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 2012

Physics A PHYA1

Unit 1 Particles, Quantum Phenomena and Electricity

Thursday 17 May 2012 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 (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.

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

1 (a) The K^- meson has strangeness –1.

1 (a) (i) State the quark composition of a meson.

.....

(1 mark)

1 (a) (ii) State the baryon number of the K^- meson.

.....

(1 mark)

1 (a) (iii) What is the quark composition of the K^- meson?

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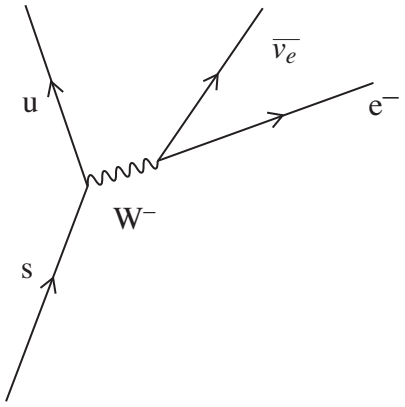
(1 mark)

1 (b) **Figure 1** shows a Feynman diagram for a possible decay of the strange quark.

Figure 1



1 (b) (i) Which interaction is responsible for this decay?

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(1 mark)

1 (b) (ii) Energy and momentum are conserved when the W^- particle is produced. State **two** other quantities that are also conserved and **one** that is not.

conserved .....

conserved .....

not conserved .....

(3 marks)

1 (b) (iii) Complete this equation for the decay of a K^- meson.

$K^- \rightarrow$ ..... + ... + ...

(2 marks)

9

2 (a) The nucleus of a particular atom has a *nucleon number* of 14 and a *proton number* of 6.

2 (a) (i) State what is meant by nucleon number and proton number.

nucleon number .....

.....

.....

proton number .....

.....

.....

(1 mark)

2 (a) (ii) Calculate the number of neutrons in the nucleus of this atom.

answer = ...

(1 mark)

2 (a) (iii) Calculate the specific charge of the nucleus.

answer = ... $C\,kg^{-1}$

(3 marks)

Question 2 continues on the next page

2 (b) The specific charge of the nucleus of another isotope of the element is 4.8×10^7 C kg^{-1}.

2 (b) (i) State what is meant by an isotope.

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(2 marks)

2 (b) (ii) Calculate the number of neutrons in this isotope.

answer = ...

(3 marks)

10

3 (a) Protons can interact with electrons by gravity and by two other fundamental interactions. In the following table identify these interactions and name the exchange particle involved.

interaction	exchange particle

(2 marks)

3 (b) State the quark composition of a proton.

.....

(1 mark)

3 (c) A change in quark identity is involved in *electron capture*.

3 (c) (i) Explain what is meant by electron capture.

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(3 marks)

3 (c) (ii) In the space below draw a Feynman diagram representing electron capture.

(3 marks)

9

4 (a) When monochromatic light is shone on a clean cadmium surface, electrons with a range of kinetic energies up to a maximum of 3.51×10^{-20} J are released. The *work function* of cadmium is 4.07 e V.

4 (a) (i) State what is meant by work function.

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(2 marks)

4 (a) (ii) Explain why the emitted electrons have a range of kinetic energies up to a maximum value.

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(4 marks)

4 (a) (iii) Calculate the frequency of the light. Give your answer to an appropriate number of significant figures.

answer = ... Hz

(4 marks)

4 (b) In order to explain the photoelectric effect the wave model of electromagnetic radiation was replaced by the photon model. Explain what must happen in order for an existing scientific theory to be modified or replaced with a new theory.

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(2 marks)

12

Turn over for the next question

5 (a) An alternating current supply provides an output voltage of 12 V rms at a frequency of 50 Hz. Describe how you would use an oscilloscope to check the accuracy of the rms output voltage and the frequency of the supply.

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

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(6 marks)

5 (b) The power supply in part (a) is connected to a 12 V 24 W lamp.

5 (b) (i) Calculate the rms current in the lamp.

answer = ... A
(1 mark)

5 (b) (ii) Calculate the peak current in the lamp.

answer = ... A
(1 mark)

5 (b) (iii) Calculate the peak power of the lamp.

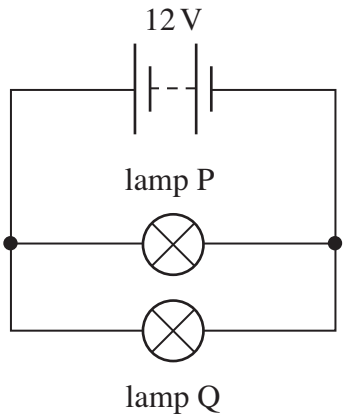
answer = ... W
(2 marks)

10

Turn over for the next question

6 A battery of negligible internal resistance is connected to lamp P in parallel with lamp Q as shown in **Figure 2**. The emf of the battery is 12 V.

Figure 2



6 (a) Lamp P is rated at 12 V 36 W and lamp Q is rated at 12 V 6 W.

6 (a) (i) Calculate the current in the battery.

answer = ... A

(2 marks)

6 (a) (ii) Calculate the resistance of P.

answer = ... Ω

(1 mark)

6 (a) (iii) Calculate the resistance of Q.

answer = ... Ω

(1 mark)

6 (b) State and explain the effect on the brightness of the lamps in the circuit shown in **Figure 2** if the battery has a significant internal resistance.

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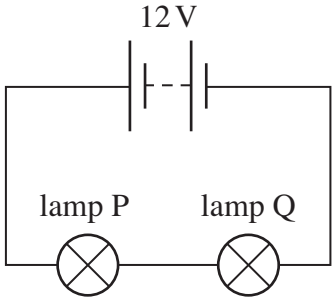
(3 marks)

Question 6 continues on the next page

6 (c) The lamps are now reconnected to the 12 V battery in series as shown in **Figure 3**.

Figure 3



6 (c) (i) Explain why the lamps will not be at their normal brightness in this circuit.

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(2 marks)

6 (c) (ii) State and explain which of the lamps will be brighter assuming that the resistance of the lamps does not change significantly with temperature.

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(3 marks)

12

Turn to page 14 for the next question

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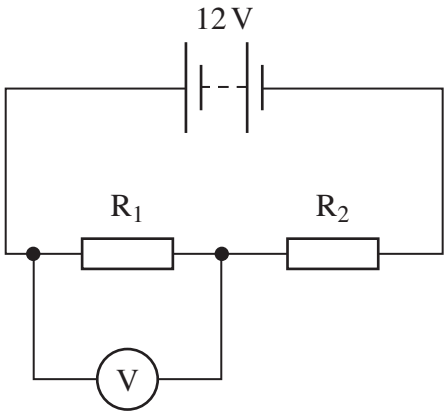
7 **Figure 4** shows two resistors, R_1 and R_2, connected in series with a battery of emf 12 V and negligible internal resistance.

Figure 4



7 (a) The reading on the voltmeter is 8.0 V and the resistance of R_2 is 60 Ω.

7 (a) (i) Calculate the current in the circuit.

answer = ... A

(2 marks)

7 (a) (ii) Calculate the resistance of R_1.

answer = ... Ω
(1 mark)

7 (a) (iii) Calculate the charge passing through the battery in 2.0 minutes. Give an appropriate unit for your answer.

answer = ... unit = ...
(2 marks)

7 (b) In the circuit shown in **Figure 4** R_2 is replaced with a thermistor. State and explain what will happen to the reading on the voltmeter as the temperature of the thermistor increases.

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(3 marks)

8

END OF QUESTIONS

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