Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Thursday 19 January 2017 – 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 4 8 3 6 1 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 Which of the following types of wave can be used in fibre optic telecommunication systems?

☒ **A** infrared

☒ **B** microwave

☒ **C** radio

☒ **D** ultrasound

(Total for Question 1 = 1 mark)

2 In a piano, a note is produced by striking a stretched wire with a hammer.

Which of the following describes the wave produced on the wire?

☒ **A** longitudinal and progressive

☒ **B** longitudinal and stationary

☒ **C** transverse and progressive

☒ **D** transverse and stationary

(Total for Question 2 = 1 mark)

3 Which of the following would improve the level of detail in an ultrasound scan?

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

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

☒ **C** increasing the interval between the pulses

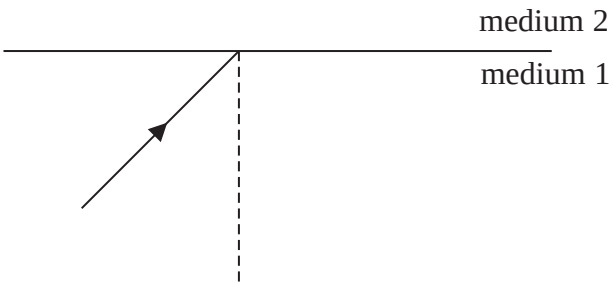
☒ **D** increasing the wavelength of the ultrasound

(Total for Question 3 = 1 mark)

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4 The diagram shows a ray of light in medium 1 striking a boundary with medium 2.

In medium 1, the light has a frequency f_1 and wavelength λ_1. In medium 2, the light has a frequency f_2 and wavelength λ_2.



Which of the following is necessary for total internal reflection to occur?

☒ **A** $f_2 > f_1$

☒ **B** $f_1 > f_2$

☒ **C** $\lambda_2 > \lambda_1$

☒ **D** $\lambda_1 > \lambda_2$

(Total for Question 4 = 1 mark)

5 A source of e.m.f. with no internal resistance is connected across a negative temperature coefficient thermistor. The current in the thermistor and the potential difference across the thermistor are measured.
The temperature of the thermistor is increased.

Which of the following will be observed?

☒ **A** a decrease in current

☒ **B** a decrease in potential difference

☒ **C** an increase in current

☒ **D** an increase in potential difference

(Total for Question 5 = 1 mark)

6 Which of the following equations does **not** include any SI base quantities?

☒ **A** $P = W \div t$

☒ **B** $Q = I \times t$

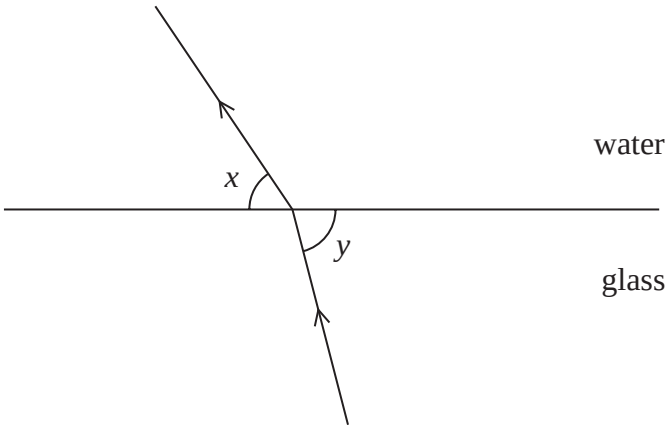
☒ **C** $R = V \div I$

☒ **D** $W = Q \times V$

(Total for Question 6 = 1 mark)

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7 The diagram shows a ray of light passing from glass to water.



Which of the following is a correct expression for the refractive index for light passing from glass to water?

☒ **A** $\frac{\sin x}{\sin y}$

☒ **B** $\frac{\sin y}{\sin x}$

☒ **C** $\frac{\sin (90° - x)}{\sin (90° - y)}$

☒ **D** $\frac{\sin (90° - y)}{\sin (90° - x)}$

(Total for Question 7 = 1 mark)

8 A water wave meets a small gap in a barrier.

Which row of the table correctly describes the speed and wavelength of the water wave after passing through the gap?

	speed	wavelength
☒ **A**	unchanged	decreased
☒ **B**	decreased	unchanged
☒ **C**	increased	increased
☒ **D**	unchanged	unchanged

(Total for Question 8 = 1 mark)

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9 The wavelength of a progressive wave is defined as the distance between adjacent points on the wave which

☒ **A** have the same displacement.

☒ **B** have the same amplitude.

☒ **C** are in phase.

☒ **D** are in antiphase.

(Total for Question 9 = 1 mark)

10 A potential difference is applied across a sample of metal wire so that there is a current in the wire. The charge carriers in the wire have a drift velocity v.
Without changing the applied potential difference, a second identical wire is placed in parallel with the first wire.

What is the drift velocity?

☒ **A** $v / 2$

☒ **B** v

☒ **C** $2v$

☒ **D** $4v$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

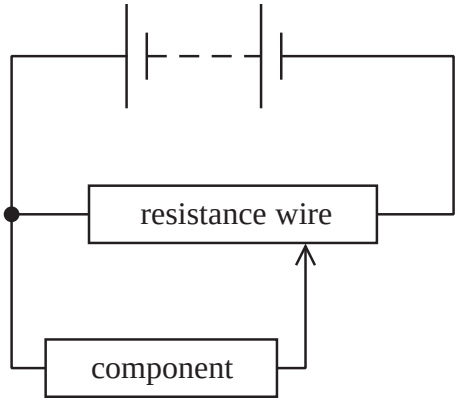
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SECTION B

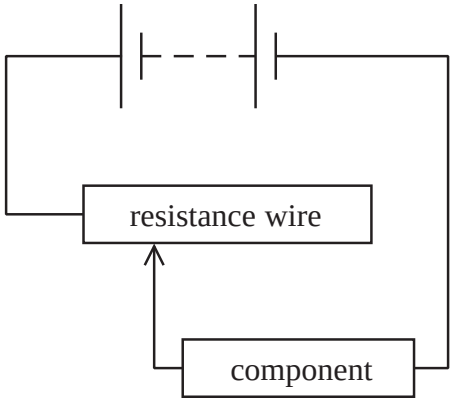
Answer ALL questions in the spaces provided.

11 A student is investigating the relationship between current and potential difference (p.d.) for a component. He does not have access to a power supply which can apply a varying p.d. He decides to use a length of resistance wire to control the p.d. applied across the component.

(a) The student could use the wire to set up a potential divider or as a variable resistor in series with the component.



Potential divider circuit



Variable resistor circuit

State the advantage of using the potential divider circuit.

(1)

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(b) The student uses a wire of resistance 24 Ω.
Calculate the diameter of the wire.

resistivity of wire = 1.2×10^{-6} Ω m
length of wire = 50 cm

(3)

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Diameter = ...

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(c) Another potential divider of length 40.0 cm and resistance 50.0 Ω has a p.d. of 12.0 V applied across its length.

The p.d. is measured across 7.16 cm of the wire.

Calculate this p.d.

(2)

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p.d. = ...

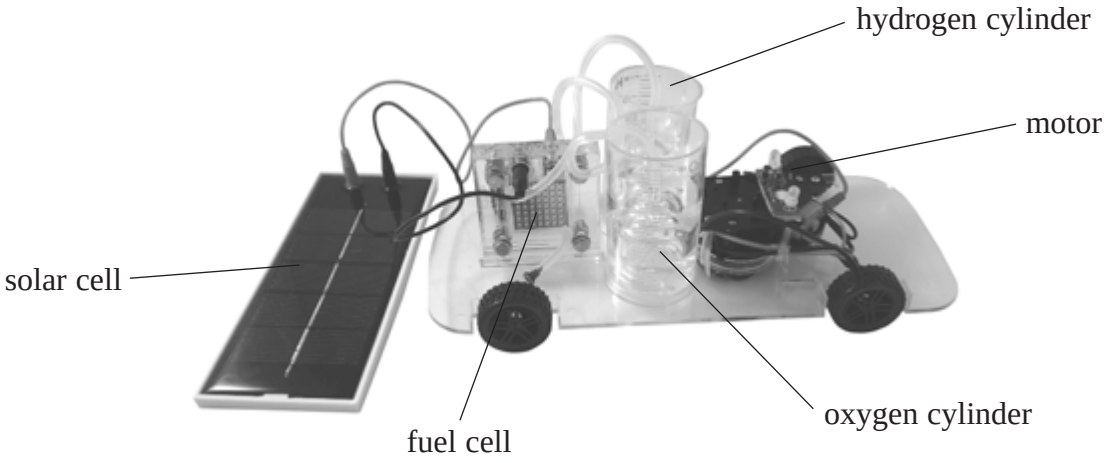
(Total for Question 11 = 6 marks)

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12 The photograph shows a model car.



A solar cell is used to produce hydrogen and oxygen from water by electrolysis. The car then uses stored chemical energy by combining the hydrogen and oxygen in a fuel cell to drive a motor.

(a) The solar cell is illuminated for one hour. The light energy incident on the cell in that time is 4590 J.

(i) Calculate the radiation flux of the incident light.

area of solar cell = 5.00×10^{-3} m^2

(2)

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Radiation flux = ...

(ii) The hydrogen and oxygen gas produced in one hour store 110 J of chemical energy.

Determine the efficiency of the arrangement at transferring light energy to stored chemical energy.

(2)

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Efficiency = ...

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(b) Explain why this arrangement is not viable in a full-sized car.

(2)

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(Total for Question 12 = 6 marks)

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13 Polarising filters may be used to investigate stress patterns in transparent materials.

(a) Describe the difference between unpolarised light and polarised light.

(3)

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(b) A polarising filter is placed above a source of unpolarised light.

A second filter is placed over the first filter so that the filters are aligned, as shown in Photograph 1.



Photograph 1

The second filter is then rotated by 90° and the result is shown in Photograph 2.



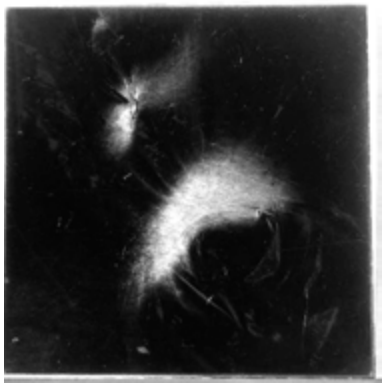
Photograph 2

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(i) Explain the appearance of Photograph 2.

(2)

(ii) A sheet of thin, transparent plastic is stretched and then placed between the filters. The result is shown in Photograph 3.



Photograph 3

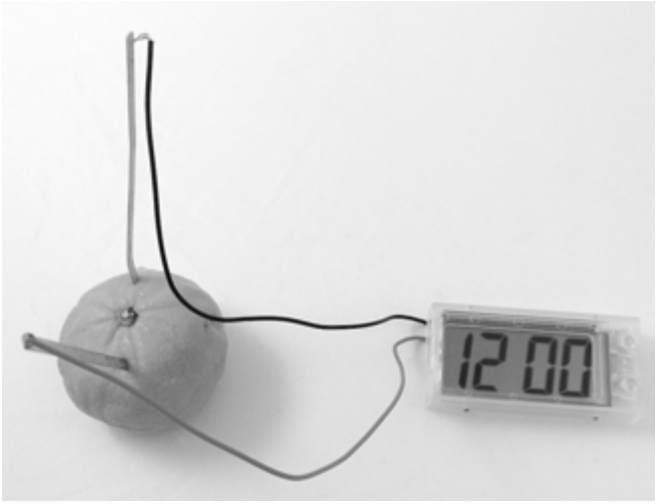
Explain why the stretched plastic produces the pattern shown in Photograph 3.

(2)

(Total for Question 13 = 7 marks)

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14 An orange cell is made by inserting magnesium and copper electrodes into an orange. The orange cell acts as a source of e.m.f. which can be used to power a clock as shown.



The following measurements are obtained from the circuit.

e.m.f. / V	1.79
p.d. across clock / V	1.72
current in clock / μA	4.20

(a) Show that the internal resistance of the orange cell is about 20 kΩ.

(3)

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(b) Calculate the output power of the cell when it is used to power the clock.

(2)

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Power = ...

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(c) The e.m.f. measurement was obtained by removing the clock and connecting a voltmeter with a resistance of $1.0 \times 10^7\ \Omega$ across the electrodes.

Discuss the suitability of this method.

(4)

(Total for Question 14 = 9 marks)

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15 The photograph shows a Blue Morpho butterfly.



The wings appear bright blue, but they do not contain blue pigment. The blue colour is caused by superposition of the light reflected from the scales on the wings.

(a) State what is meant by the principle of superposition.

(2)

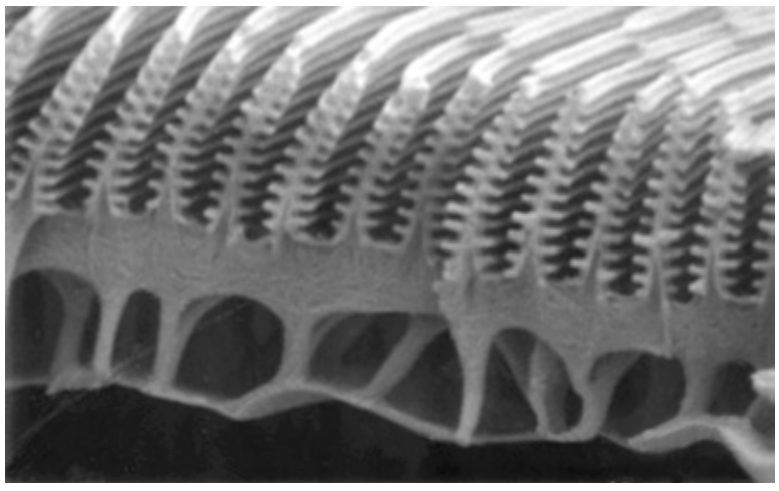
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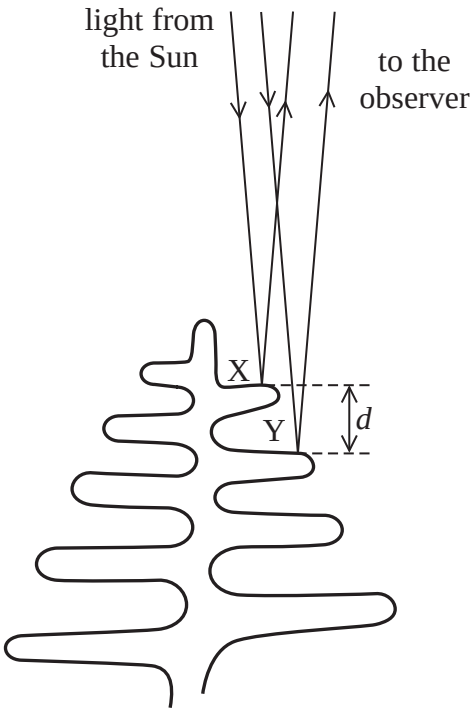
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(b) The scales on the wings are a few micrometres in size and have a series of ridges from which light is reflected.



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White light reflects from the ridges X and Y. This causes a path difference between the light reflected from X and the light reflected from Y, as the light reaches the observer as shown.



*(i) Explain why some wavelengths of light will be observed strongly and others will not be observed.

(5)

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(ii) The table shows approximate wavelength ranges for colours of the spectrum.

colour	violet	blue	green	yellow	orange	red
wavelength / nm	380 450	495	570	590	620	750

With the aid of a calculation, show that the colour observed would be blue for a butterfly where the distance d between ridges X and Y is 2.3×10^{-7} m.

(2)

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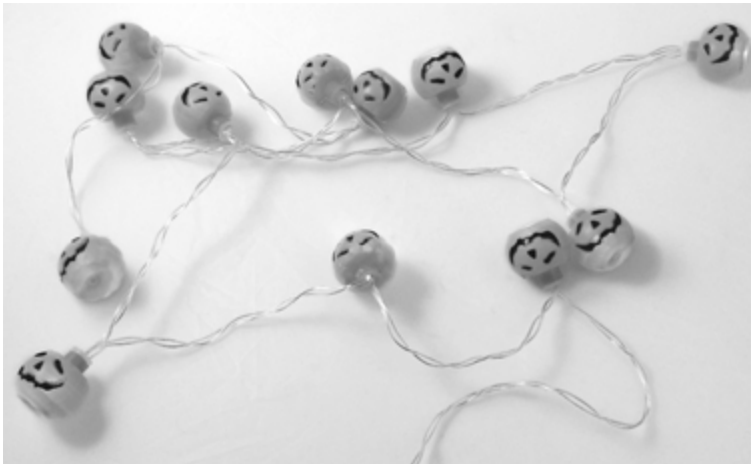
(Total for Question 15 = 9 marks)

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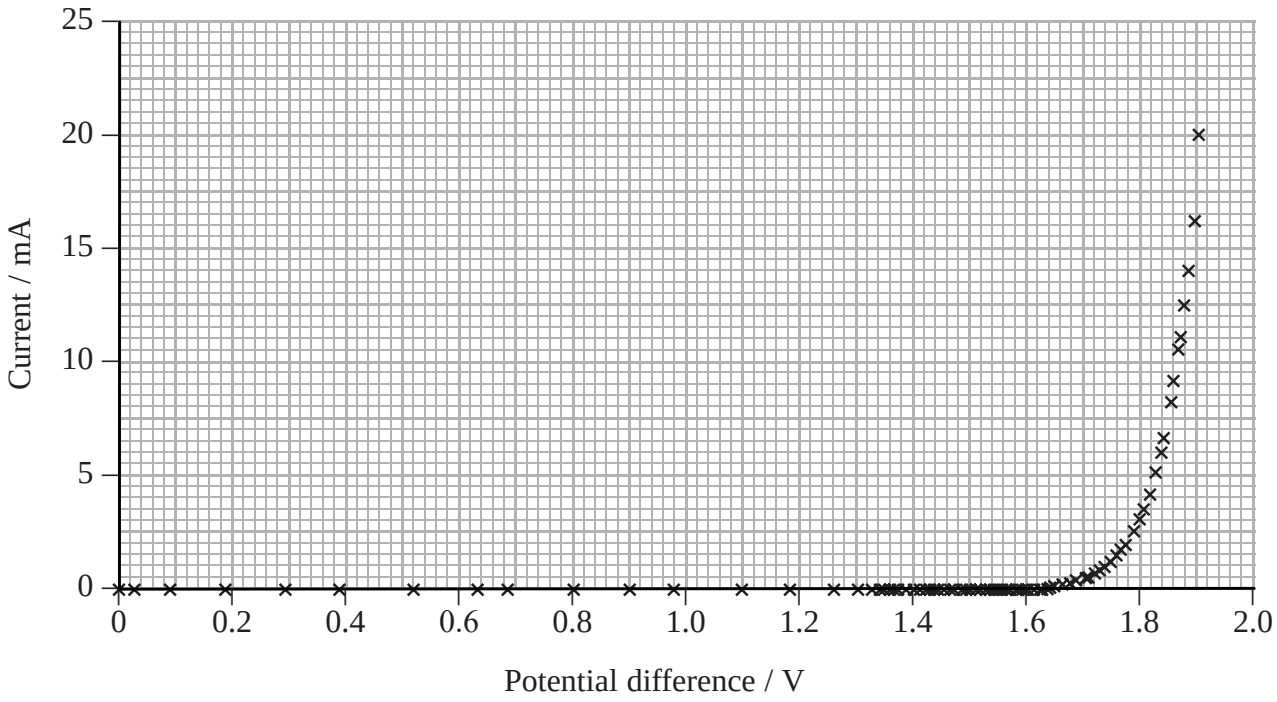
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16 The photograph shows a set of decorative lights. The lights are connected in parallel.



A student is asked to determine whether the lights contain filament bulbs or light emitting diodes (LEDs). She sets up a circuit to obtain a graph of current against potential difference for the set of lights.



The student concludes that the lights are LEDs and not filament bulbs.

(a) Explain why this conclusion is justified.

(2)

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(b) (i) Discuss the distribution of readings.

(2)

(ii) Determine the resistance of a single LED when the total current for the set of lights is 15 mA.

(3)

Resistance = ...

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(c) The light from the LED, at a typical potential difference of 2.1 V, appears orange.

(i) For an LED to emit light, the work done on a single electron by the applied potential difference must be equal to or greater than the photon energy of the emitted light.

Calculate the frequency of the orange light emitted.

(3)

Frequency = ...

(ii) The orange light from the LED is part of a continuous spectrum of red, orange and yellow light. When a current is passed through low pressure sodium gas, orange light is also observed. However, the light from the sodium gas only contains a limited number of frequencies.

Explain why the light from the sodium gas only contains a limited number of frequencies.

(2)

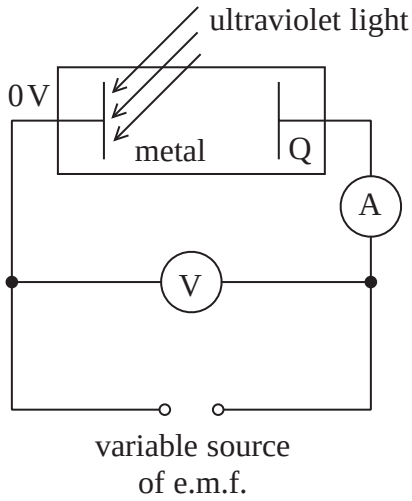
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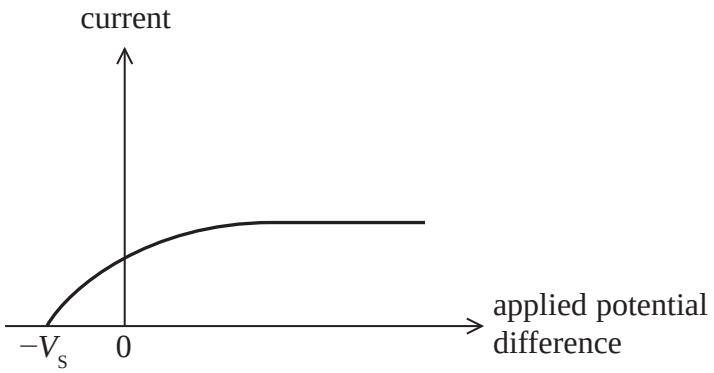
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17 The diagram shows apparatus used to investigate the photoelectric effect.



When ultraviolet light of a particular frequency is shone on the metal a current is produced.
Current is produced for all values of potential difference when Q is positive.
If Q is negative there is a p.d. beyond which there is no current. The magnitude of this p.d. is called the stopping potential V_S.

The graph shows the results for a particular investigation with light intensity *I*.

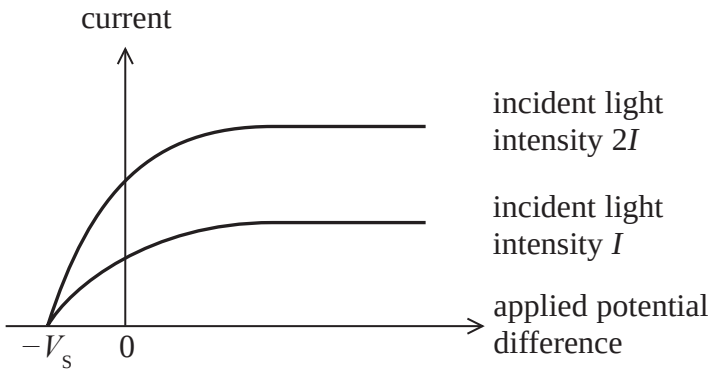


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*(a) (i) Explain why there is a current for positive p.d.s, but none for reverse p.d.s greater than the stopping potential.

(5)

(ii) The investigation is repeated with light intensity 2*I*. The results are as shown below.



Explain the difference between the results for incident light intensity *I* and incident light intensity 2*I* for positive values of the applied potential difference.

(2)

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(b) Calculate the value of V_S.

frequency of ultraviolet light = 1.20×10^{15} Hz
work function of metal = 4.26 eV

(3)

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V_S = ...

(Total for Question 17 = 10 marks)

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18 Traffic police sometimes use 'speed guns' to check the speed of cars.

(a) Radar speed guns use the Doppler effect to determine the speed of cars travelling towards or away from the radar speed gun.
A radar speed gun emits a continuous microwave signal at a frequency of 40 GHz and detects the signal reflected from a moving car.

Explain how the frequency of the microwave signal detected is affected by the speed of the car and whether the car is travelling towards or away from the radar speed gun.

(4)

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(b) Lidar speed guns use infrared radiation instead of microwaves to measure the speed of a car. Lidar speed guns emit a series of short pulses of infrared radiation. The time taken for the pulses to return after being reflected from the moving car is measured.

A pulse is detected 3.333×10^{-7} s after it is emitted.
The next pulse is detected 3.315×10^{-7} s after it is emitted.
The time interval between the two reflections was 0.0091 s.

Calculate the speed of the car.

(4)

Speed of the car = ...

(c) A speed gun needs to be able to measure a vehicle's speed even when other vehicles are nearby. By considering the wavelengths of the radiations used by the two different speed guns, explain why the lidar gun is more suitable for this.

(3)

(Total for Question 18 = 11 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

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

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

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