

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  
June 2011

# Physics A

# PHYA1

## Unit 1 Particles, Quantum Phenomena and Electricity

Tuesday 24 May 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.



J U N 1 1 P H Y A 1 0 1

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

1 (a) (i) Name two baryons.

.....  
(2 marks)

1 (a) (ii) State the quark structure of the pion  $\pi^+$ .

.....  
(1 mark)

1 (b) (i) The  $K^+$  kaon is a strange particle. Give **one** characteristic of a strange particle that makes it different from a particle that is not strange.

.....  
.....  
(1 mark)

1 (b) (ii) One of the following equations represent a possible decay of the  $K^+$  kaon.

$$K^+ \rightarrow \pi^+ + \pi^0$$

$$K^+ \rightarrow \mu^+ + \bar{\nu}_\mu$$

State, with a reason, which one of these decays is not possible.

.....  
.....  
(2 marks)

1 (c) Another strange particle, X, decays in the following way:

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

1 (c) (i) State what interaction is involved in this decay.

.....  
(1 mark)

1 (c) (ii) Show that X must be a neutral particle.

.....  
.....  
(1 mark)



**1 (c) (iii)** Deduce whether X is a meson, baryon or lepton, explaining how you arrive at your answer.

.....  
.....  
.....  
.....

*(2 marks)*

**1 (c) (iv)** Which particle in this interaction is the most stable?

.....

*(1 mark)*

11
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**Turn over for the next question**

**Turn over ►**



**2** Alpha decay is a process by which an unstable *isotope* of an element may decay.

**2 (i)** State what is meant by isotopes.

.....

.....

.....

.....

(2 marks)

**2 (ii)** Complete this equation for alpha decay.



(2 marks)

**2 (iii)** Calculate the specific charge of an alpha particle, stating an appropriate unit.

answer = .....

(4 marks)



**2 (iv)** Explain why the alpha particle, once outside the nucleus, is unaffected by the strong nuclear force.

.....

.....

.....

.....

.....

*(2 marks)*

10

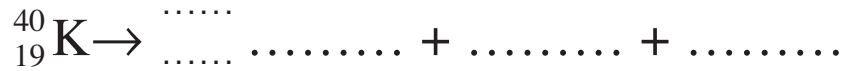
**Turn over for the next question**

**Turn over ►**



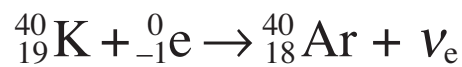
**3** The isotope of potassium  ${}^{40}_{19}\text{K}$  can decay by positron emission to form an isotope of argon, Ar.

**3 (a)** Complete the following equation which represents this decay.



(4 marks)

**3 (b)** The following equation represents another possible decay for  ${}^{40}_{19}\text{K}$ .



**3 (b) (i)** What is this type of decay called?

.....  
(1 mark)

**3 (b) (ii)** Where does the electron on the left-hand side of the equation come from?

.....  
(1 mark)

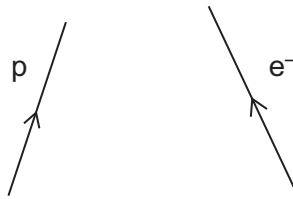
**3 (b) (iii)** Explain why this reaction has to produce a neutrino rather than an antineutrino.

.....  
.....  
(1 mark)



3 (b) (iv) Complete the Feynman diagram shown in **Figure 1** that represents this decay.

**Figure 1**



(3 marks)

10
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**Turn over for the next question**

**Turn over ►**







4 (b) The *ionisation energy* of a hydrogen atom is 13.6 eV.

4 (b) (i) State what is meant by the ionisation energy of hydrogen.

.....  
.....

(2 marks)

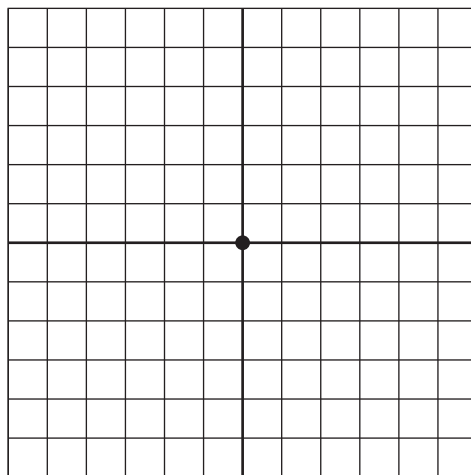
4 (b) (ii) Express the ionisation energy of hydrogen in joules, giving your answer to an appropriate number of significant figures.

answer = ..... J  
(3 marks)

11

5 An oscilloscope is used to investigate various voltage sources. In order to do this a voltage source is connected to the y-input and the time base is switched off. **Figure 2** shows the screen of the oscilloscope when the y-input is not connected to a voltage source.

**Figure 2**



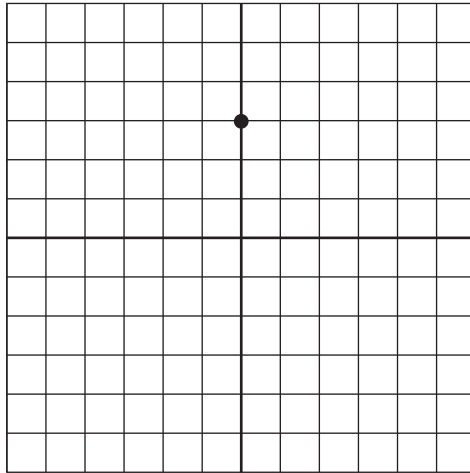
**Question 5 continues on the next page**

**Turn over ►**

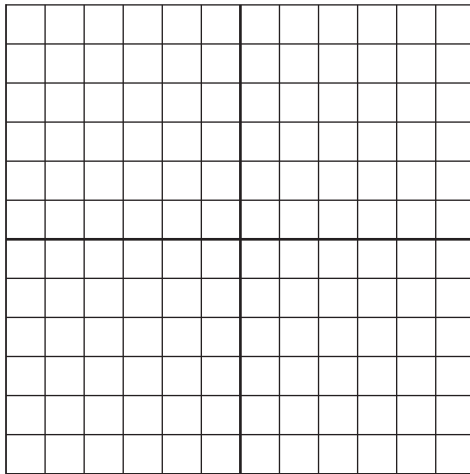


**Figure 3** shows the screen when a 1.5 V cell is connected to the y-input.

**Figure 3**



- 5 (a)** On the grid below show the appearance of the screen if the y-input is connected to a 2.5 V dc supply.

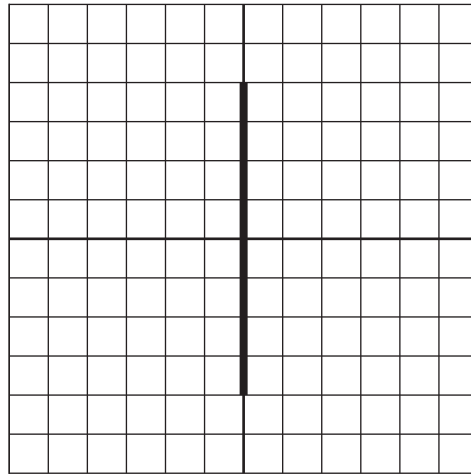


*(1 mark)*



5 (b) The y-input is now connected to a sinusoidal ac voltage supply and the screen is shown in Figure 4.

Figure 4



5 (b) (i) Explain why a vertical line is now seen on the screen.

.....

.....

.....

.....

.....

.....

(2 marks)

5 (b) (ii) Calculate the peak-to-peak voltage of the ac supply.

answer = ..... V

(2 marks)

Question 5 continues on the next page

Turn over ►



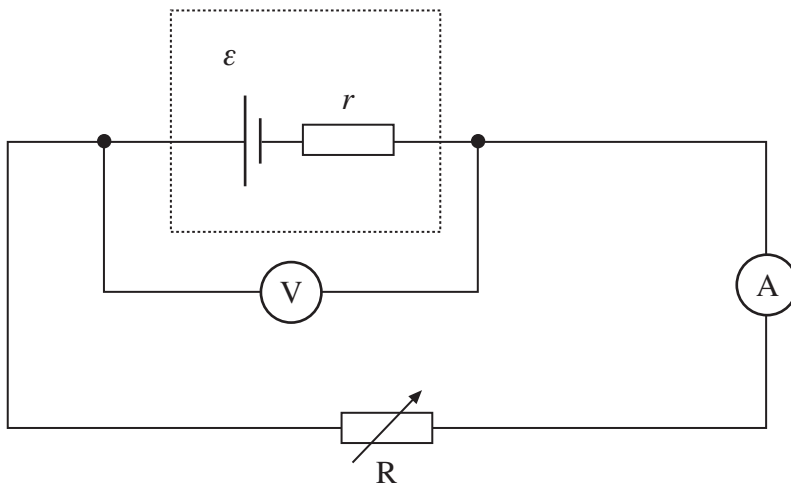
5 (b) (iii) Calculate the root mean square voltage of the supply.

answer = ..... V  
(2 marks)

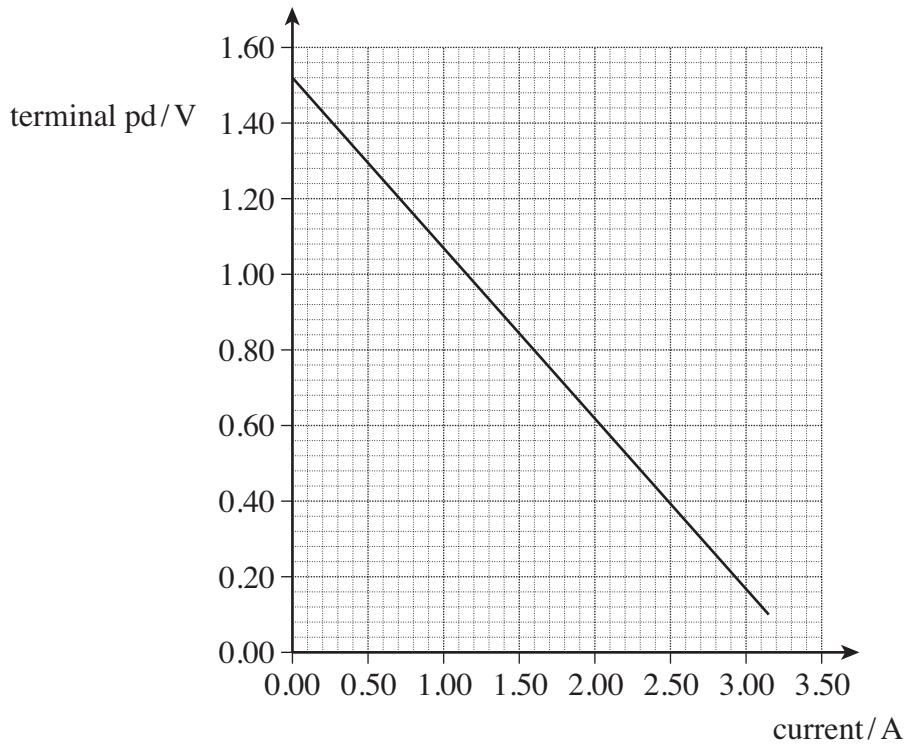
7
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6 A cell of emf,  $\varepsilon$ , and internal resistance,  $r$ , is connected to a variable resistor  $R$ . The current through the cell and the terminal pd of the cell are measured as  $R$  is decreased. The circuit is shown in **Figure 5**.

**Figure 5**



The graph below shows the results from the experiment.



**6 (a)** Explain why the terminal pd decreases as the current increases.

.....

.....

.....

.....

(2 marks)

**6 (b) (i)** Use the graph to find the emf,  $\epsilon$ , of the cell.

answer = ..... V  
(1 mark)

**Question 6 continues on the next page**

**Turn over** ►



**6 (b) (ii)** Use the graph, on page 13, to find the internal resistance,  $r$ , of the cell.

answer = .....  $\Omega$   
(3 marks)

**6 (c)** Draw a line on the graph, on page 13, that shows the results obtained from a cell with

**6 (c) (i)** the same emf but double the internal resistance of the first cell labelling your graph **A**  
(2 marks)

**6 (c) (ii)** the same emf but negligible internal resistance labelling your graph **B**.  
(1 mark)

**6 (d)** In the original circuit shown in **Figure 5**, on page 12, the variable resistor is set at a value such that the current through the cell is 0.89 A.

**6 (d) (i)** Calculate the charge flowing through the cell in 15 s, stating an appropriate unit.

answer = .....  
(2 marks)



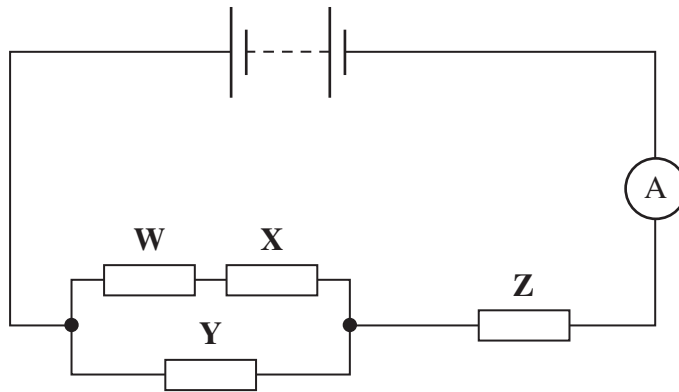
6 (d) (ii) Calculate the energy dissipated in the internal resistance of the cell per second.

answer = ..... W  
(2 marks)

13
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7 The circuit shown in **Figure 6** shows an arrangement of resistors, **W**, **X**, **Y**, **Z**, connected to a battery of negligible internal resistance.

**Figure 6**



The emf of the battery is 10 V and the reading on the ammeter is 2.0 A.

7 (a) (i) Calculate the total resistance of the circuit.

answer = .....  $\Omega$   
(1 mark)

**Question 7 continues on the next page**

Turn over ►



7 (a) (ii) The resistors **W**, **X**, **Y**, and **Z** all have the same resistance. Show that your answer to part (a) (i) is consistent with the resistance of each resistor being  $3.0 \Omega$ .

answer = .....  $\Omega$   
(3 marks)

7 (b) (i) Calculate the current through resistor **Y**.

answer = ..... A  
(2 marks)

7 (b) (ii) Calculate the pd across resistor **W**.

answer = ..... V  
(2 marks)

**END OF QUESTIONS**

8
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