Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Monday 12 January 2015 – Morning
Time: 1 hour 30 minutes

Paper Reference
WPH02/01

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 ▶

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 numbers in the table represent regions of the electromagnetic spectrum in order from low frequency to high frequency.

Low frequency → High frequency

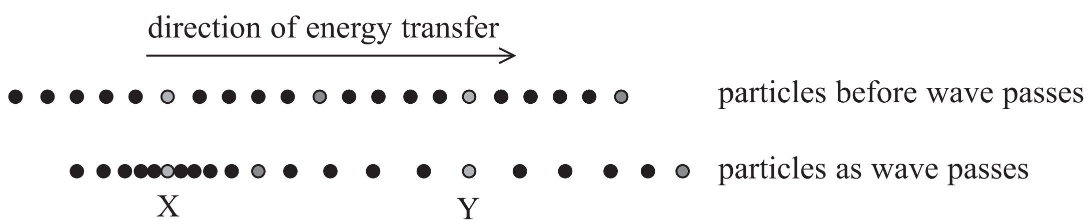
1	2	3	4	5	6	7

Which line of the table correctly matches a region of the electromagnetic spectrum to its name and an application?

	Region	Name	Application
☒ **A**	1	gamma	sterilising medical equipment
☒ **B**	3	infrared	optical fibre communication
☒ **C**	5	visible	astronomical observation
☒ **D**	7	gamma	television signals

(Total for Question 1 = 1 mark)

2 The diagram represents the particles in a medium before a sound wave passes through and while a sound wave is passing through.



Which statement is **not** true?

☒ **A** Particle displacement is parallel to the direction of energy transfer.

☒ **B** The wave causes the formation of compressions and rarefactions.

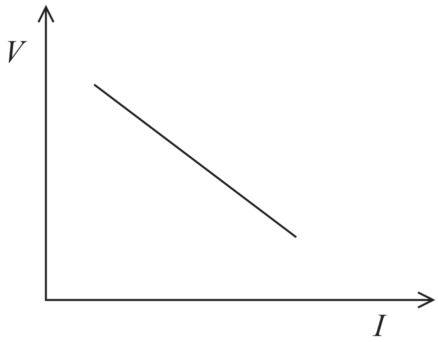
☒ **C** X is a position of maximum particle displacement.

☒ **D** Y is a position of zero particle displacement.

(Total for Question 2 = 1 mark)

3 The current I and terminal potential difference V for a cell are measured as the current through the cell is varied.

The following graph is produced from the results.



Which row of the table correctly gives the e.m.f. and the internal resistance of the cell?

	E.m.f.	Internal resistance
☒ **A**	x intercept	negative gradient
☒ **B**	y intercept	negative gradient
☒ **C**	negative gradient	x intercept
☒ **D**	negative gradient	y intercept

(Total for Question 3 = 1 mark)

4 Which of the following is equivalent to a single SI base unit?

☒ **A** coulomb per second

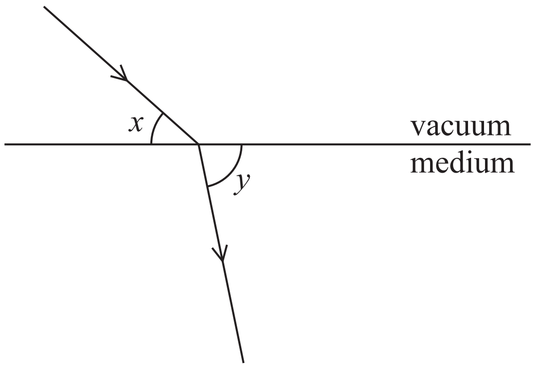
☒ **B** joule per coulomb

☒ **C** joule per second

☒ **D** metre per second

(Total for Question 4 = 1 mark)

5 The diagram shows a ray of light passing from a vacuum into a transparent medium.



The refractive index of the medium is given by

☒ **A** $\dfrac{\text{frequency of light in the vacuum}}{\text{frequency of light in the medium}}$

☒ **B** $\dfrac{\text{sine of angle } x}{\text{sine of angle } y}$

☒ **C** $\dfrac{\text{speed of light in the vacuum}}{\text{speed of light in the medium}}$

☒ **D** $\dfrac{\text{wavelength of light in the medium}}{\text{wavelength of light in the vacuum}}$

(Total for Question 5 = 1 mark)

---

6 Which of the following would allow the level of detail in an ultrasound scan to be increased?

☒ **A** increasing the duration of the pulses

☒ **B** increasing the frequency of the ultrasound

☒ **C** increasing the intensity of the ultrasound

☒ **D** increasing the wavelength of the ultrasound

(Total for Question 6 = 1 mark)

7 The current in a wire is I and the drift velocity of the electrons in the wire is v.
The wire is replaced with another of the same metal but half the diameter.

If the current in the new wire is the same, the drift velocity is

☒ **A** $\frac{v}{4}$

☒ **B** $\frac{v}{2}$

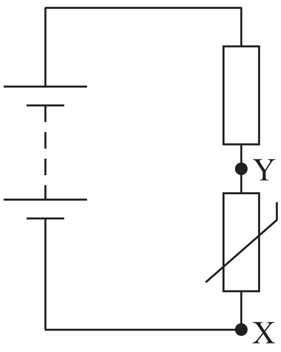
☒ **C** $2v$

☒ **D** $4v$

(Total for Question 7 = 1 mark)

Questions 8 and 9 refer to the diagram below.

The diagram shows a circuit containing a fixed resistor and a negative temperature coefficient thermistor.



8 The temperature in the circuit increases.
Which row in the table correctly shows what happens to the current in the thermistor and the potential difference across the thermistor?

	Current	**Potential difference**
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

(Total for Question 8 = 1 mark)

9 The potential difference of the supply is 15 V. The resistance of the fixed resistor is 40 Ω and the resistance of the thermistor is 60 Ω.

What is the potential difference across XY?

☒ **A** 1.5 V

☒ **B** 4.0 V

☒ **C** 6.0 V

☒ **D** 9.0 V

(Total for Question 9 = 1 mark)

10 In plane polarised light, the oscillations of the electric field are

☒ **A** in a single plane, which includes the direction of energy transfer.

☒ **B** in a single plane, which is perpendicular to the direction of energy transfer.

☒ **C** in perpendicular planes, which are perpendicular to the direction of energy transfer.

☒ **D** in perpendicular planes, which include the direction of energy transfer.

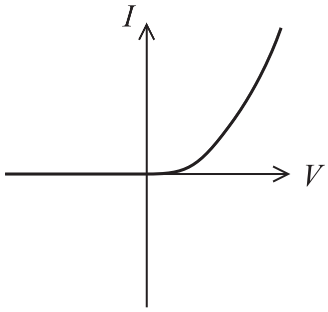
(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 The graph shows how current varies with applied potential difference for a diode.



Explain the shape of the graph.

(3)

....

....

....

....

....

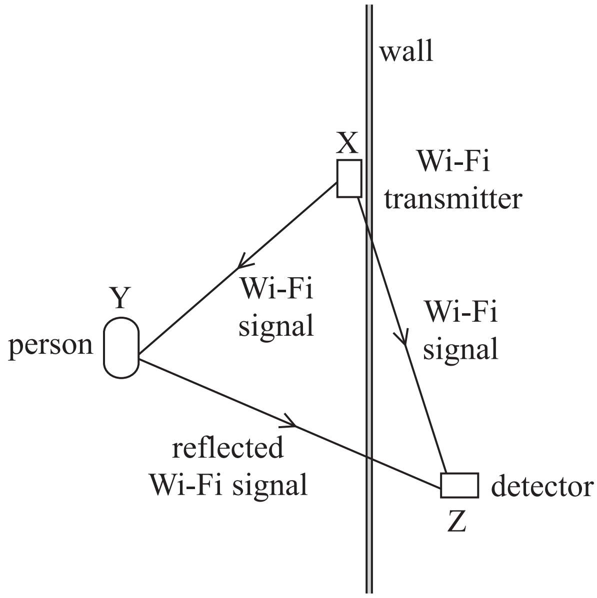
....

(Total for Question 11 = 3 marks)

12 Engineers are developing a system, using the Doppler effect, which will detect the movement of people in a room during a hostage situation.

The system makes use of the Wi-Fi transmitter already in a building, rather than needing a separate transmitter.

The system is shown in the diagram.



A detector placed outside the room receives signals directly from the Wi-Fi transmitter, along path XZ. It also receives signals reflected by the person in the room, which have travelled along path XYZ.

(a) Explain how the system uses the Doppler effect to detect the motion of the person.

(3)

....

....

....

....

....

....

(b) Suggest an advantage of a pulse-echo technique over this system.

(1)

....

....

(Total for Question 12 = 4 marks)

13 The photograph shows a shoe with novelty shoelaces.

The laces are long, flexible plastic strands. Light from the light source passes through the tied laces, illuminating the ends.

(a) (i) State what is meant by critical angle.

(2)

....

....

....

(ii) Show that the refractive index for the plastic used for the laces is about 1.5

speed of light in plastic = 1.97×10^{8} m s^{-1}

(2)

....

....

....

....

(iii) Calculate the critical angle for the plastic used for the laces.

(2)

....

....

....

....

Critical angle = ...

(b) Explain how light from the source is able to reach the end of the laces.

(2)

....

....

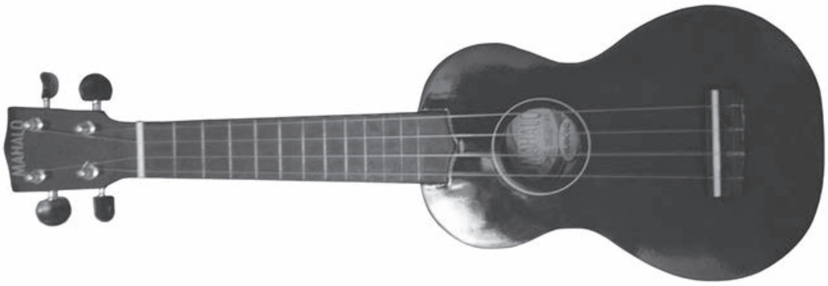
....

....

....

(Total for Question 13 = 8 marks)

14 The photograph shows a stringed instrument called a ukulele.



When a string is plucked, progressive waves travel in both directions along the string and reflect at the ends, producing a standing wave.

Figure 1 represents a standing wave on a string.

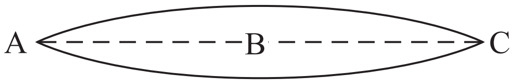


Figure 1

(a) The wave in Figure 1 can be shown graphically as below.

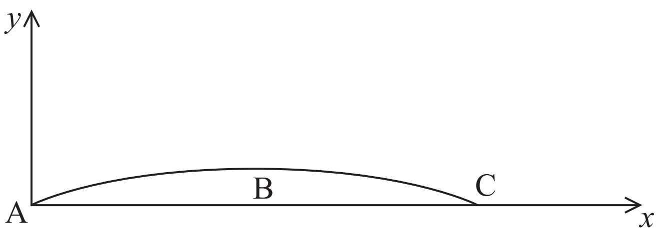


Figure 2

(i) Suggest suitable labels for the x-axis and the y-axis.

(2)

x-axis ....

y-axis ....

(ii) The waves undergo a phase change of π radians when they reflect at the ends.

Explain how this produces nodes at A and C.

(3)

....

....

....

....

....

P 4 5 0 3 6 A 0 1 2 2 4

(b) A particular string on the ukulele has a length of 35 cm.

(i) State the wavelength of the wave on the string when it is vibrating as shown in Figure 1.

(1)

....

(ii) The string is oscillating at a frequency of 196 Hz.

Calculate the speed of the waves along this string.

(2)

....

....

....

....

Speed = ...

(Total for Question 14 = 8 marks)

15 (a) State what is meant by the ground state of an atom.

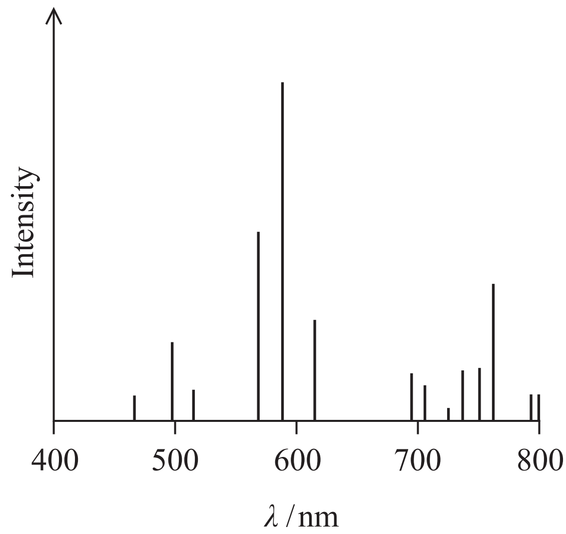
(1)

....

....

*(b) Some street lamps produce a bright light which appears yellow. This light is produced by sodium vapour in the lamp.

The graph shows the relative intensity of different wavelengths of light in the visible spectrum produced by this type of street lamp.



Explain why only certain wavelengths of light are emitted.

(6)

....

....

....

....

....

....

....

....

....

....

....

(Total for Question 15 = 7 marks)

16 A metal surface is illuminated with ultraviolet light of a single frequency. Electrons are emitted from the metal surface.

*(a) It can be observed that the electrons have a range of kinetic energies up to a specific maximum.

Explain how this observation provides evidence to support the particle nature of light rather than the wave nature of light.

(4)

(b) Calculate the maximum kinetic energy, in joule, of the emitted electrons when the frequency of the ultraviolet light is 2.5×10^{15} Hz.

work function = 2.3 eV

(4)

Maximum kinetic energy = ... J

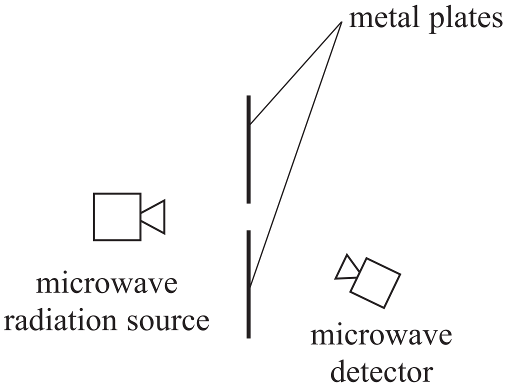
(Total for Question 16 = 8 marks)

17 A student investigates diffraction.

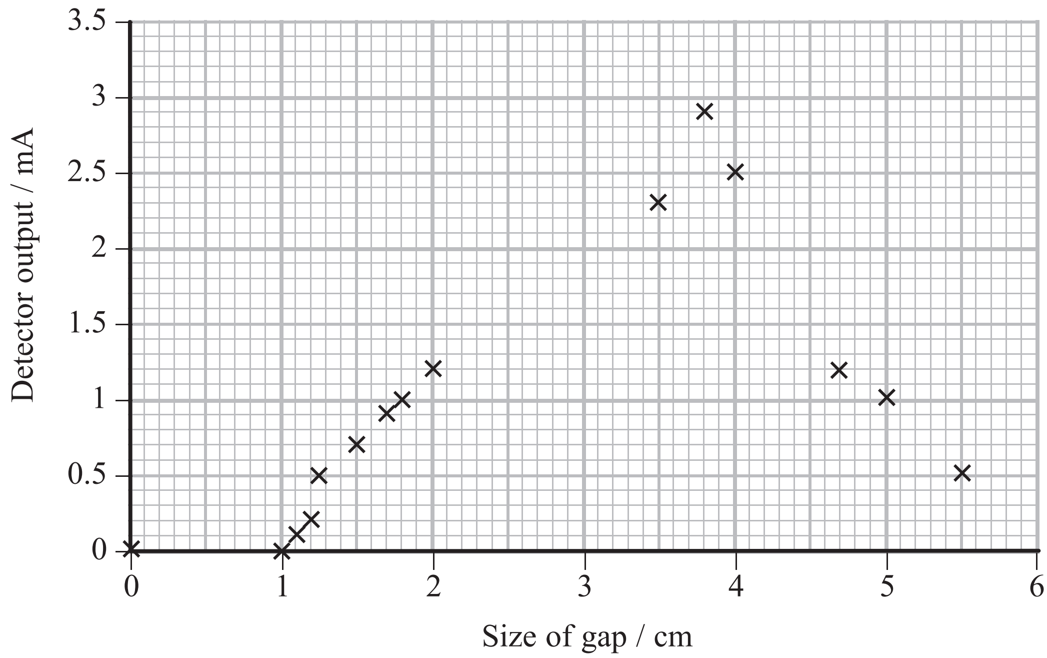
(a) Draw a diagram to illustrate what is meant by diffraction.

(2)

(b) The student directs microwave radiation at the gap between two metal plates, as shown below.



The microwave radiation source and detector are left in the same positions while the size of the gap between the metal plates is varied. The output of the detector and size of the gap are measured. The graph shows the results.



(i) Explain the shape of the graph, including an estimate of the wavelength of the microwave radiation used.

(4)

....

....

....

....

....

....

....

....

....

....

(ii) Comment on the distribution of values for the size of the gap selected by the student for this investigation.

(2)

....

....

....

....

(Total for Question 17 = 8 marks)

18 The photograph shows a solar charging unit consisting of a solar panel connected to three rechargeable cells.

(a) (i) The radiation flux incident on the solar panel is 49 W m^{-2}. The area of the panel is 6.4×10^{-3} m^2.

Show that the panel receives radiation energy at a rate of about 0.3 W.

(2)

....

....

....

....

....

(ii) The e.m.f. of the solar panel is 5.6 V.

Calculate the efficiency of the solar panel when the current is 6.8 mA.

(3)

....

....

....

....

....

....

....

....

Efficiency = ...

(b) Each rechargeable cell is marked 1.2 volts, 1500 milliamp hours.

Calculate the maximum energy that can be delivered by the three fully charged cells.

(3)

Maximum energy = ...

(c) Assuming that the current in the solar cell remains at 6.8 mA, explain whether the three cells would be charged more quickly if connected in series or in parallel.

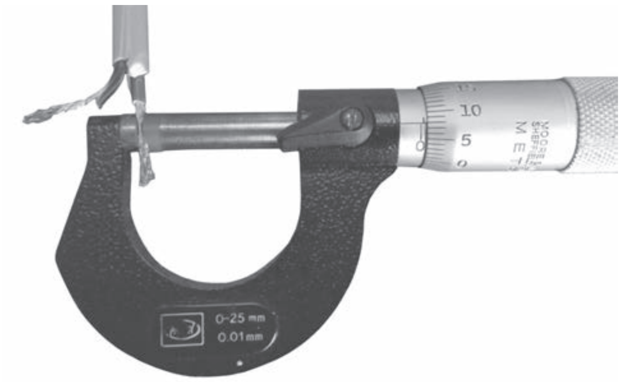
(2)

(Total for Question 18 = 10 marks)

19 A student is investigating whether the length of a mains electrical cable can be determined accurately by taking measurements of resistance using an ohmmeter and hence calculating the length.

She takes measurements of resistance and diameter for the live conductor, as shown in the photographs below. She uses these measurements to calculate the length of the cable and then compares this value with a direct measurement of length.

Resistance = 0.3 Ω



Diameter = 1.08 mm

Length = 14.500 m

P 4 5 0 3 6 A 0 2 0 2 4

(a) (i) Show that the cross-sectional area of the live conductor is about 9×10^{-7} m^2.

(1)

....

....

....

(ii) Calculate the length of the live conductor.

resistivity of copper = 1.68×10^{-8} Ω m

(2)

....

....

....

....

Length = ...

(iii) Comment on the accuracy of this method of determining the length of the live conductor.

(1)

....

....

....

(iv) The student wants to improve the determination of length.

Explain why she should improve the measurement of resistance rather than the measurement of diameter.

(3)

....

....

....

....

....

....

(v) Describe an alternative way of determining the resistance of the live conductor and how this would improve the accuracy of the resistance value obtained.

(3)

....

....

....

....

....

....

....

....

(b) The mains electrical cable is used as an extension lead for a lawnmower.

The lawnmower is labelled 1200 W, 230 V.

(i) Calculate the operating current of the lawnmower.

(2)

....

....

....

Current = ...

(ii) Calculate the rate at which energy is dissipated by the live conductor when it is used with the lawnmower.

(2)

....

....

....

....

Rate = ...

(Total for Question 19 = 14 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \mathrm{m\ s^{-2}}$	(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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\% \text{ efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} \times 100$
	$\% \text{ efficiency} = \dfrac{\text{useful power output}}{\text{total power input}} \times 100$
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	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Quantum physics

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \tfrac{1}{2}mv^2_{max}$