Edexcel Physics Unit 2

Past Paper Pack

2009-2013

Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Thursday 15 January 2009 – Afternoon
Time: 1 hour 20 minutes

Paper Reference
6PH02/01

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.
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- 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 child's toy is operated by a small motor. The potential difference across the motor is 6.0 V and the current in it is 0.20 A. The energy used by the motor in 120 s is

☒ **A** 2.40 J

☒ **B** 60.0 J

☒ **C** 144 J

☒ **D** 3600 J

(Total for Question 1 = 1 mark)

2 Which one of the following does **not** apply to sound waves?

☒ **A** They transmit energy.

☒ **B** They travel faster in a vacuum.

☒ **C** They result from vibrations.

☒ **D** They are longitudinal waves.

(Total for Question 2 = 1 mark)

3 Two coherent sources emit waves of wavelength λ in phase. At a point where the two waves meet they have a phase difference of 90° ($\frac{\pi}{2}$ radians). Which of the following could be the path difference at this point?

☒ **A** 2λ

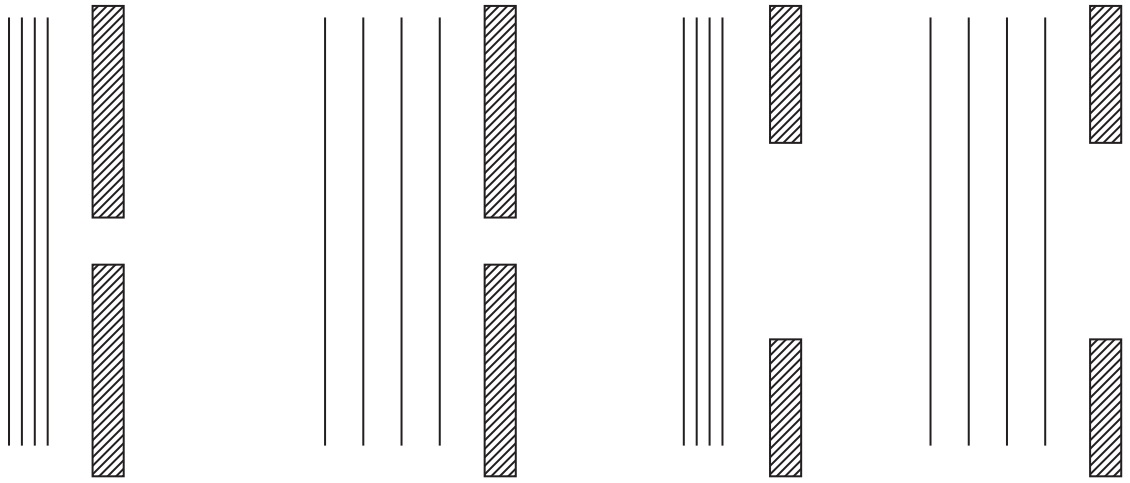
☒ **B** λ

☒ **C** $\frac{\lambda}{2}$

☒ **D** $\frac{\lambda}{4}$

(Total for Question 3 = 1 mark)

4 The four diagrams show waves of different wavelengths approaching slits of different widths.



A **B** **C** **D**

In which diagram will the diffraction be the greatest?

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

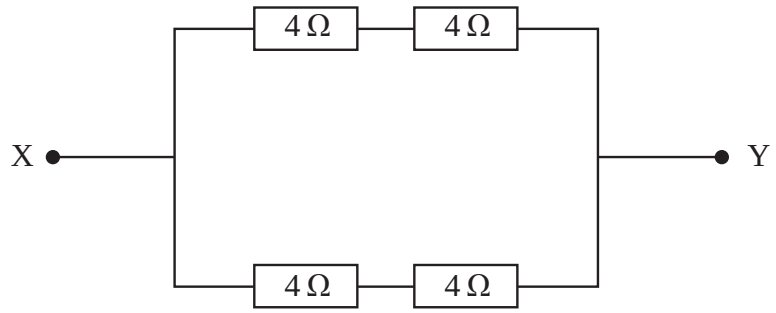
(Total for Question 4 = 1 mark)

5 The heating element for an electric fire is made from a wire of resistance R. It is replaced with a wire of the same material which has the same length but is twice the diameter. The resistance of this second wire is

- ☒ **A** $\frac{1}{4}R$
- ☒ **B** $\frac{1}{2}R$
- ☒ **C** $2R$
- ☒ **D** $4R$

(Total for Question 5 = 1 mark)

6 The diagram shows a resistor network.



The total resistance between points X and Y is

☒ **A** 0.25 Ω

☒ **B** 1.0 Ω

☒ **C** 4.0 Ω

☒ **D** 16 Ω

(Total for Question 6 = 1 mark)

7 The speed of sound in steel is 6000 m s^{-1}. The wavelength of an ultrasound wave of frequency 50 kHz travelling through a steel girder is

☒ **A** 0.0083 m

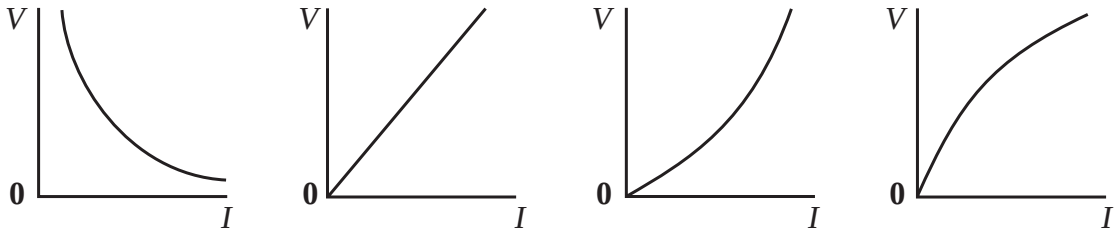
☒ **B** 0.12 m

☒ **C** 8.3 m

☒ **D** 120 m

(Total for Question 7 = 1 mark)

8 Which one of the following graphs correctly shows the relationship between potential difference (V) and current (I) for a filament lamp?



A **B** **C** **D**

☒ **A**

☒ **B**

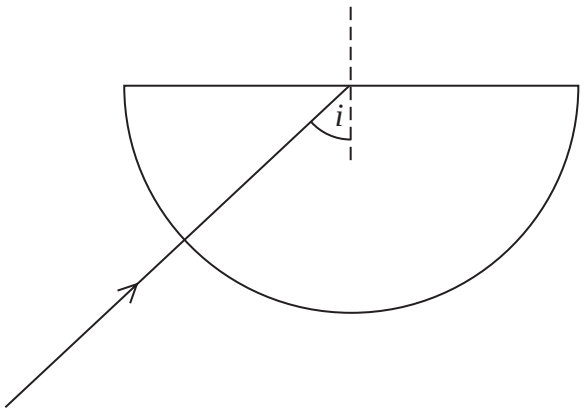
☒ **C**

☒ **D**

(Total for Question 8 = 1 mark)

9 Light travels into a semicircular glass block as shown in the diagram. The ray of light reaches the straight edge of the block at an angle of incidence *i*.

The critical angle for glass is *c*.



Which one of the following statements is true for light at the straight edge?

☒ **A** When *i* is bigger than *c* then no light is reflected.

☒ **B** When *i* is bigger than *c* then no light is transmitted.

☒ **C** When *i* is smaller than *c* then no light is reflected.

☒ **D** When *i* is smaller than *c* then no light is transmitted.

(Total for Question 9 = 1 mark)

10 When a fire engine moves away from an observer, the pitch of the siren heard by the observer decreases. This is because

☒ **A** the wavelength of the sound wave decreases

☒ **B** the speed of the fire engine increases

☒ **C** the frequency of the siren decreases

☒ **D** the distance travelled by each wavefront increases

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 Explain, in terms of energy, the difference between potential difference (p.d.) and electromotive force (e.m.f.).

(2)

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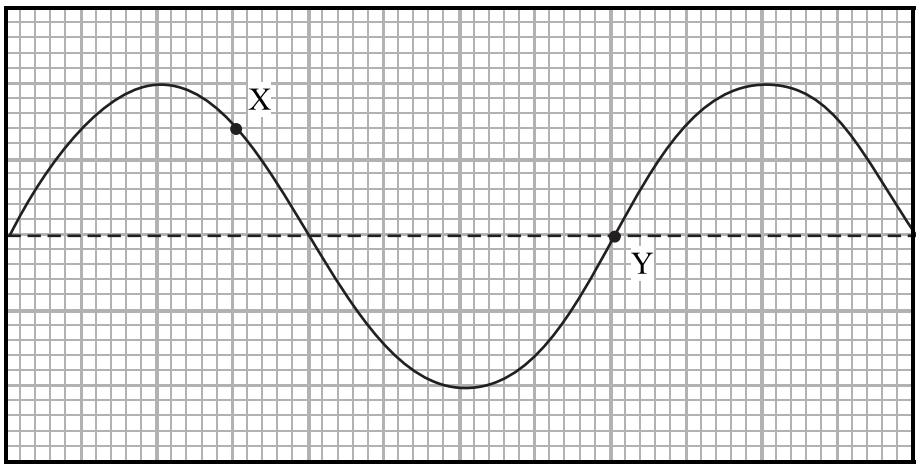
(Total for Question 11 = 2 marks)

12 The diagram shows the shape of a wave on the surface of a tank of water at one instant of time. The wave is travelling to the right.



On the diagram

(a) mark a point on the water surface whose motion is exactly 180° out of phase with the motion at X. Label this point A,

(1)

(b) draw an arrow at point Y to show the direction in which the water at Y is moving at the instant shown,

(1)

(c) mark a point on the water surface that is at rest at the instant shown. Label this point B.

(1)

(Total for Question 12 = 3 marks)

13 (a) What is the coulomb in base units?

(1)

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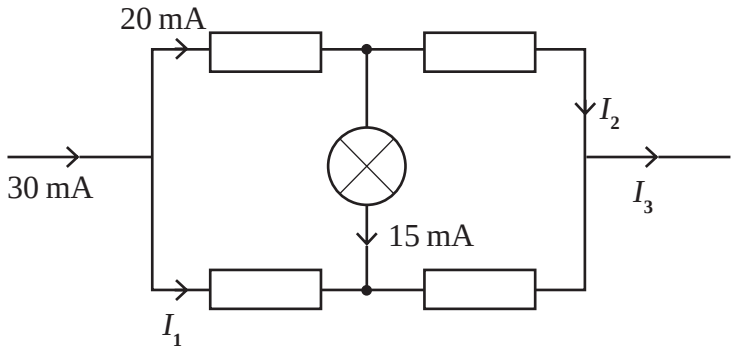
(b) The diagram shows part of an electrical circuit.



Determine the magnitudes of the currents I_1, I_2 and I_3.

(3)

I_1 = ...

I_2 = ...

I_3 = ...

(Total for Question 13 = 4 marks)

***14** A student looks at the sunlight reflected off a puddle of water. She puts a polarising (Polaroid) filter in front of her eye. As she rotates the filter the puddle appears darker then lighter.

Explain this observation.

(3)

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(Total for Question 14 = 3 marks)

15 The current I in a length of aluminium of cross-sectional area A is given by the formula

$$I = nevA$$

where e is the charge on an electron.

(a) State the meanings of n and v.

(2)

n: .....

v: .....

(b) Show that the units on the left hand side of the equation are consistent with those on the right hand side.

(3)

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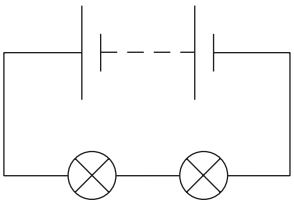
(Total for Question 15 = 5 marks)

16 (a) Two lamps A and B are connected in series with a battery.



Lamp B glows more brightly than lamp A. Complete each of the sentences by choosing one of the phrases in the box.

(3)

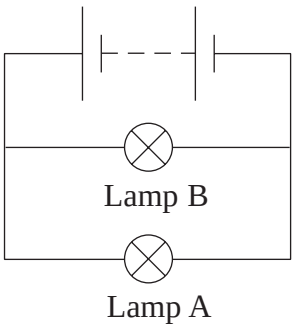
equal to	**greater than**	**less than**

The current in lamp A is ..... the current in lamp B.

The p.d. across lamp A is ..... the p.d. across lamp B.

The resistance of lamp A is ..... the resistance of lamp B.

(b) The same bulbs are now connected in parallel with the battery.



State which bulb will be brighter and explain your answer.

(3)

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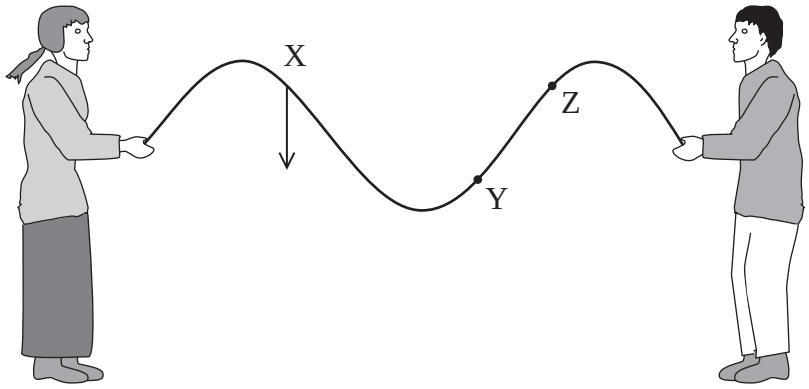
(Total for Question 16 = 6 marks)

17 Two students demonstrate standing waves to the rest of the class using a rope.

The diagram shows the appearance of the standing wave on the rope at one instant. Each part of the rope is at its maximum displacement.



(a) (i) Mark the position of **one** node on the diagram. Label this point N.

(1)

(ii) The arrow at point X shows the direction in which the point X is about to move. Add arrows to the diagram to show the directions in which points Y and Z are about to move.

(2)

(b) The frequency of the vibration shown in the diagram is 1.5 Hz. When a rope is vibrating with its fundamental frequency there is one antinode. Calculate the fundamental frequency of this wave.

(2)

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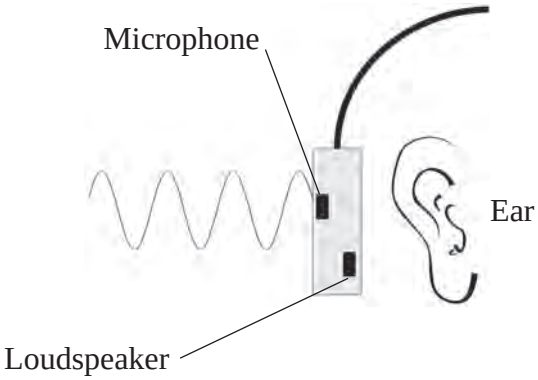
.....

Frequency = ...

(Total for Question 17 = 5 marks)

18 Noise cancelling headphones were first invented to cancel the noise in aeroplane and helicopter cockpits. They work using the principle of superposition of waves.

Sound waves enter and pass through the headphone and are detected by a microphone. An electronic circuit sends a signal to the loudspeaker so that it produces an 'opposite wave'.



(a) Compare the properties of the two sound waves necessary to produce complete cancellation of the two waves that reach the ear.

(3)

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(b) In practice the incoming sound is reduced in volume rather than cancelled completely.

Noise-cancelling headphones work well when the noise is from a jet engine. They are not very effective at cancelling speech or music. Explain why.

(3)

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(Total for Question 18 = 6 marks)

***19** (a) A 60 W filament light bulb is used as a ceiling light. The bulb is 2.5 m above the floor and is 5.0% efficient at converting electrical energy into visible light.

Calculate the visible light intensity (radiation flux) on the floor directly below the bulb.

Assume that at a distance r from the source the energy is spread over a total area $4\pi r^2$.

(3)

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Visible light intensity = ...

(b) Increasingly a different type of light bulb is being used. It is a coiled fluorescent bulb. A 10 W bulb of this type could replace the 60 W filament bulb and give the same visible light intensity on the floor.

Approximately 25% of national power production is used for lighting.

Discuss why some countries have announced that filament bulbs will be banned in the next few years.

(3)

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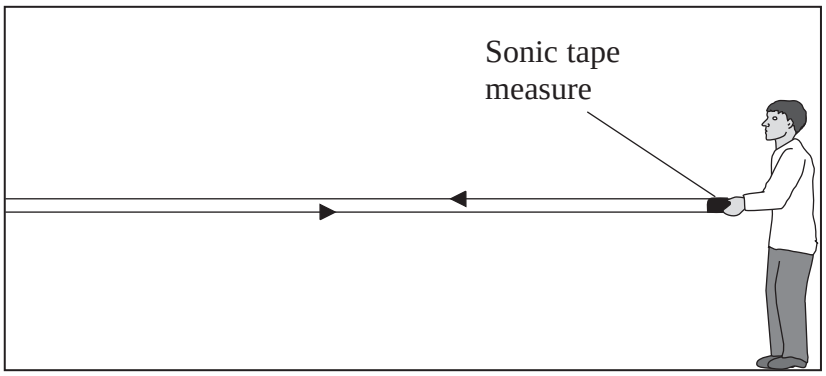
(Total for Question 19 = 6 marks)

20 A sonic tape measure uses ultrasound to measure distances in buildings. It sends out pulses of ultrasound towards a distant wall and records the time interval between a pulse being sent and its return.



(a) For one particular measurement the time interval was 25 ms.

Calculate the distance from the sonic tape measure to the wall.

Speed of sound = 330 m s^{-1}

(3)

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Distance = ...

(b) Why is the ultrasound transmitted in pulses?

(1)

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(Total for Question 20 = 4 marks)

21 An electronics student is using light emitting diodes (LEDs) to make a traffic light model. He uses red, orange and green LEDs. The table gives information about these LEDs. They are identified as 1, 2 and 3.

LED	Frequency / 10^{14} Hz	Wavelength / 10^{-9} m	Colour
1	5.66	530	
2	5.00	600	
3	4.41	680	

(a) Complete the table by filling in the colour of light emitted by each LED.

(1)

(b) Calculate the energy of the lowest energy photon emitted by this traffic light model.

(3)

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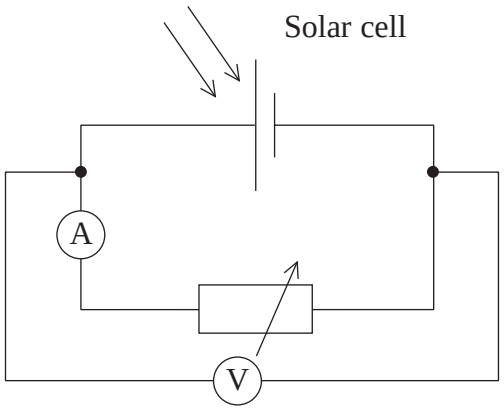
Energy = ...

(Total for Question 21 = 4 marks)

22 A solar cell generates an e.m.f. when certain wavelengths of light are incident on it. A student connects a solar cell in the following circuit.

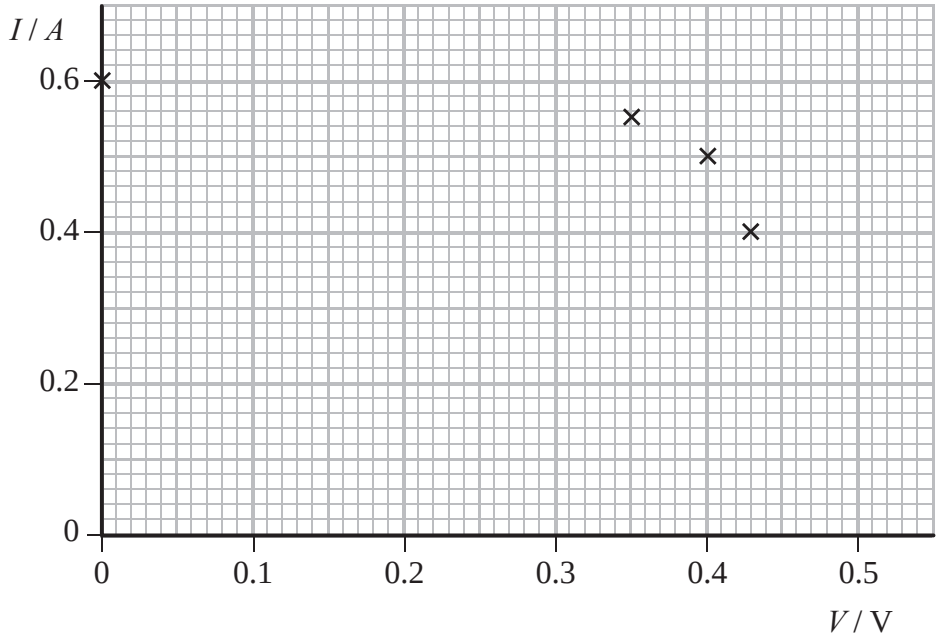


The student keeps the intensity and wavelength of the incident light constant and adjusts the variable resistor to obtain the following set of results.

Current I / A	**Terminal potential difference V / V**
0.60	0.00
0.55	0.35
0.50	0.40
0.40	0.43
0.30	0.46
0.20	0.48
0.10	0.50
0.00	0.52

(a) On the grid opposite, plot these results and draw the line of best fit through all the points. The first four points have been plotted.

(3)



(b) (i) Calculate the power output of the solar cell when the current in the cell is 0.40 A.

(2)

Power = ...

(ii) Explain why the e.m.f. of this cell is 0.52 V.

(2)

(iii) Calculate the internal resistance of the cell when the potential difference across the cell is 0.40 V.

(3)

Internal resistance = ...

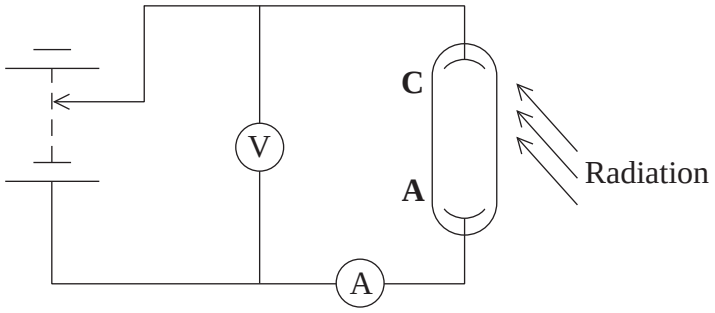
(c) The e.m.f. of this particular cell is independent of the light intensity.
The current increases as the light intensity increases.

Add to the grid above a line showing a set of results that might be obtained if the intensity of the incident light was increased.

(2)

(Total for Question 22 = 12 marks)

23 The diagram shows the apparatus for an experiment on the photoelectric effect.



(a) A light is shone onto the cathode **C** and a potential difference is applied between the cathode and the anode **A** of the photocell. A sensitive ammeter is used to detect any current that flows.

The light is replaced by one of the same intensity, but a different photon energy. The results are shown in the table below.

	Photon energy/eV	**Intensity of light/W m^{-2}**	**Work function/eV**	**Ammeter reading/A**
First light	1.8	1.0	2.3	0.0
Second light	3.8	1.0	2.3	5.0×10^{-12}

Explain why the first ammeter reading is zero.

(2)

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(b) The experiment is repeated using the same two photon energies but the intensities of the sources are increased. Add the new ammeter readings to the table below.

(2)

	Photon energy/eV	**Intensity of light/W m^{-2}**	**Work function/eV**	**Ammeter reading/A**
First light	1.8	4.0	2.3	
Second light	3.8	4.0	2.3	

(c) (i) The cathode metal is lithium.

Express the work function of lithium in joules.

Work function of lithium = 2.3 eV

(2)

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Work function = ... J

(ii) Ultraviolet radiation with photon energy of 4.8×10^{-18} J is shone onto the lithium cathode.

Calculate the maximum speed of the photoelectrons that are emitted.

(4)

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Maximum speed = ...

(Total for Question 23 = 10 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

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

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Turn over ▶

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N 3 4 5 0 6 A 0 1 2 4

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SECTION A

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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)

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.

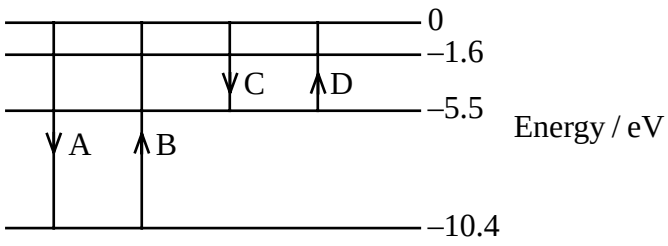
☒ **B** an even number of wavelengths.

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

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

(Total for Question 5 = 1 mark)

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

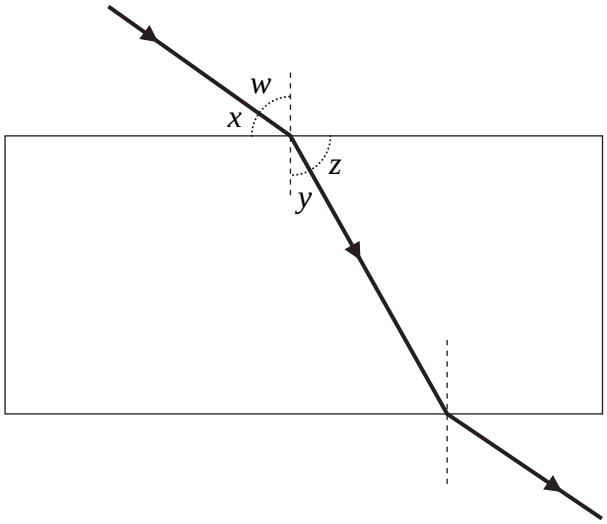
☒ **B** standing wave

☒ **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.

Internal resistance = ...

(Total for Question 11 = 3 marks)

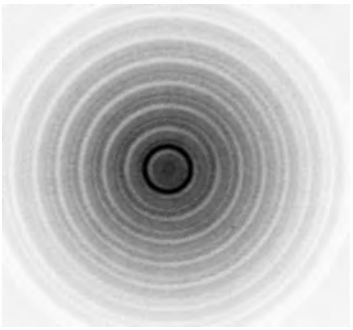
12 The planet Jupiter has a moon Io. Volcanic activity on Io releases clouds of electrons which travel at high speeds towards Jupiter. During a 15 s time period, 2.6×10^{26} electrons reach Jupiter from Io.

Calculate the current.

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)

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.....

(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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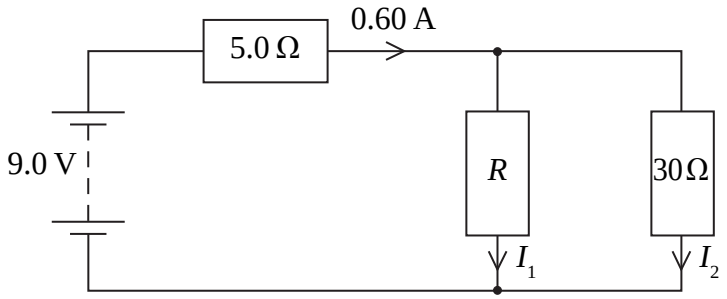
(Total for Question 14 = 6 marks)

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)

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I_2 = ...

(c) Calculate the resistance R.

(2)

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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.

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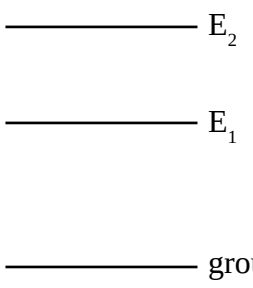
(Total for Question 16 = 5 marks)

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)

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.....

(b) What is a photon?

(1)

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.....

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

(1)

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

Calculate the energy of this photon.

(3)

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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

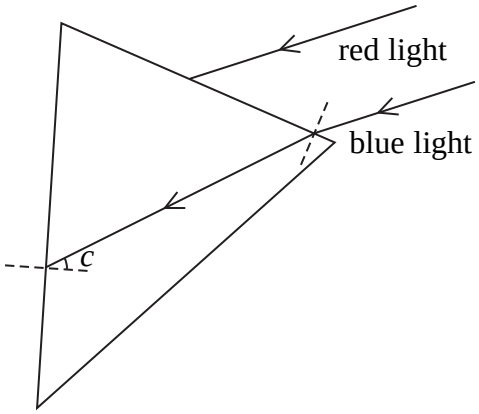
$$hf = \Phi + \tfrac{1}{2}mv^2$$

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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.....

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Refractive angle = ...

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

(2)

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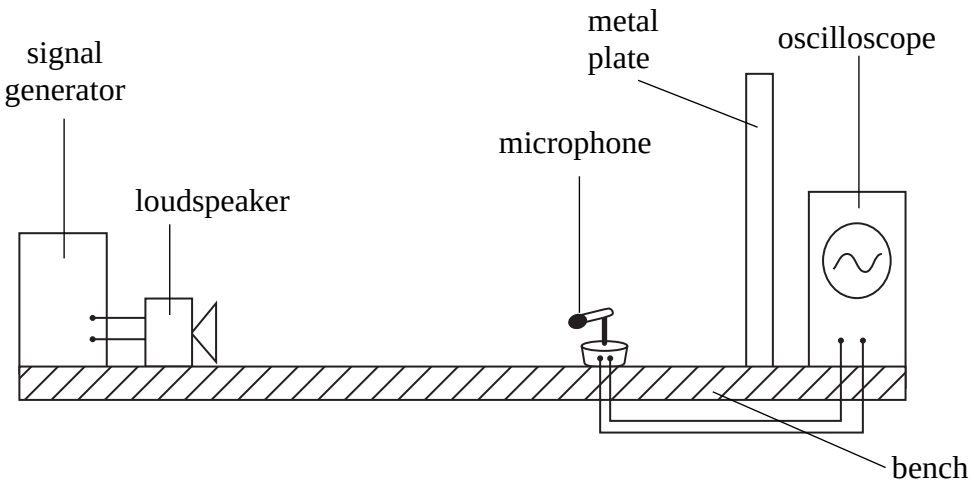
Critical angle = ...

(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)

.....

Wavelength = ...

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

Calculate the speed of sound in air.

(2)

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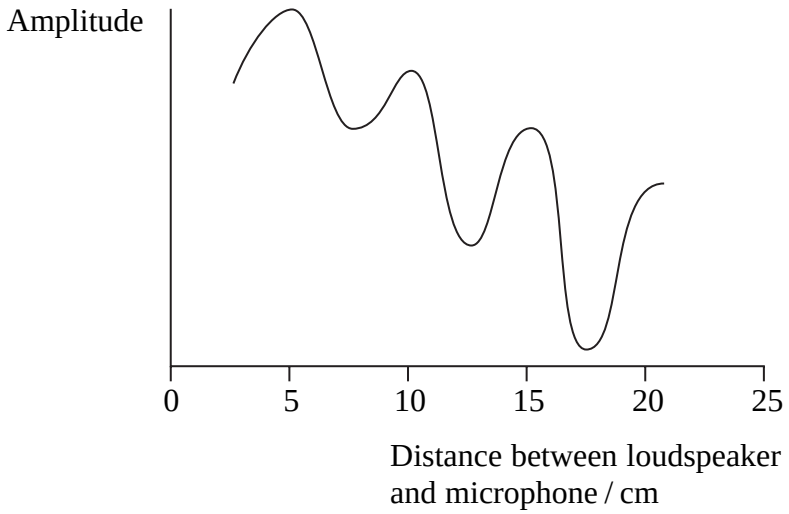
.....

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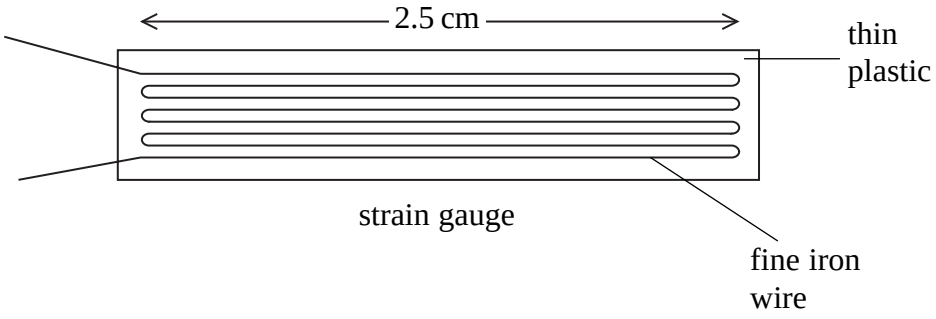
(b) The diagram shows a typical resistance strain gauge. The wire in the gauge is arranged in a zigzag pattern.



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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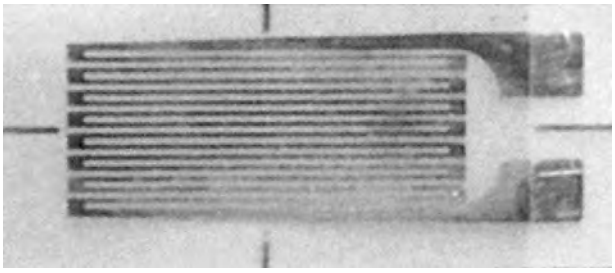
.....

.....

.....

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

Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Monday 18 January 2010 – 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 ▶

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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 Identify which of the following pairs of units are both SI base units.

☒ **A** Ampere Hertz

☒ **B** Ampere Second

☒ **C** Coulomb Hertz

☒ **D** Coulomb Second

(Total for Question 1 = 1 mark)

---

2 The resistance of a length of copper wire is 6 Ω. A second piece of copper wire has twice the length and twice the cross-sectional area. The resistance of the second piece of copper wire is

☒ **A** 3 Ω

☒ **B** 6 Ω

☒ **C** 12 Ω

☒ **D** 24 Ω

(Total for Question 2 = 1 mark)

---

3 Which of the following statements about standing waves is **not** true?

☒ **A** particles between adjacent nodes oscillate with varying amplitudes

☒ **B** particles between adjacent nodes are moving in phase with each other

☒ **C** particles immediately either side of a node are moving in opposite directions

☒ **D** particles undergo no disturbance at an antinode

(Total for Question 3 = 1 mark)

---

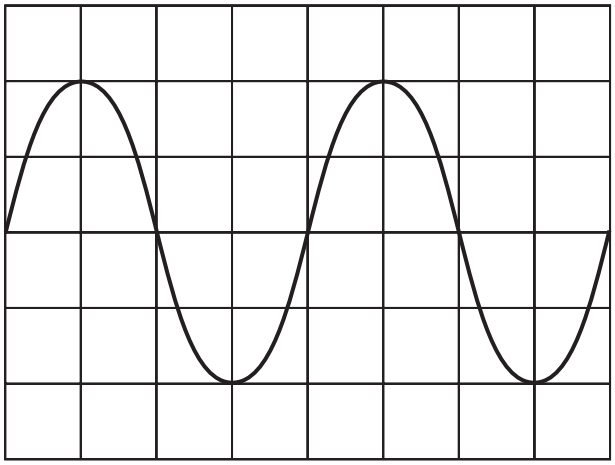
4 A resistor is connected to a cell. An amount of charge Q passes through the resistor in a time t. During this time, the amount of chemical energy converted to electrical energy by the cell is E.

Select the row of the table which correctly gives the current in the resistor and the e.m.f. of the cell.

		Current	**e.m.f.**
☒	**A**	Q/t	EQ
☒	**B**	Qt	EQ
☒	**C**	Q/t	E/Q
☒	**D**	Qt	E/Q

(Total for Question 4 = 1 mark)

5 A cathode ray oscilloscope can be used to show how the displacement of a wave varies with time. Each square in the horizontal direction represents 5.00 ms.



The frequency of the wave is

☒ **A** 25 Hz

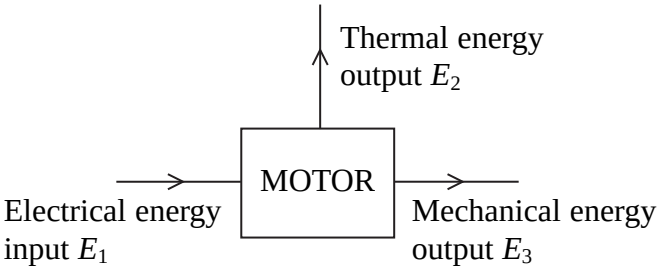
☒ **B** 50 Hz

☒ **C** 250 Hz

☒ **D** 500 Hz

(Total for Question 5 = 1 mark)

6 The diagram shows the energy transfer for an electric motor.



The efficiency of the motor is

☒ **A** $\frac{E_1}{E_2 + E_3}$

☒ **B** $\frac{E_1}{E_2}$

☒ **C** $\frac{E_3}{E_1}$

☒ **D** $\frac{E_2 + E_3}{E_1}$

(Total for Question 6 = 1 mark)

7 An electron is accelerated through a large potential difference and gains a kinetic energy of 47 keV. This energy expressed as joules equals

☒ **A** 7.5×10^{-18} J

☒ **B** 7.5×10^{-15} J

☒ **C** 2.9×10^{20} J

☒ **D** 2.9×10^{23} J

(Total for Question 7 = 1 mark)

8 A source of sound moves away from an observer at a steadily increasing speed. Compared with the original sound, the wavelength reaching the observer will be

☒ **A** greater and decreasing.

☒ **B** greater and increasing.

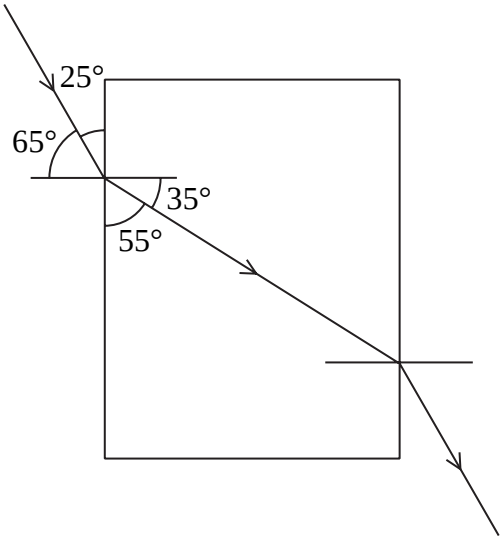
☒ **C** smaller and decreasing.

☒ **D** smaller and increasing.

(Total for Question 8 = 1 mark)

Use the diagram below for questions 9 and 10.

The diagram shows a ray of light passing through a rectangular glass block.



9 Which row in the table below correctly identifies the changes to the properties of the light as it enters the glass block?

		Frequency	Velocity	Wavelength
☒	**A**	no change	decreases	decreases
☒	**B**	no change	increases	increases
☒	**C**	increases	increases	no change
☒	**D**	increases	no change	decreases

(Total for Question 9 = 1 mark)

10 The refractive index of the glass is

☒ **A** 0.52

☒ **B** 0.63

☒ **C** 1.6

☒ **D** 1.9

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 (a) State Ohm's law.

(2)

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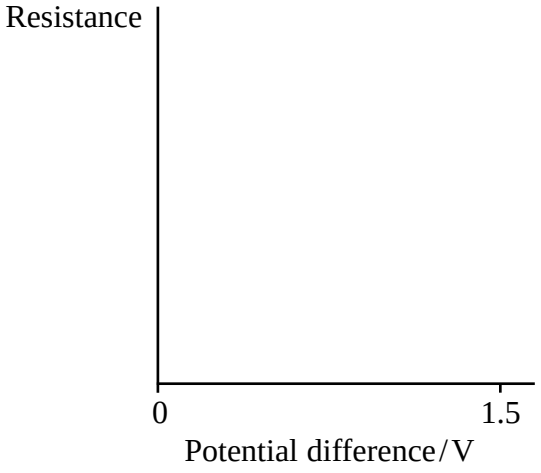
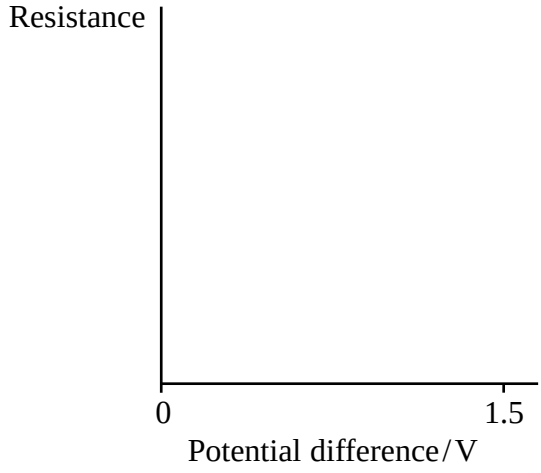
(b) Using the axes below sketch graphs to show how resistance varies with potential difference for a fixed resistor and a 1.5 V filament lamp.

(3)



FIXED RESISTOR



FILAMENT LAMP

(c) The filament of a lamp is made of metal. Explain why the lamp does not demonstrate Ohm's law.

(2)

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(Total for Question 11 = 7 marks)

12 If you look into a fish pond on a bright sunny day, you sometimes cannot see the fish because of the glare of light reflected off the surface. When the sunlight is reflected off the surface of the water it is partially plane-polarised.

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

(1)

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(b) Explain how Polaroid sunglasses can enable the fish to be seen.

(3)

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(c) State why sound waves cannot be polarised.

(1)

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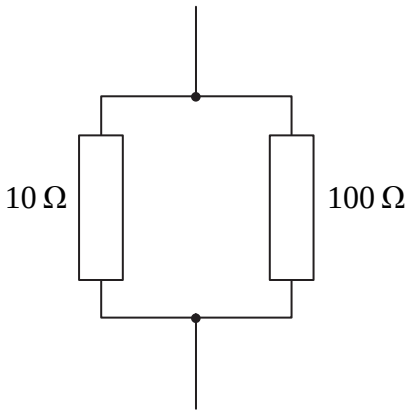
(Total for Question 12 = 5 marks)

13 Two resistors are connected in parallel.



(a) Calculate the resistance of the combination.

(2)

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.....

.....

Resistance = ...

(b) This resistance combination is used in an electrical circuit. A student measures the potential difference across the combination with a high resistance voltmeter. Explain why the resistance of the combination is hardly changed by the addition of the voltmeter.

(3)

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(Total for Question 13 = 5 marks)

14 Frequencies below the audible range for humans are called infrasound. Infrasound is produced by earthquakes.

(a) Describe how sound waves travel through air.

(3)

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(b) State what is meant by frequency.

(1)

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(c) An infrasound wave has a wavelength of 1500 m and a frequency of 2.0 Hz.

Calculate the speed of infrasound in the ground.

(2)

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.....

Speed = ...

(d) In 2004, a huge earthquake produced a very large tidal wave which swept across the Indian Ocean towards Sri Lanka. Many large animals in Sri Lanka moved away from the coast before the tidal wave hit.

Suggest a reason for the animals behaving in this way.

(2)

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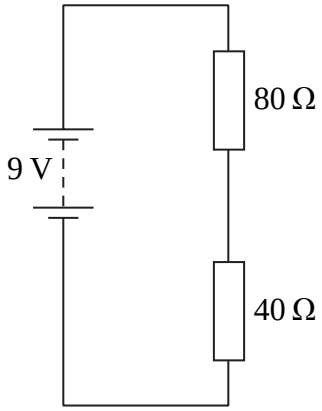
(Total for Question 14 = 8 marks)

*15 A circuit is set up as shown in the diagram. The battery has negligible internal resistance.



(a) Calculate the potential difference across the 40 Ω resistor.

(2)

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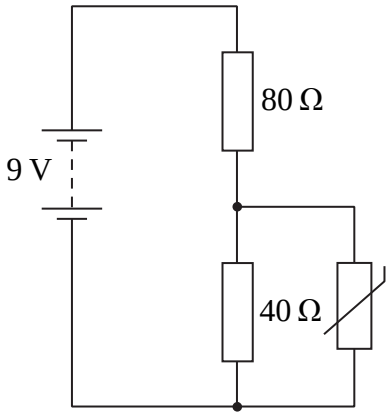
Potential difference = ...

(b) A thermistor is connected in parallel with the 40 Ω resistor as shown.



The thermistor is initially at a temperature of 100 °C and its resistance is 20 Ω. As the thermistor cools down, its resistance increases.

Explain what happens to the current through the battery as the temperature of the thermistor decreases.

(3)

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(Total for Question 15 = 5 marks)

*16 In 1921, Albert Einstein won the Nobel Prize for his work on the photoelectric effect.

The results of experiments on the photoelectric effect show that:

- photoelectrons are not released when the incident radiation is below a certain threshold frequency;
- the kinetic energy of the photoelectrons released depends on the frequency of the incident light and not its intensity.

Explain how these results support a particle theory, but not a wave theory of light.

(Total for Question 16 = 6 marks)

17 An integrated circuit uses strips of gold as connectors and strips of silicon as resistors.

A strip of gold of cross-sectional area 3.0×10^{-6} m^2 carries a current of 8.0 mA. The charge carrier density n is 6.0×10^{28} m^{-3}.

(a) Show that the carrier drift velocity v for gold is approximately 3×10^{-7} m s^{-1}.

(2)

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(b) An approximate value of v for a sample of silicon of the same dimensions, carrying the same current, would be 0.2 m s^{-1}.

Compare this value with the one for gold and account for the difference in the values.

(2)

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(c) State and explain what happens to the resistance of a sample of silicon as its temperature increases.

(2)

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(Total for Question 17 = 6 marks)

***18** Ready-meals that can be heated in a microwave oven always have the instruction that the food should be stirred properly before eating. This is because 'hot and cold spots' within the oven lead to uneven heating of the food.

A microwave source within the oven emits coherent waves in all directions. The waves are reflected off the walls and so the microwaves arrive at one spot by several different routes. The waves interfere with each other and set up standing waves.

(a) Explain what is meant by the following words:

(2)

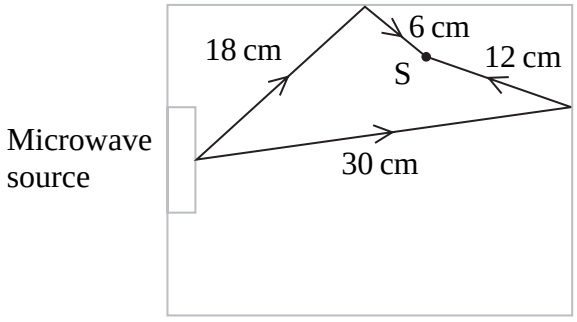
Coherent .....

.....

Standing wave .....

.....

(b) The diagram shows the path of two microwaves arriving at point S.



The wavelength of the microwaves is 12 cm.

Explain why S is a 'cold spot'. Assume that no other microwaves arrive at that point.

(4)

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(c) Uneven heating can be reduced by placing the food on a rotating turntable. Explain why this will reduce the uneven heating of the food.

(2)

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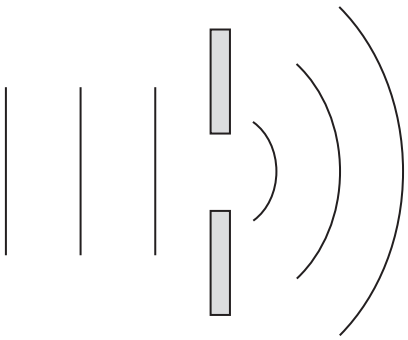
(Total for Question 18 = 8 marks)

19 Wavefronts of light change shape when they pass around an edge or through a slit. This means that the light bends and the effect is called diffraction. The longer the wavelength of light, the more the light bends.

(a) The diagram on the left shows red light passing through a slit and undergoing diffraction.



Red light

Blue light

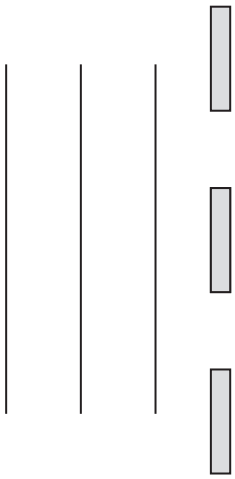
On the diagram on the right, show the same effect for blue light.

(2)

(b) If the red light passes through two slits that are close together, the waves spread out, overlap and add together to produce a pattern of light and dark bands.

Complete the diagram below to show how two overlapping waves produce the pattern of light and dark bands.

(4)



(c) (i) The spacing between two dark bands in the pattern produced is inversely proportional to the distance between the two slits. Red light is shone through two slits that are separated by 1.2 mm and the dark bands in the pattern are 0.60 mm apart.

Calculate how far apart the dark bands will be if the distance between the two slits is reduced to 0.40 mm.

(2)

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Distance between dark bands = ...

(ii) Describe the effect on the pattern if the distance between the two slits is gradually increased to 1 cm.

(2)

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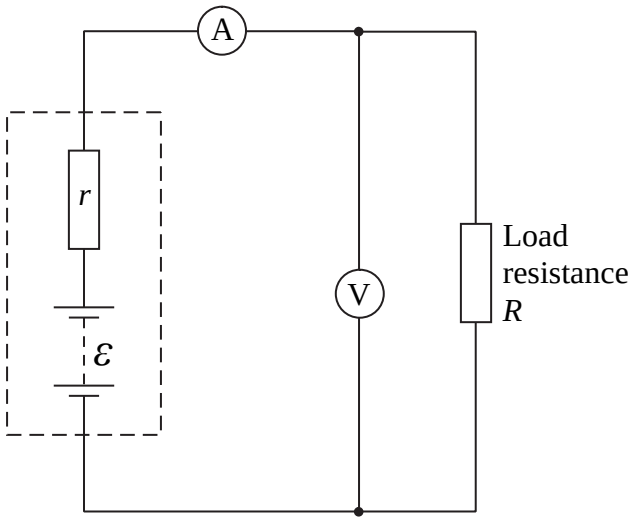
(Total for Question 19 = 10 marks)

20 A student uses a battery of e.m.f. $\mathcal{E}$ and internal resistance r to investigate how the power delivered to a load R by a battery, varies with the resistance of the load.
The following circuit is used.



The student uses a spreadsheet to model the behaviour of the circuit.

	A	B	C	D	E	F
1	Load resistance / Ω	E.m.f. / V	Internal resistance / Ω	Current / A	P.d. across load / V	Power in load / W
2	0.00	6.00	0.800	7.50	0.00	0.0
3	0.40	6.00	0.800	5.00	2.00	10.0
4	0.80	6.00	0.800	3.75	3.00	11.3
5	1.20	6.00	0.800	3.00	3.60	10.8
6	1.60	6.00	0.800	2.50	4.00	10.0
7	2.00	6.00	0.800	2.14	4.29	
8	2.40	6.00	0.800	1.88	4.50	8.4

(a) (i) The formula to calculate the value of cell D8 is

=B8/(A8+C8)

Show why this is the correct formula.

(1)

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.....

(ii) Write the formula to calculate the value of cell E4.

(1)

.....

(iii) Calculate the value for cell F7.

(1)

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(b) Explain why the p.d. across the load increases as the current decreases.

(3)

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(c) (i) Describe how the power delivered to the load varies for load resistances in the range used.

(2)

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(ii) A battery of e.m.f. 12 V and internal resistance 1.6 Ω is now used with the same range of load resistances. Describe how the power delivered to the load resistance will now vary.

(2)

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(Total for Question 20 = 10 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Wednesday 9 June 2010 – Morning
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.*
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  – *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.

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- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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N 3 5 8 7 6 A 0 1 2 4

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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 formula for the speed v of ocean waves, in terms of the acceleration of free fall g and the wavelength λ, is $v = \sqrt{g\lambda}$.

Which of the following is the correct expression for the SI base units on the right hand side of this formula?

☒ **A** $\sqrt{\text{m}^2\text{s}^{-2}}$

☒ **B** m s^{-2}

☒ **C** m^2s^{-2}

☒ **D** $\sqrt{\text{m s}^{-2}}$

(Total for Question 1 = 1 mark)

2 Which line of the table correctly summarises the changes in wave characteristics when moving from ultraviolet to infrared in the visible spectrum?

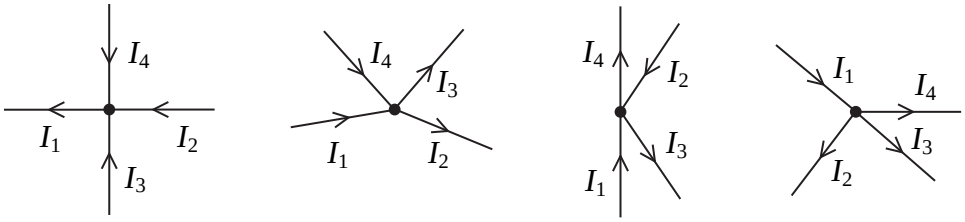
		Wavelength	Speed in a vacuum
☒	**A**	Decreases	Increases
☒	**B**	Increases	Decreases
☒	**C**	Decreases	Remains the same
☒	**D**	Increases	Remains the same

(Total for Question 2 = 1 mark)

3 The diagrams show connected wires that carry currents I_1, I_2, I_3 and I_4.

The currents are related by the equation $I_1 + I_2 = I_3 + I_4$

Identify the diagram that this equation applies to.



A **B** **C** **D**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 = 1 mark)

---

4 A 100 W lamp connected to the 230 V mains is replaced by a lamp which has twice the resistance. The power of the new lamp is

☒ **A** 25 W

☒ **B** 50 W

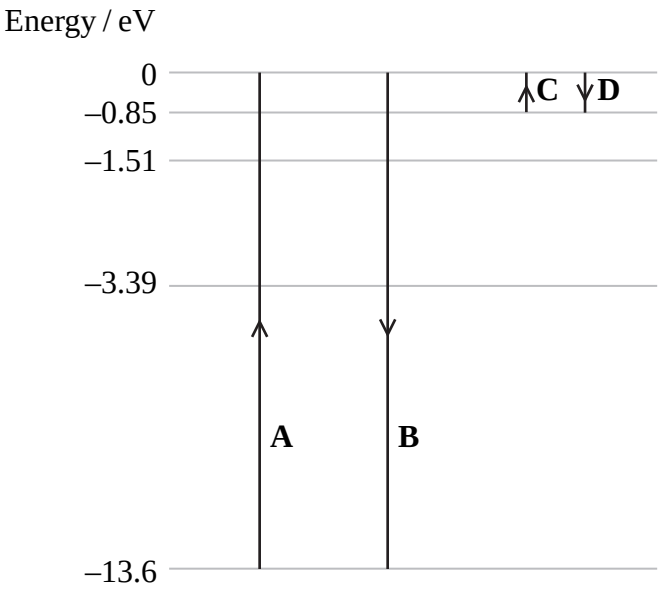
☒ **C** 200 W

☒ **D** 400 W

(Total for Question 4 = 1 mark)

---

5 The diagram shows some of the electron energy levels for the hydrogen atom with four possible transitions.



The transition that would result in the emission of the longest wavelength is

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 5 = 1 mark)

---

6 Ultrasound pulses are used to detect shoals of fish in the sea. A shoal of fish is at a depth of 300 m and the speed of ultrasound in water is 1500 m s^{-1}. The time interval between transmitting and receiving the pulse will be

☒ **A** 0.20 s

☒ **B** 0.40 s

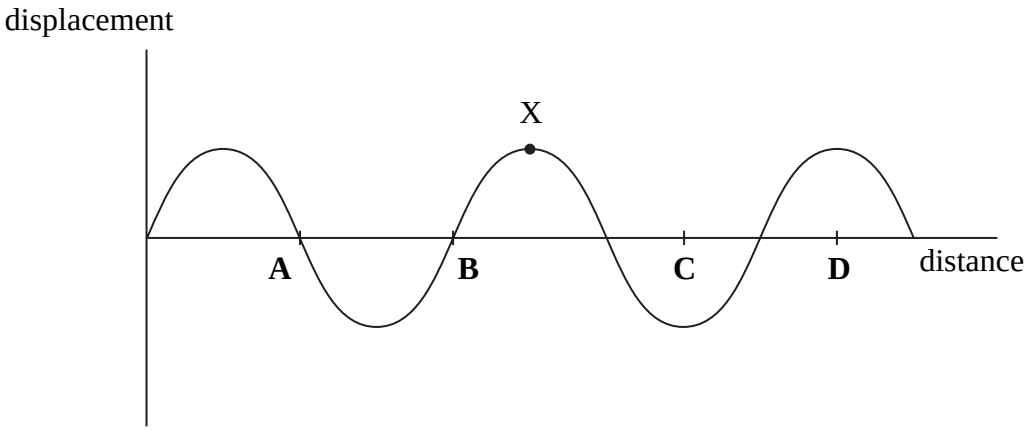
☒ **C** 2.5 s

☒ **D** 5.0 s

(Total for Question 6 = 1 mark)

---

7 The graph shows the displacement of molecules against their distance from a wave source. Which of the points A to D, marked on the graph, has a phase difference of 270° with point X?



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 7 = 1 mark)

---

8 The behaviour of light can be described in terms of waves or particles. The particle nature of light can be demonstrated by

☒ **A** light being diffracted as it passes through a narrow slit.

☒ **B** the speed of light reducing when it is refracted by glass.

☒ **C** light causing electrons to be emitted from a metal surface.

☒ **D** light being polarised.

(Total for Question 8 = 1 mark)

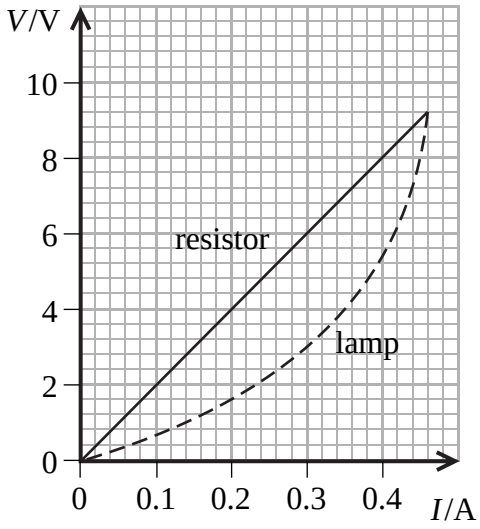
---

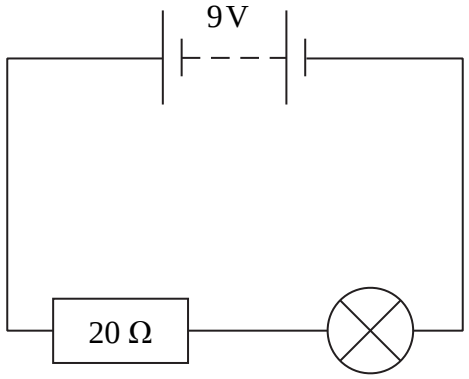
9 The current in a wire

- ☒ **A** depends only on the potential difference applied.
- ☒ **B** depends only on the resistance of the wire.
- ☒ **C** depends on both the potential difference and the resistance of the wire.
- ☒ **D** does not depend on the potential difference or the resistance of the wire.

(Total for Question 9 = 1 mark)

10 The graph shows the relationship between potential difference V and current I for a fixed 20 Ω resistor and a filament lamp.





The resistor and lamp are placed in series with a 9 V battery of negligible internal resistance. The current in the circuit is

- ☒ **A** 0.1 A
- ☒ **B** 0.2 A
- ☒ **C** 0.3 A
- ☒ **D** 0.4 A

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 A London radio station broadcasts at a frequency of 95.8 MHz. Calculate the wavelength in air of these radio waves.

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Wavelength = ...

(Total for Question 11 = 3 marks)

12 (a) Explain the difference between resistance and resistivity.

(2)

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(b) The resistivity of copper is 1.7×10^{-8} Ω m. A copper wire is 0.50 m long and has a cross sectional area of 1.0×10^{-6} m^2. Calculate its resistance.

(2)

.....

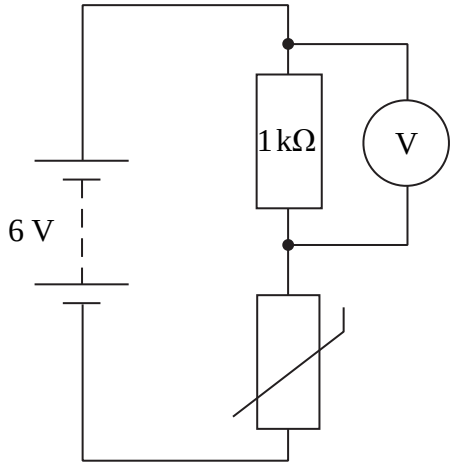
.....

.....

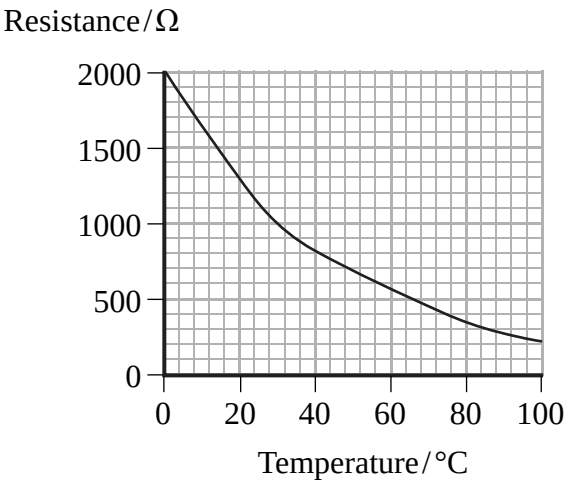
Resistance = ...

(Total for Question 12 = 4 marks)

13 The following circuit is used to monitor the temperature in a greenhouse. The battery has no internal resistance.



(a) The graph shows how the resistance of the thermistor varies with temperature.



(i) Use the graph to find the resistance of the thermistor at 20 °C.

(1)

Resistance = ...

(ii) Calculate the reading on the voltmeter when the thermistor is at 20 °C.

(3)

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Reading on the voltmeter = ...

(b) Explain what will happen to the reading on the voltmeter as the temperature of the greenhouse decreases.

(2)

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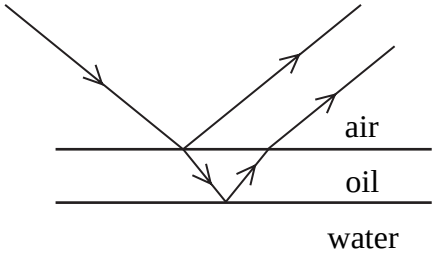
(Total for Question 13 = 6 marks)

***14** When oil floats on water, coloured interference patterns are often seen. The interference patterns are formed because of the thin film of oil. A thin film of oil can also produce interference patterns with monochromatic light.
The diagram shows light from a monochromatic source, incident on a film of oil.

Explain why interference patterns may be seen.

(5)



(Total for Question 14 = 5 marks)

***15** Many computers operate through an uninterrupted power supply (UPS) to protect them and the information stored on them from power surges or power cuts. A UPS will run the computer from the mains supply until it detects a problem and then the computer will run off the UPS's rechargeable battery.
A UPS is rated by the maximum power that it can provide to the computer. The unit that is used is the volt-amp (VA).

(a) Use expressions for potential difference and current to show that the volt-amp is equivalent to the watt.

(3)

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(b) Each cell of the rechargeable battery has an internal resistance. An advertisement for a UPS states that, at an output power to the computer of 700 W, it can provide a continuous supply for 7 minutes.

(i) Calculate how much energy is provided in this time.

(2)

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Energy = ...

(ii) The advertisement also states that if the output power is halved, the supply will last for 23 minutes. Without doing any calculations, explain why halving the power output more than doubles the time.

(3)

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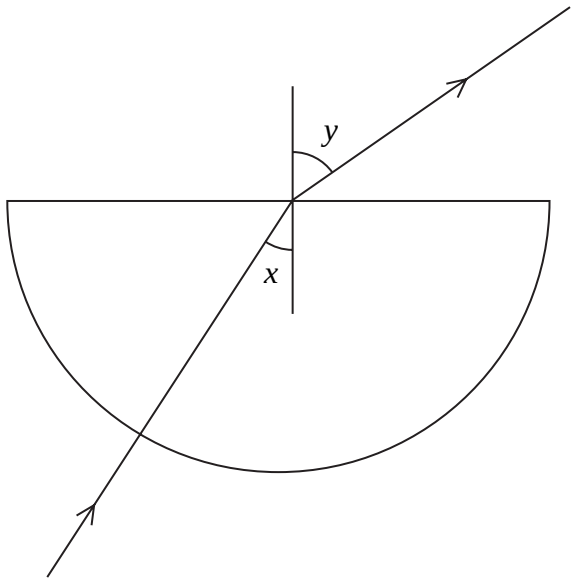
(Total for Question 15 = 8 marks)

***16** A student carries out an experiment to measure the refractive index of glass. She does this by shining a ray of light through a semicircular glass block and into the air as shown.



$x = 30°$
$y = 48°$

(a) Calculate the refractive index from air to glass ${}_{a}\mu_{g}$.

(2)

.....

.....

Refractive index = ...

(b) (i) The student steadily increases the angle x in glass and finds that eventually the light does not pass into the air. Explain this observation.

(3)

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(ii) Calculate the largest value of angle x that allows the light to pass out of the block into the air.

(2)

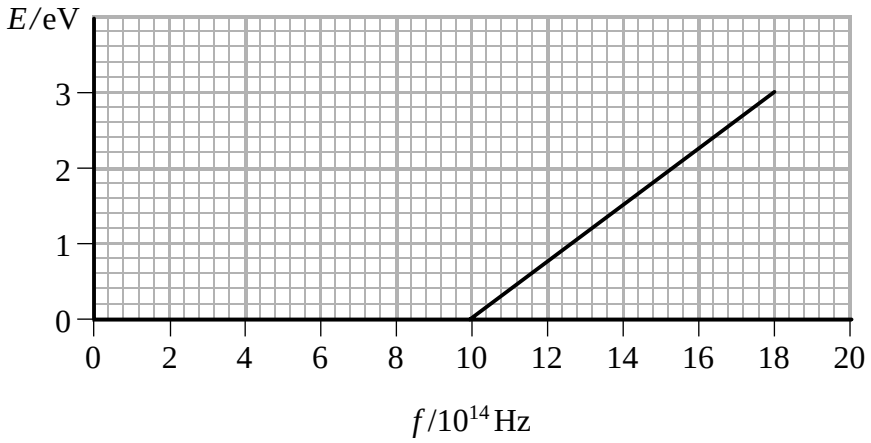
.....

.....

Angle = ...

(Total for Question 16 = 7 marks)

17 The graph shows how the maximum kinetic energy E of photoelectrons emitted from the surface of aluminium varies with the frequency f of the incident radiation.



(a) Explain why no photoelectrons are emitted below a frequency of 10×10^{14} Hz.

(1)

.....

.....

(b) Calculate the work function of aluminium in electron volts.

(3)

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.....

Work function = ...

(c) State the quantity represented by the gradient of the graph.

(1)

.....

(d) Add a second line to the graph to show how E varies with f for a metal which has a work function less than aluminium.

(2)

(Total for Question 17 = 7 marks)

18 A length of wire has a cross-sectional area of 3.1×10^{-6} m^2. A current of 1.5 A flows through the wire when there is a p.d. of 3.0 V across it.

(a) Draw a diagram of the circuit you would use to check these current and p.d. values.

(2)

(b) Calculate the rate at which energy is transferred to the wire.

(2)

.....

.....

Rate of energy transfer = ...

(c) (i) The wire has 1.0×10^{29} electrons per metre cubed.

Calculate the drift velocity of the electrons.

(2)

.....

.....

.....

Drift velocity = ...

(ii) The temperature of the wire increases. Explain what happens to the drift velocity of the electrons if the potential difference remains constant.

(3)

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(Total for Question 18 = 9 marks)

19 A student is investigating the physics of an electric guitar. When a string on a guitar is plucked, a standing wave is produced with one antinode.

The student finds that the speed of a wave, v, in a stretched string is given by

$$v = \sqrt{\frac{T}{\mu}}$$

where T is the tension in the string and μ is the mass per unit length of the string.

The student decides to measure the diameters of the strings and the frequency of the fundamental note produced when each string is plucked. She then constructs a spreadsheet to record these results and to calculate v, μ and T for each string.

The strings are made of a material of density (mass per unit volume) 7800 kg m^{-3}.

	A	B	C	D	E	F	G
1	Length / m	Frequency / Hz	Speed / m s^{-1}	Diameter / mm	Volume of a 1 metre length / 10^{-6} m^3	Mass per unit length / 10^{-3} kg m^{-1}	Tension / N
2	0.655	82	107	1.240	1.210	9.42	108
3	0.655	110	144	0.914	0.656		106
4	0.655	147	193	0.711	0.397	3.10	115
5	0.655	196	257	0.457	0.164	1.28	84
6	0.655	247	324	0.356	0.100	0.78	
7	0.655	330	432	0.279	0.061	0.48	90

(a) (i) The formula to calculate the value of cell C3 is

= 2*A3*B3

Explain why this is the correct formula.

(2)

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(ii) Write the formula to calculate the value of cell E3.

(1)

.....

.....

(iii) Write the formula to calculate the value of cell F4.

(1)

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(iv) Hence calculate the value of cell F3.

(1)

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.....

(v) Calculate the value of cell G6.

(2)

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.....

(b) The student decides to verify the equation $v = \sqrt{\frac{T}{\mu}}$ by using one string.

She removes a string from the guitar and clamps one end in a support. She varies the tension by hanging known weights on the other end of the string. The speed of the wave is calculated from the length of the string and the measured frequency of the fundamental note when the string is plucked.

Describe how the student could use a graph to verify the equation.

(3)

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(Total for Question 19 = 10 marks)

20 Warning traffic signs that tell motorists they are speeding are often solar powered.

The speed of an approaching car is measured by transmitting microwaves towards it. These waves are reflected off the car and picked up by a receiver, which uses the Doppler effect to calculate the speed of the car.

(a) A narrow beam of waves is necessary to pick out a single car. Suggest a reason why microwaves are used rather than radio waves.

(2)

.....

.....

(b) (i) State how the frequency of the reflected signal would differ from the frequency of the transmitted signal.

(1)

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.....

.....

(ii) Explain how the system detects that a car is speeding.

(2)

.....

.....

.....

(c) If a car is speeding, the warning sign flashes to alert the driver. The warning sign is powered by solar cells covering a rectangular area 0.5 m × 0.3 m. The average intensity of the solar energy radiation hitting the solar cells is 500 W m^{-2}. The solar cells are 8% efficient at transforming light energy into electrical energy, which is stored in a battery.

(i) Calculate how much electrical energy is produced each second by the solar panel.

(3)

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.....

.....

.....

Electrical energy each second = ...

(ii) The panel receives solar energy for 8 hours per day. The warning sign requires 100 J of electrical energy each time it flashes.

Calculate how many times the warning sign can flash in a day.

(3)

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.....

.....

.....

Number of flashes = ...

(Total for Question 20 = 11 marks)

TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS

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

☒ **A** 1500 J

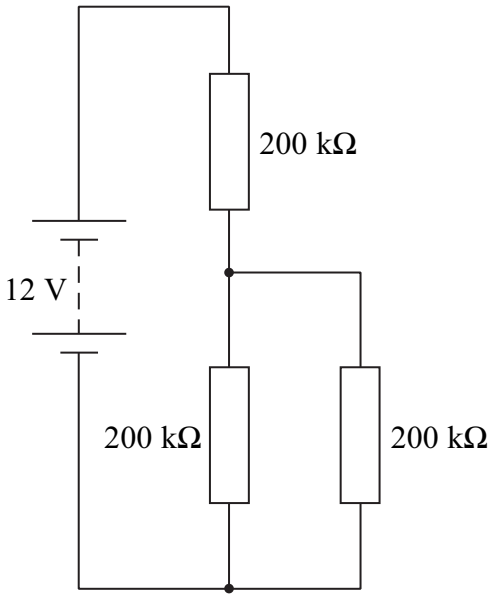
☒ **B** 96 J

☒ **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)

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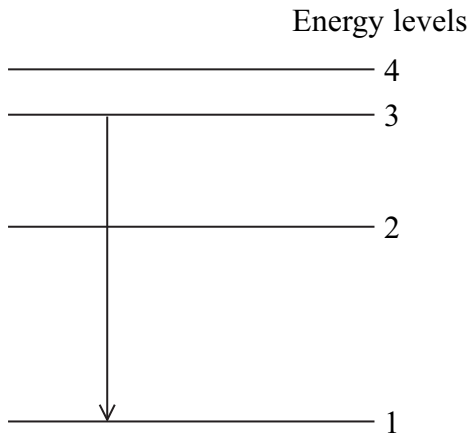
4 The diagram shows four electron energy levels in an atom. The transition of an electron from level 3 to level 1 is shown. This results in the emission of a photon in the visible range.



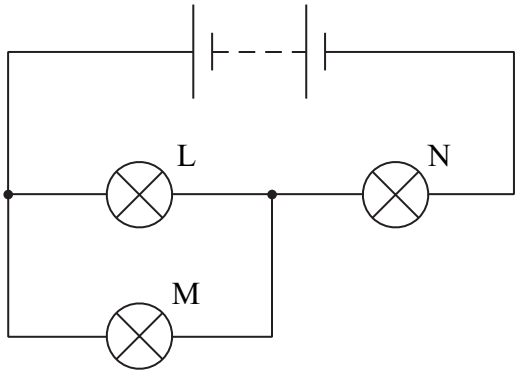
Which transition might emit a photon in the ultraviolet range?

- ☒ **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.

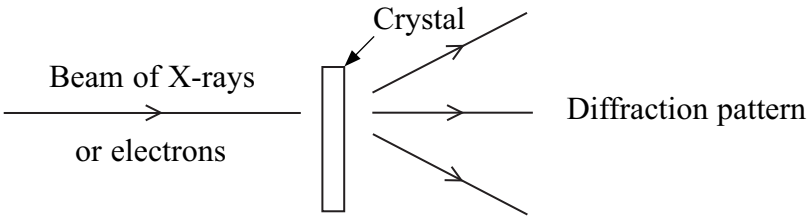
(Total for Question 7 = 1 mark)

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.

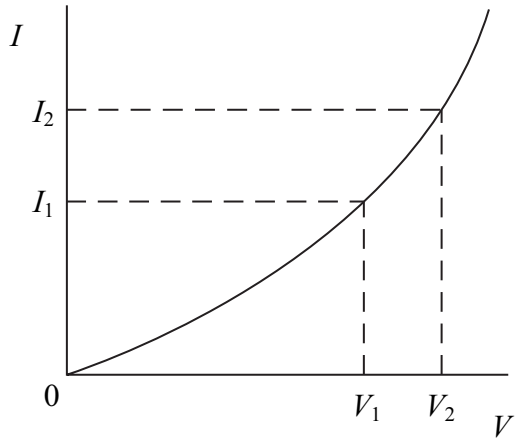


Which of the following statements about the experiments is correct?

- ☒ **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

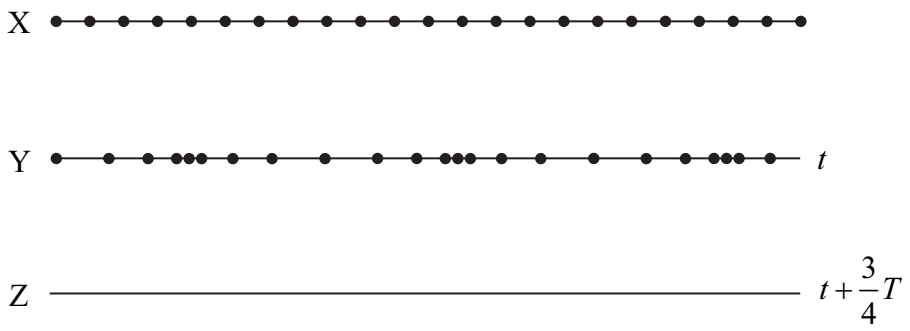
SECTION B

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)

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.....

(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 5.4×10^{-3} Ω 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)

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.....

*(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)

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(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)

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.....

.....

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.

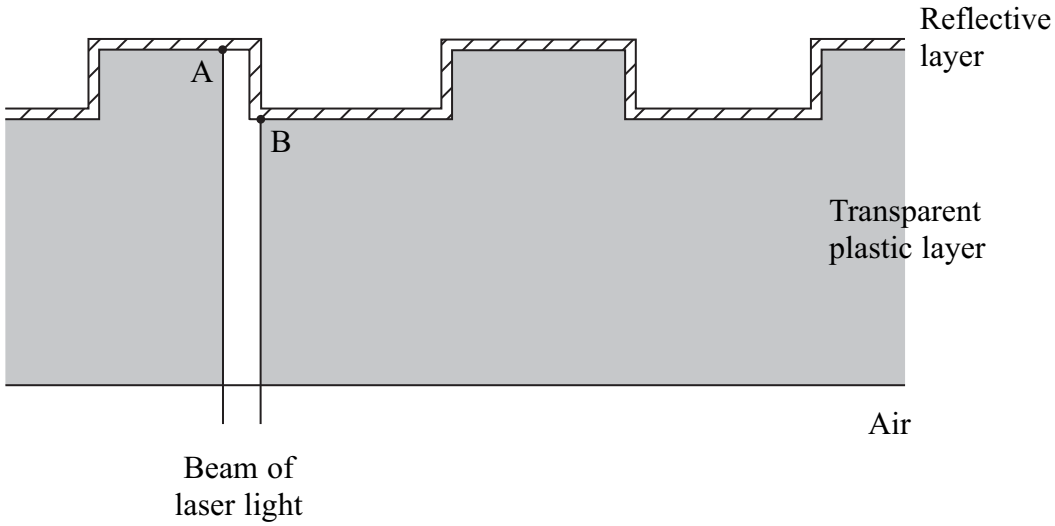
(1)

.....

.....

(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 = ...

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

(2)

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(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)

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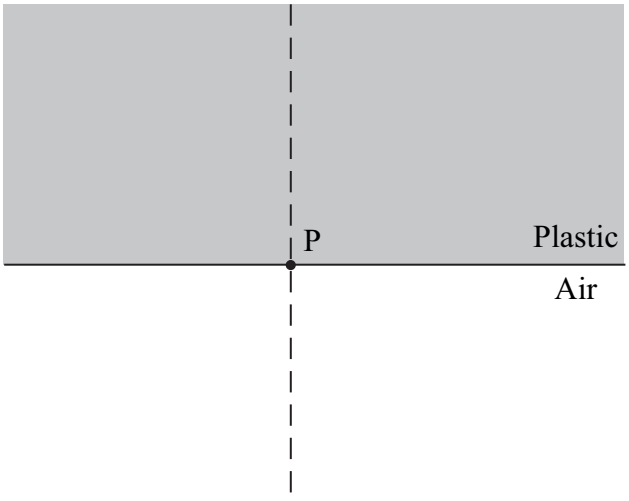
.....

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

Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Monday 6 June 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

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Turn over ▶

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P 3 8 4 1 5 A 0 1 2 8

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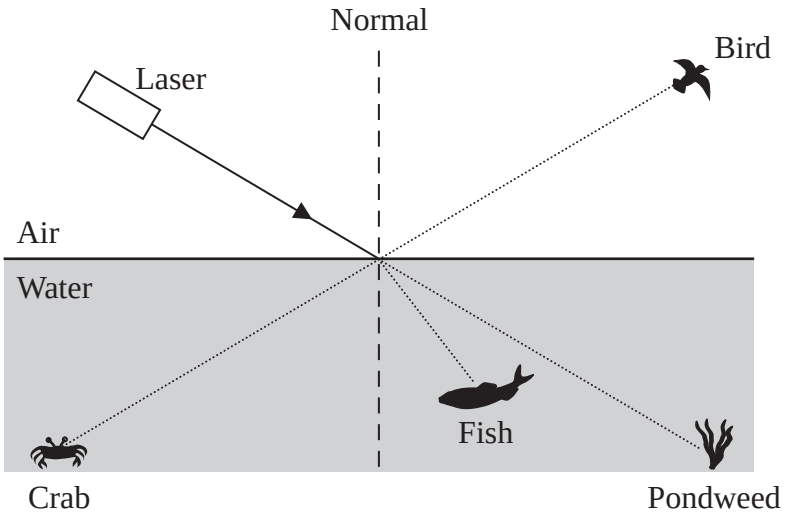
SECTION A

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 laser beam is directed at the surface of a smooth, calm pond as shown in the diagram.



Which organisms could be illuminated by the laser light?

☒ **A** The bird and the fish.

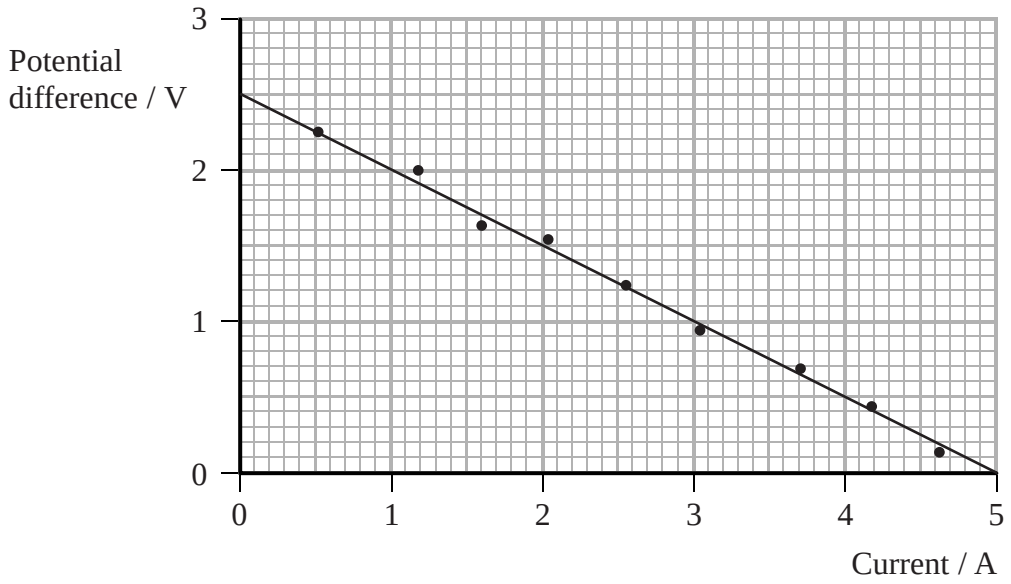
☒ **B** The crab and the pondweed.

☒ **C** The bird and the pondweed.

☒ **D** The crab and the fish.

(Total for Question 1 = 1 mark)

2 A student wants to find the internal resistance of a cell. He plots a graph of the potential difference across the terminals of the cell against the current through the cell.



Which of the following quantities gives the internal resistance of the cell?

☒ **A** The area under the graph.

☒ **B** The intercept on the current axis.

☒ **C** The intercept on the potential difference axis.

☒ **D** The magnitude of the gradient.

(Total for Question 2 = 1 mark)

3 A longitudinal wave is moving along a spring. Two points on the spring are separated by half a wavelength. The displacements at these points on the spring are always

☒ **A** constant.

☒ **B** in the same direction as each other.

☒ **C** in opposite directions to each other.

☒ **D** in a direction at right angles to the direction of travel of the wave.

(Total for Question 3 = 1 mark)

4 Which of the following statements about infrared radiation and ultraviolet radiation is true?

☒ **A** An ultraviolet photon has more energy than an infrared photon.

☒ **B** Energy can be transferred by infrared radiation but not by ultraviolet radiation.

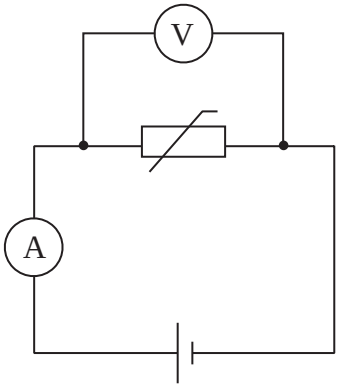
☒ **C** In a vacuum, infrared radiation travels faster than ultraviolet radiation.

☒ **D** Ultraviolet radiation has a longer wavelength than infrared radiation.

(Total for Question 4 = 1 mark)

---

5 A negative temperature coefficient thermistor is connected as shown in the circuit diagram.



The cell has a negligible internal resistance. The effect of decreasing the temperature of the thermistor is that the

☒ **A** ammeter reading will decrease.

☒ **B** ammeter reading will increase.

☒ **C** voltmeter reading will decrease.

☒ **D** voltmeter reading will increase.

(Total for Question 5 = 1 mark)

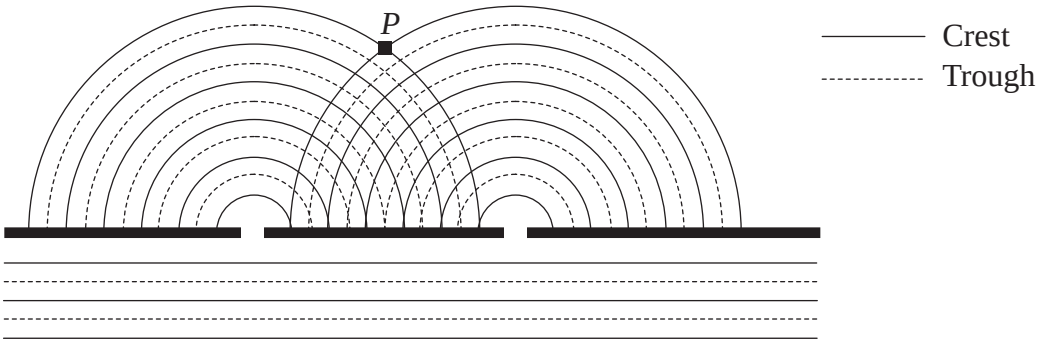
---

6 The unit of potential difference is the volt. A correct alternative unit is

- ☒ **A** $J A^{-1} s^{-1}$
- ☒ **B** $J A s^{-1}$
- ☒ **C** $J A s$
- ☒ **D** $J A^{-1} s$

(Total for Question 6 = 1 mark)

7 The diagram represents shallow water waves of constant wavelength passing through two small openings in a barrier.



The statement which best describes the interference at point *P* is:

- ☒ **A** It is constructive and causes a longer wavelength.
- ☒ **B** It is constructive and causes an increase in amplitude.
- ☒ **C** It is destructive and causes a shorter wavelength.
- ☒ **D** It is destructive and causes a decrease in amplitude.

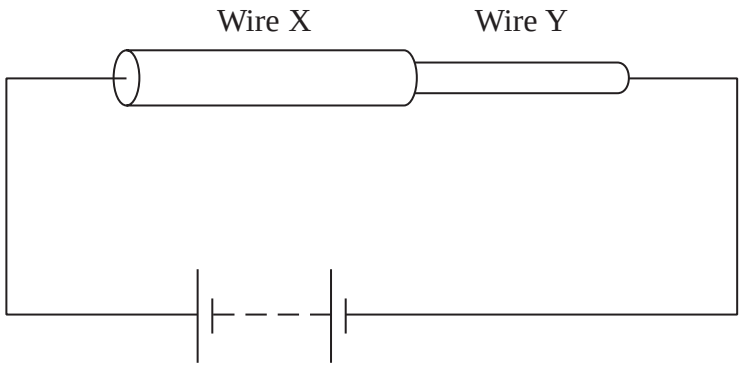
(Total for Question 7 = 1 mark)

8 A wave is diffracted as it passes through an opening in a barrier. The amount of diffraction that the wave undergoes depends on both the

- ☒ **A** amplitude and frequency of the incident wave.
- ☒ **B** wavelength and amplitude of the incident wave.
- ☒ **C** wavelength of the incident wave and the size of the opening.
- ☒ **D** amplitude of the incident wave and the size of the opening.

(Total for Question 8 = 1 mark)

9 Two wires of the same material are connected in series in the circuit shown.



The cross-sectional area of wire X is twice the cross-sectional area of wire Y.

The drift velocities of the electrons in these two wires are v_X and v_Y.

The value of $\frac{v_X}{v_Y}$ is

☒ **A** ½

☒ **B** 1

☒ **C** 2

☒ **D** 4

(Total for Question 9 = 1 mark)

10 Which of the following provides evidence that light has a wave nature?

☒ **A** The emission of light from an energy-level transition in a hydrogen atom.

☒ **B** The diffraction of light passing through a narrow opening.

☒ **C** The absorption of ultra-violet radiation in the photoelectric effect.

☒ **D** The reflection of light from a mirror.

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 The photograph shows a marble statue. The statue is protected by a lightning conductor.

During a storm, a flash of lightning passes between a cloud and the lightning conductor. As a result a current of 15 000 A flows for a time of 3.0×10^{-2} s.

(a) Calculate the charge that flows in the lightning conductor during this time.

(2)

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.....

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.....

Charge = ...

(b) The lightning conductor is 1 m taller than the statue and is made from copper, which has a resistivity of 1.7×10^{-8} Ω m. The lightning conductor has a cross-sectional area of 1.5×10^{-4} m^2 and a resistance of 2.7×10^{-3} Ω.

Calculate the height of the statue and state an assumption that you have made.

(4)

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Height of statue = ...

Assumption: .....

(c) Suggest why the lightning conductor is taller than the statue.

(1)

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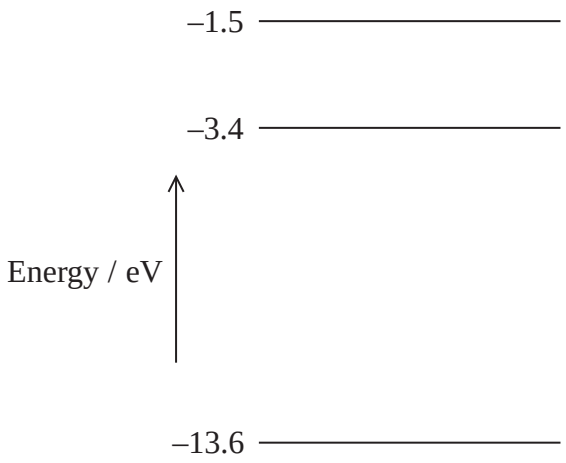
(Total for Question 11 = 7 marks)

12 The diagram shows the lowest three energy levels of a hydrogen atom.



(a) Excited hydrogen atoms can emit light of wavelength 6.56×10^{-7} m.

(i) Calculate the frequency of this light.

(2)

.....

.....

.....

Frequency = ...

(ii) The energy of a photon of this frequency is 3.03×10^{-19} J.
By means of a calculation determine which electron transition emits this photon.

(2)

.....

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.....

from ..... to .....

(b) The spectrum of light from the Sun has a dark line at a wavelength of 656 nm. In the spectrum of light received from a distant galaxy, the corresponding line appears at a wavelength of 690 nm.

Explain what the observation tells us about this galaxy. Do not include calculations in your answer.

(2)

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(Total for Question 12 = 6 marks)

13 Mobile phones have a rechargeable battery which is recharged by means of a mains adaptor. One such adaptor has an input power of 4.8 W at a voltage of 230 V.

(a) Calculate the input current to the adaptor when it is in use.

(2)

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.....

Input current = ...

(b) The adaptor's output is labelled as 5 V 0.1 A 0.5 V A

(i) Show that the unit V A is equivalent to the watt.

(1)

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(ii) Calculate the efficiency of the adaptor.

(2)

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Efficiency = ...

(iii) Suggest a reason why the efficiency is less than 100%.

(1)

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(Total for Question 13 = 6 marks)

14 (a) Describe the difference between a transverse wave and a longitudinal wave.

(2)

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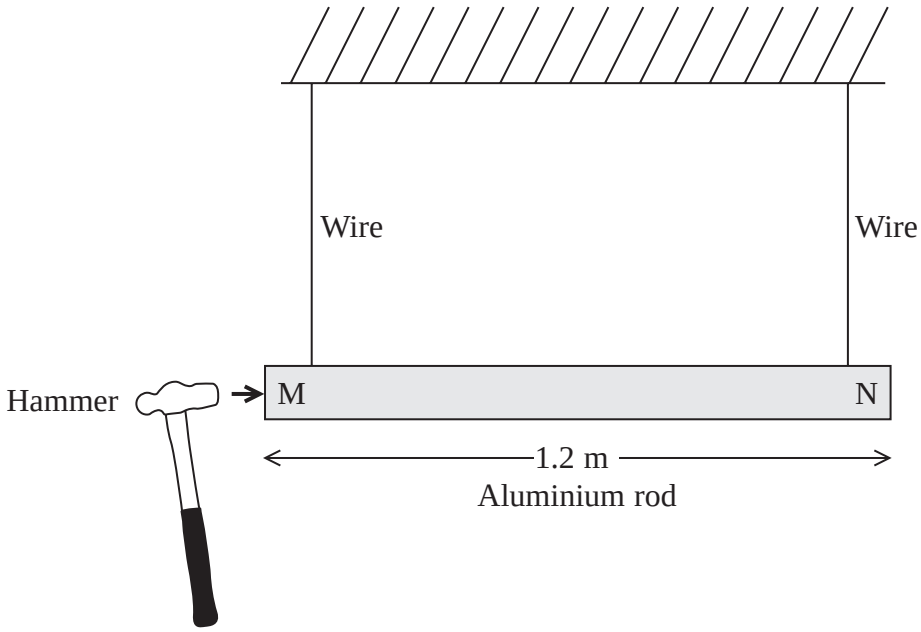
(b) A teacher sets up the following demonstration to show that the speed of sound in an aluminium rod is greater than in air.

An aluminium rod MN of length 1.2 m is suspended horizontally by two wires as shown in the diagram.



A wave pulse is made to travel along the rod and reflect from end N. The wave pulse is produced by hitting end M gently with a hammer so that the hammer remains in contact with end M until the reflected pulse returns.

(i) State and explain whether the wave pulse is transverse or longitudinal.

(2)

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.....

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.....

(ii) The hammer remains in contact with end M for a time of 4.8×10^{-4} s.

Calculate the speed of the wave pulse in the rod.

(3)

Speed in rod = ...

(iii) When the rod is hit, a sound is heard.

Suggest how this sound is created.

(1)

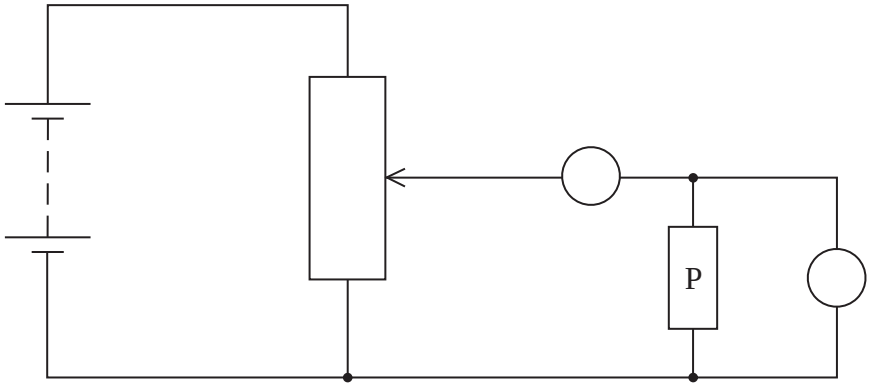
(c) A standing wave is set up in the rod.

Explain how a standing wave is formed.

(3)

(Total for Question 14 = 11 marks)

15 (a) The diagram shows the circuit used to investigate how the current varies with potential difference for an electrical component P. The circuit contains an ammeter and a voltmeter.



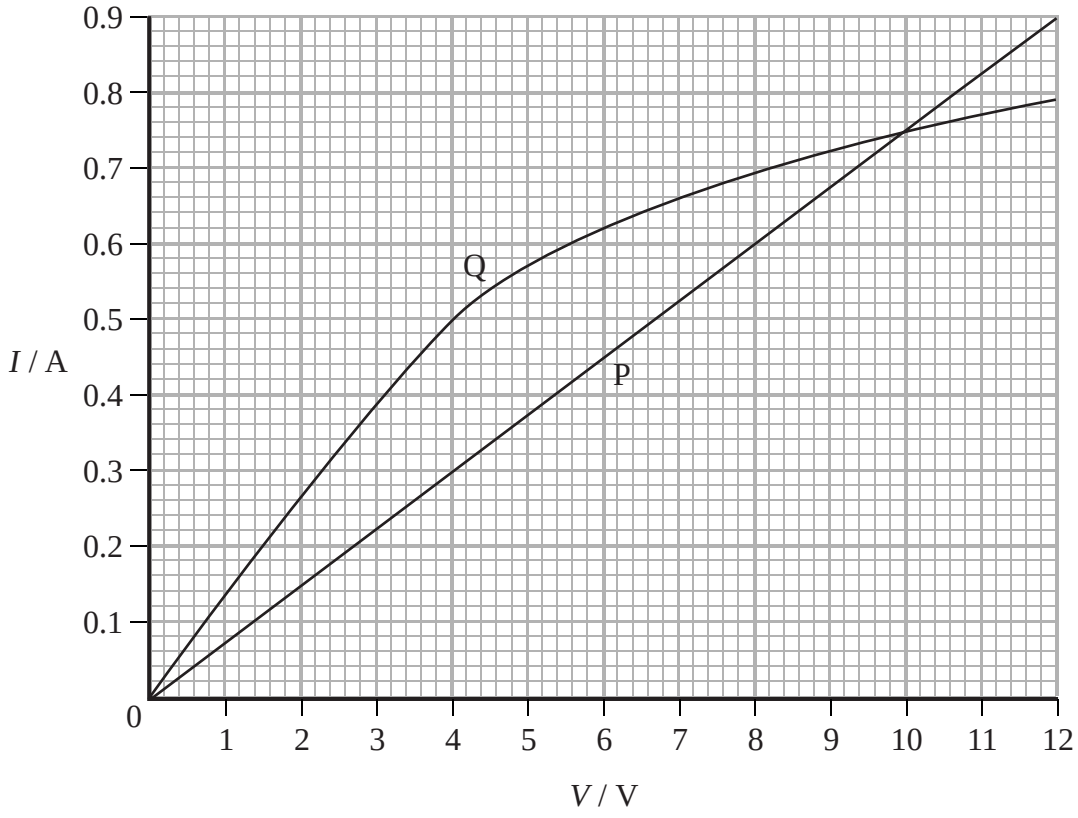
(i) On the diagram, label the ammeter A and the voltmeter V.

(1)

(ii) The position of the contact of the potential divider is moved so that the reading on the voltmeter becomes zero. Label this position Z.

(1)

(b) The graph shows how the current *I* varies with potential difference *V* for two electrical components P and Q.



(i) State the value of the current for which the resistance of P is the same as the resistance of Q and determine this value of resistance.

(3)

Current = ...

.....

.....

Resistance = ...

*(ii) Component Q is a filament lamp. Explain the shape of its graph.

(3)

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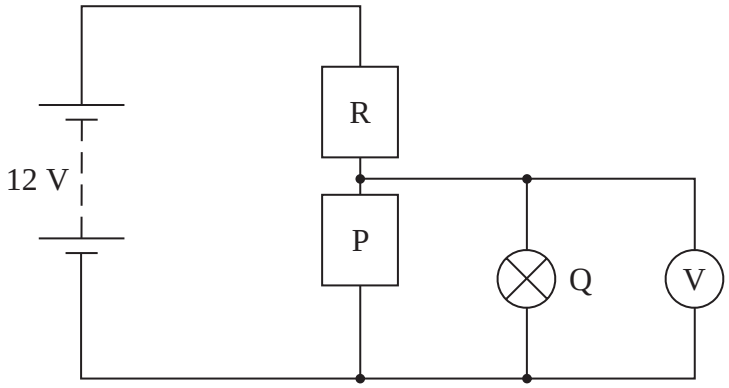
(c) A potential divider consisting of component P and a resistor R is connected to a 12 V supply. The lamp Q and a voltmeter are connected to the circuit as shown.



The supply has a negligible internal resistance. The reading on the voltmeter is 4.0 V.

(i) Use the graph in part (b) to determine the current in the resistor R.

(2)

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Current = ...

(ii) Calculate the resistance of the resistor R.

(2)

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Resistance = ...

(iii) The lamp Q is removed.

Explain, without further calculation, how the voltmeter reading would change.

(3)

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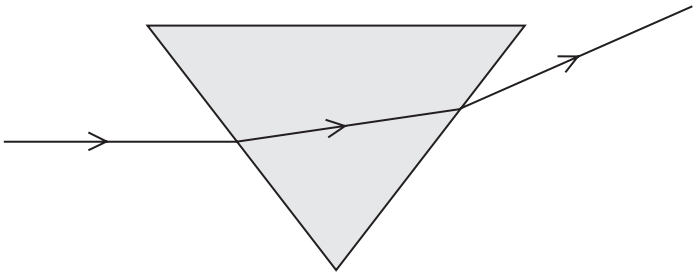
(Total for Question 15 = 15 marks)

16 (a) Refractometers are used in the food manufacturing industry to measure the concentration of sugar in different drinks. As the concentration of sugar increases, the refractive index of the liquid also increases. A simple refractometer uses a hollow prism shape that can be filled with different liquids.

(i) The simplified diagram below shows a ray of light passing through a prism filled with a liquid.

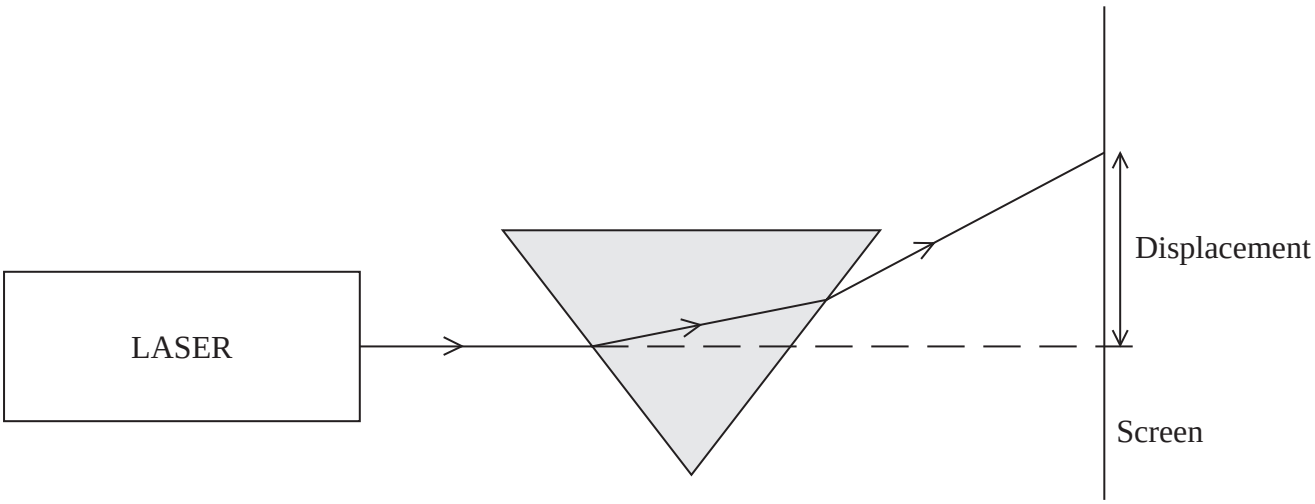


The liquid is replaced with one of a higher sugar concentration.

Using the same incident ray, draw the new path through the liquid and out of the prism.

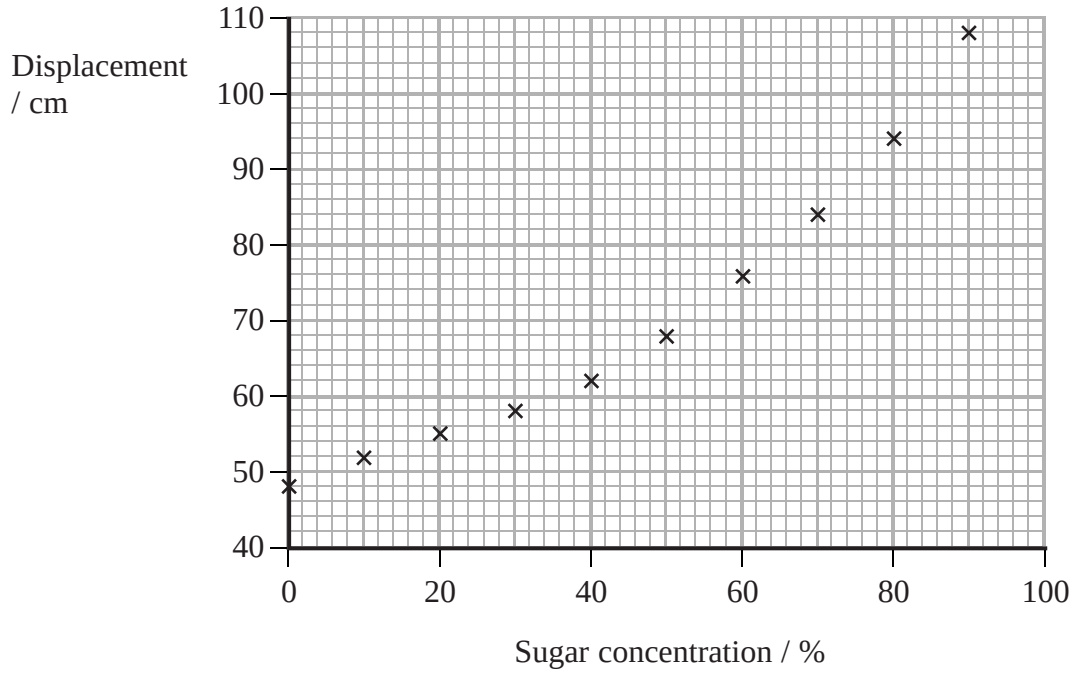
(2)

(ii) In practice, a laser beam is shone through the empty prism. The position of the emergent ray is marked on a screen. The prism is filled with a liquid of a known sugar concentration and the displacement on the screen is recorded.



This is repeated for a number of different known concentrations.

The graph shows how the displacement varies with the sugar concentration.



Describe how the displacement varies with sugar concentration.

(2)

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(iii) A sample of unknown concentration produced a displacement of 88 cm.

Draw the line of best fit on the graph and use it to find the sugar concentration of the sample.

(2)

Concentration = ...

(iv) Give a reason why the distance between the screen and the prism must be kept constant.

(1)

(b) Another method of measuring sugar concentrations uses polarised light.

(i) Explain what is meant by polarised light.

(2)

*(ii) When polarised light passes through a sugar solution, the plane of polarisation rotates through an angle.

Explain how to measure this angle of rotation.

(4)

(Total for Question 16 = 13 marks)

17*(a) In a demonstration, ultraviolet light is incident on a zinc plate and electrons are emitted.

The intensity of the ultraviolet light is increased.

Explain the following observations:

- the number of electrons emitted per second increases
- the maximum kinetic energy of an electron does not change.

(4)

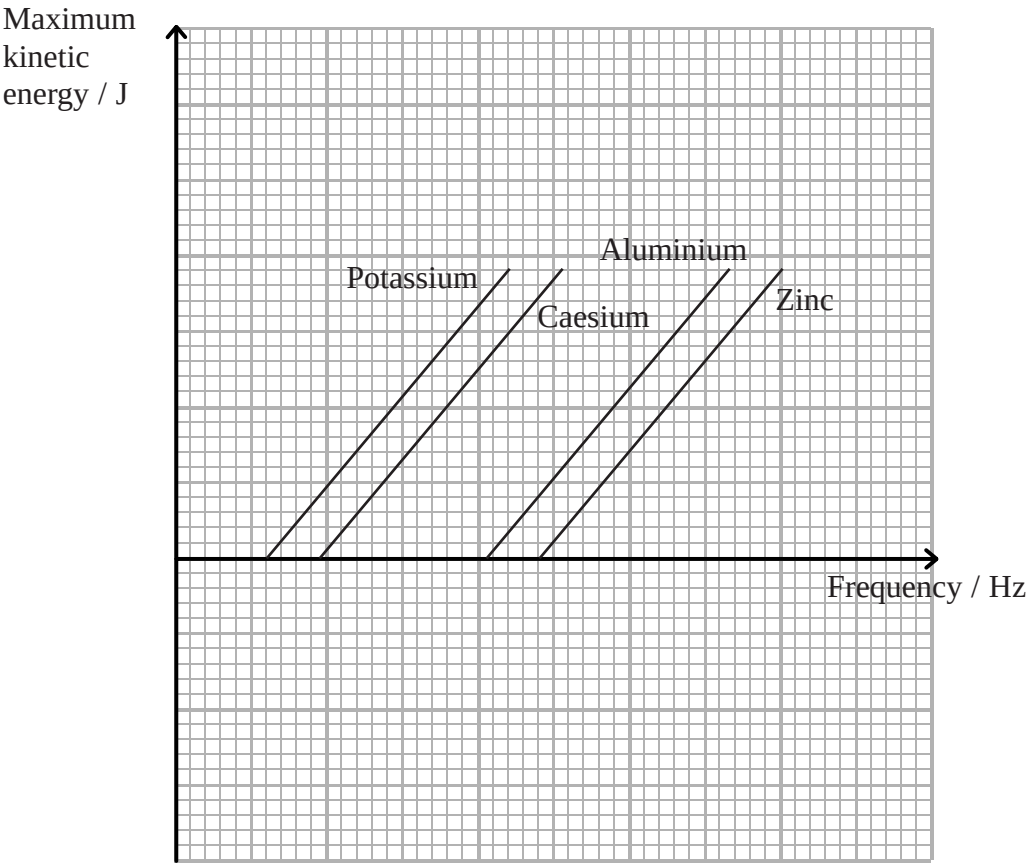
(b) The table shows the work functions of four metals.

Metal	Work function / 10^{-19} J
Aluminium	6.53
Caesium	3.36
Potassium	2.30
Zinc	6.88

(i) Determine which of these metals would emit electrons when illuminated with visible light of frequency 5.88×10^{14} Hz.

(3)

(ii) The graphs show how the maximum kinetic energy of the emitted electrons varies with the frequency of incident light for the four metals.



Use the relationship $hf = ½ mv^2 + \varphi$ to explain the relative positions of the graphs and why they are all parallel.

(3)

(iii) A school laboratory has a photoelectric cell for student use. The metal plate in the photoelectric cell is made of caesium and it can be used with a set of filters to obtain a graph similar to the one in (ii).

Explain why the metal plate is made of caesium rather than zinc.

(2)

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(Total for Question 17 = 12 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Friday 20 January 2012 – Morning
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
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Turn over ▶

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P 3 9 8 4 8 A 0 1 2 4

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 electromagnetic radiations has the lowest frequency?

☒ **A** gamma

☒ **B** infrared

☒ **C** ultraviolet

☒ **D** X-rays

(Total for Question 1 = 1 mark)

2 When light from a distant star reaches us on Earth, its wavelength appears shifted towards the red end of the spectrum. This is because

☒ **A** the distance travelled by each successive wave has increased.

☒ **B** the frequency of the light emitted has decreased.

☒ **C** the speed of the star has increased.

☒ **D** the star is emitting longer wavelengths.

(Total for Question 2 = 1 mark)

3 Two loudspeakers produce identical sounds of frequency 440 Hz which superpose to produce a standing wave. Adjacent nodes are formed 0.75 m apart.

Select the correct statement about the waves.

☒ **A** The frequency heard is 880 Hz.

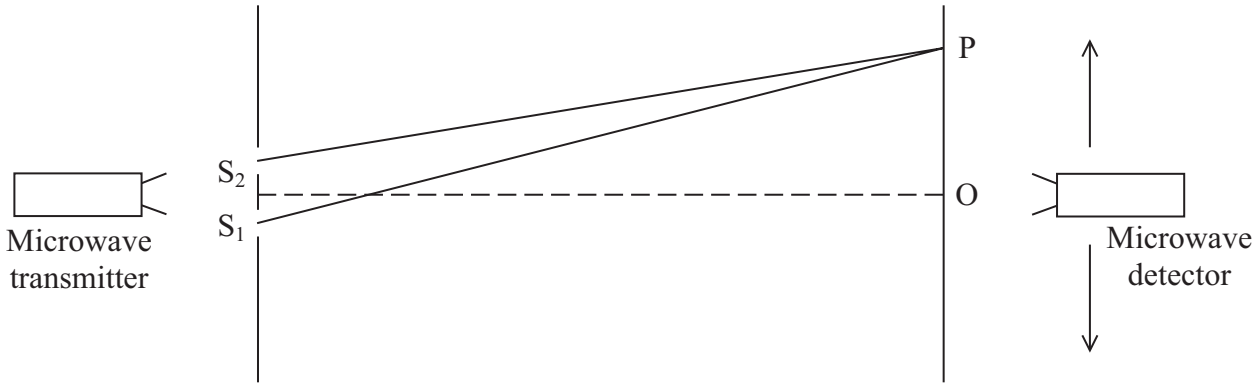
☒ **B** The speed of the waves is 165 m s^{-1}.

☒ **C** The wavelength of the waves is 1.5 m.

☒ **D** The waves are travelling in the same direction.

(Total for Question 3 = 1 mark)

4 The diagram shows an experiment set up to demonstrate two-source interference, using microwaves of wavelength λ.



The detector is moved from O in the direction of the upwards arrow. The first position where the signal is a minimum is P.

The equation that correctly determines the position of P is

☒ **A** OP = λ

☒ **B** OP = $\lambda/2$

☒ **C** $S_1P - S_2P = \lambda$

☒ **D** $S_1P - S_2P = \lambda/2$

(Total for Question 4 = 1 mark)

5 During a thunderstorm, a flash of lightning resulted in 600 000 C of charge flowing in a lightning conductor in a time of 40 ms. The current in the conductor was

☒ **A** 1.5×10^4 A

☒ **B** 2.4×10^4 A

☒ **C** 1.5×10^7 A

☒ **D** 2.4×10^7 A

(Total for Question 5 = 1 mark)

6 The unit of potential difference can be expressed as

☒ **A** $C\ s^{-1}$

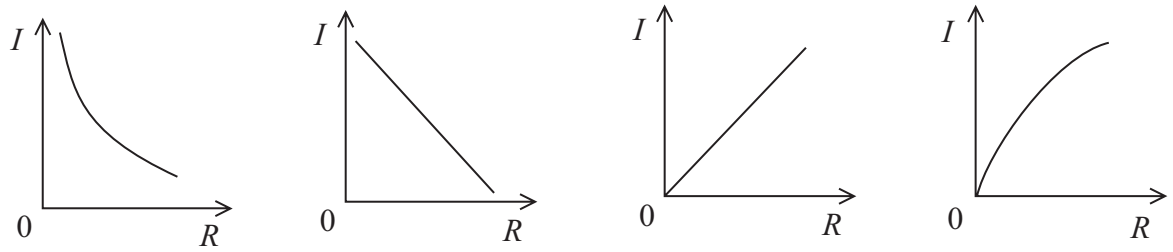
☒ **B** $J\ C^{-1}$

☒ **C** $A\ \Omega^{-1}$

☒ **D** $J\ A^{-1}$

(Total for Question 6 = 1 mark)

7 A steady potential difference is applied across a variable resistor that is kept at a constant temperature.



A **B** **C** **D**

The graph which represents the relationship between the resistance R of the variable resistor and the current I through it is

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 7 = 1 mark)

8 Early experiments to measure the speed of light involved timing pulses of light being reflected back from distant mirrors. If a pulse of light was emitted and then detected 0.24 ms later, the distance to the mirror was

☒ **A** 7.2×10^7 m

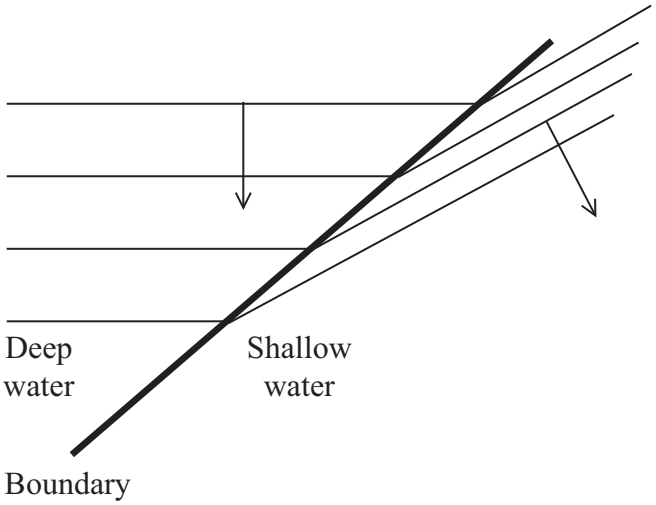
☒ **B** 3.6×10^7 m

☒ **C** 7.2×10^4 m

☒ **D** 3.6×10^4 m

(Total for Question 8 = 1 mark)

9 The diagram represents straight wavefronts passing across a boundary from deep water into shallow water, with a change in speed and direction.



Which wave property does this diagram illustrate?

- ☒ **A** diffraction
- ☒ **B** interference
- ☒ **C** reflection
- ☒ **D** refraction

(Total for Question 9 = 1 mark)

10 Which of the following quantities is shown with the correct unit?

- ☒ **A** current and C s
- ☒ **B** potential difference and eV
- ☒ **C** power and J s
- ☒ **D** resistivity and Ω m

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 The photograph shows a solar panel being used to produce electricity.

The solar panel has an efficiency of 15%. The average radiation flux falling on the panel is 210 W m^{-2}.

Assuming that this radiation falls normally on the panel, calculate the area of the panel that would provide an average power output of 500 W.

(3)

Area = ...

(Total for Question 11 = 3 marks)

12 (a) A tiger's roar includes sounds at frequencies below the range of human hearing known as infrasound.

Infrasound of wavelength 45 m travels at 330 m s^{-1} in air.

Calculate the frequency of this infrasound.

(2)

Frequency = ...

(b) The roar of a tiger in a zoo can be heard by visitors at the entrance, even though the tiger can not be seen because there is a hill in the way.

Name and explain this effect.

(2)

(Total for Question 12 = 4 marks)

13 Waves may be transverse or longitudinal.

(a) The table shows three types of wave. Complete the table by putting tick(s) in the box(es) to show which waves are longitudinal.

(1)

Type of wave	Longitudinal
Radio waves	
Ultrasound	
Visible light	

(b) Some waves can be plane polarised. Explain why longitudinal waves cannot be plane polarised.

(2)

.....

.....

.....

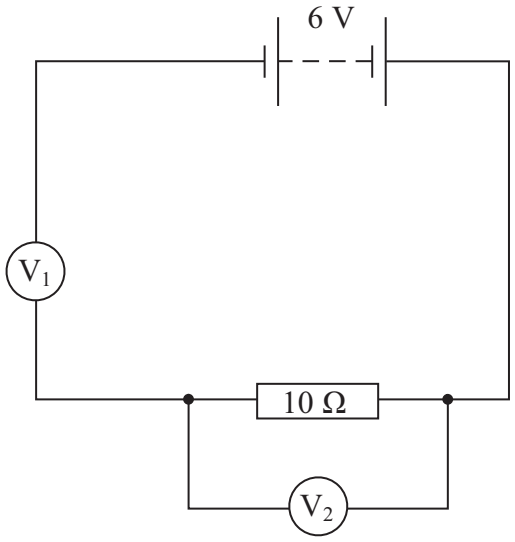
.....

.....

.....

(Total for Question 13 = 3 marks)

14 The diagram shows a circuit set up by a student.



(a) Both voltmeters have a resistance of 10 MΩ. The reading on V_1 is 6 V and the reading on V_2 is zero.

Explain these readings.

(2)

(b) The student replaces the 10 Ω resistor with a resistor of unknown resistance *R*. The reading on V_1 is now 4 V.

Calculate the value of *R*.

(3)

R = ...

(Total for Question 14 = 5 marks)

***15** In a fluorescent lighting tube, electrons with a range of kinetic energies collide with atoms of mercury vapour. These atoms are initially in their ground state. As a result of these collisions, some of the atoms emit photons.

Explain what is meant by the ground state of an atom and why photons are emitted.

(6)

(Total for Question 15 = 6 marks)

16 A car battery has an e.m.f. of 12 V and an internal resistance of $3.0 \times 10^{-3}\ \Omega$. For the starter motor to turn the engine, the battery must provide a current of 400 A.

(a) Calculate the terminal potential difference across the terminals of the battery when the current through the battery is 400 A.

(3)

Terminal potential difference = ...

(b) The copper wires between the battery and the motor have a diameter of 1 cm.

Explain why such a thick wire is needed.

(3)

(Total for Question 16 = 6 marks)

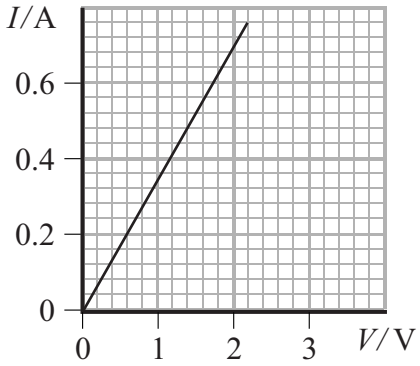
17 (a) Show how the ohm is derived.

(1)

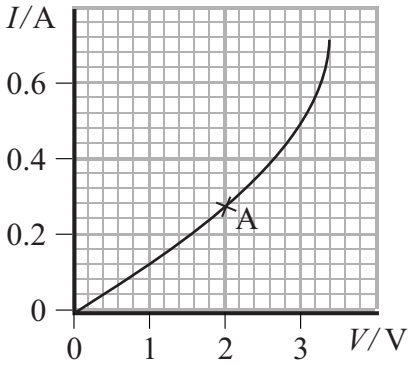
.....

.....

(b) The graphs show the current-potential difference (*I*-*V*) characteristics for a metal conductor and for a thermistor.



Metal conductor



Thermistor

(i) Calculate the resistance of the thermistor at point A.

(2)

.....

.....

.....

Resistance = ...

(ii) Use the graphs to describe how the resistance varies with potential difference for each component.

(2)

.....

.....

.....

.....

(iii) Explain, in terms of electrons, why the thermistor behaves in this way.

(2)

.....

.....

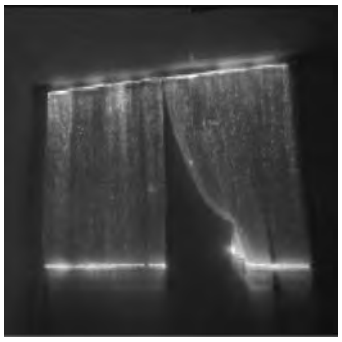
.....

.....

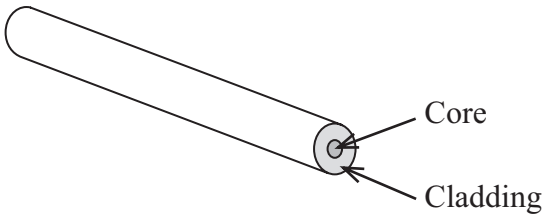
.....

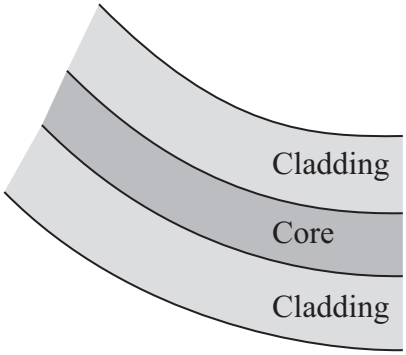
(Total for Question 17 = 7 marks)

18 Optical fibres have many uses in medicine and communications. They can also be incorporated into items such as the curtains shown in the photograph.



Some optical fibres are made from a central core of transparent material surrounded by a material of a different refractive index as a cladding.





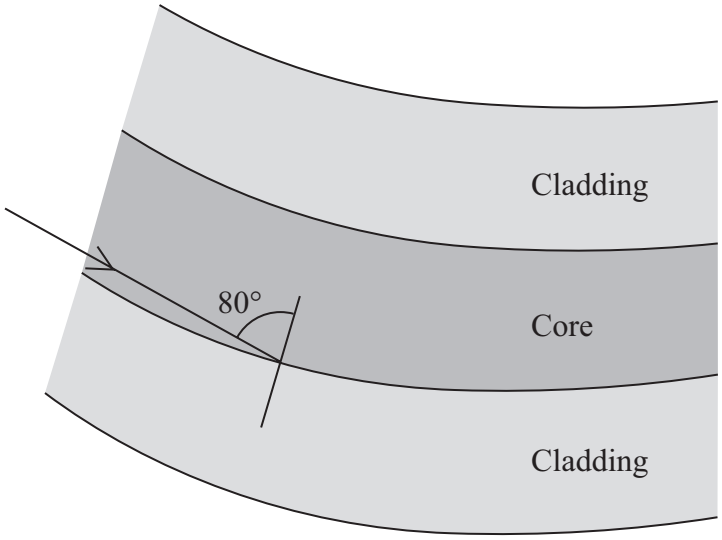
speed of light in the core = 1.96×10^8 m s^{-1}
speed of light in the cladding = 2.03×10^8 m s^{-1}

(a) Calculate the critical angle for the core-cladding boundary.

(3)

Critical angle = ...

(b) The diagram below shows a ray of light inside the core of a fibre. The ray is incident on the core-cladding boundary at an angle of 80°.



State what happens to this ray of light when it is incident on the core-cladding boundary as shown.

(1)

(c) The light source for these curtains is at the top.

Suggest why the bottom of the curtain is much brighter than the rest of the curtain.

(2)

(Total for Question 18 = 6 marks)

19 Energy is a very important concept in physics. Energy is usually measured in joules, but may be measured in electronvolts (eV) or kilowatt-hours (kW h).

(a) In an X-ray tube an electron is accelerated across a potential difference of 100 000 V. The electron gains 100 000 eV of kinetic energy.

Calculate this energy in joules.

(2)

100 000 eV = ... J

(b) A 1000 W domestic heater dissipates 8 kW h of energy when used for 8 hours.

Calculate the energy dissipated in joules.

(2)

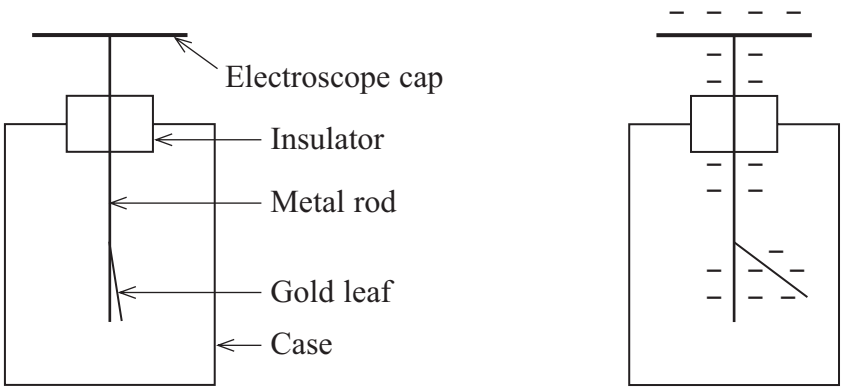
8 kW h = ... J

(c) Suggest why, in the above cases, the electronvolt and the kilowatt-hour are more convenient units than the joule.

(2)

(Total for Question 19 = 6 marks)

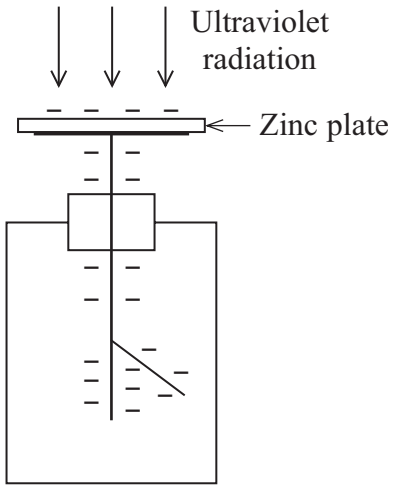
20 A gold leaf electroscope is used to detect very small amounts of charge. When the electroscope cap is negatively charged, electrons spread along the metal rod and the gold leaf so they both become negatively charged. The rod and leaf repel each other, so the gold leaf rises up.



Uncharged electroscope

Charged electroscope

A gold leaf electroscope can be used to demonstrate the photoelectric effect. A clean zinc plate is placed onto the cap of the electroscope and the plate and electroscope are charged negatively. Ultraviolet radiation is shone onto the zinc plate.



*(a) The gold leaf slowly falls.

Explain, with reference to the work function of zinc, why this happens.

(4)

(b) Why is the effect not observed if the ultraviolet radiation is replaced by visible light?

(1)

(c) Ultraviolet radiation of wavelength 2.00×10^{-7} m is shone onto the zinc plate.
Calculate the maximum speed of the electrons emitted from the plate.

work function of zinc = 6.88×10^{-19} J

(4)

Maximum speed of electrons = ...

(d) The source of ultraviolet radiation is moved further away from the zinc plate.

State what will happen to the maximum speed of the electrons emitted from the plate. Justify your answer.

(2)

(Total for Question 20 = 11 marks)

21 (a) A transverse wave travelling along a wire under tension has a speed v given by

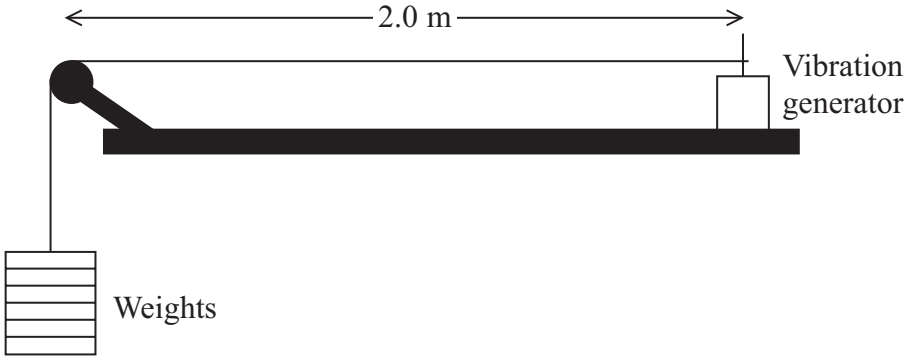
$$v = \sqrt{\frac{T}{\mu}}$$

where T is the tension in the wire and μ is the mass per unit length of the wire.

Show that the units on both sides of the equation are the same.

(3)

(b) The diagram shows a wire held under tension by hanging weights at one end and supported by a vibration generator at the other end. The frequency of the vibration generator is slowly increased from zero until a standing wave is formed.



(i) Explain how the standing wave is produced.

(3)

(ii) Calculate the wavelength of the standing wave.

(1)

Wavelength = ...

(iii) The weight is 150 N and the mass per unit length of the wire is 0.0050 kg m^{-1}.

Using the equation given in (a), calculate the speed of the transverse wave along the wire.

(2)

Speed of transverse wave = ...

(iv) The wire is observed as the frequency of the vibration generator is steadily increased to several times the frequency that produced the first standing wave.

Describe and explain what is seen as the frequency is increased.

(4)

(Total for Question 21 = 13 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Friday 25 May 2012 – 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 ▶

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1/1/1/1/C2/

P 3 9 8 5 4 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 The resistance of a negative temperature coefficient thermistor

☒ **A** becomes zero above a certain temperature.

☒ **B** decreases as the temperature decreases.

☒ **C** increases as the temperature decreases.

☒ **D** is constant at temperatures below 0 °C.

(Total for Question 1 = 1 mark)

2 Compared to ultraviolet radiation, gamma radiation has

☒ **A** a higher frequency and a longer wavelength.

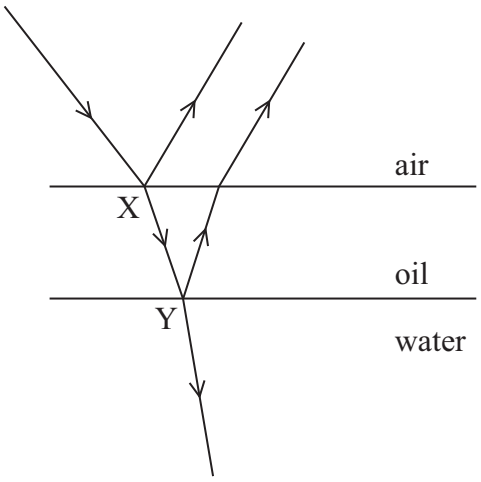
☒ **B** a higher frequency and a shorter wavelength.

☒ **C** a lower frequency and a longer wavelength.

☒ **D** a lower frequency and a shorter wavelength.

(Total for Question 2 = 1 mark)

3 A ray of light is incident on a thin film of oil on water. Some of the light is reflected at X and some at Y.

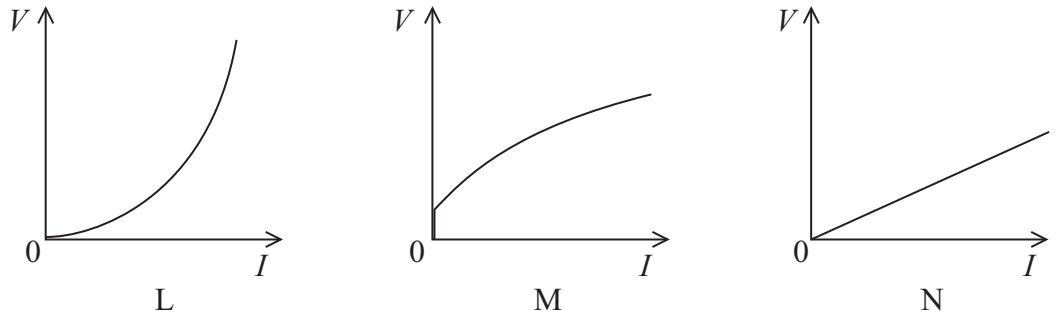


The two reflected rays will be 180° out of phase if the path difference is

- ☒ **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 3 = 1 mark)

4 The graphs show the variation of potential difference V with the current I for three components.



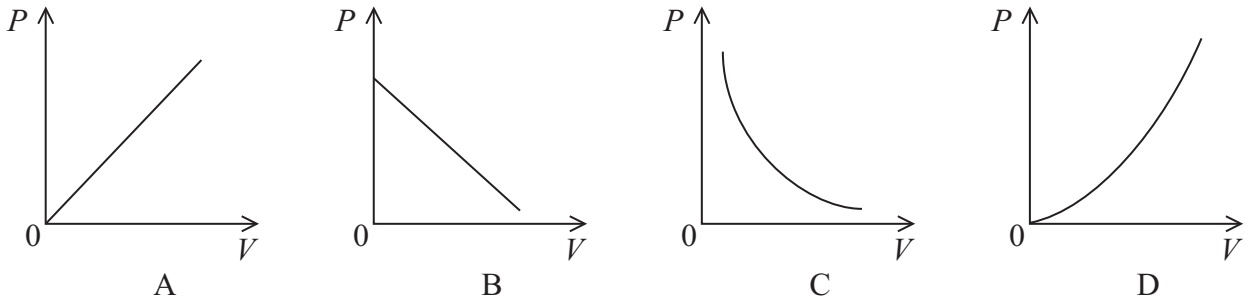
The three components are a metal wire at constant temperature, a filament lamp and a diode.

Which row of the table correctly identifies these graphs?

	Metal wire at constant temperature	Filament lamp	Diode
☒ **A**	L	M	N
☒ **B**	L	N	M
☒ **C**	N	M	L
☒ **D**	N	L	M

(Total for Question 4 = 1 mark)

5 The graphs show possible variations of power P with potential difference V.

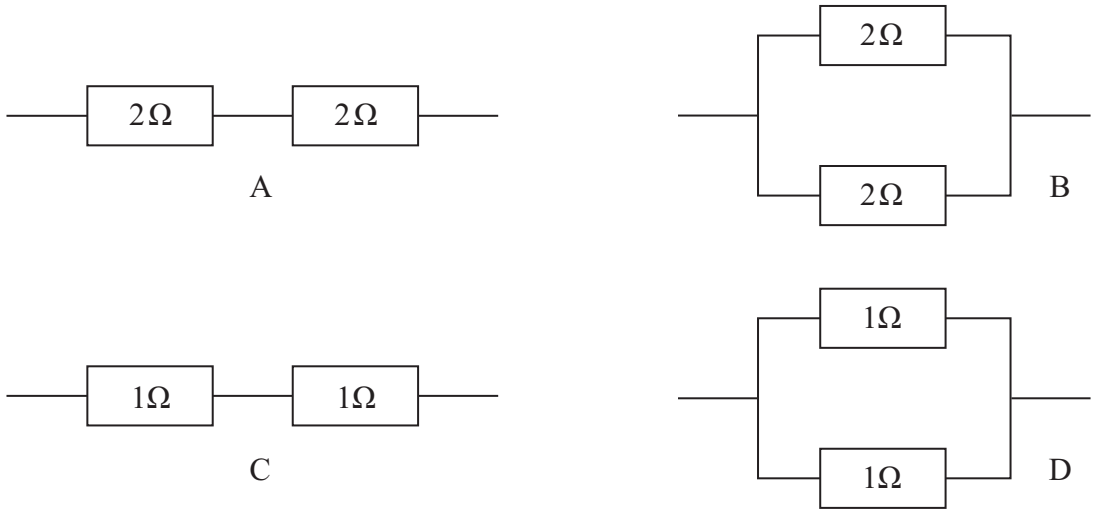


Which graph is correct for a resistor that obeys Ohm's law?

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 5 = 1 mark)

6 Which combination of resistors has the smallest total resistance?

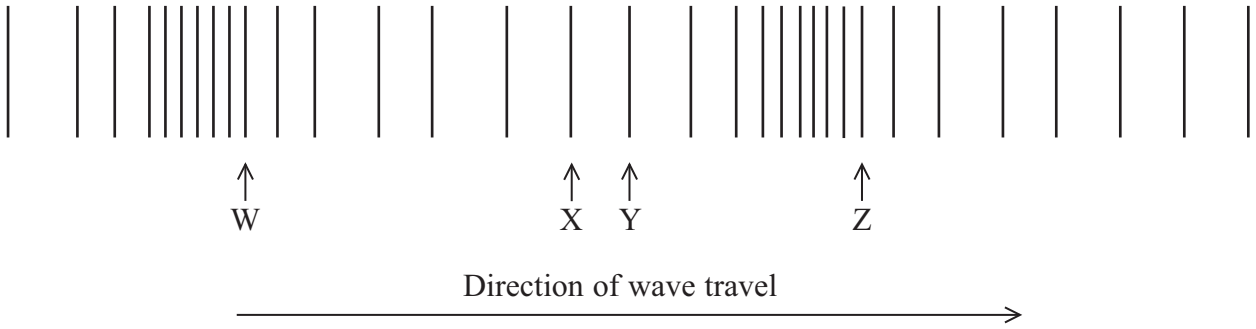


- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 6 = 1 mark)

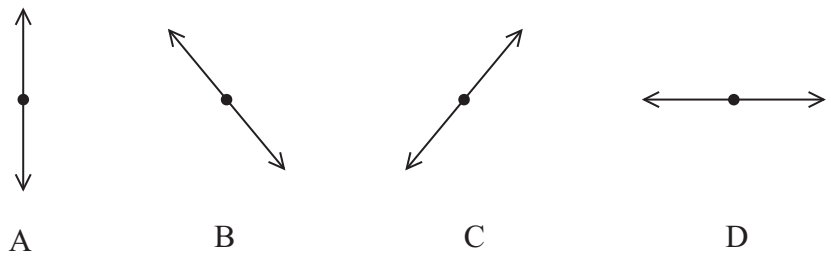
Use the following diagram to answer Questions 7 and 8

The diagram represents a longitudinal wave moving to the right through a uniform medium.



Points W, X, Y and Z represent the positions of particles of the medium.

7 The motion of the particle at W is represented by



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 7 = 1 mark)

8 The wavelength of the wave shown is the distance between points

☒ **A** W and Y.

☒ **B** W and Z.

☒ **C** X and Y.

☒ **D** Y and Z.

(Total for Question 8 = 1 mark)

9 Two wires of the same material are connected in series with a potential difference across them. Wire A has twice the cross-sectional area of wire B.

The ratio $\frac{\text{drift speed of electrons in A}}{\text{drift speed of electrons in B}}$ equals

- ☒ **A** ¼
- ☒ **B** ½
- ☒ **C** 2
- ☒ **D** 4

(Total for Question 9 =1 mark)

10 A student investigates how the resistance of a filament lamp varies during the first second after it is switched on.

He decides to use a computer with data logging sensors to take the readings.
The best reason for this is that

- ☒ **A** a large number of readings can be taken.
- ☒ **B** the computer can calculate the resistance.
- ☒ **C** there is no human error.
- ☒ **D** there is no zero error.

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

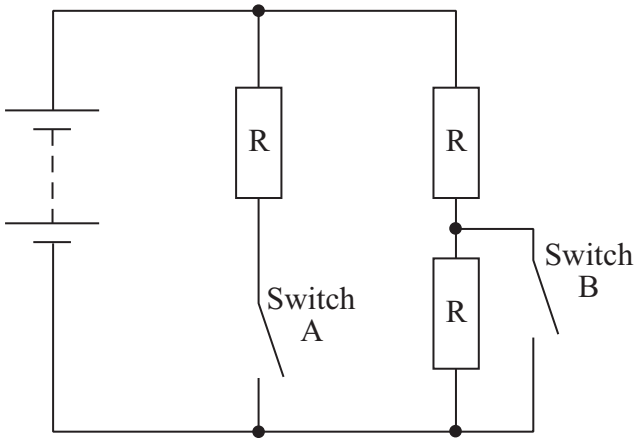
SECTION B

Answer ALL questions in the spaces provided.

11 The photograph shows a convector heater designed for use in a home. It operates by air flowing through the heater and passing over its heating elements.

The heater contains three identical heating elements and two switches.

(a) A student models the heater using the circuit below. The power supply has a negligible internal resistance.



The table gives the four possible combinations of the two switches.
Complete the table to show the total circuit resistance for each switch combination.

(3)

Switch combinations	Total circuit resistance
A open. B closed	R
A open. B open	
A closed. B closed	
A closed. B open	

(b) Explain which switch combination dissipates the most energy in a given time.

(2)

(c) The power supply is replaced by one with an internal resistance.

Explain what effect this change will have on the thermal energy output of the heater.

(2)

(Total for Question 11 = 7 marks)

12 Monochromatic light is shone onto the surface of a clean metal plate. The photoelectric effect results in electrons being emitted from the surface.

(a) State and explain the effect on the emitted electrons if

(i) the frequency of the light is increased

(2)

(ii) the intensity of the light is increased.

(2)

*(b) Explain how the photoelectric effect supports the particle model of light and not the wave model of light.

(4)

(Total for Question 12 = 8 marks)

13 The photograph shows a typical hairdryer.

(a) The hairdryer contains a heating element which consists of a long nichrome wire wound around an insulator. The heating element operates at 230 V and has a power rating of 1 kW.

Show that the resistance of the heating element is about 50 Ω.

(3)

(b) The nichrome wire has a cross-sectional area of 1.3×10^{-7} m^2.

Calculate the length of the wire.

resistivity of nichrome = 1.1×10^{-6} Ω m

(2)

Length = ...

(c) The nichrome wire has a diameter of 0.40 mm. A manufacturer wishes to make a hairdryer of the same resistance but using half the length of wire.

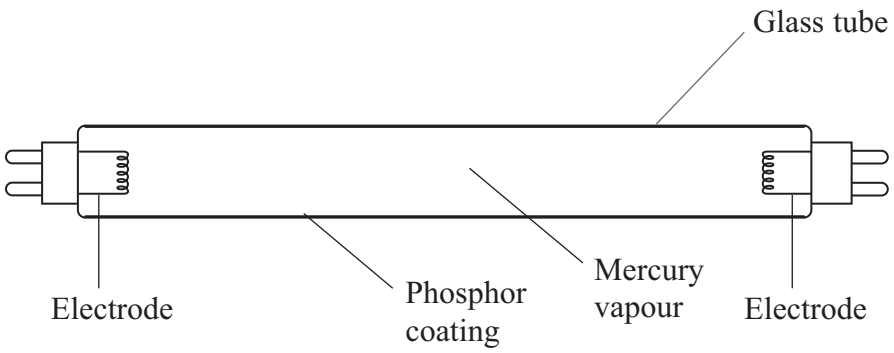
Calculate the diameter of nichrome wire that must be used.

(3)

Diameter = ...

(Total for Question 13 = 8 marks)

14 The diagram shows the main components of a fluorescent light tube.



When the light is switched on, charge flows between the electrodes and the mercury atoms become excited. The mercury atoms then emit electromagnetic radiation.

(a) What is meant by *the mercury atoms become excited*?

(2)

.....

.....

.....

.....

(b) (i) Explain how the excited atoms emit radiation.

(2)

(ii) Explain why only certain frequencies of radiation are emitted.

(3)

(iii) Some of the radiation is ultraviolet radiation which the human eye cannot detect. The phosphor coating absorbs the ultraviolet radiation and emits visible light.

Suggest why the phosphor coating emits different wavelengths from the mercury.

(1)

(Total for Question 14 = 8 marks)

15 The photograph shows the image of a fetus inside its mother's uterus. Ultrasound was used to produce this image.

(a) Explain how ultrasound pulses can be used to build up the image of the fetus in the uterus.

(3)

(b) Explain how the Doppler effect is used to detect the heartbeat of the fetus.

(2)

(c) The smallest detail that can be seen on the image is half the length of the ultrasound pulse. The thumbnail on the fetus is 0.50 mm thick. The speed of ultrasound in the thumbnail is 2000 m s^{-1}.

Calculate the maximum pulse duration if the thumbnail is to be seen on the image.

(3)

Maximum pulse duration = ...

(Total for Question 15 = 8 marks)

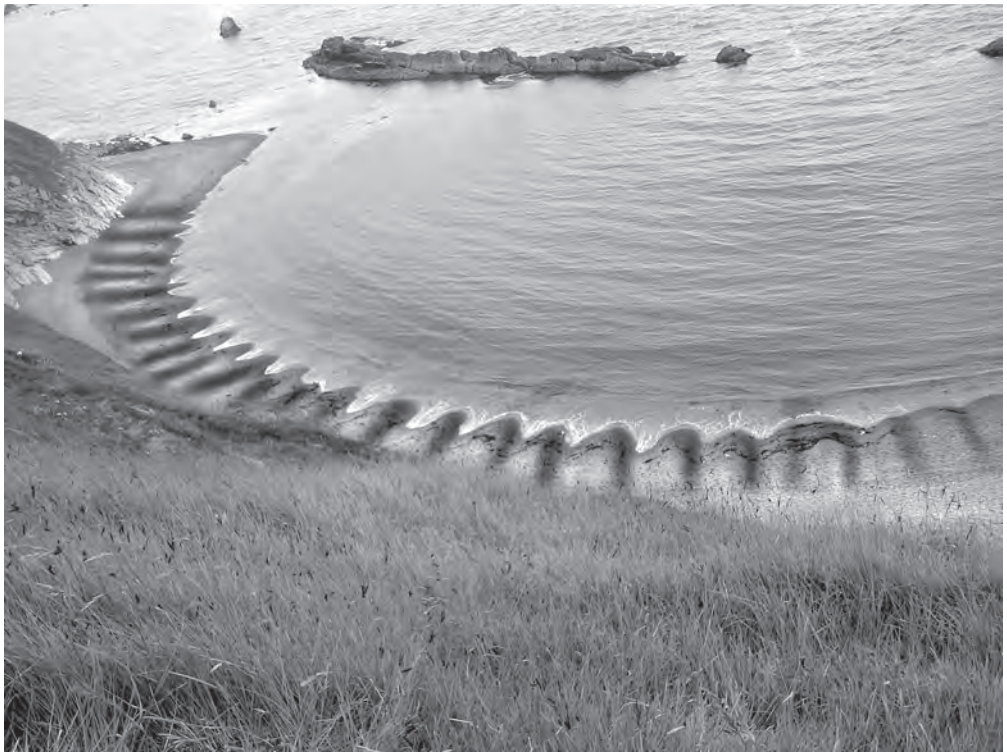
16 (a) State what is meant by diffraction.

(2)

(b) State the principle of superposition of waves.

(2)

*(c) The photograph shows a beach in England. Waves can be seen passing rocks on their way to the beach. The uneven surface of the sand has formed as a result of diffraction and superposition of these waves.



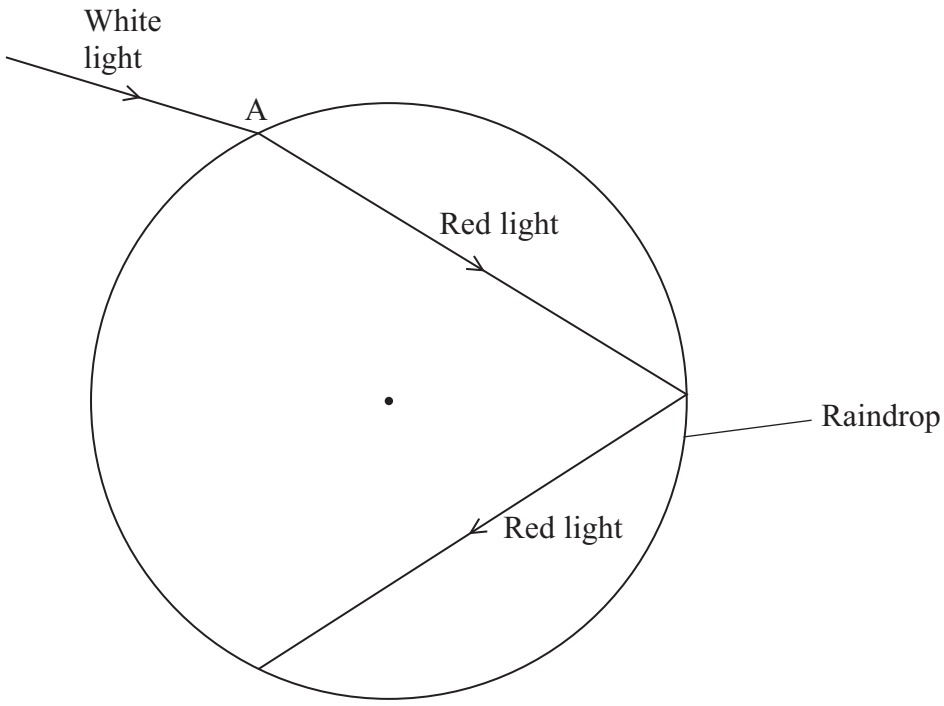
Use the ideas of diffraction and superposition to explain why the sand surface becomes uneven.

(5)

(Total for Question 16 = 9 marks)

17 Rainbows are seen when sunlight is dispersed by raindrops. The light is separated into different colours because they each take different paths through raindrops.

A ray of white light is incident on a raindrop. The diagram shows the subsequent path of the red light.



(a) Name the effect that is experienced by the red light at A.

(1)

.....

(b) (i) On the diagram label an angle of incidence with an *i* and an angle of refraction with an *r*.

(2)

(ii) On the diagram draw the path that a violet ray of light would take, through the raindrop and into the air.

(2)

(c) (i) State what is meant by the critical angle.

(1)

.....

.....

(ii) Calculate the critical angle for red light in the raindrop.

refractive index for red light in water = 1.3

(2)

.....

.....

.....

.....

.....

.....

Critical angle = ...

(d) Red light has a frequency of 4.2×10^{14} Hz and travels at a speed of 2.2×10^{8} m s^{-1} in the raindrop.

Calculate the wavelength of the red light in the raindrop.

(2)

.....

.....

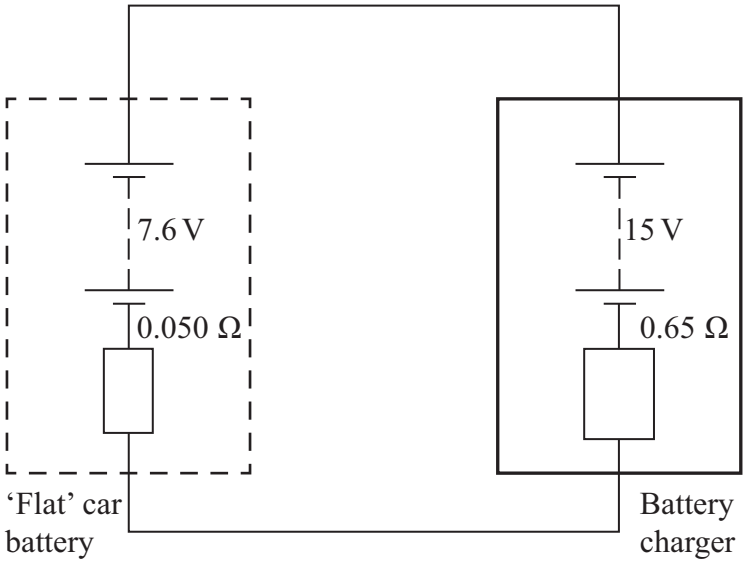
.....

.....

Wavelength = ...

(Total for Question 17 = 10 marks)

18 A 'flat' car battery of internal resistance 0.050 Ω is charged with a battery charger. The battery charger consists of a power supply (with negligible internal resistance) of e.m.f. 15 V in series with a resistor of resistance 0.65 Ω.



The positive terminal of the car battery is connected to the positive terminal of the battery charger.

(a) (i) Determine the resultant e.m.f. of the circuit.

(1)

.....

.....

Resultant e.m.f. = ...

(ii) Determine the total resistance of the circuit.

(1)

.....

.....

Total resistance = ...

(iii) Calculate the initial charging current.

(2)

.....

.....

.....

Charging current = ...

(b) The e.m.f. of the car battery quickly increases to 12.0 V and the charging current becomes 4.30 A.

(i) Show that the terminal potential difference across the battery charger is now about 12 V.

(3)

(ii) Calculate the rate at which electrical energy is now being supplied by the 15 V power supply.

(2)

Rate of energy supply = ...

(iii) The wasted energy in this process is the energy dissipated in the internal resistance of the car battery and the series resistor in the battery charger.

Calculate the efficiency of the charging process when the current is 4.30 A.

(3)

Efficiency = ...

(Total for Question 18 = 12 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Friday 18 January 2013 – Morning
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 ▶

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P 4 1 6 2 8 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 An ampere can be expressed as

☒ **A** $C\ s^{-1}$

☒ **B** $J\ C^{-1}$

☒ **C** $V\ W^{-1}$

☒ **D** $V\ \Omega$

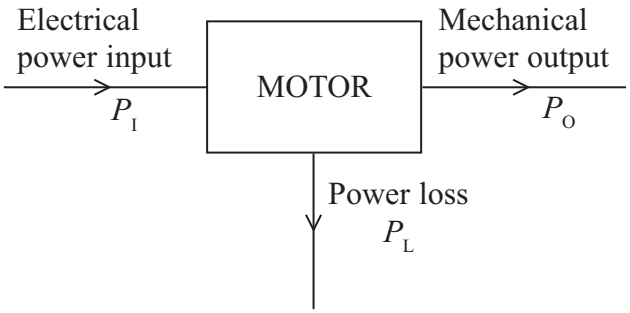
(Total for Question 1 = 1 mark)

2 Which of the following summarises the change in wave characteristics when going from ultraviolet to infrared in the electromagnetic spectrum?

	Frequency	Speed (in a vacuum)
☒ **A**	decreases	decreases
☒ **B**	decreases	stays the same
☒ **C**	increases	decreases
☒ **D**	increases	stays the same

(Total for Question 2 = 1 mark)

3 Electrical power is transferred in a motor as shown.



What is the efficiency of the motor?

☒ **A** $\frac{P_O + P_L}{P_I}$

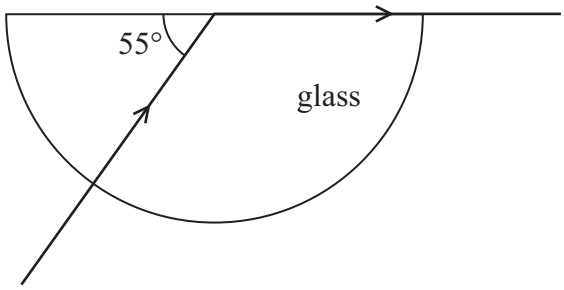
☒ **B** $\frac{P_I}{P_O}$

☒ **C** $\frac{P_L}{P_I}$

☒ **D** $\frac{P_O}{P_I}$

(Total for Question 3 = 1 mark)

4 A ray of monochromatic light passes into a glass block as shown.



The refractive index of the glass for this light is

☒ **A** 0.57

☒ **B** 0.81

☒ **C** 1.22

☒ **D** 1.74

(Total for Question 4 = 1 mark)

5 An electron is accelerated from rest through a potential difference of 5.0 kV.

The kinetic energy gained by the electron is

☒ **A** 8.0×10^{-16} J

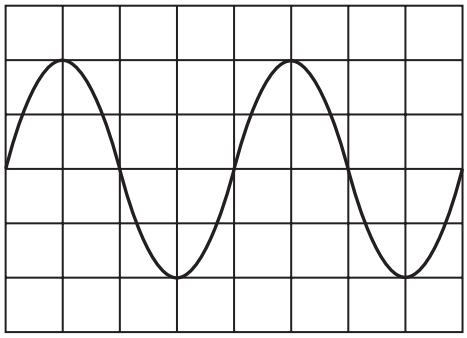
☒ **B** 8.0×10^{-19} J

☒ **C** 3.2×10^{-20} J

☒ **D** 3.2×10^{-23} J

(Total for Question 5 = 1 mark)

6 A particular sound is investigated by connecting a microphone to an oscilloscope. The diagram shows the trace of a sound wave on the oscilloscope. The screen of the oscilloscope has a grid on it. On the x-axis 1 division represents 5 ms.



The frequency of the sound wave is

☒ **A** 0.05 Hz

☒ **B** 0.1 Hz

☒ **C** 50 Hz

☒ **D** 100 Hz

(Total for Question 6 = 1 mark)

7 Two coherent sources emit waves of wavelength λ which are in phase. The two waves meet at a point, having travelled slightly different distances. The waves now have a phase difference of 180° (π radians).

Which of the following could be the path difference at this point?

☒ **A** $\frac{\lambda}{4}$

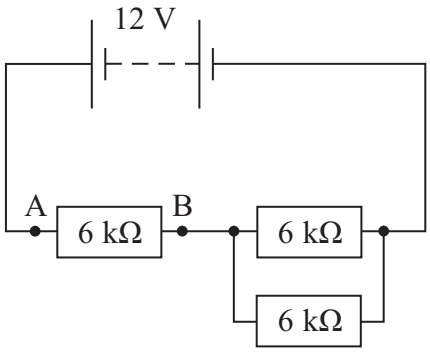
☒ **B** $\frac{\lambda}{2}$

☒ **C** $\frac{3\lambda}{4}$

☒ **D** λ

(Total for Question 7 = 1 mark)

8 A combination of resistors is connected to a 12 V supply of negligible internal resistance.



The potential difference between points A and B is

☒ **A** 4 V

☒ **B** 6 V

☒ **C** 8 V

☒ **D** 12 V

(Total for Question 8 = 1 mark)

9 Ultrasound is used to investigate the blood in an artery in a human body by detecting a Doppler shift. This Doppler shift is used to measure the

☒ **A** diameter of the artery.

☒ **B** size of the particles in the blood.

☒ **C** temperature of the blood.

☒ **D** velocity of the blood.

(Total for Question 9 = 1 mark)

10 The effect of diffraction is more noticeable, in everyday life, with sound than with light. This is because

☒ **A** sound has a much longer wavelength than light.

☒ **B** sound is a longitudinal wave, light is a transverse wave.

☒ **C** sound is a mechanical wave, light is an electromagnetic wave.

☒ **D** sound travels more slowly in air than light does.

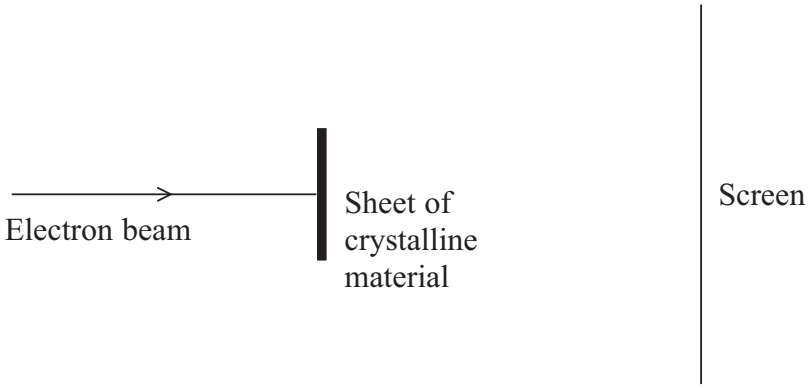
(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

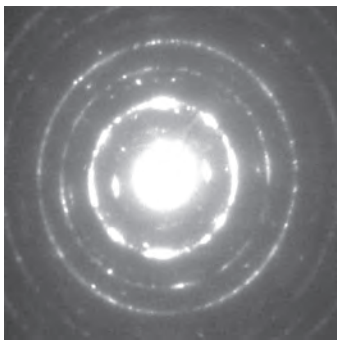
SECTION B

Answer ALL questions in the spaces provided.

11 The diagram shows a beam of electrons being fired towards a thin sheet of crystalline material. The screen detects electrons after they have passed through the sheet.



The photograph shows the positions at which electrons strike the screen.



Explain what can be deduced about the behaviour of electrons from the formation of this pattern.

(3)

(Total for Question 11 = 3 marks)

12 A thermistor has a negative temperature coefficient. With reference to the equation $I = nqvA$, explain what happens to the resistance of the thermistor when its temperature increases.

(3)

.....

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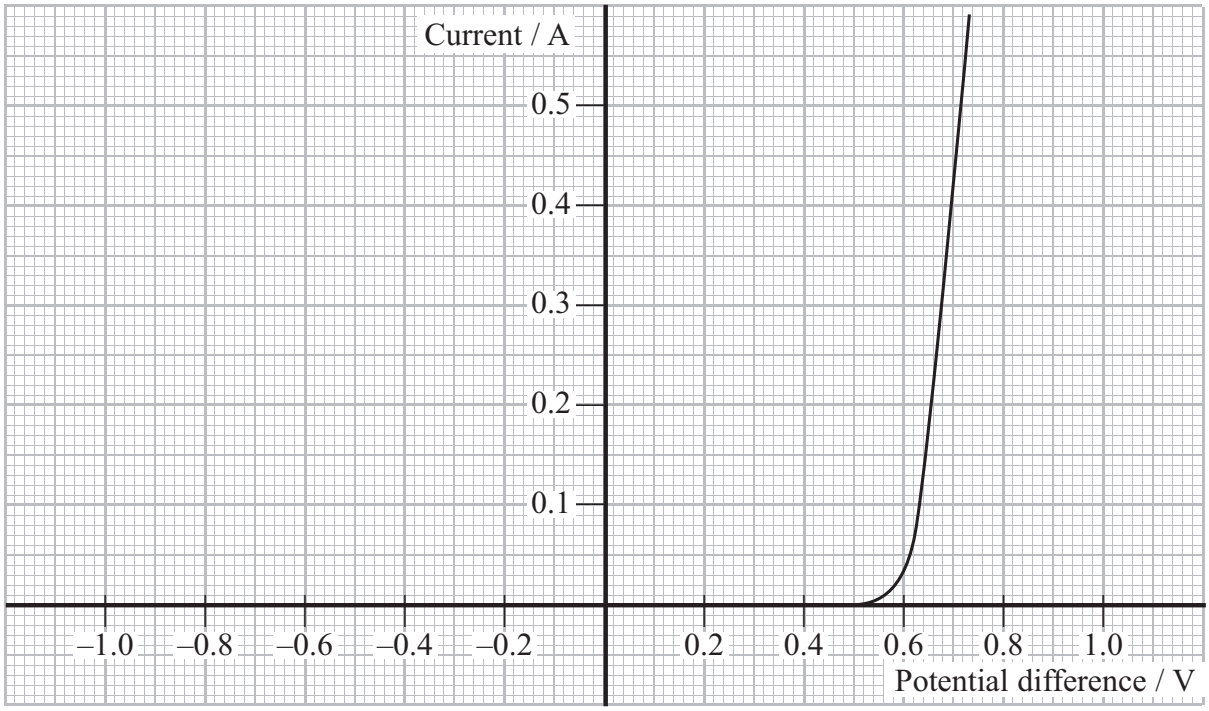
.....

(Total for Question 12 = 3 marks)

13 The graph shows the current–potential difference characteristic for an electrical component.



(a) State the name of the component.

(1)

.....

(b) State the resistance of the component when the potential difference is – 0.7 V.

(1)

.....

(c) Calculate the resistance of the component when the potential difference is + 0.7 V.

(2)

.....

.....

.....

Resistance = ...

(d) State a practical use for this component.

(1)

.....

.....

(Total for Question 13 = 5 marks)

14 (a) Explain what is meant by the work function of a metal.

(1)

.....

.....

.....

*(b) Observations of the photoelectric effect support the particle theory of light.

State **one** such observation and explain how it supports the particle theory of light.

(3)

.....

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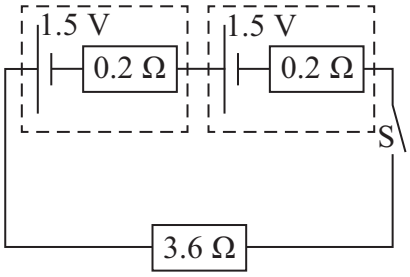
(Total for Question 14 = 4 marks)

15 Electrically heated gloves are used by skiers and climbers to provide extra warmth for their hands.

Each glove has a heating element of resistance 3.6 Ω. Two cells each of e.m.f. 1.5 V and internal resistance 0.2 Ω are used to operate each heating element.



(a) When the switch is closed:

(i) Calculate the total resistance in the circuit

(1)

.....

Total resistance = ...

(ii) Calculate the current in the heating element

(2)

.....

.....

Current = ...

(iii) Calculate the power output from the heating element.

(2)

.....

.....

Power output = ...

(b) When in use the internal resistance of each cell gradually increases.

State and explain the effect this will have on the power output of the heating element.

(3)

.....

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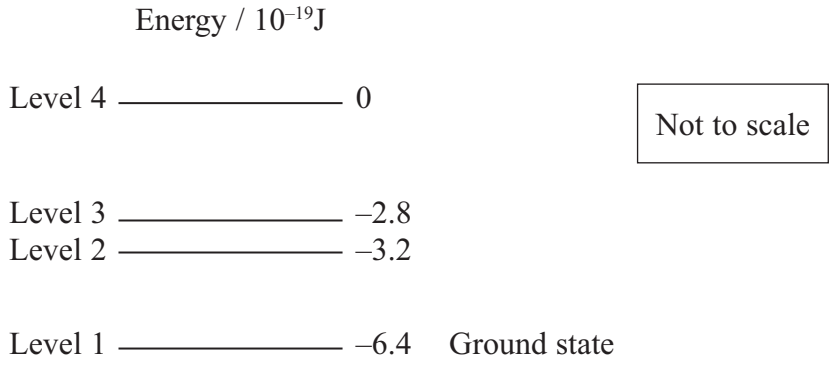
(Total for Question 15 = 8 marks)

16 The diagram shows four energy levels for an electron in a particular atom.



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

(1)

(b) Draw on the diagram **two** arrows to indicate two different transitions that would result in emitted radiation of the same frequency.

(2)

(c) A gas consisting of these atoms can emit a line spectrum.

Explain how this happens.

(3)

(d) One of these atoms in its ground state absorbs 3.6×10^{-19} J of energy from a collision with an electron.

Calculate the smallest frequency of radiation that the atom may subsequently emit.

(3)

Smallest frequency = ...

(e) Calculate how much energy in eV would be required to ionise the atom in its ground state.

(2)

Energy = ...

(Total for Question 16 = 11 marks)

17 When tidying a prep room, a teacher discovers a tray of resistance wires that have lost their labels. She decides to ask her students to carry out experiments to determine the material that each wire is made of by measuring the resistivity of the wires.

(a) Explain why the teacher asks the students to measure the resistivity and not the resistance of the wires.

(2)

.....

.....

.....

.....

*(b) You are to describe a method to determine accurately the resistivity of one of the metal wires.

Your description should include:

- the circuit diagram you would use
- the quantities you would measure
- the graph you would plot
- how you would determine the resistivity.

(9)

(Total for Question 17 = 11 marks)

18 If certain crystals are subjected to a mechanical stress, a potential difference is generated across them. This is called the piezoelectric effect. These crystals can be produced as very thin films.

Below is a photograph of a T-shirt with a built-in phone charger, which is being tested at a music festival. The white rectangle is a piezoelectric film.

(a) By considering how a sound wave travels through the air, explain how sound can cause a piezoelectric film to generate a potential difference.

(4)

(b) Explain why the crystals used in the T-shirt need to be in the form of a large, thin film.

(3)

(c) When the T-shirt is used at a music festival the sound levels are sufficient to generate about 20 kJ over ten hours. This is enough to charge one phone.

Calculate the electrical power output.

(3)

Power output = ...

(d) Give **one** advantage and **one** disadvantage of this charger compared with a conventional charger.

(2)

(Total for Question 18 = 12 marks)

19 The 2010 Football World Cup was held in South Africa and is remembered for the noise of the vuvuzelas.

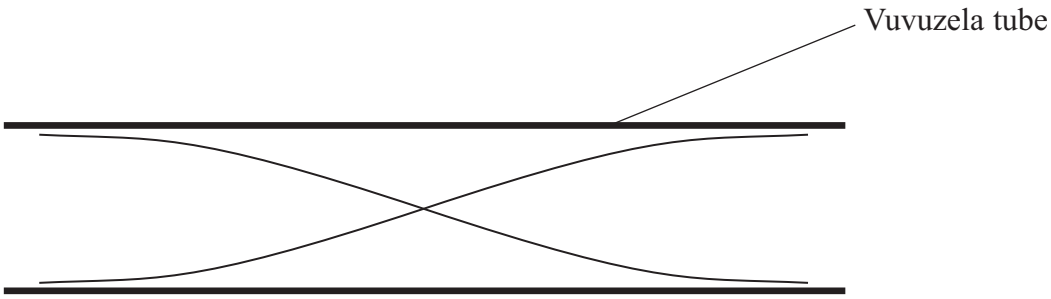
The vuvuzela is a musical instrument which works by making the air inside the vuvuzela vibrate so that a standing wave is produced.

*(a) Explain how a standing wave is produced.

(3)

(b) The vuvuzela makes a noise because it is producing standing waves of different frequencies.

The diagram shows the standing wave with the lowest frequency.



Calculate the frequency of this standing wave.

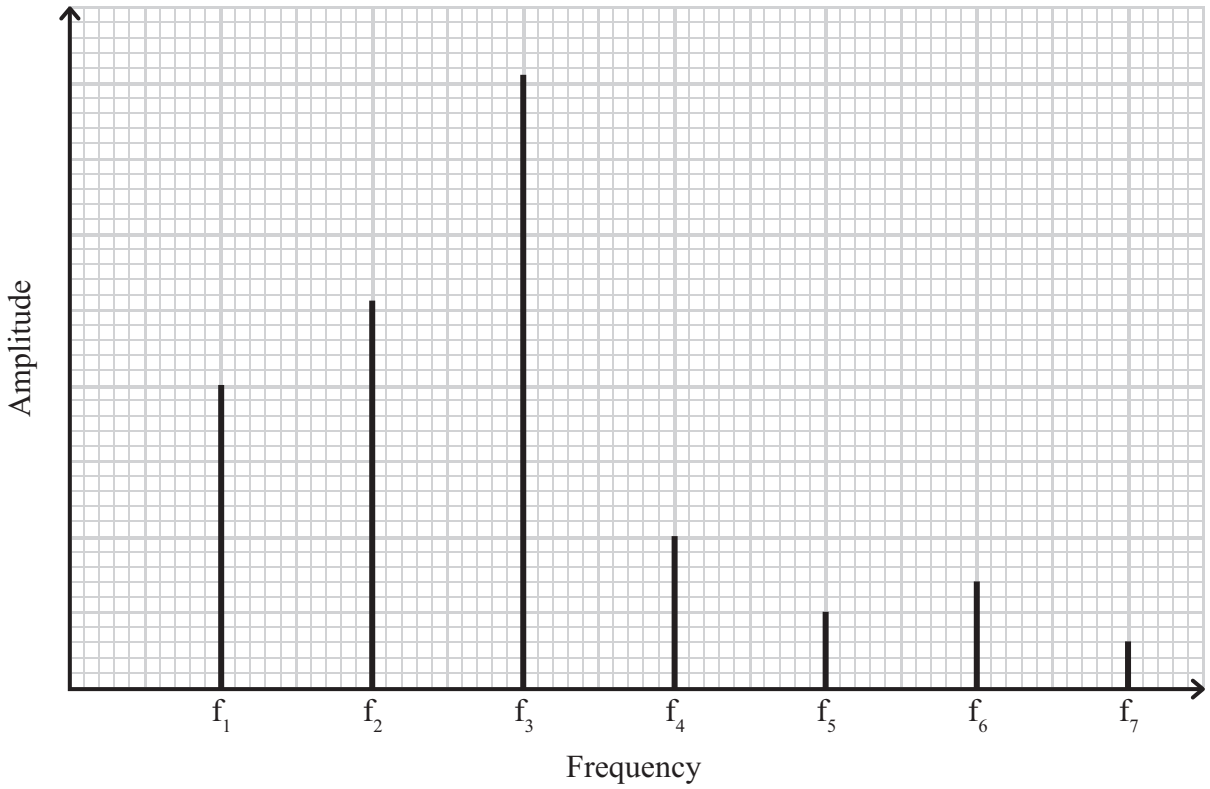
length of the vuvuzela = 60 cm

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

(3)

Frequency = ...

(c) Human speech contains a continuous range of frequencies.
When the vuvuzela's sound is analysed it is found to contain only certain fixed frequencies which can be heard by humans.



At the Football World Cup the noise of the vuvuzelas made it difficult for the television commentators to be heard. A solution was to use a filter that removed some of the frequencies produced by the vuvuzelas.

Suggest which **two** frequencies it would be best to remove, the effect this would have and the disadvantage of removing all of the frequencies.

(3)

(d) Noise cancelling headphones work by detecting a sound and producing another sound that is in antiphase and so causing destructive interference.

(i) Explain what is meant by antiphase and destructive interference.

(3)

(ii) Explain why the headphones could not be used to cancel the noise of the vuvuzelas.

(1)

(Total for Question 19 = 13 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Wednesday 5 June 2013 – Morning
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.
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Information

- The total mark for this paper is 80.
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Turn over ▶

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P 4 1 6 3 4 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 is a standing wave?

☒ **A** light emitted as a line spectrum

☒ **B** ripples on water from a stone thrown into a pond

☒ **C** sound from an opera singer in a theatre

☒ **D** vibrations on a violin string as it is played

(Total for Question 1 = 1 mark)

2 An electric motor with potential difference V and current I lifts a mass m through a height h in time t at a steady speed v.

The efficiency of the motor is given by

☒ **A** $\frac{\frac{1}{2}mv^2}{VIt}$

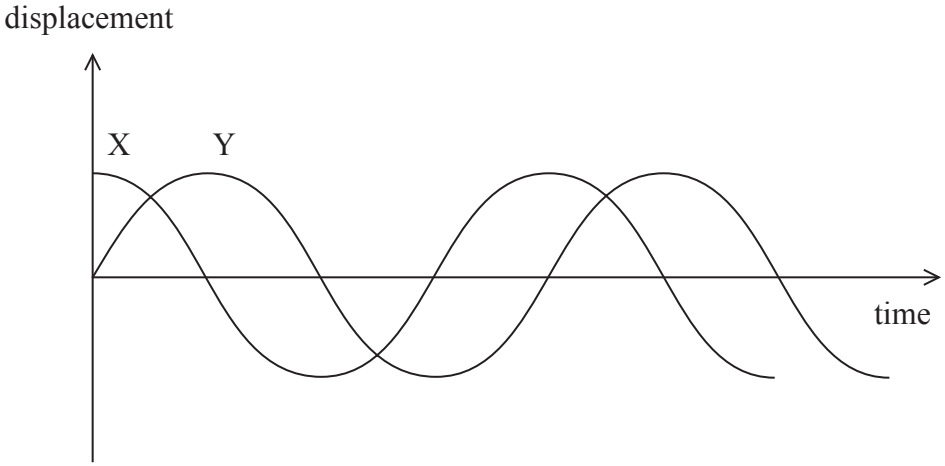
☒ **B** $\frac{VI}{mg}$

☒ **C** $\frac{VIt}{mv}$

☒ **D** $\frac{mgh}{VIt}$

(Total for Question 2 = 1 mark)

3 The diagram shows displacement-time graphs for two oscillations, X and Y.



Which of the following statements correctly describes their phase relationship?

☒ **A** X and Y are in antiphase

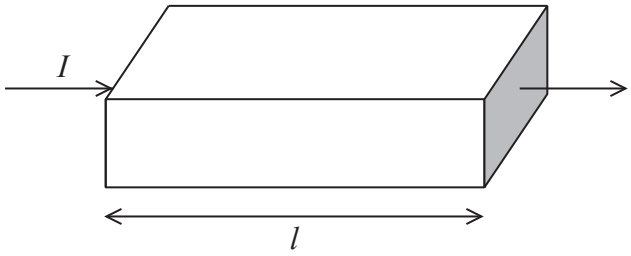
☒ **B** X and Y are in phase

☒ **C** X is $\pi/2$ radians ahead of Y

☒ **D** Y is $\pi/2$ radians ahead of X

(Total for Question 3 = 1 mark)

4 The diagram shows a current I flowing through a sample of material of length l and cross-sectional area A.



The drift velocity of the free electrons is v.

If the area and length are both doubled, but the current remains the same, the drift velocity will be

☒ **A** $v / 4$

☒ **B** $v / 2$

☒ **C** $2v$

☒ **D** $4v$

(Total for Question 4 = 1 mark)

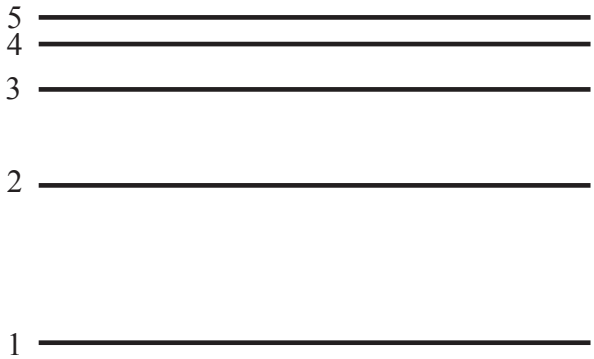
5 The diagrams show the motions of a source of sound, S, and an observer, O.

Which line of the table correctly shows the effect this relative motion has on the frequency of the sound heard by the observer.

	Motions of S and O	Frequency
☒ **A**	S ← ● O ● stationary	increased
☒ **B**	S ● → ● ← O	decreased
☒ **C**	S ← ● O ● →	decreased
☒ **D**	S ● stationary O ● →	increased

(Total for Question 5 = 1 mark)

6 The diagram shows five energy levels in an atom.



Electromagnetic radiation is incident on the atom.

Which transition would be caused by the absorption of the lowest frequency of radiation?

☒ **A** 1 to 5

☒ **B** 1 to 2

☒ **C** 4 to 5

☒ **D** 5 to 4

(Total for Question 6 = 1 mark)

7 Light is shone perpendicularly onto a photovoltaic cell of area 0.01 m^2. In 60 seconds, the total energy falling on the cell is 3 J.

The radiation flux is

☒ **A** 18 000 W m^{-2}

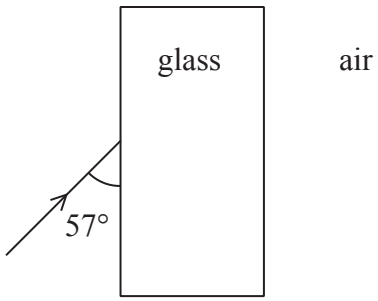
☒ **B** 5 W m^{-2}

☒ **C** 1.8 W m^{-2}

☒ **D** 0.0005 W m^{-2}

(Total for Question 7 = 1 mark)

8 The diagram shows a ray of light incident upon the surface of a glass block.



Which line could correctly show the angle of incidence and the angle of refraction?

	Angle of incidence	Angle of refraction
☒ **A**	33°	21°
☒ **B**	33°	55°
☒ **C**	57°	34°
☒ **D**	57°	38°

(Total for Question 8 = 1 mark)

9 A current of 0.2 A flows through a lamp for 3 hours.

The total charge passing through the lamp in this time is

☒ **A** 2160 C

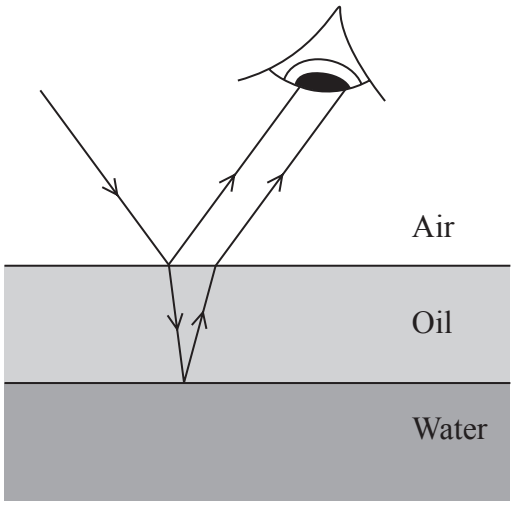
☒ **B** 600 C

☒ **C** 36 C

☒ **D** 0.6 C

(Total for Question 9 = 1 mark)

10 The diagram shows a ray of white light striking a thin layer of oil on water. Light reflects from the upper and lower surfaces of the oil, so that two rays reach the eye of an observer. With the eye in different positions the observer sees different colours from the oil.



Which of the following phenomena is not involved in the production of the colours seen?

☒ **A** polarisation

☒ **B** reflection

☒ **C** refraction

☒ **D** superposition

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 (a) Some radio signals have a frequency of 218.6 MHz.

Calculate their wavelength.

(2)

Wavelength = ...

(b) State what is meant by:

(i) frequency

(1)

(ii) wavelength.

(1)

(Total for Question 11 = 4 marks)

12 (a) You are asked to find the refractive index for light passing from air to glass by tracing the path of a ray of light through a glass block.

State the measurements you would take, the graph you would plot and how you would use the graph to determine a value for the refractive index.

(3)

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

(2)

(ii) Calculate the critical angle for light passing from water to air.

refractive index of water = 1.33

(2)

Critical angle = ...

(Total for Question 12 = 7 marks)

13 A strain gauge measures changes in the resistance of a metal under strain to find the applied force. The kitchen balance in the photograph uses strain gauges to measure the weight of cooking ingredients.

A student tests this method by measuring the resistance of a wire before a force is applied and while it is under tension.

(a) Calculate the initial resistance of the wire.

length of wire = 1.0 m

cross sectional area of wire = 2.9×10^{-8} m^2

resistivity of wire = 4.9×10^{-7} Ω m

(2)

Resistance of wire = ...

(b) The student applies a force to the wire and measures the new length. He calculates the increase in the resistance to be 0.035 Ω. He measures the increase in resistance and finds it to be 0.070 Ω.

The student suggests that the difference between these two values is because the cross-sectional area of the wire changes under strain.

Explain why a change in cross-sectional area would cause this difference.

(3)

(Total for Question 13 = 5 marks)

14 Films made to be watched in three dimensions (3D) are produced by projecting two slightly different images on to the screen, one to be seen by each eye.

In one technique the images are polarised. The viewers wear special glasses where the lenses are replaced by two separate plane polarising filters.

(a) Explain what is meant by plane polarised light.

(3)

(b) The light from the screen reaching each eye passes through a different filter so each eye sees a different image. The filter for one eye has a plane of polarisation of 45° and the filter for the other eye has a plane of polarisation of 135°.

Explain this choice of angles.

(2)

(c) One complaint about 3D films seen through polarising filters is that they appear darker compared to ordinary films.

Suggest why this is the case.

(2)

(d) 3D film viewing is no longer done with plane polarised glasses because these require the viewers to keep their heads exactly level for the whole film. Tilting of the head causes partial viewing of the left image by the right eye and vice versa.

Explain why one eye would see a faint image intended for the other eye if the head is tilted slightly.

(2)

(Total for Question 14 = 9 marks)

15 When the photoelectric effect was first observed in the nineteenth century, scientists could not explain it using the wave theory of light.

In 1905 Albert Einstein published a paper, for which he won a Nobel Prize, explaining the photoelectric effect by using a photon model of light, rather than a wave model.

(a) Explain what is meant by a photon.

(2)

*(b) Explain why the following observations may be understood by using a photon model of light, rather than a wave model.

- Light above a certain frequency causes the emission of electrons from the surface of a metal. This emission occurs instantaneously.
- Light below a certain frequency will not result in the emission of electrons however long it illuminates the surface.

(5)

(c) Zinc has a work function of 4.3 eV.

(i) Calculate the threshold frequency for zinc.

(3)

Threshold frequency = ...

(ii) State the part of the electromagnetic spectrum to which radiation of this frequency belongs.

(1)

.....

(Total for Question 15 = 11 marks)

16 Ultrasonic testing can be used for detecting corrosion inside metal pipes.

(a) Describe how the ultrasound travels through a metal.

(3)

(b) A steel pipe was manufactured with a wall thickness of 4.0 cm.

After several years of use this pipe is tested for corrosion. A pulse of ultrasound is sent into the steel from the outer surface and the reflection from the inner surface is detected after a time of 5.1×10^{-6} s.

Determine whether the steel is corroded at this point.

speed of sound in steel = 5900 m s^{-1}

(4)

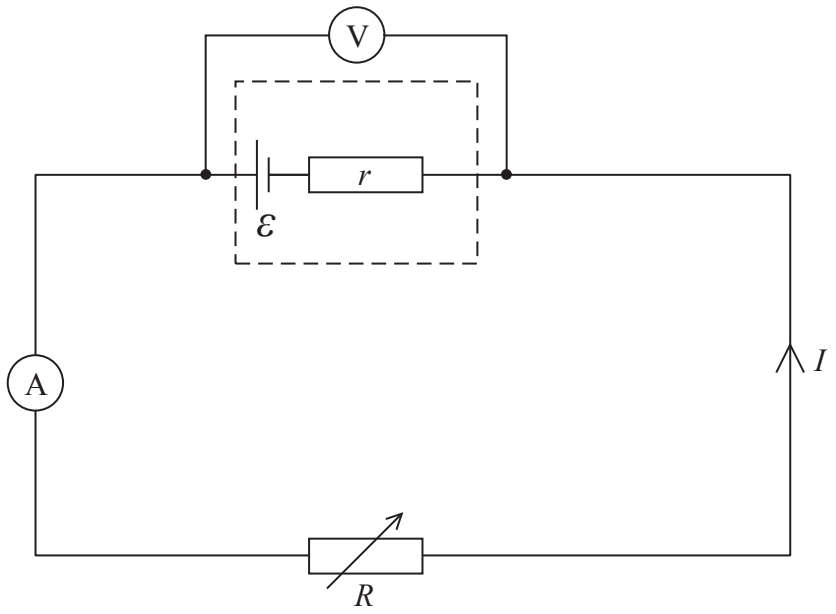
(c) In this technique the ultrasound is emitted as pulses.

Explain why pulses are used rather than a continuous wave and how the duration of the pulse affects the thickness of the pipe wall that can be accurately measured.

(3)

(Total for Question 16 = 10 marks)

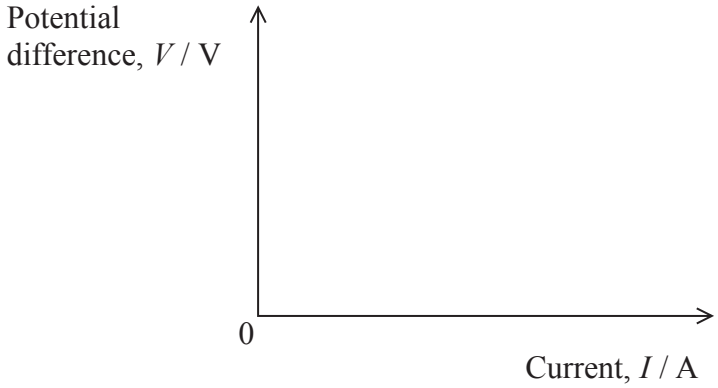
17 The diagram shows a circuit which may be used to find the emf $\mathcal{E}$ and internal resistance r of a cell.



(a) As the resistance R of the variable resistor is varied, values of the current I in the circuit and the terminal potential difference V across the cell are recorded.

Sketch the graph of V against I and explain how it may be used to determine $\mathcal{E}$ and r.

(5)



*(b) We usually assume that ammeters have negligible resistance and voltmeters have infinite resistance.

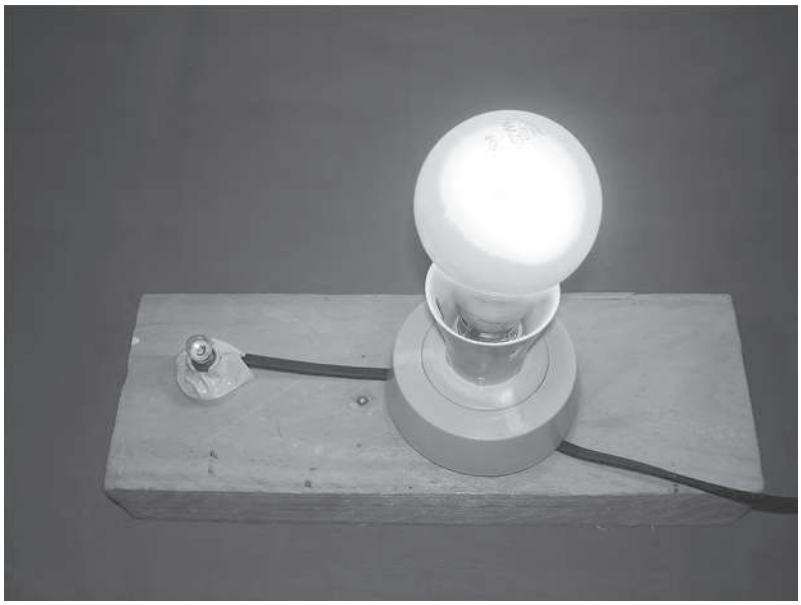
The determination of $\mathcal{E}$ and r is not affected by using an ammeter with non-negligible resistance but is affected by using a voltmeter with a low resistance.

Explain why.

(4)

(Total for Question 17 = 9 marks)

18 The photograph shows a piece of apparatus in which a mains light bulb and a torch bulb are both connected to the mains.



Students were surprised to see both bulbs shining normally when the apparatus was switched on.

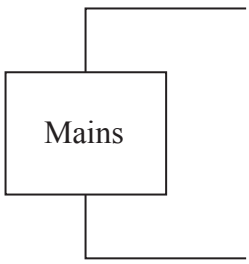
It is impossible to tell from looking at the apparatus whether the bulbs are connected in series or in parallel.

To test this, the apparatus was switched off and the mains bulb was removed. When it was switched on again the torch bulb did not light up. When this was repeated, removing the torch bulb, the mains bulb did not light up.

When the circuit was tried again with both bulbs, they still operated normally.

(a) Complete the circuit diagram to show how the bulbs are connected and explain why they must be connected in this way and not the alternative.

(3)



(b) The mains bulb is marked 40 W, 230 V.

(i) Show that the current in the mains bulb is about 0.2 A when it is operating normally.

(2)

(ii) Calculate the resistance of the mains bulb when it is operating normally.

(2)

Resistance = ...

(iii) The torch bulb is marked 2.5 V, 0.20 A.

Calculate the resistance of the torch bulb when it is operating normally.

(2)

Resistance = ...

(c) Explain, with reference to both current and potential difference, why it is possible to operate both bulbs at the same time from the same power supply.

(2)

(d) Earlier in the question you were asked to calculate the resistances of the bulbs when operating normally.

Explain the effect on the resistances of the bulbs if they are operated at a much smaller current so that neither bulb lights up.

(4)

(Total for Question 18 = 15 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS

Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Wednesday 5 June 2013 – Morning
Time: 1 hour 30 minutes

Paper Reference
6PH02/01R

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 ▶

P43322A

1/1/1/1/C2

P 4 3 3 2 2 A 0 1 2 4

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 type of electromagnetic radiation is used for communicating with satellites?

☒ **A** infrared

☒ **B** microwave

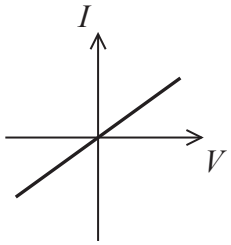
☒ **C** ultraviolet

☒ **D** visible light

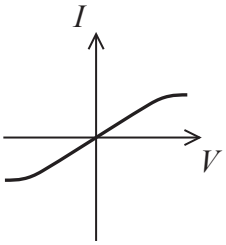
(Total for Question 1 = 1 mark)

2 Which of the following current – potential difference (*I*–*V*) graphs shows the correct behaviour for a filament bulb?

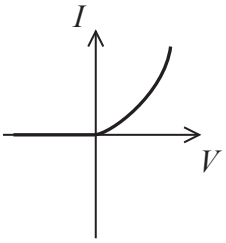
A



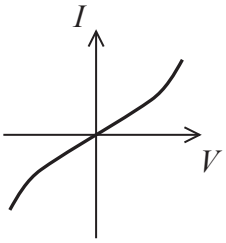
B



C



D



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 2 = 1 mark)

3 A standing wave is created on a string stretched between two supports.

Which statement is always true?

☒ **A** There is a node at each end.

☒ **B** There is a node in the centre.

☒ **C** There is an antinode at each end.

☒ **D** There is an antinode in the centre.

(Total for Question 3 = 1 mark)

4 Light from a lamp passes through two polarising filters, P1 and P2, before reaching a detector. The filters initially have their planes of polarisation parallel.

The intensity of light at the detector will be greatest if

☒ **A** P1 is rotated by 45° and P2 is rotated by 315° in the same direction.

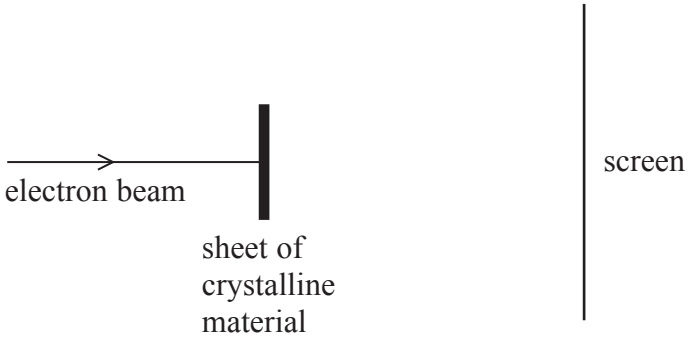
☒ **B** P1 is rotated by 90° and P2 is rotated by 270° in the same direction.

☒ **C** P1 is rotated by 45° and P2 is rotated by 270° in the same direction.

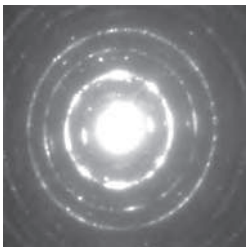
☒ **D** P1 is rotated by 90° and P2 is rotated by 315° in the same direction.

(Total for Question 4 = 1 mark)

5 A beam of electrons is directed towards a section of crystalline material.



The following pattern is produced by the electrons on the screen.



This pattern demonstrates

☒ **A** diffraction.

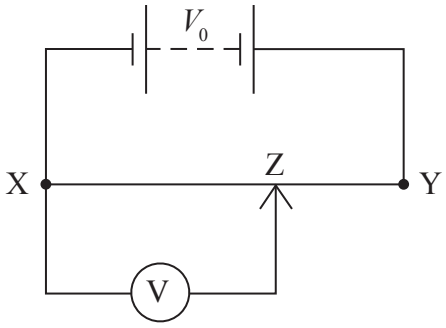
☒ **B** polarisation.

☒ **C** reflection.

☒ **D** refraction.

(Total for Question 5 = 1 mark)

6 The diagram shows a uniform wire XY across which a potential difference V_0 is applied.



Which of the following correctly shows the output potential difference across XZ?

☒ **A** $V = \frac{XY}{XZ}V_0$

☒ **B** $V = \frac{XZ}{XY}V_0$

☒ **C** $V = \frac{XZ}{ZY}V_0$

☒ **D** $V = \frac{ZY}{XY}V_0$

(Total for Question 6 = 1 mark)

7 When a semiconductor has its temperature increased from room temperature, its resistance usually decreases because

☒ **A** the electrons are moving faster.

☒ **B** the lattice atoms vibrate with greater amplitude.

☒ **C** the lattice atoms vibrate with smaller amplitude.

☒ **D** the number of charge carriers per unit volume increases.

(Total for Question 7 = 1 mark)

8 Which of the following is a base SI unit?

☒ **A** ampere

☒ **B** coulomb

☒ **C** ohm

☒ **D** volt

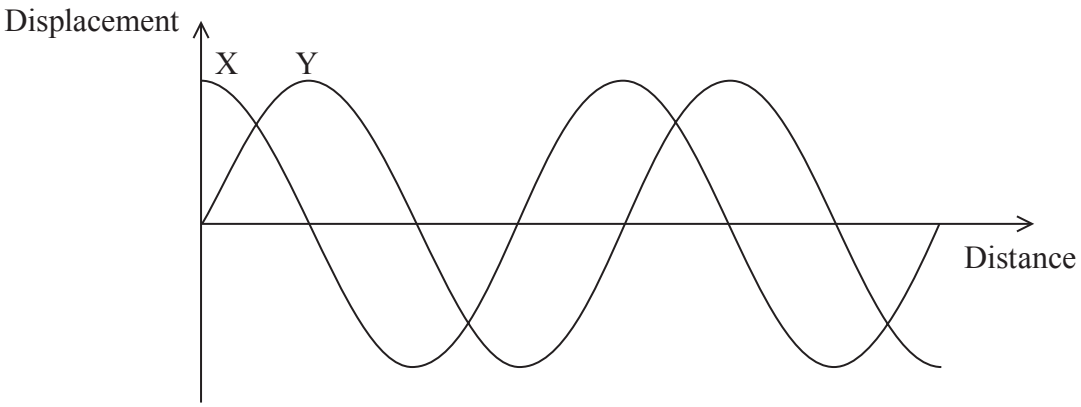
(Total for Question 8 = 1 mark)

9 Which term may be defined as the number of waves passing a point in one second?

- ☒ **A** wave speed
- ☒ **B** wavelength
- ☒ **C** period
- ☒ **D** frequency

(Total for Question 9 = 1 mark)

10 The diagram shows a displacement–distance graph at an instant for two waves, X and Y, travelling to the right.



Which of the following statements correctly describes the phase relationship between the two waves?

- ☒ **A** X and Y are in antiphase
- ☒ **B** X and Y are in phase
- ☒ **C** X is $\pi/2$ radians ahead of Y
- ☒ **D** Y is $\pi/2$ radians ahead of X

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 Explain why an ammeter

- must be placed in series to measure current through a component
- must have a very low resistance.

(3)

(Total for Question 11 = 3 marks)

12 When a cell of e.m.f. 1.5 V is connected across a resistance of 6.6 Ω the current is 0.21 A.

Calculate the internal resistance of the cell.

(3)

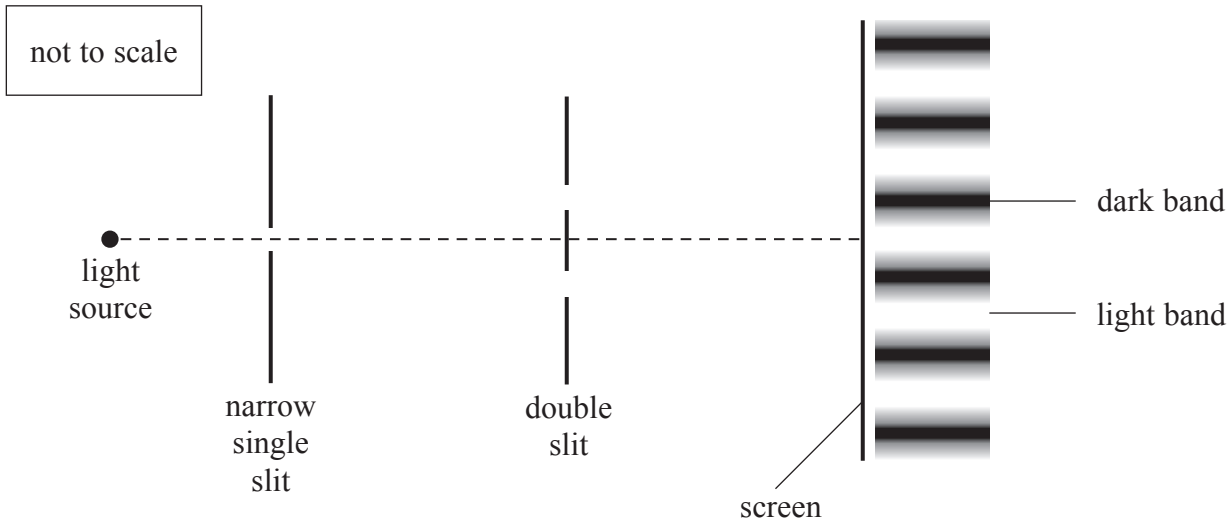
Internal resistance = ...

(Total for Question 12 = 3 marks)

13 In the 17th century, Isaac Newton suggested that light was made up of very small particles which he called corpuscles.

Newton's theory was favoured in England throughout the 18th century because of his great reputation although scientists elsewhere applied the wave theory.

In 1801 Thomas Young demonstrated his double slit experiment. Monochromatic light from a narrow single slit was passed through a double slit and a pattern of light and dark bands was seen on a screen, as shown in the diagram.



*(a) Explain how the light and dark bands are formed in the double slit experiment.

(4)

(b) The observation of light and dark bands with the double slit experiment depends on the light from the slits being coherent.

Explain why coherence is necessary to observe the light and dark bands.

(2)

(c) State why Young's experiment disproved Newton's corpuscular theory.

(1)

(Total for Question 13 = 7 marks)

14 A rechargeable AA cell is labelled 2.0 Ah (ampere hours), 1.2 V.

(a) Show that Ah is a unit of charge.

(2)

(b) When charging the cell, the current is 0.19 A and the potential difference is 1.5 V for 10 hours.

Calculate the electrical energy supplied while the cell is being charged.

(2)

Electrical energy supplied = ...

(c) The maximum charge that can be delivered from a fully charged cell is 7200 C.

Calculate the maximum energy which could be transferred by the cell if the output potential difference remained constant at 1.2 V.

(2)

Maximum energy = ...

(d) Calculate the efficiency of the charging process.

(2)

Efficiency = ...

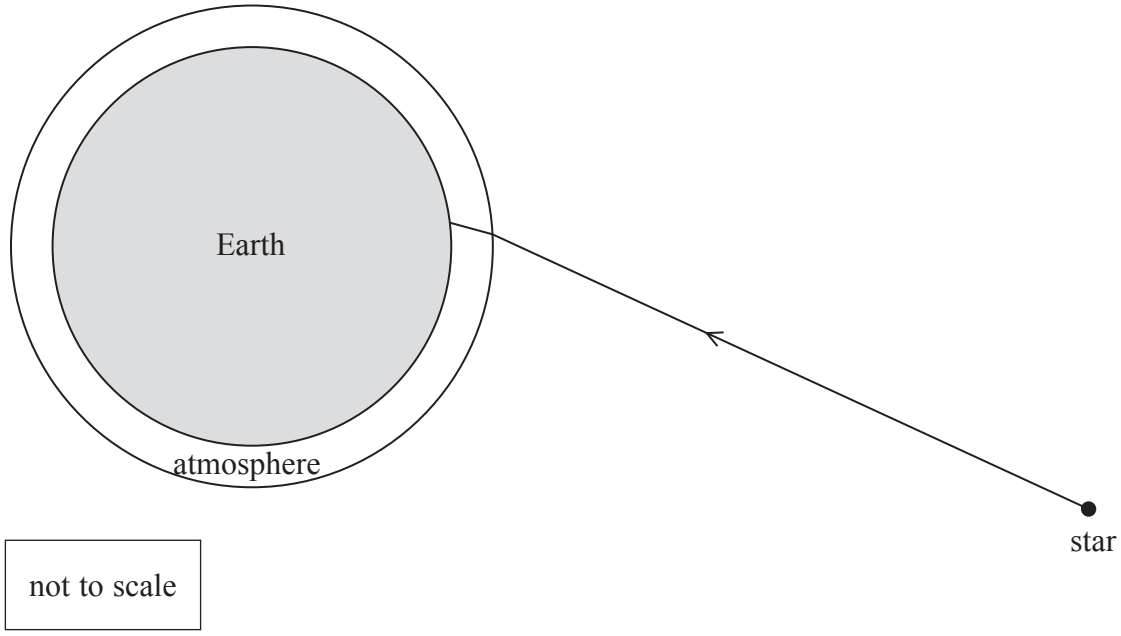
(Total for Question 14 = 8 marks)

15 When light rays enter the Earth's atmosphere from space they undergo refraction. This can lead to a star appearing to be in a different position from its actual position.

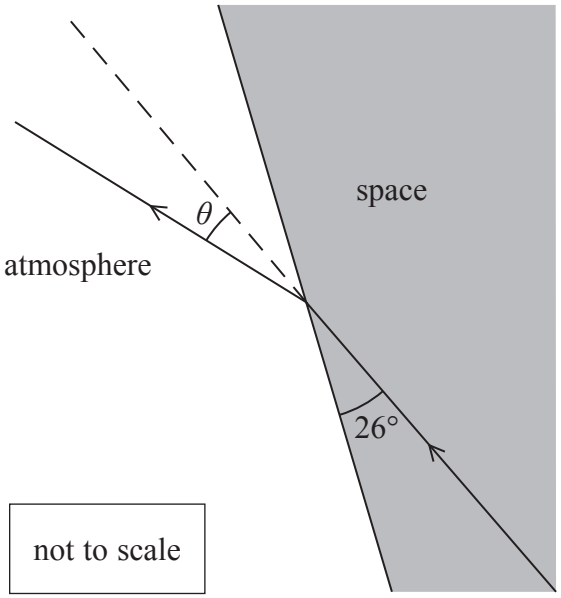
(a) Explain what is meant by refraction and why it occurs for light entering the Earth's atmosphere.

(3)

(b) The diagram shows a ray of light from a star reaching the Earth's surface.



The diagram shows in more detail the ray of light as it enters the atmosphere.



Calculate the change in direction θ of the ray.

refractive index of atmosphere = 1.001

(4)

θ = ...

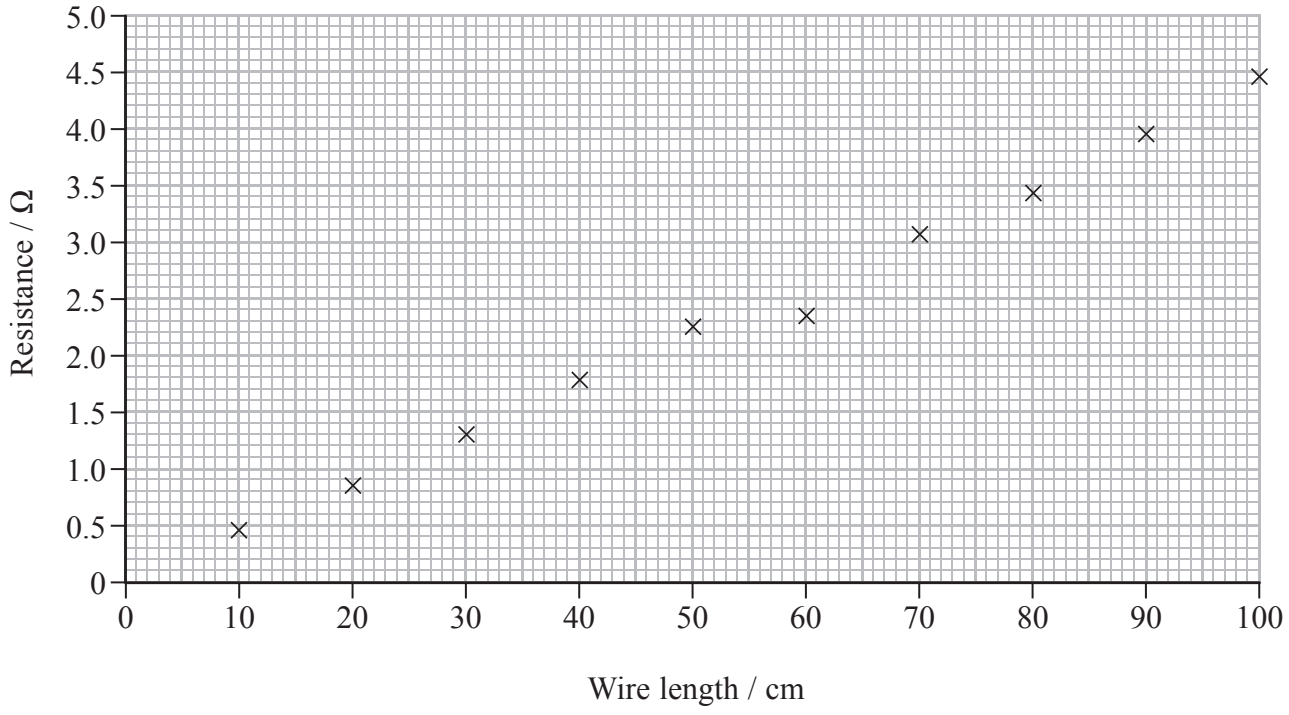
(Total for Question 15 = 7 marks)

16 A student carried out a series of measurements to determine how the resistance of a wire varies with its length.

The student obtained the following results.

Wire length / cm	Current / A	Potential difference / V	Resistance / Ω
100	0.15	0.67	4.47
90	0.16	0.63	3.94
80	0.17	0.58	3.41
70	0.17	0.52	3.06
60	0.18	0.42	2.33
50	0.18	0.40	2.22
40	0.19	0.34	1.79
30	0.20	0.26	1.30
20	0.22	0.18	0.82
10	0.22	0.10	0.45

The student plotted the results on a graph.



(a) Calculate the resistivity of the wire used.

cross-sectional area of wire = 1.06×10^{-7} m^2

(4)

Resistivity = ...

(b) One precaution taken by the student was to keep the current small.

Explain why this precaution was necessary.

(2)

(c) Explain **one** other precaution which should be taken by the student to ensure the accuracy of the results in the table.

(2)

(Total for Question 16 = 8 marks)

17 Analysing the light from a star allows elements present in its outer atmosphere to be identified because each element produces a distinctive set of spectral lines.

*(a) Describe how a spectral line is produced by a hot gas, explaining why a particular element can only give rise to particular frequencies.

(6)

(b) The diagram shows the spectral lines produced by a particular element when observed in a laboratory.

The diagram below shows the spectral lines obtained by analysing the light from a star. This shows the same pattern of lines, but in a different part of the spectrum.

Name this effect and explain what may be deduced about the motion of this star relative to the Earth.

(3)

(c) Suggest what the phenomena in parts (a) and (b) imply about the nature of light.

(1)

(Total for Question 17 = 10 marks)

18 Dolphins use ultrasound when hunting prey. They emit short pulses of ultrasound, known as clicks, and detect the ultrasound reflected from their prey.

(a) Describe how ultrasound travels through water.

(2)

(b) Suggest why the dolphins emit a series of clicks rather than a continuous sound.

(1)

(c) When searching for prey the dolphins emit 16 clicks per second.

(i) Show that the time between clicks when searching for prey is about 0.06 s.

(1)

(ii) Calculate the maximum distance that can be determined by the dolphin when searching for prey.

speed of sound in seawater = 1530 m s^{-1}

(3)

Maximum distance = ...

(iii) The dolphin increases the number of clicks per second to 125 when near to capturing its prey.

Suggest why.

(1)

(d) Bats use ultrasound in air when hunting prey. The ultrasound frequency and the duration of the click is the same for both bats and dolphins.

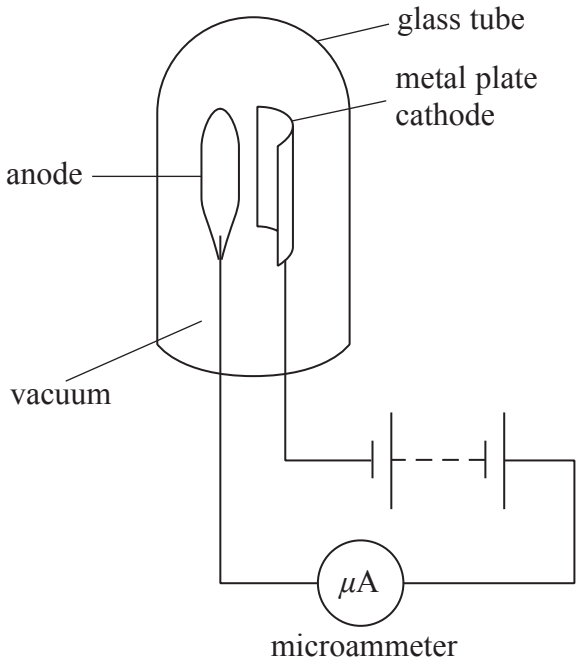
Explain whether bats or dolphins would be able to locate their prey more precisely.

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

(3)

(Total for Question 18 = 11 marks)

19 Phototubes are devices which make use of the photoelectric effect to detect light above a specific frequency.



(a) Explain why

- no current flows when the phototube is in darkness
- current flows in the circuit when the phototube is illuminated by light above a specific frequency.

(5)

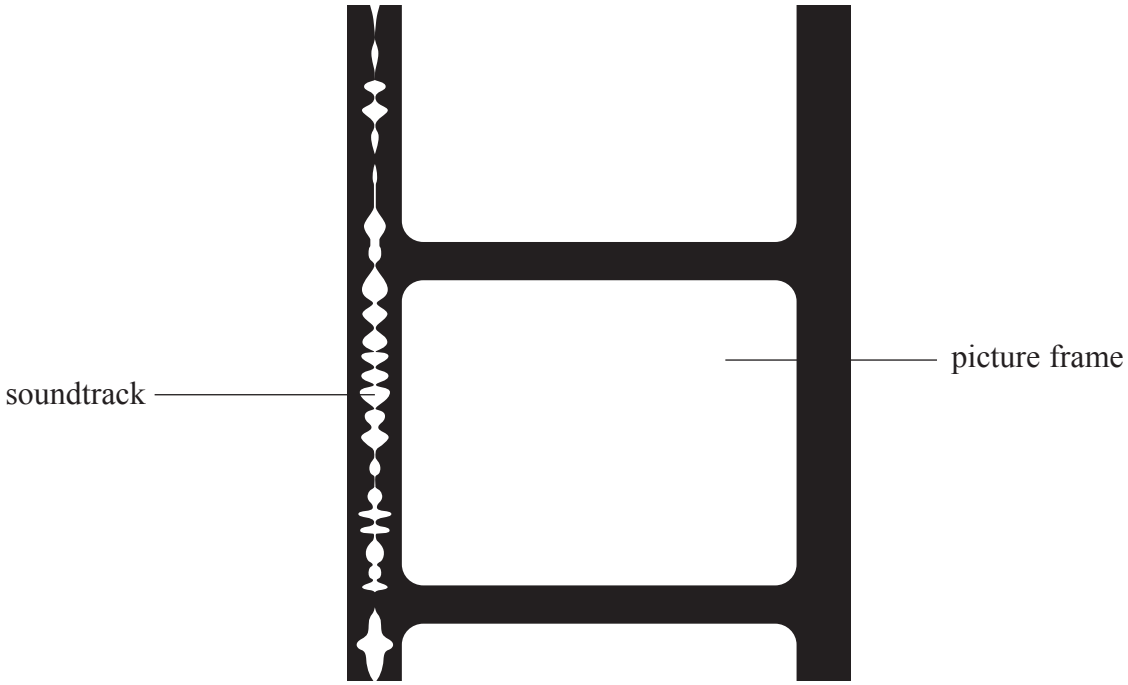
(b) Make an appropriate calculation to explain why caesium is used as the cathode for visible light but zinc is not.

work function of zinc = 3.63 eV

work function of caesium = 2.14 eV

(4)

(c) Before digital technology was used, the films used at the cinema had an optical soundtrack next to the picture frames.



The film, including the soundtrack as shown, moves through a projector past a source of light. Light is detected by a phototube on the other side of the soundtrack. The changing current produced by the phototube circuit is converted to a sound signal with the same variation in amplitude and frequency as the original sound.

(i) State what is meant by amplitude.

(1)

(ii) Explain how the changing pattern of the soundtrack produces a changing current in the phototube circuit.

(3)

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

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

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

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