Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Advanced
Paper 1: Advanced Physics I

Specimen Paper for first teaching September 2015
Time: 1 hour 45 minutes

Paper Reference
9PH0/01

You may need the Formulae Sheet.

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.*
- You may use a scientific calculator.

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- You are advised to show your working in calculations including units where appropriate.

Turn over ▶

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Answer ALL questions.

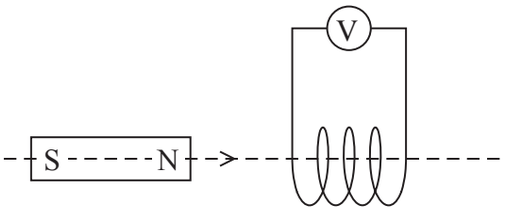
All multiple choice questions must be answered with a cross ☒ in the box for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Select the row of the table that correctly identifies a derived unit and a base unit.

	Derived unit	Base unit
☒ **A**	ampere	joule
☒ **B**	coulomb	kilogram
☒ **C**	joule	coulomb
☒ **D**	kilogram	ampere

(Total for Question 1 = 1 mark)

2 A magnet is passed along the axis of a short coil of wire.



An e.m.f. is induced across the ends of the coil.

Which of the following would increase the maximum e.m.f. induced?

☒ **A** decreasing the area of the coil

☒ **B** decreasing the number of turns per metre in the coil

☒ **C** increasing the speed of the magnet

☒ **D** reversing the polarity of the magnet

(Total for Question 2 = 1 mark)

3 Two objects of mass m travel towards each other on a smooth horizontal surface, each with velocity of magnitude v. The collision is elastic.

After the collision the

☒ **A** total kinetic energy is $2mv^2$

☒ **B** total kinetic energy is mv^2

☒ **C** total momentum is $2mv$

☒ **D** total momentum is mv

(Total for Question 3 = 1 mark)

4 A capacitor is charged and then discharged through a resistor of resistance R.
As the capacitor discharges, the maximum current is 5 mA and the time for the current to fall to 2.5 mA is 6 s.

The experiment is repeated using the same charging potential difference but a lower value of R.

Select the row of the table that shows possible values of current and time.

	Maximum current / mA	Time for current to halve / s
☒ **A**	3	4
☒ **B**	3	8
☒ **C**	7	4
☒ **D**	7	8

(Total for Question 4 = 1 mark)

5 Two copper wires are joined in series in a circuit. Wire A has twice the radius of wire B.

The drift velocity of the electrons in wire A is v_A and the drift velocity of the electrons in wire B is v_B.

The ratio $v_A : v_B$ is

☒ **A** 1 : 2

☒ **B** 1 : 4

☒ **C** 2 : 1

☒ **D** 4 : 1

(Total for Question 5 = 1 mark)

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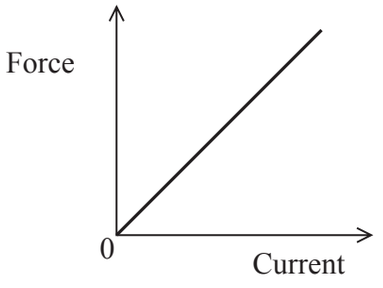
6 A current-carrying conductor with length l is placed at right angles to a magnetic field with magnetic flux density B. The graph shows how the force on the wire varies with the current passing through it.



The gradient of the graph is equal to

☒ **A** B

☒ **B** Bl

☒ **C** $\frac{1}{B}$

☒ **D** $\frac{B}{l}$

(Total for Question 6 = 1 mark)

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7 A cyclist travels up a slope through a vertical height h in a time t. The mass of the cyclist and his bike is m.

The average power of the cyclist is

☒ **A** $\frac{mg}{t}$

☒ **B** $\frac{t}{mg}$

☒ **C** $\frac{mgh}{t}$

☒ **D** $\frac{t}{mgh}$

(Total for Question 7 = 1 mark)

8 A constant potential difference is maintained across a negative temperature coefficient thermistor. The thermistor is heated and its resistance decreases.

Which of the following explains this decrease in resistance?

☒ **A** the collision rate of conduction electrons with lattice ions increases

☒ **B** the drift velocity of the conduction electrons decreases

☒ **C** the kinetic energy of the lattice ions decreases

☒ **D** the number density of the conduction electrons increases

(Total for Question 8 = 1 mark)

9 An electron and an alpha particle enter a uniform magnetic field which is acting perpendicular to their motion. The electron is travelling at four times the velocity of the alpha particle. The force on the electron is F.

The force on the alpha particle is

☒ **A** $F/2$

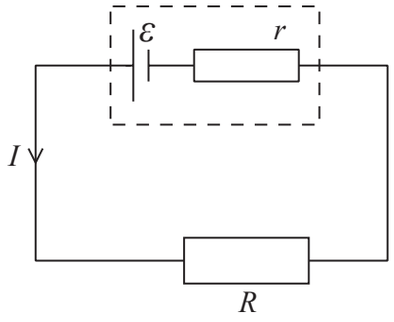
☒ **B** F

☒ **C** $4F$

☒ **D** $16F$

(Total for Question 9 = 1 mark)

10 A cell of e.m.f. ε and internal resistance r is connected across an external resistor of resistance R.



Which is the correct expression for the terminal potential difference V of the cell?

☒ **A** $V = \varepsilon + Ir$

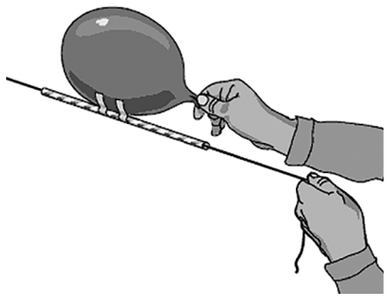
☒ **B** $V = \varepsilon - Ir$

☒ **C** $V = \varepsilon + IR$

☒ **D** $V = \varepsilon - IR$

(Total for Question 10 = 1 mark)

11 A length of string is threaded through a drinking straw. The string is fixed at one end and held at the other so that it is at 30° to the horizontal. A balloon is inflated and attached to the straw. When the balloon is released, the air escapes from the balloon and the balloon and straw start to move up the string.



(a) With reference to Newton's laws of motion, explain why the balloon starts to move.

(3)

(b) Calculate the minimum force on the balloon due to the escaping air if the balloon is to move in this way.

mass of straw and balloon = 11 g

(3)

Minimum force = ...

(Total for Question 11 = 6 marks)

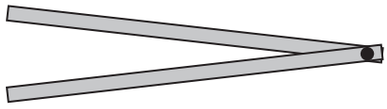
12 The diagram shows a battery-powered clock on a wall. It has a minute hand and an hour hand.

(a) Calculate the average angular velocity of the minute hand.

(2)

Angular velocity = ...

(b) The diagram shows the position of the minute hand when the time is 1 : 44 and when the time is 1 : 46.



The diagram is not to scale.

Show that the work done against the force of gravity to move the minute hand from 1 : 44 to 1 : 46 is about 1 mJ.

mass of minute hand = 14 g

length of minute hand = 8.0 cm

(5)

(c) The clock uses a 1.5 V cell and draws a maximum current of 8.0 μA.

After a time, the maximum power of the cell has reduced to 65% of its initial value making the clock run slowly.

Calculate the time taken for the minute hand to move from the 1 : 44 position to the 1 : 46 position.

(3)

Time taken = ...

(Total for Question 12 = 10 marks)

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13 The following extract is taken from a quote by Rutherford, speaking about the scattering of alpha particles by a thin gold foil.

> We knew the alpha particle was a very fast, massive particle with a great deal of energy, and the chance of an alpha particle being scattered backward was very small. Then I remember two or three days later Geiger coming to me in great excitement and saying "We have been able to get some of the alpha particles coming backward …" It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you.

(a) Rutherford compared the scattering of alpha particle through large angles to firing "a 15-inch shell at a piece of tissue paper and it came back and hit you."

Explain, with reference to the properties of the alpha particle, why a relatively large force is needed to deflect alpha particles through a large angle.

(2)

(b) Before the alpha particle scattering experiment, scientists believed that the mass and charge of an atom were uniformly distributed throughout the atom in a radius of about 1.4×10^{-10} m. Following the scattering experiments, a model of the atom was developed in which there was a concentrated centre of charge called the nucleus.

Assess the validity of this model of the atom given that the magnitude of the force required to scatter these alpha particles by a large angle is about 2.0 N. You should include a calculation in your answer.

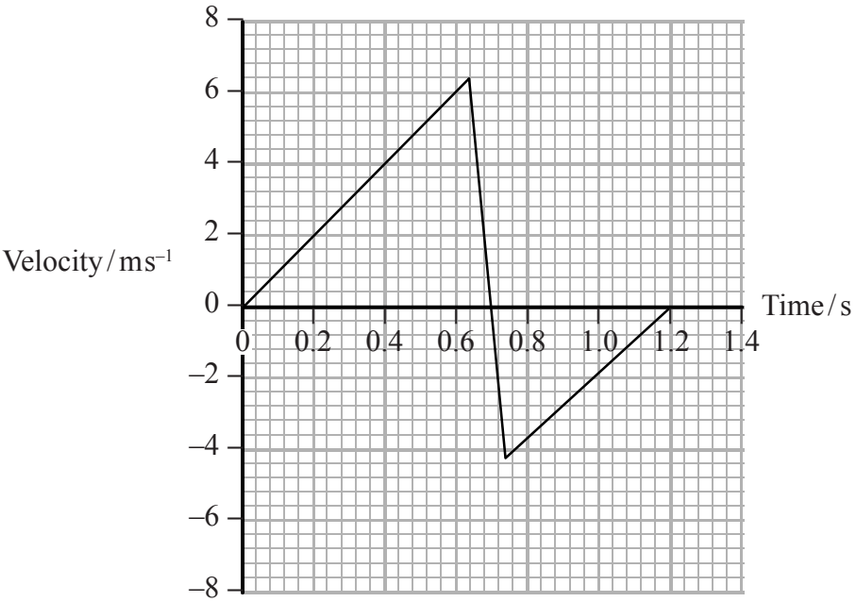
proton number of gold = 79

(5)

(Total for Question 13 = 7 marks)

14 A stationary ball is released from a height of 2.0 m onto a hard surface.

The simplified velocity-time graph shows the motion of the ball as it falls and bounces back to its maximum height.



(a) Calculate the maximum height reached by the ball after bouncing.

(2)

Maximum height = ...

(b) Calculate the decrease in kinetic energy of the ball as it bounces.

mass of ball = 60 g

(2)

Decrease in kinetic energy = ...

(c) Calculate the resultant force on the ball when it is in contact with the ground.

(3)

Resultant force = ...

(d) The ball is replaced with one that is softer. It is released from a height of 2.0 m onto the same surface as before. A velocity-time graph is drawn to show the motion of the new ball.

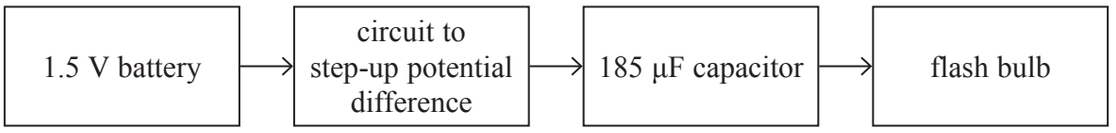
Describe the similarities and differences between the two graphs.

(3)

(Total for Question 14 = 10 marks)

***15** Cameras usually have an inbuilt flash bulb that can be used to take photographs in poor light conditions. As a photograph is taken, the bulb should be able to produce a bright flash of light for up to 4 ms.

A capacitor can be used along with a battery as a power supply for the flash bulb. The flow diagram shows a possible arrangement.



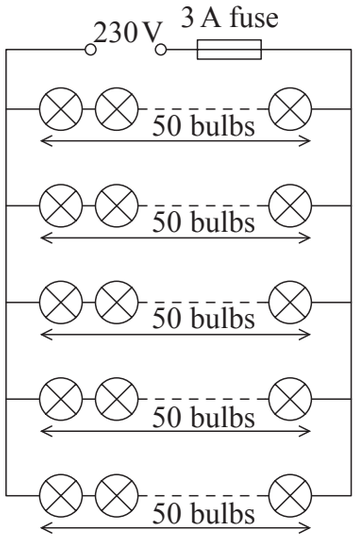
Comment on the suitability of using this capacitor arrangement as a power supply rather than connecting the bulb directly to the battery.

A typical flash bulb has a resistance of 6 Ω.

(6)

(Total for Question 15 = 6 marks)

16 A set of festive lights is made up of five parallel strands of filament bulbs. Each strand contains 50 bulbs in series as shown.



(a) When a bulb is working normally its resistance is 8.0 Ω. If the filament of the bulb breaks, the lamp is designed to still conduct and its resistance becomes 3.0 Ω.

(i) The filament of one bulb on a strand breaks.
By considering the effect this has on the remaining bulbs in that strand, explain why it is recommended that broken bulbs are replaced as soon as possible.

(3)

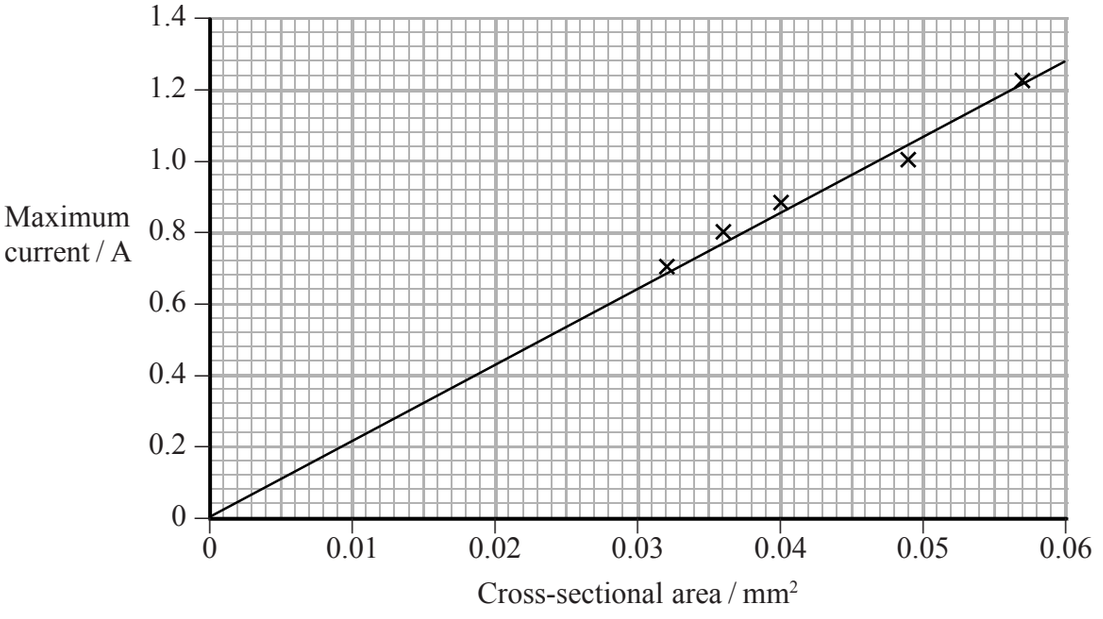
(ii) The set of festive lights are fitted with a 3 A fuse. Five bulbs in one strand break.

Determine whether the fuse blows.

(3)

(b) A student investigates how the cross-sectional area of a fuse wire affects the current at which the fuse blows. She uses pieces of wire of the same material and length, but different cross-sectional areas. She steadily increases the current through each piece of wire and records the maximum current through the wire before it breaks.

She then plots a graph of maximum current against cross-sectional area.



(i) Describe how the student should determine the cross-sectional area of the wire.

(3)

(ii) State the relationship between the maximum current and the cross-sectional area of the wire.

(1)

(iii) The student chooses a piece of wire, of the same material and length as used in the investigation. The piece of wire has a diameter of 0.40 mm.

Use the graph to determine whether the piece of wire is suitable to use as the 3A fuse wire for the set of festive lights.

(4)

(Total for Question 16 = 14 marks)

17 Protons interact with particles in the upper atmosphere and create new particles. Pions can be produced from high energy proton collisions.

(a) (i) State why the following reaction is not possible.

$$p + p \rightarrow p + p + \pi^-$$

(1)

(ii) State one similarity and one difference between the electric field of a proton and the electric field of a π^-.

(2)

(b) A high energy proton collides with a stationary proton and a π^0 particle is produced. The equation for the reaction is

$$p + p \rightarrow p + p + \pi^0$$

(i) Explain why the proton must have a high energy in order for this reaction to occur.

(2)

.....

.....

.....

.....

(ii) The rest mass of the π^0 is $\frac{1}{7}$ of the rest mass of a proton.

In this reaction the total kinetic energy of the particles decreases.

Calculate the minimum decrease in kinetic energy if the reaction is to occur.

rest mass of proton = 938 GeV/c^2

(2)

.....

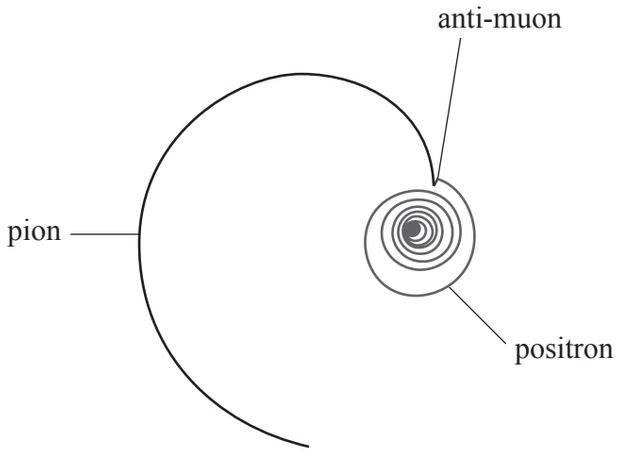
.....

.....

.....

Minimum decrease in kinetic energy = ...

(c) Pions have a short half-life and decay into muons.
The diagram shows the tracks from the decay of a pion in a bubble chamber.



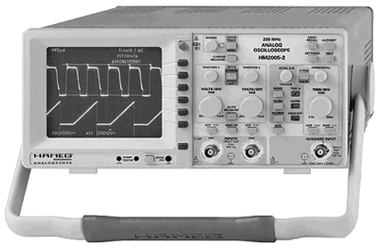
The pion decays into an anti-muon and muon neutrino.
The anti-muon then decays into a positron and an electron neutrino.
The magnetic field acts out of the page.

Use the diagram and the information given to explain what conclusions can be made about the particles in this interaction.

(6)

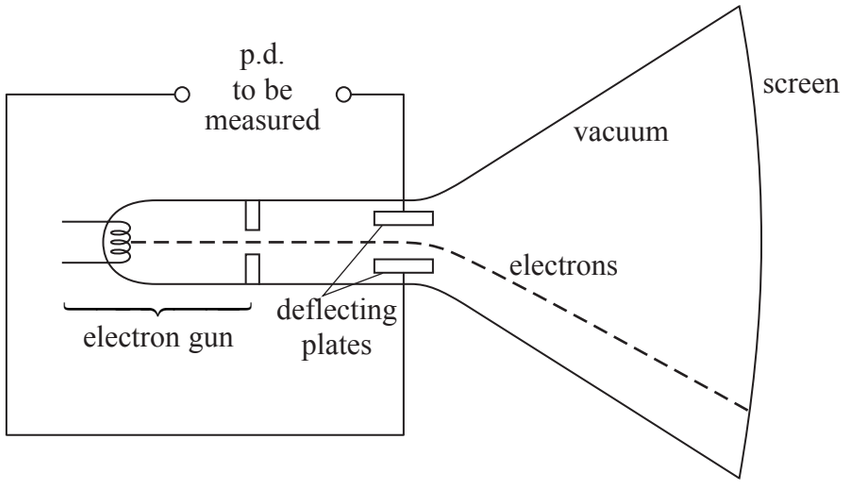
(Total for Question 17 = 13 marks)

18 Cathode ray tubes are used in oscilloscopes.



The diagram shows a simplified cathode ray tube that can be used to determine the magnitude and polarity of a potential difference (p.d.).

The cathode ray tube consists of an electron gun, a pair of deflecting plates and a fluorescent screen.



(a) The electron gun includes a filament. When this filament is heated, electrons are released and are accelerated by a p.d. of 1.5 kV to form an electron beam.

(i) Name the process by which electrons are released from the heated filament.

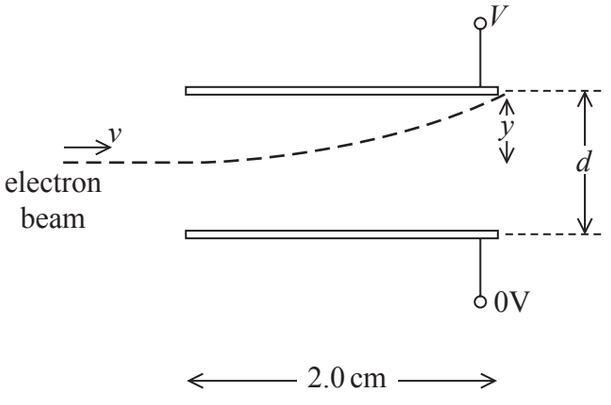
(1)

(ii) Show that the maximum velocity of the electrons is about 2×10^7 m s^{-1}.

(2)

(b) The electron beam then enters a uniform electric field between the two parallel horizontal deflecting plates. The magnitude and direction of the deflection is determined by the p.d. V that is applied across the plates.

The diagram shows one possible path of the electron beam as it passes between the plates.



(i) Show that the acceleration of an electron, of mass m and charge Q, is given by

$$\frac{VQ}{dm}$$

(2)

(ii) Calculate the magnitude of the vertical deflection y of the beam as it leaves the plates.

$V = 50$ V
$d = 0.01$ m

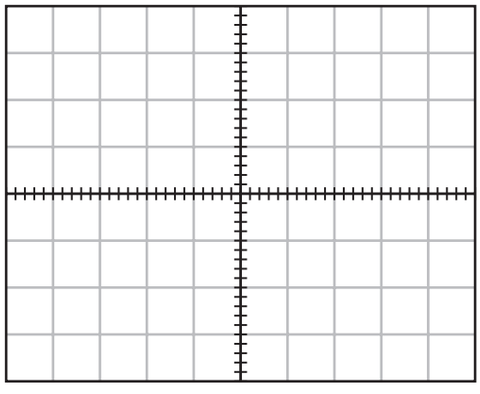
(5)

$y =$ .....

(c) A laboratory oscilloscope with the time base turned off operates in the same way as this simplified cathode ray tube. A student uses an oscilloscope in this way to monitor an alternating p.d. of 53 V_{rms}

On the grid, draw the trace that would be seen on the screen.

(4)



1 square = 25 V

(Total for Question 18 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

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