Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Thursday 21 May 2009 – Afternoon **Time: 1 hour 20 minutes**	Paper Reference **6PH02/01**

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 date, formulae and relationships is printed at the end of this booklet.
- Candidates my 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 ▶

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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 A volt can be defined as

☒ **A** a coulomb per joule

☒ **B** a coulomb per second

☒ **C** a joule per coulomb

☒ **D** a joule per second

(Total for Question 1 = 1 mark)

2 Which of the following electromagnetic radiations has the highest frequency?

☒ **A** infrared

☒ **B** radio

☒ **C** ultraviolet

☒ **D** X-rays

(Total for Question 2 = 1 mark)

3 Which of the following properties could **not** be demonstrated using sound waves?

☒ **A** diffraction

☒ **B** polarisation

☒ **C** reflection

☒ **D** refraction

(Total for Question 3 = 1 mark)

4 Two identical resistors connected in series have a total resistance of 8 Ω.
The same two resistors when connected in parallel have a total resistance of

☒ **A** 0.5 Ω

☒ **B** 2 Ω

☒ **C** 4 Ω

☒ **D** 8 Ω

(Total for Question 4 = 1 mark)

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5 A beam of light travels a distance *X* to arrive at a point. A second beam of light of the same frequency and initially in phase with the first beam, travels a distance *Y* to arrive at the same point. For destructive interference to occur between these two beams, the path difference *X*–*Y* must equal

☒ **A** an odd number of wavelengths.

☒ **B** an even number of wavelengths.

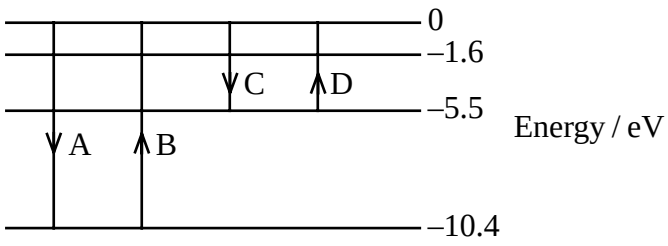
☒ **C** an odd number of half wavelengths.

☒ **D** an even number of half wavelengths.

(Total for Question 5 = 1 mark)

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6 The diagram shows some of the electron energy levels for a mercury atom.



Which of the lines A to D, drawn on the diagram, would correspond to the emission of the photon with the shortest wavelength?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 6 = 1 mark)

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7 To be able to see smaller details in an ultrasound scan, you should

☒ **A** decrease the frequency of the ultrasound

☒ **B** decrease the wavelength of the ultrasound

☒ **C** increase the duration of the pulse of the ultrasound

☒ **D** increase the size of the screen to view the scan

(Total for Question 7 = 1 mark)

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8 An earthquake wave travels in an east-west direction in rocks.
The rocks are vibrating in a north-south direction.
The wave must be classified as a

☒ **A** longitudinal wave

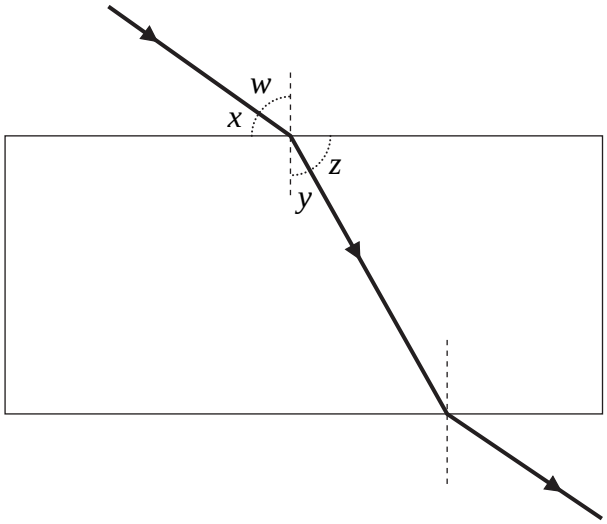
☒ **B** standing wave

☒ **C** stationary wave

☒ **D** transverse wave

(Total for Question 8 = 1 mark)

9 The refractive index of glass can be found by tracing a ray of light through a block of glass and measuring angles.



Which of the following expressions is equal to the refractive index of glass?

☒ **A** $\frac{\sin w}{\sin y}$

☒ **B** $\frac{\sin y}{\sin w}$

☒ **C** $\frac{\sin x}{\sin z}$

☒ **D** $\frac{\sin z}{\sin x}$

(Total for Question 9 = 1 mark)

10 Two wires of the same material are connected in series with each other. Wire A has twice the diameter of wire B. In which of the following rows are both statements correct?

		$\frac{\text{current in wire A}}{\text{current in wire B}}$	$\frac{\text{drift speed in wire A}}{\text{drift speed in wire B}}$
☒	**A**	1	$\frac{1}{4}$
☒	**B**	1	4
☒	**C**	2	4
☒	**D**	2	$\frac{1}{4}$

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 A cell of e.m.f. 1.5 V is connected to a lamp of resistance 80 Ω. The current in the circuit is 17 mA.

Calculate the internal resistance of this cell.

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.....

.....

Internal resistance = ...

(Total for Question 11 = 3 marks)

12 The planet Jupiter has a moon Io. Volcanic activity on Io releases clouds of electrons which travel at high speeds towards Jupiter. During a 15 s time period, 2.6×10^{26} electrons reach Jupiter from Io.

Calculate the current.

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.....

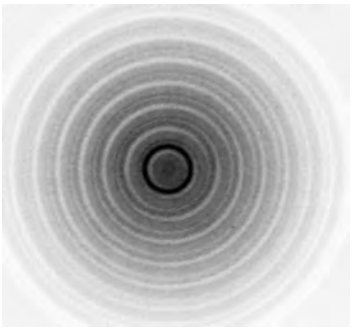
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Current = ...

(Total for Question 12 = 3 marks)

13 The diagram shows a diffraction pattern.



(a) Explain what is meant by diffraction.

(2)

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(b) This diffraction pattern is produced by electrons passing through a thin sheet of graphite.

(i) State what this suggests about the behaviour of electrons.

(1)

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.....

(ii) Suggest why substantial diffraction occurs.

(1)

.....

.....

(Total for Question 13 = 4 marks)

14 The siren of an ambulance emits a sound of a certain frequency. As the ambulance passes a pedestrian, the frequency of the sound he hears changes.

(a) What name is given to this effect?

(1)

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(b) Describe and explain how the movement of the ambulance causes the frequency of the sound he hears to change.

(3)

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(c) Suggest how what he hears would be different if the ambulance were moving faster.

(2)

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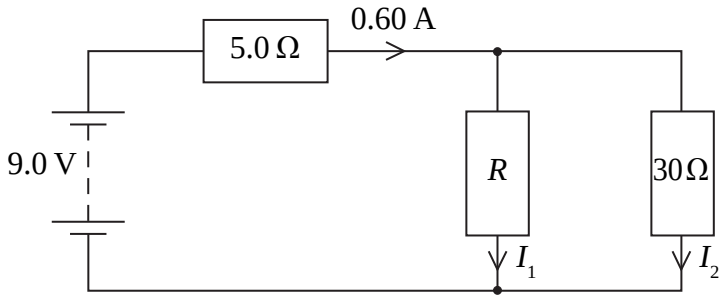
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(Total for Question 14 = 6 marks)

15 The circuit diagram shows a battery of negligible internal resistance connected to three resistors.



(a) Calculate the potential difference across the 5 Ω resistor.

(2)

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Potential difference = ...

(b) Calculate the current I_2.

(2)

.....

.....

.....

I_2 = ...

(c) Calculate the resistance R.

(2)

.....

.....

.....

R = ...

(Total for Question 15 = 6 marks)

***16** A student is asked to explain which of two filament lamps will be brighter when they are connected in parallel across a power supply. She is told that the resistance of lamp A is greater than the resistance of lamp B.

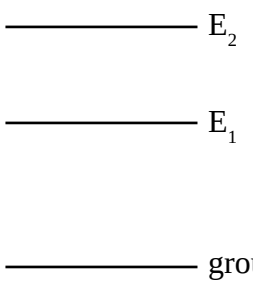
The student wrote the following explanation that contains some mistakes:

"The current is the same in both lamps. Because lamp A has a higher resistance, it is harder for the electrons to move through this lamp so they will lose more energy. Lamp A will therefore be brighter than lamp B."

Write a correct explanation.

(Total for Question 16 = 5 marks)

17 The energy level diagram shows the ground state and two excited states E_1 and E_2 of a neon atom.



In a helium neon laser, collisions occur between helium atoms and neon atoms. This results in the helium neon atoms being excited from the ground state to level E_2. They then emit photons and move to level E_1.

(a) What is meant by 'energy level'?

(1)

.....

.....

(b) What is a photon?

(1)

.....

.....

(c) Write a formula in terms of E_1 and E_2 for the energy of an emitted photon.

(1)

.....

.....

(d) The wavelength of an emitted photon is 6.33×10^{-7}m.

Calculate the energy of this photon.

(3)

.....

.....

Energy = ...

(Total for Question 17 = 6 marks)

18 The following passage describes some important aspects of the photoelectric effect. Insert the missing words.

In the photoelectric effect, a single ..... interacts with a single electron at the surface of a ..... In this interaction ..... is conserved. This was summarised by Albert Einstein in the following equation

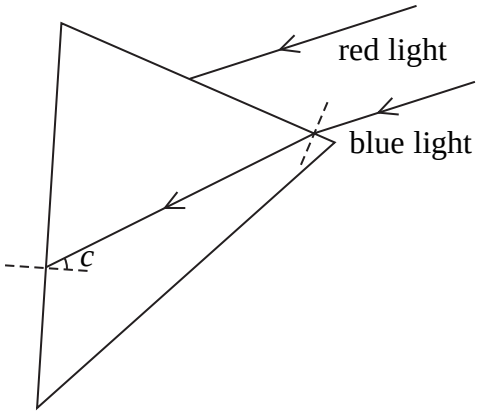
$$hf = \Phi + \tfrac{1}{2}mv^2$$

where $\tfrac{1}{2}mv^2$ is the maximum kinetic energy of the .....

and Φ is the .....

(Total for Question 18 = 5 marks)

19 Two parallel rays of light, one blue, one red, are travelling in air and are incident on one side of a glass prism. The blue light passes into the prism and meets the second face at the critical angle as shown in the diagram.



(a) Add to the diagram the path of the blue light after it meets the second face. Label this path X.

(1)

(b) (i) The speed of blue light in the glass prism is 1.96×10^8 m s^{-1}.

Calculate the refractive index of this glass for blue light.

(2)

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Refractive angle = ...

(ii) Calculate the critical angle for blue light in this glass prism.

(2)

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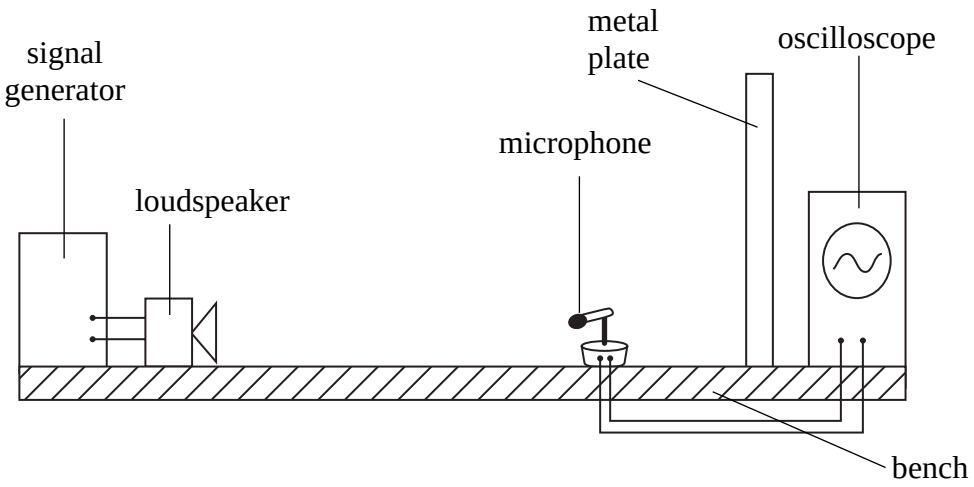
Critical angle = ...

(c) The refractive index of this glass for red light is less than for blue light. Add to the diagram to complete the path of the red light through the prism. Label this path Y.

(2)

(Total for Question 19 = 7 marks)

***20** The diagram shows an experiment with sound waves.



A loudspeaker is connected to a signal generator. A microphone is connected to an oscilloscope. Sound waves reach the microphone directly from the loudspeaker and after reflection from the metal plate.
As the microphone is moved towards the loudspeaker, the amplitude of the wave displayed on the oscilloscope varies through a series of maxima and minima.

(a) Explain why the amplitude of the sound varies in this way.

(4)

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(b) (i) The distance moved by the microphone between two adjacent maxima is 0.050 m.

Calculate the wavelength of the sound wave.

(2)

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Wavelength = ...

(ii) The frequency of the sound wave is 3.3 kHz.

Calculate the speed of sound in air.

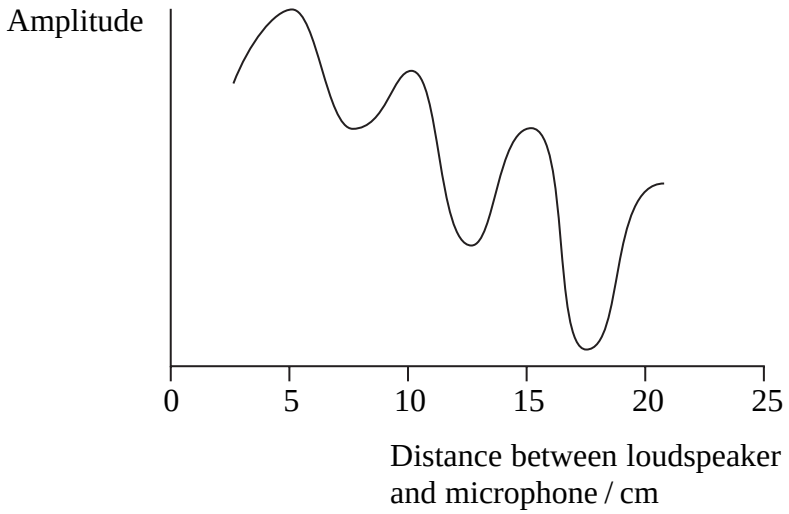
(2)

.....

.....

Speed of sound in air = ...

(c) The microphone is placed close to the loudspeaker and gradually moved towards the metal plate. The graph shows how the amplitude of the wave displayed on the oscilloscope varies with the position of the microphone.



(i) Explain why the minima never have a zero value.

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.....

.....

(ii) As the microphone is moved towards the metal plate, the amplitudes at the minima gradually decrease. Suggest why this happens.

(4)

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(Total for Question 20 = 12 marks)

21 The aircraft industry uses an instrument called a resistance strain gauge to determine the strain in propellers.

The resistance strain gauge is based on the principle that the electrical resistance of a wire changes when it is stretched.

(a) A stretched wire becomes longer and thinner. Using an equation to justify your answer, explain what effect stretching a length of wire would have on its resistance.

(3)

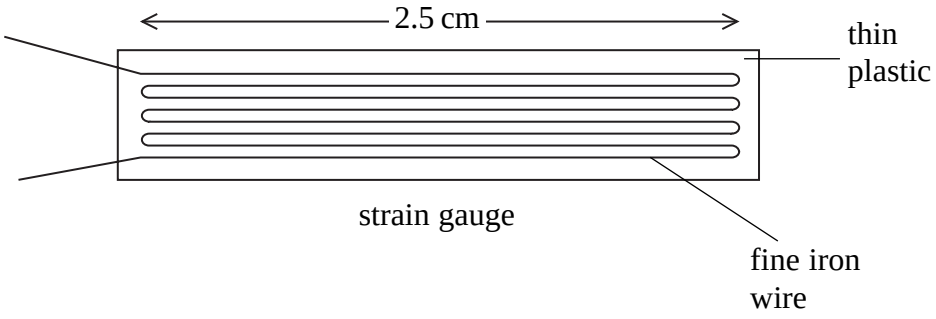
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(b) The diagram shows a typical resistance strain gauge. The wire in the gauge is arranged in a zigzag pattern.



The length of the zigzag pattern is 2.50 cm and the cross-sectional area of the iron wire is $9.0 \times 10^{-8}\,m^2$. The resistivity of iron is $9.9 \times 10^{-8}\,\Omega\,m$.

Show that the total resistance of the strain gauge is about $0.2\,\Omega$.

(3)

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(c) (i) A wire of length l and cross-sectional area A is stretched. Assuming the volume V of the wire remains constant

$$V = lA = \text{constant}$$

Show that the resistance of the wire is directly proportional to l^2.

(2)

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(ii) The length of the zigzag pattern, when under strain, increases to 2.51 cm.

Calculate the increase in resistance of the wire in the gauge.

(3)

.....

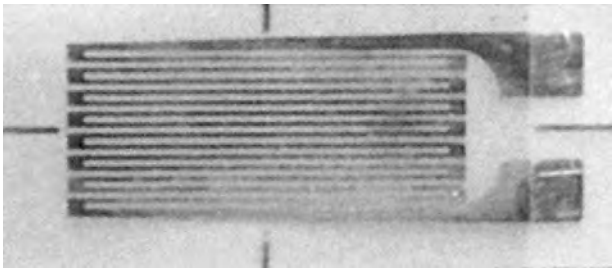
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Increase in resistance = ...

(d) In practice, very small changes in length are to be determined and the gauge itself has to be reasonably small. Consequently, the gauge is made of a length of very fine iron wire which is arranged in a zigzag pattern between two thin sheets of plastic.



What is the benefit of the iron wire being in this pattern?

(2)

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(Total for Question 21 = 13 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	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$ $g = F/m$ $W = mg$
Work and energy	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{grav} = mg\Delta h$

Materials

Stokes' law	$F = 6\pi\eta rv$
Hooke's law	$F = k\Delta x$
Density	$\rho = m/V$
Pressure	$p = F/A$
Young's modulus	$E = \sigma/\varepsilon$ where Stress $\sigma = F/A$ Strain $\varepsilon = \Delta x/x$
Elastic strain energy	$E_{el} = \frac{1}{2}F\Delta x$

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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$
	$\%\ \text{efficiency} = \dfrac{\text{useful energy output}}{\text{energy input}} \times 100$
	$\%\ \text{efficiency} = \dfrac{\text{useful power output}}{\text{power input}} \times 100$
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	$hf = \phi + \frac{1}{2}mv^2_{max}$