ERRATUM NOTICE

General Certificate of Education
January 2011

PHYSICS A PHYA1

Unit 1 Particles, Quantum Phenomena and Electricity

Wednesday 12 January 2011 9.00 am to 10.15 am

Instructions to Invigilators

Before the start of the examination please ask candidates to amend their question papers as follows. (Please read out this message twice to ensure understanding.)

Turn to page 2, Question 1(b)

In the question under the figure, cross out the fourth word, 'laws' and insert the word 'law'.

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Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2011

Physics A PHYA1

Unit 1 Particles, Quantum Phenomena and Electricity

Wednesday 12 January 2011 9.00 am to 10.15 am

For this paper you must have:
- a pencil and a ruler
- a calculator
- a Data and Formulae Booklet.

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 Sub-atomic particles can either be hadrons or leptons.

1 (a) (i) State **one difference** between these two groups of particles.

.....

(1 mark)

1 (a) (ii) Give an example of a non-strange hadron and an example of a lepton.

hadron .....

lepton .....

(2 marks)

1 (a) (iii) Hadrons can be further divided into two groups. Name these two groups **and** state a difference between them.

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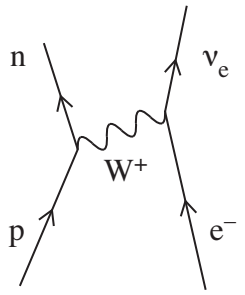
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(3 marks)

1 (b) The Feynman Diagram in **Figure 1** represents an interaction known as electron capture.

Figure 1



1 (b) State a conservation laws obeyed in this interaction. Show how the property mentioned in the law is conserved.

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(2 marks)

8

Do not write outside the box

2 A neutral atom of a radium isotope may be represented by $^{228}_{88}\text{Ra}$.

2 (a) (i) Name the constituents of this atom and state how many of each are present.

.....

.....

.....

(3 marks)

2 (a) (ii) Which constituent of an atom has the largest specific charge?

.....

(1 mark)

2 (a) (iii) This isotope of radium decays by β^- decay to form an element with symbol, Ac. Write down an equation that represents this decay.

(4 marks)

2 (b) $^{A}_{Z}\text{Ra}$ is a neutral atom of a different isotope of radium. State a possible value for A and for Z.

A: .....

Z: .....

(2 marks)

10

Turn over for the next question

Do not write outside the box

3 Under certain circumstances, a photon moving through a material can interact with the nucleus of an atom of the material to produce an electron and a positron.

3 (i) What is the name of this process?

.....

(1 mark)

3 (ii) Give one reason why the photon could not produce a single electron instead of an electron and a positron.

.....

.....

.....

.....

(2 marks)

3 (iii) Make use of the Data and Formulae booklet to show that the minimum energy of the photon required for this process is 1.02 MeV.

(1 mark)

3 (iv) Photons whose wavelength exceeds a certain value will not cause this process. Calculate the maximum wavelength for the process to occur stating your answer to an appropriate number of significant figures.

answer = ... m

(4 marks)

Do not write outside the box

3 **(v)** Explain what will happen to the positron produced by the interaction.

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(2 marks)

10

Turn over for the next question

Do not write outside the box

4 (a) The photoelectric effect suggests that electromagnetic waves can exhibit particle - like behaviour. Explain what is meant by threshold frequency and why the existence of a threshold frequency supports the particle nature of electromagnetic waves.

The quality of your written communication will be assessed in this question.

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(6 marks)

Do not write outside the box

4 (b) (i) An alpha particle of mass 6.6×10^{-27} kg has a kinetic energy of 9.6×10^{-13} J.
Show that the speed of the alpha particle is 1.7×10^{7} m s^{-1}.

(3 marks)

4 (b) (ii) Calculate the momentum of the alpha particle, stating an appropriate unit.

answer = ...
(3 marks)

4 (b) (iii) Calculate the de Broglie wavelength of the alpha particle.

answer = ... m
(2 marks)

14

Turn over for the next question

Do not write outside the box

5 Domestic users in the United Kingdom are supplied with mains electricity at a *root mean square voltage* of 230 V.

5 (a) State what is meant by root mean square voltage.

.....

.....

.....

(1 mark)

5 (b) (i) Calculate the peak value of the supply voltage.

answer = ... V

(2 marks)

5 (b) (ii) Calculate the average power dissipated in a lamp connected to the mains supply when the rms current is 0.26 A.

answer = ... W

(1 mark)

Do not write outside the box

5 (c) The frequency of the voltage supply is 50 Hz. On the axes below draw the waveform of the supplied voltage labelling the axes with appropriate values.



(4 marks)

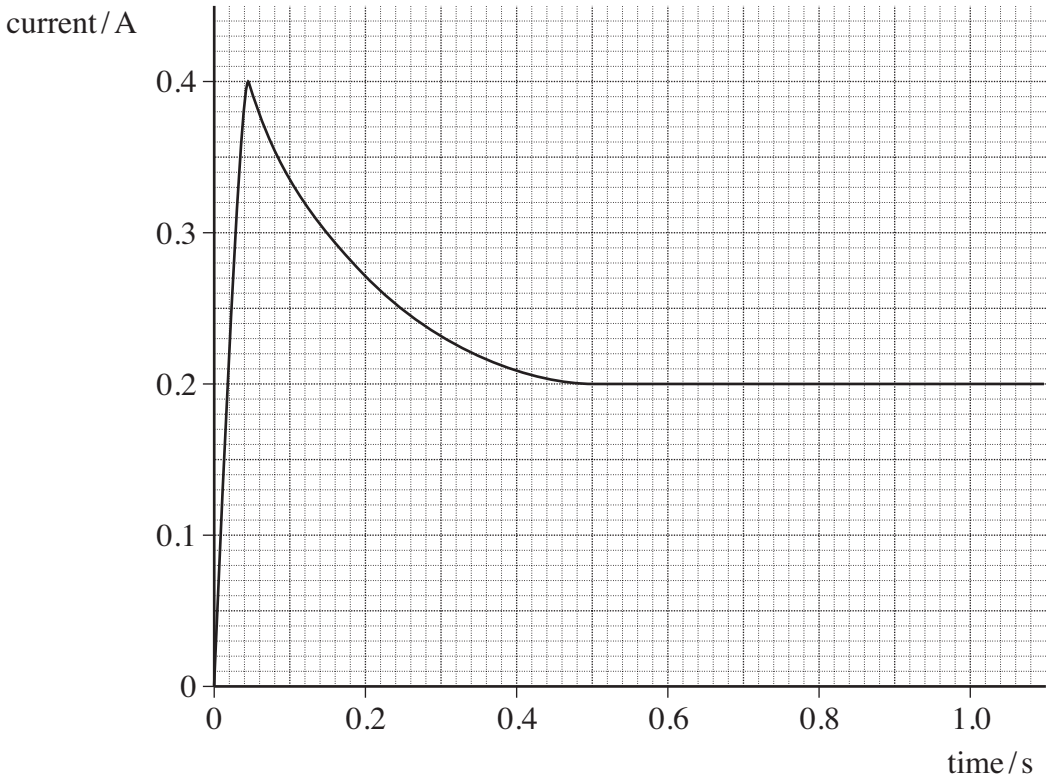
8

Turn over for the next question

Do not write outside the box

6 When a filament lamp is switched on it takes 0.50 seconds for the filament to reach its normal operating temperature. The way in which the current changes during the first second after switching on is shown on the graph in **Figure 2**.

Figure 2



6 (a) Use the graph to determine the maximum current through the lamp.

answer = ... A

(1 mark)

Do not write outside the box

6 (b) Assuming that the lamp is connected to a 12 V dc supply of a negligible internal resistance,

6 (b) (i) Calculate the resistance of the lamp when it has reached its normal operating temperature,

answer = ... Ω
(1 mark)

6 (b) (ii) Calculate the power of the lamp when it has reached its normal operating temperature.

answer = ... W
(1 mark)

6 (c) Explain why the current through the lamp decreases between 0.05 s and 0.50 s.

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(2 marks)

Question 6 continues on the next page

Do not write outside the box

6 (d) State and explain the change, if any, to the final current through the lamp if it is connected to the same supply with another similar lamp

6 (d) (i) in series,

.....

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.....

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(2 marks)

6 (d) (ii) in parallel.

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(2 marks)

6 (e) State and explain why a filament lamp is most likely to fail as it is switched on.

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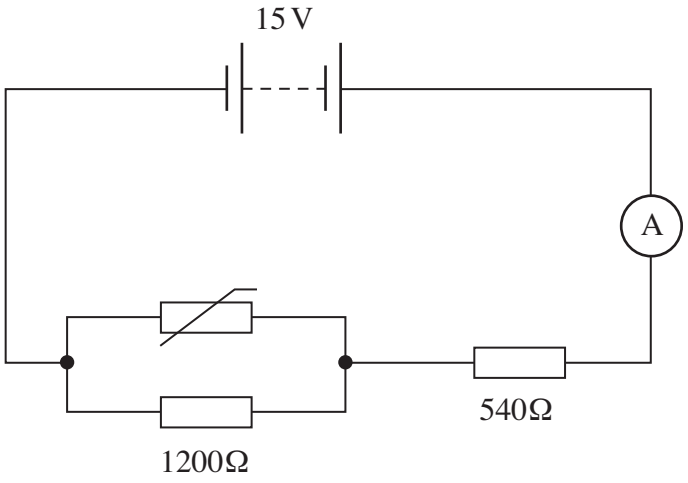
(2 marks)

11

Do not write outside the box

7 The circuit shown in **Figure 3** shows a thermistor connected in a circuit with two resistors, an ammeter and a battery of emf 15 V and negligible internal resistance.

Figure 3



7 (a) When the thermistor is at a certain temperature the current through the ammeter is 10.0 mA.

7 (a) (i) Calculate the pd across the 540 Ω resistor.

answer = ... V

(1 mark)

7 (a) (ii) Calculate the pd across the 1200 Ω resistor.

answer = ... V

(1 mark)

Question 7 continues on the next page

Do not write outside the box

7 (a) (iii) Calculate the resistance of the parallel combination of the resistor and the thermistor.

answer = ... Ω
(2 marks)

7 (a) (iv) Calculate the resistance of the thermistor.

answer = ... Ω
(2 marks)

7 (b) The temperature of the thermistor is increased so that its resistance decreases.
State and explain what happens to the pd across the 1200 Ω resistor.

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(3 marks)

9

END OF QUESTIONS

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