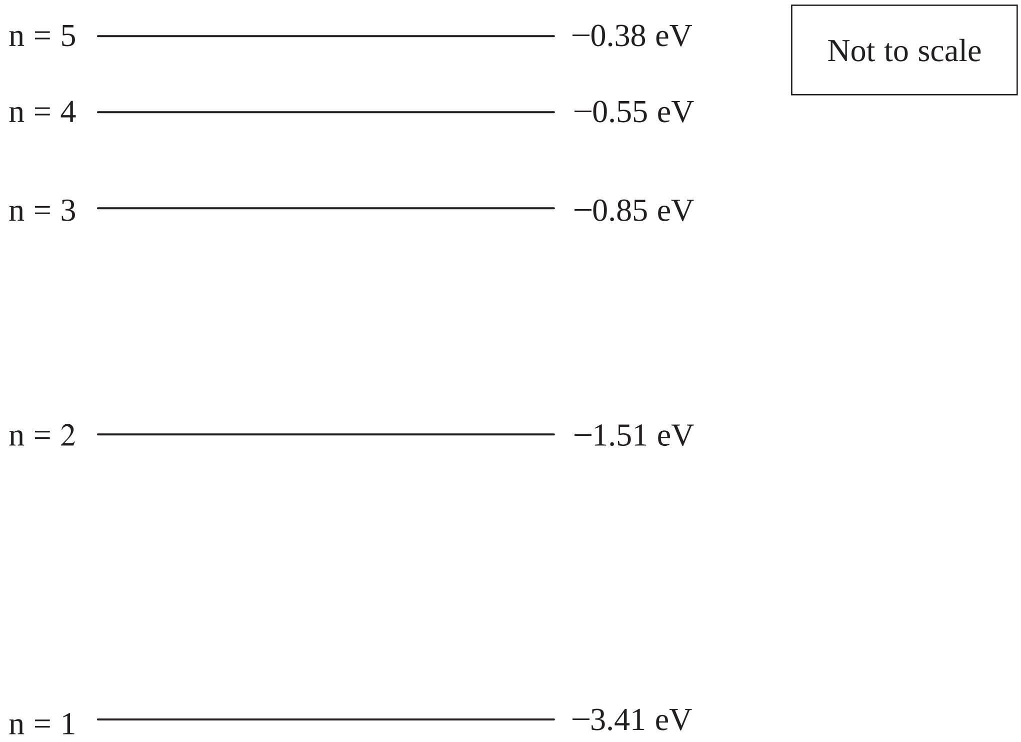
(b) The diagram shows some energy levels of an atom.



(i) State what is meant by an energy level.

(1)

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(ii) Transitions between energy levels are associated with the emission or absorption of photons.

Describe the emission of the lowest frequency photon possible for an excited atom with these energy levels and calculate its frequency.

(6)

Frequency = ...

(Total for Question 16 = 9 marks)

*17 The list of data, formulae and relationships for this paper states the following:

Einstein's photoelectric equation $hf = \phi + ½mv^2_{max}$

Describe the photoelectric effect, including an explanation of each of the terms, hf, ϕ and $½mv^2_{max}$, in the equation.

(6)

(Total for Question 17 = 6 marks)

18 A student wants to determine the efficiency of a filament bulb at transferring electrical energy to light energy. She does this by measuring the thermal energy given out by the bulb.

The bulb is mounted on a piece of wood and placed upside down in water as shown in the photograph.

(a) Explain why the temperature of the filament in the bulb increases when a potential difference is applied.

(3)

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(b) The bulb is switched on for 7 minutes. The current is 1.95 A and the potential difference is 11.6 V.

(i) Show that the rate of electrical energy transfer is about 20 W.

(2)

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(ii) Show that the electrical work done is about 10 000 J.

(2)

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(iii) The temperature rise of the water is measured and used to determine that the thermal energy gained by the water is 7800 J.

Calculate the efficiency of the bulb as a source of light.

(3)

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Efficiency = ...

(iv) Suggest why this represents the maximum efficiency.

(1)

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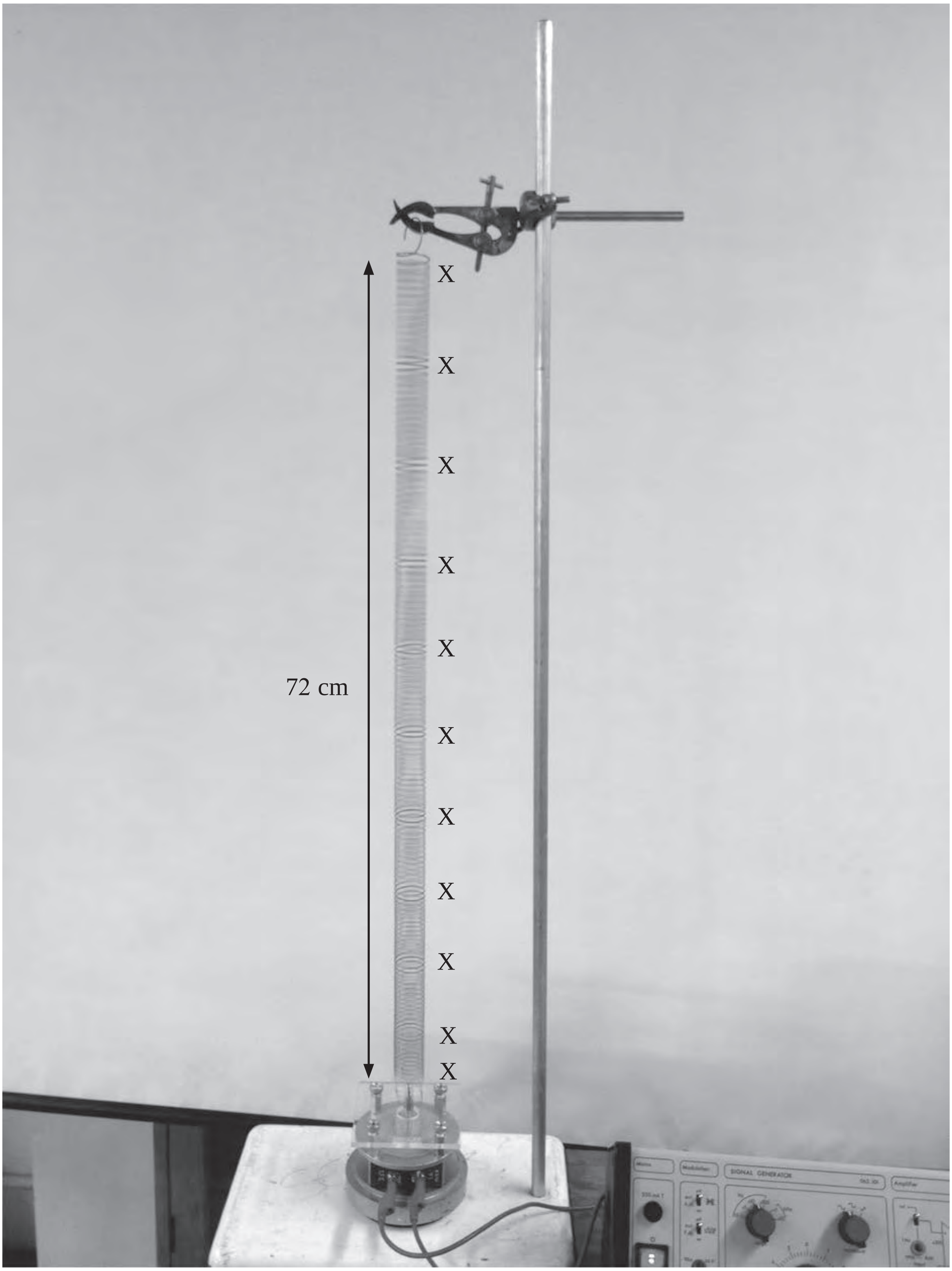
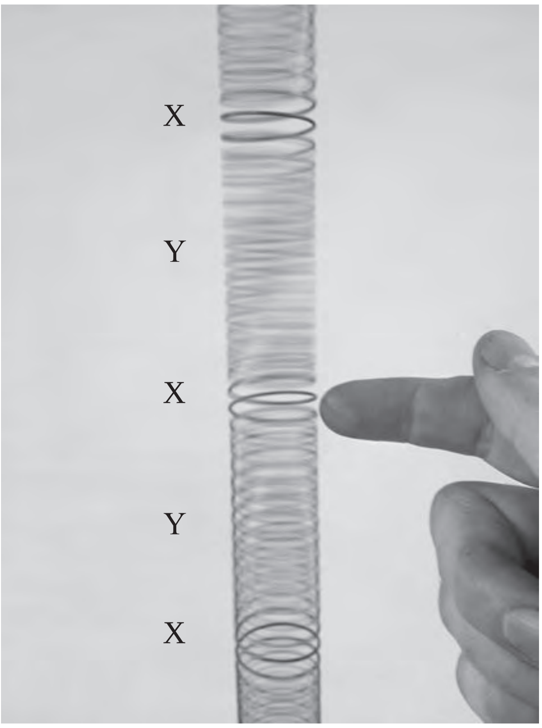
(Total for Question 18 = 11 marks)

19 A vibration generator vibrates vertically to create a standing wave in a spring as shown in Photograph 1. The positions marked X show where the coils are stationary.



Photograph 1

Photograph 2 shows a section of the spring. The coils at the positions marked Y look blurred because the coils are in motion.



Photograph 2

(a) Explain why the waves shown in Photograph 2 must be longitudinal.

(2)

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(b) The positions marked X are nodes.

State what is meant by a node.

(1)

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(c) Explain how the standing wave is produced.

(3)

(d) The frequency of the standing wave in Photograph 1 is 34 Hz.

Show that the velocity of longitudinal waves in the spring is about 5 m s^{-1}.

(3)

(e) The velocity of longitudinal waves in the spring is also determined by finding the time for a pulse to travel along the length of the spring.

The spring is filmed while a pulse is created at the bottom and allowed to reflect from the top. The pulse travels up and back down the spring 21 times.

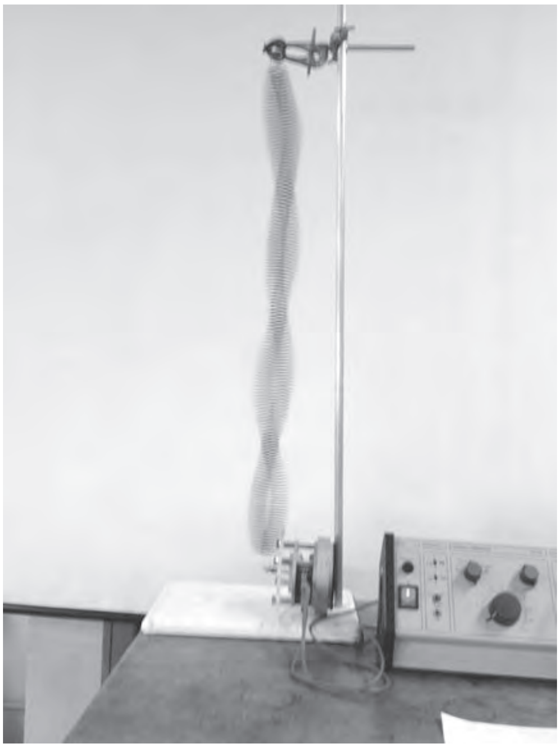
Show that the velocity of longitudinal waves in the spring determined by this method is also about 5 m s^{-1}.

time taken = 6.17 s

length of spring = 72 cm

(3)

(f) The vibration generator is then turned sideways so that it vibrates horizontally. Photograph 3 was taken when the frequency was set to 14 Hz. The length of the spring is still 72 cm.



Photograph 3

Compare the patterns shown in Photograph 1 and Photograph 3.

(3)

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(Total for Question 19 = 15 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \mathrm{m\ s^{-2}}$	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19}\ \mathrm{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$	
Electronvolt	$1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$	
Gravitational field strength	$g = 9.81\ \mathrm{N\ kg^{-1}}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34}\ \mathrm{J\ s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$	

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

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	$hf = \phi + \frac{1}{2}mv^2_{max}$