Write your name here

Surname	Other names

Edexcel GCE

Centre Number | | | | | |

Candidate Number | | | | |

Physics
Advanced Subsidiary
Unit 2: Physics at Work

Monday 17 January 2011 – Afternoon
Time: 1 hour 30 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 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 ▶

1/1/1/1/1/1/

N 3 7 9 6 5 A 0 1 2 4

edexcel
advancing learning, changing lives

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 amount of electrical energy transferred when a charge of 8 mC moves through a potential difference of 12 V is

☒ **A** 1500 J

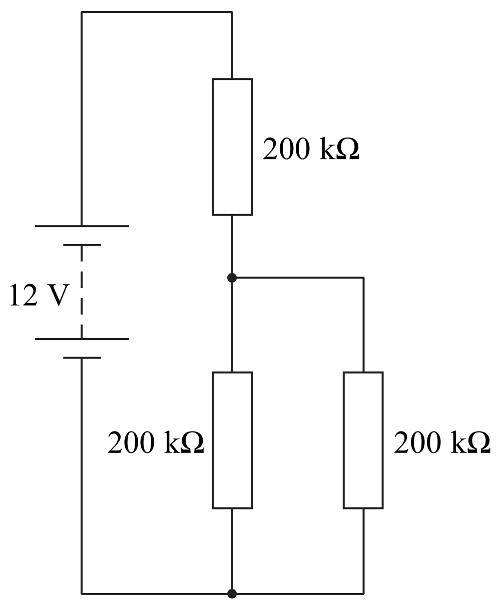
☒ **B** 96 J

☒ **C** 9.6×10^{-2} J

☒ **D** 6.7×10^{-4} J

(Total for Question 1 = 1 mark)

2 The battery in the circuit has negligible internal resistance and an e.m.f. of 12 V.



The potential difference across the parallel combination is

☒ **A** 0 V

☒ **B** 4 V

☒ **C** 6 V

☒ **D** 8 V

(Total for Question 2 = 1 mark)

3 A stationary observer hears a sound emitted by a moving source.

This produces a Doppler effect which is a

☒ **A** change in frequency of the sound emitted by the source.

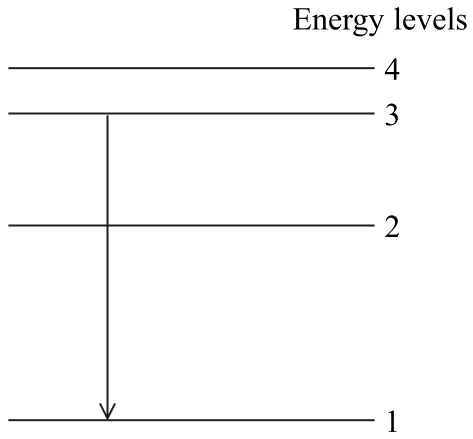
☒ **B** change in frequency of the sound heard by the observer.

☒ **C** change in velocity of the sound emitted by the source.

☒ **D** change in velocity of the sound heard by the observer.

(Total for Question 3 = 1 mark)

4 The diagram shows four electron energy levels in an atom. The transition of an electron from level 3 to level 1 is shown. This results in the emission of a photon in the visible range.



Which transition might emit a photon in the ultraviolet range?

☒ **A** from level 2 to level 1

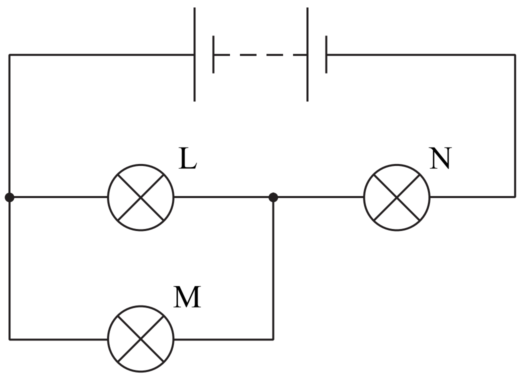
☒ **B** from level 4 to level 1

☒ **C** from level 3 to level 2

☒ **D** from level 4 to level 2

(Total for Question 4 = 1 mark)

5 In the circuit shown, the battery has negligible internal resistance. L, M and N are identical lamps.



The filament of lamp M breaks. Identify the row of the table which shows the resulting changes in the brightness of lamps L and N.

		Lamp L	**Lamp N**
☒	**A**	increases	stays the same
☒	**B**	stays the same	decreases
☒	**C**	decreases	increases
☒	**D**	increases	decreases

(Total for Question 5 = 1 mark)

6 Which of the following can be used as a unit of electrical resistance?

☒ **A** W A^{-2}

☒ **B** A V^{-1}

☒ **C** W V^{-2}

☒ **D** V C^{-1}

(Total for Question 6 = 1 mark)

7 Two waves have the same frequency and are travelling in the same medium.
The two waves can produce a standing wave if they

☒ **A** have different amplitudes and travel in opposite directions.

☒ **B** have different amplitudes and travel in the same direction.

☒ **C** have the same amplitude and travel in opposite directions.

☒ **D** have the same amplitude and travel in the same direction.

(Total for Question 7 = 1 mark)

---

8 The drift velocity *v* of electrons in a conductor is directly proportional to

☒ **A** electron charge.

☒ **B** charge carrier density.

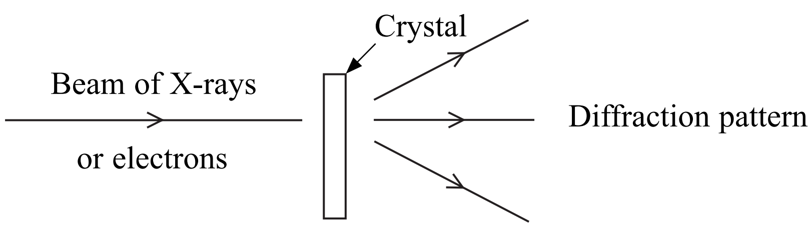
☒ **C** cross-sectional area.

☒ **D** current.

(Total for Question 8 = 1 mark)

---

9 In the 1930s, experiments were performed where beams of X-rays or beams of high energy electrons were directed through a crystal as shown in the diagram.



Which of the following statements about the experiments is correct?

☒ **A** They show that the X-rays are behaving like particles.

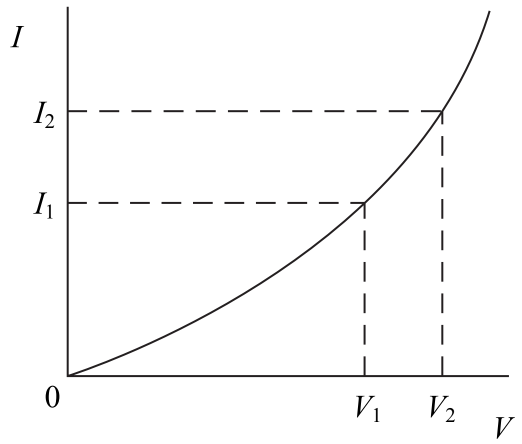
☒ **B** They show that the electrons have a wavelength similar to the size of the atoms.

☒ **C** They show that electrons are charged.

☒ **D** They show that electrons can have all of the properties of electromagnetic radiation.

(Total for Question 9 = 1 mark)

10 The graph shows how the current I varies with potential difference V for an electrical component.



Which row of the table gives the resistance of the component at V_2 and describes how the resistance changes from V_1 to V_2?

		Resistance at V_2	**Change in resistance from V_1 to V_2**
☒	**A**	$\frac{V_2 - V_1}{I_2 - I_1}$	increases
☒	**B**	$\frac{V_2 - V_1}{I_2 - I_1}$	decreases
☒	**C**	$\frac{V_2}{I_2}$	increases
☒	**D**	$\frac{V_2}{I_2}$	decreases

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

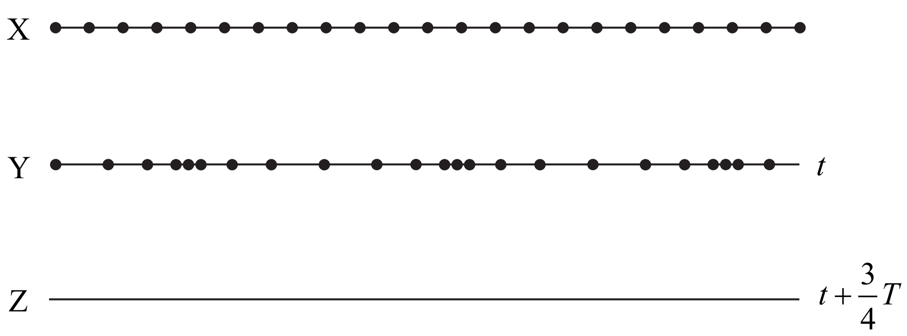
SECTION B

Answer ALL questions in the spaces provided.

11 In the diagram, line X represents the equilibrium positions of a line of molecules in a solid.

A sound wave of wavelength λ and frequency f passes through the solid from left to right.

Line Y represents the positions of the same molecules at a time t.



(a) Explain how the diagram shows that the wave is longitudinal.

(1)

....

....

(b) On line Y

(i) identify **two** compressions and label them C;

(ii) identify **two** rarefactions and label them R;

(iii) label the wavelength λ of the wave.

(3)

(c) The period of the wave is T.

On the line Z mark the positions of two compressions at a time $t+\frac{3}{4}T$ and label them P.

(2)

(Total for Question 11 = 6 marks)

12 A radio station broadcasts at a frequency of 198 kHz.

(a) Calculate the wavelength of these radio waves.

(3)

....

....

Wavelength = ...

*(b) Obstacles such as buildings and hills can make it difficult to receive some radio signals with shorter wavelengths.

Explain why this is less of a problem for this radio station.

(3)

....

....

....

....

....

....

(Total for Question 12 = 6 marks)

13 (a) Ultrasound scanning can be used by doctors to obtain information about the internal structures of the human body without the need for surgery. Pulses of ultrasound are sent into the body from a transmitter placed on the skin.

(i) The ultrasound used has a frequency of 4.5 MHz.

State why waves of this frequency are called ultrasound.

(1)

....

....

(ii) A pulse of ultrasound enters the body and its reflection returns to the transmitter after a total time of 1.6×10^{-4} s.

Calculate how far the reflecting surface is below the skin.

average speed of ultrasound in the body = 1500 m s^{-1}

(3)

....

....

....

Distance = ...

(iii) State why the ultrasound is transmitted in pulses.

(1)

....

....

(b) Another way of obtaining information about the internal structures of the human body is by the use of X-rays.

(i) Give **one** property of X-rays which makes them more hazardous to use than ultrasound.

(1)

....

....

....

(ii) State **two** other differences between X-rays and ultrasound.

(2)

....

....

....

....

(Total for Question 13 = 8 marks)

14 The black core of a pencil is referred to as pencil lead.

Pencil lead is a non-metallic material which has a resistivity of $5.4 \times 10^{-3}\ \Omega$ m at room temperature.

(a) A piece of pencil lead has a length of 15 cm and a cross-sectional area of 1.5×10^{-6} m^2.

Show that its resistance is approximately 500 Ω.

(3)

....

....

....

....

....

....

(b) (i) Pencil lead has a negative temperature coefficient of resistance.

Explain what this means.

(2)

....

....

....

....

*(ii) A piece of pencil lead is connected in series with an ammeter and a power supply.
The power supply is turned on. After a few minutes, although the potential difference across the pencil lead does not change, the current in the circuit increases significantly.

Explain why the current increases.

(3)

....

....

....

....

....

....

....

(Total for Question 14 = 8 marks)

15 (a) A kettle is rated at 1 kW, 220 V.

Calculate the working resistance of the kettle.

(2)

....

....

....

Resistance = ...

(b) When connected to a 220 V supply, it takes 3 minutes for the water in the kettle to reach boiling point.

Calculate how much energy has been supplied.

(2)

....

....

....

Energy = ...

(c) Different countries supply mains electricity at different voltages. Many hotels now offer a choice of voltage supplies as shown in the photograph.

(i) By mistake, the kettle is connected to the 110 V supply. Assuming that the working resistance of the kettle does not change, calculate the time it would take for the same amount of water to reach boiling point.

(3)

....

....

....

....

....

....

Time = ...

(ii) Explain what might happen if a kettle designed to operate at 110 V is connected to a 220 V supply.

(2)

....

....

....

....

(Total for Question 15 = 9 marks)

16 (a) Light from the Sun is unpolarised.

Explain what is meant by unpolarised.

(2)

....

....

....

....

*(b) When a ray of light from the Sun is incident on a block of ice, most of the light is refracted into the ice. Some of it is reflected. The light that is reflected is partially plane polarised.

Describe a test to confirm that the reflected ray is partially plane polarised.

(3)

....

....

....

....

....

....

....

....

(c) Some skiers wear sunglasses with polarising lenses. These sunglasses reduce the amount of reflected light entering their eyes.

Suggest how these sunglasses work.

(2)

....

....

....

....

....

(Total for Question 16 = 7 marks)

17 (a) A student uses a computer for an average of 5 hours every day. The battery supplies a current of 3.5 A to the computer.

Calculate how many electrons flow through the computer's battery in 5 hours.

(4)

Number of electrons = ...

(b) The computer's screen emits visible light photons with an average frequency of 5.5×10^{14} Hz. The power of the light emitted is 10 W.

Calculate the number of photons emitted per second from the computer screen.

(3)

Number of photons = ...

(Total for Question 17 = 7 marks)

18 Ultraviolet radiation incident on a zinc plate releases electrons from the zinc's surface. The energy of each incident photon is 5.4 eV. Zinc has a work function of 4.3 eV.

(a) (i) State the name given to this effect.

(1)

....

(ii) State the speed of the photons.

(1)

....

(iii) What is meant by the work function of a metal?

(1)

....

....

....

(b) An electron is emitted from the surface of the zinc.

(i) Calculate the maximum kinetic energy of the electron in joules.

(3)

....

....

Maximum kinetic energy = ...

(ii) Calculate the maximum speed of the electron.

(2)

....

....

Maximum speed = ...

(c) The intensity of the ultraviolet radiation is doubled.

State what happens to the maximum speed of an electron emitted from the zinc.

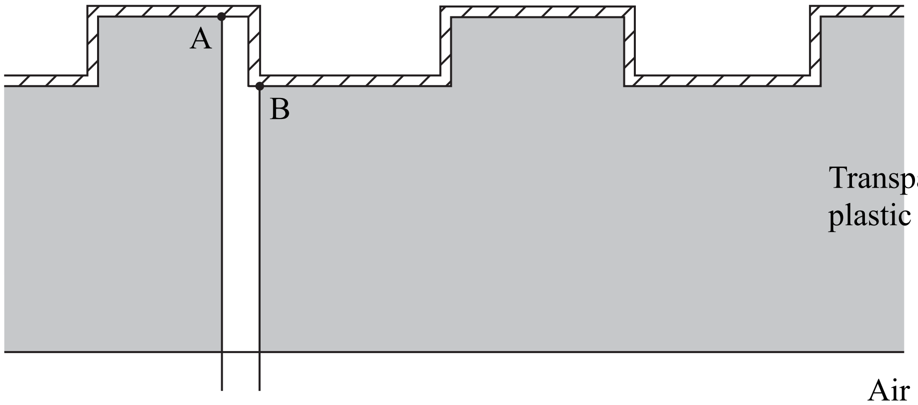
(1)

....

....

(Total for Question 18 = 9 marks)

19 A diagram shows the structure of a compact disc. A laser light beam is directed at right angles to the underside of the disc.



The wavelength of the laser light in the transparent plastic layer is 414 nm

refractive index of the transparent plastic layer = 1.53

(a) (i) Calculate the wavelength of the light in air.

(2)

....

....

....

Wavelength = ...

(ii) Light reflected from point A is 180° out of phase with light reflected from point B.

Calculate the minimum vertical distance from A to B.

(2)

....

....

....

....

Minimum vertical distance = ...

N 3 7 9 6 5 A 0 2 0 2 4

(iii) Explain the effect when the light reflected from A and B is combined.

(2)

....

....

....

....

(b) Some of the reflected light will not hit the plastic-air boundary at 90°.

(i) Calculate the critical angle of the plastic-air boundary.

(2)

....

....

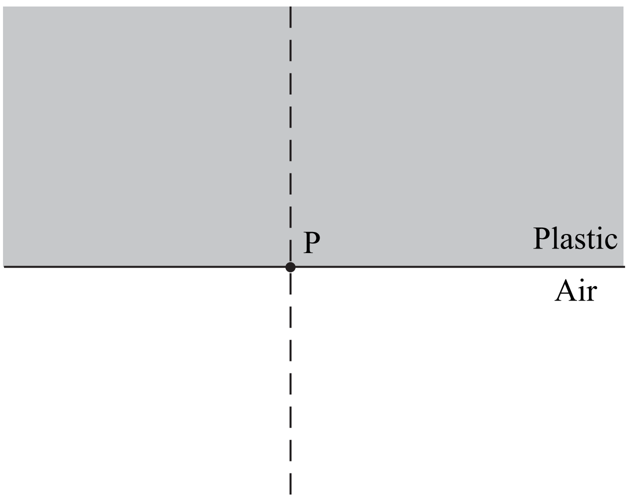
....

....

Critical angle = ...

(ii) On the diagram below, show what happens to a ray of light which hits the plastic-air boundary at point P at an angle greater than the critical angle.

(2)



(Total for Question 19 = 10 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	$P = VI$ $P = I^2R$ $P = V^2/R$ $W = VIt$

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

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

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	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Quantum physics

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