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 2012

Physics A PHYA1

Unit 1 Particles, Quantum Phenomena and Electricity

Thursday 12 January 2012 1.30 pm to 2.45 pm

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

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.
- Show all your working.

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 (a) The table gives information about some fundamental particles.

Complete the table by filling in the missing information.

particle	quark structure	charge	strangeness	baryon number
	uud		0	
Sigma $^{+}$	uus	+ 1		
	$u\bar{d}$		0	0

(7 marks)

1 (b) Each of the particles in the table has an antiparticle.

1 (b) (i) Give **one** example of a baryon particle **and** its corresponding antiparticle.

particle .....

antiparticle .....

(1 mark)

1 (b) (ii) State the quark structure of an antibaryon.

.....

(1 mark)

1 (b) (iii) Give **one** property of an antiparticle that is the same for its corresponding particle and **one** property that is different.

Same .....

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Different .....

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(2 marks)

11

Do not write outside the box

2 (a) State what is meant by the specific charge of a nucleus and give an appropriate unit for this quantity.

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unit: .....

(2 marks)

2 (b) Nucleus X has the same nucleon number as nucleus Y. The specific charge of X is 1.25 times greater than that of Y.

2 (b) (i) Explain, in terms of protons and neutrons, why the specific charge of X is greater than that of Y.

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(2 marks)

2 (b) (ii) Nucleus X is $^{10}_{5}B$. Deduce the number of protons and the number of neutrons in nucleus Y.

number of protons .....

number of neutrons .....

(4 marks)

8

Do not write outside the box

3 (a) Pair production can occur when a photon interacts with matter. Explain the process of pair production.

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(2 marks)

3 (b) Explain why pair production cannot take place if the frequency of the photon is below a certain value.

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(3 marks)

3 (c) Energy and momentum are conserved during pair production. State **two** other quantities that must also be conserved.

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(2 marks)

7

Do not write outside the box

4 (a) When free electrons collide with atoms in their *ground state*, the atoms can be excited or ionised.

4 (a) (i) State what is meant by ground state.

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(1 mark)

4 (a) (ii) Explain the difference between excitation and ionisation.

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(3 marks)

4 (b) An atom can also become excited by the absorption of photons. Explain why only photons of certain frequencies cause excitation in a particular atom.

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(4 marks)

Question 4 continues on the next page

Do not write outside the box

4 (c) The ionisation energy of hydrogen is 13.6 eV. Calculate the minimum frequency necessary for a photon to cause the ionisation of a hydrogen atom. Give your answer to an appropriate number of significant figures.

answer .....Hz

(4 marks)

12

5 (a) A student is given a piece of metal wire and asked to investigate how the resistance of the wire changes between a temperature of 0 °C and 100 °C.

5 (a) (i) Draw a labelled diagram of a suitable arrangement that would enable the student to carry out the experiment.

(3 marks)

Do not write outside the box

5 (a) (ii) Describe the procedure the student would follow in order to obtain accurate and reliable measurements of the resistance of the wire at different temperatures between 0 °C and 100 °C.

The quality of written communication will be assessed in your answer.

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(6 marks)

Question 5 continues on the next page

Do not write outside the box

5 (b) A certain metal has a *critical temperature* of –268 °C (5 K). Explain what is meant by critical temperature.

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(2 marks)

11

6 **X** and **Y** are two lamps. **X** is rated at 12 V 36 W and **Y** at 4.5 V 2.0 W.

6 (a) Calculate the current in each lamp when it is operated at its correct working voltage.

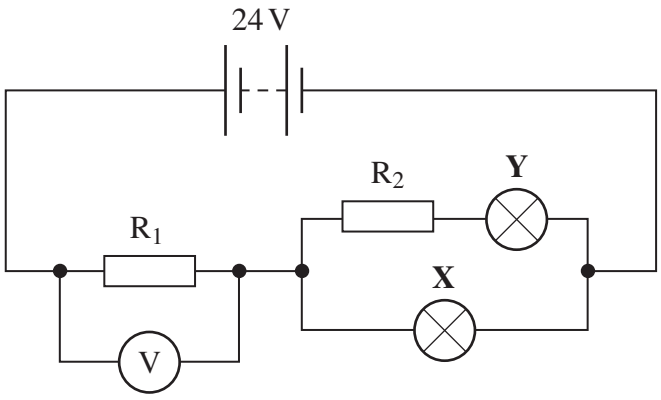
X ..... A

Y ..... A

(2 marks)

6 (b) The two lamps are connected in the circuit shown in **Figure 1**. The battery has an emf of 24 V and negligible internal resistance. The resistors, R_1 and R_2 are chosen so that the lamps are operating at their correct working voltage.

Figure 1



Do not write outside the box

6 (b) (i) Calculate the pd across R_1.

answer V
(1 mark)

6 (b) (ii) Calculate the current in R_1.

answer ..... A
(1 mark)

6 (b) (iii) Calculate the resistance of R_1.

answer ..... Ω
(1 mark)

6 (b) (iv) Calculate the pd across R_2.

answer V
(1 mark)

6 (b) (v) Calculate the resistance of R_2.

answer ..... Ω
(1 mark)

Question 6 continues on the next page

Do not write outside the box

6 (c) The filament of the lamp in **X** breaks and the lamp no longer conducts. It is observed that the voltmeter reading decreases and lamp **Y** glows more brightly.

6 (c) (i) Explain without calculation why the voltmeter reading decreases.

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(2 marks)

6 (c) (ii) Explain without calculation why the lamp **Y** glows more brightly.

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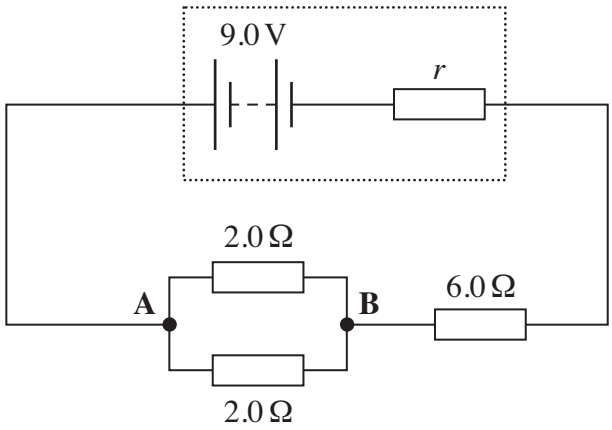
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(2 marks)

11

7 A battery of emf 9.0 V and internal resistance, r, is connected in the circuit shown in **Figure 2**.

Figure 2



Do not write outside the box

7 (a) The current in the battery is 1.0 A.

7 (a) (i) Calculate the pd between points **A** and **B** in the circuit.

answer = ... V
(2 marks)

7 (a) (ii) Calculate the internal resistance, *r*.

answer = ... Ω
(2 marks)

7 (a) (iii) Calculate the **total** energy transformed by the battery in 5.0 minutes.

answer = ... J
(2 marks)

7 (a) (iv) Calculate the percentage of the energy calculated in part (iii) that is dissipated in the battery in 5.0 minutes.

answer ..... %
(2 marks)

Question 7 continues on the next page

Do not write outside the box

7 (b) State and explain **one** reason why it is an advantage for a rechargeable battery to have a low internal resistance.

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(2 marks)

10

END OF QUESTIONS

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