

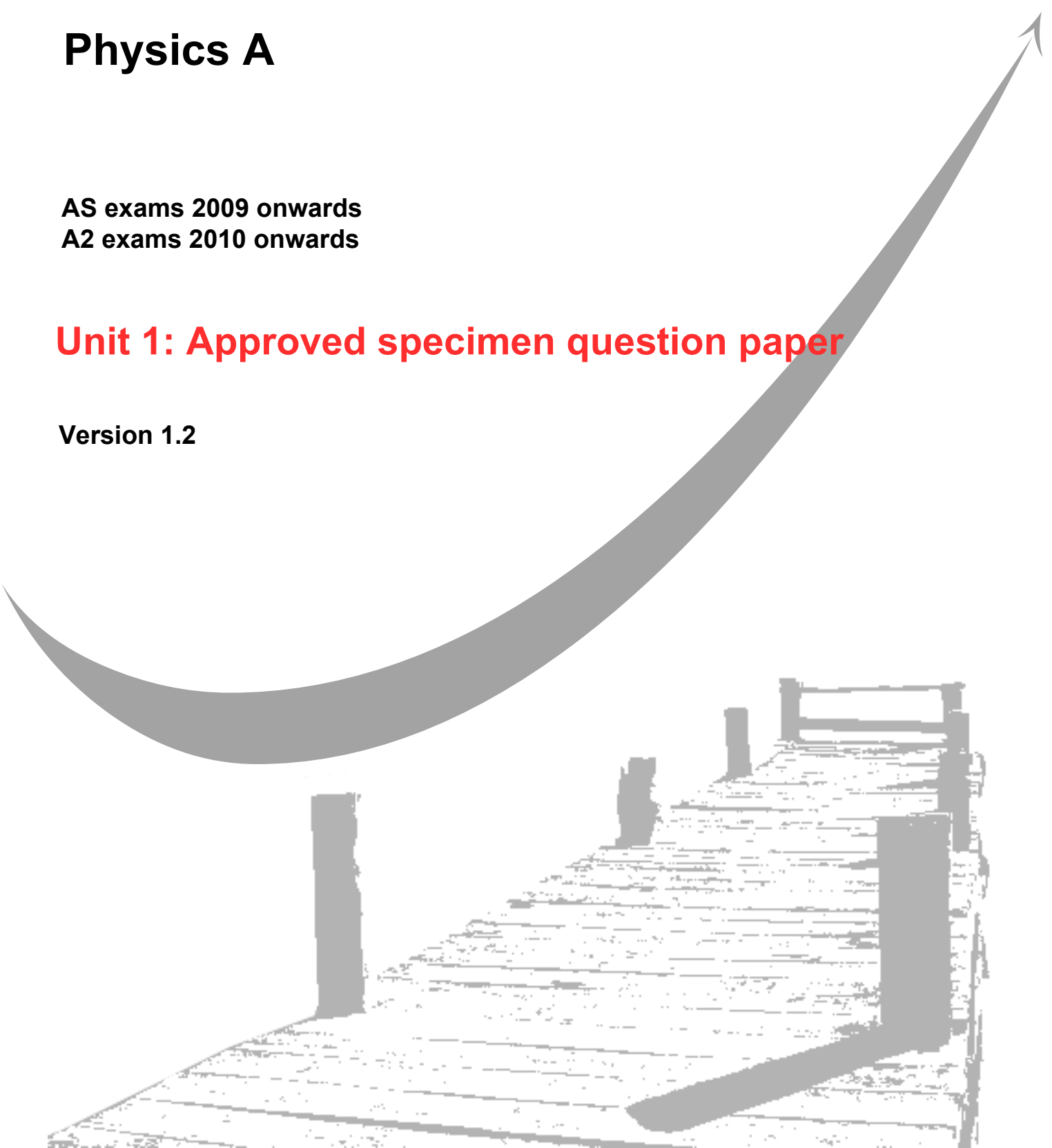
**GCE**  
**AS and A Level**

# Physics A

**AS exams 2009 onwards**  
**A2 exams 2010 onwards**

## **Unit 1: Approved specimen question paper**

**Version 1.2**



Surname					Other Names				
Centre Number					Candidate Number				
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General Certificate of Education  
2009  
Advanced Subsidiary Examination



version 1.2

**PHYSICS A** **PHYA1**  
**Unit 1** **Particles, Quantum Phenomena and Electricity**

SPECIMEN PAPER

Time allowed: 1 ¼ hours

**Instructions**

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- A *Data and Formula Booklet* is provided as a loose insert.

**Information**

- The maximum mark for this paper is 70.
- The marks for the questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers. You will be assessed on your quality of written communication where indicated in the question.

For Examiner's Use			
Number	Mark	Number	Mark
1		5	
2		6	
3		7	
4			
Total (Column 1)			
Total (Column 2)			
TOTAL			
Examiner's Initials			

1 (a) How many protons, neutrons and electrons are there in an atom of caesium,  $^{133}_{55}\text{Cs}$ , which is the most abundant and stable *isotope* of caesium.

..... protons

.....neutrons

..... electrons

(2 marks)

(b) (i) Explain what is meant by isotopes.

.....

.....

(ii) Write down an isotope  $^{133}_{55}\text{Cs}$  that is likely to be a beta minus emitter.

.....

(3 marks)

(c) Determine the specific charge of a nucleus of  $^{133}_{55}\text{Cs}$ .

specific charge = .....

(3 marks)

**Total 8 marks**

2 The quark model was developed to help understand hadrons. Quarks cannot exist separately, they form combinations.

(a) (i) List the **three** combinations that quarks can form.

.....

(ii) Give the quark combination for a positive pion,  $\pi^+$  and an antiproton,  $\bar{p}$ .

$\pi^+$  .....

$\bar{p}$  .....

(4 marks)

(b) The event represented by,  $K^- + p \rightarrow K^0 + K^+ + X$ , is a strong interaction.

The  $K^-$  has strangeness -1 and the kaons  $K^+$  and  $K^0$  both have strangeness +1.

(i) Use the conservation laws to deduce the strangeness, charge, baryon number and lepton number of the particle represented by X.

Strangeness .....

Charge .....

Baryon number .....

Lepton number .....

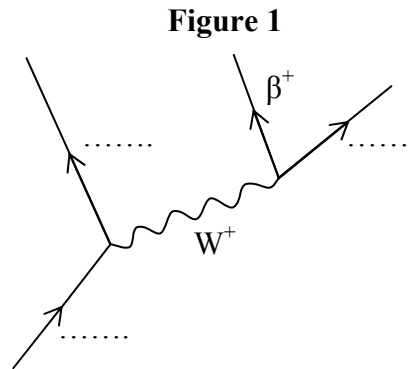
(ii) What will particle X eventually decay into?

.....

(4 marks)

**Total 8 marks**

- 3 (a) Complete the labelling of the Feynman diagram, **Figure 1**, representing positron emission from an individual nucleon.



(3 marks)

- (b) (i) What is the virtual exchange particle used by electromagnetic force?
- .....
- (ii) State **two** differences between the exchange particles used by the weak interaction and used by the electromagnetic force.

.....

.....

.....

(3 marks)

- (c) The theoretical work of Dirac suggested that for every particle there should exist a corresponding antiparticle. The first to be antiparticle to be discovered was the positron.

- (i) State what is meant by an antiparticle.

.....

.....

- (ii) Write down the corresponding antiparticle for each of the particles listed in the following table.

Particle	antiparticle
$\beta^-$	$\beta^+$
$\pi^0$	
$K^0$	
$\gamma$	

(5 marks)

**Total 11 marks**

4 (a) When monochromatic light is incident on a metal plate, electrons are emitted only when the frequency of light exceeds a certain frequency.

Explain in terms of energy, why this threshold frequency exists and why a photon theory of light provides a better explanation of the photoelectric effect than a wave theory of light.

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

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(7 marks)

(b) A gold surface is illuminated with monochromatic ultra violet light of frequency  $2.10 \times 10^{15}$  Hz. The maximum kinetic energy of an emitted photoelectron is  $6.20 \times 10^{-19}$  J.  
Calculate

(i) the energy, in J, of the incident photon,

energy = ..... J

(ii) the work function of gold,

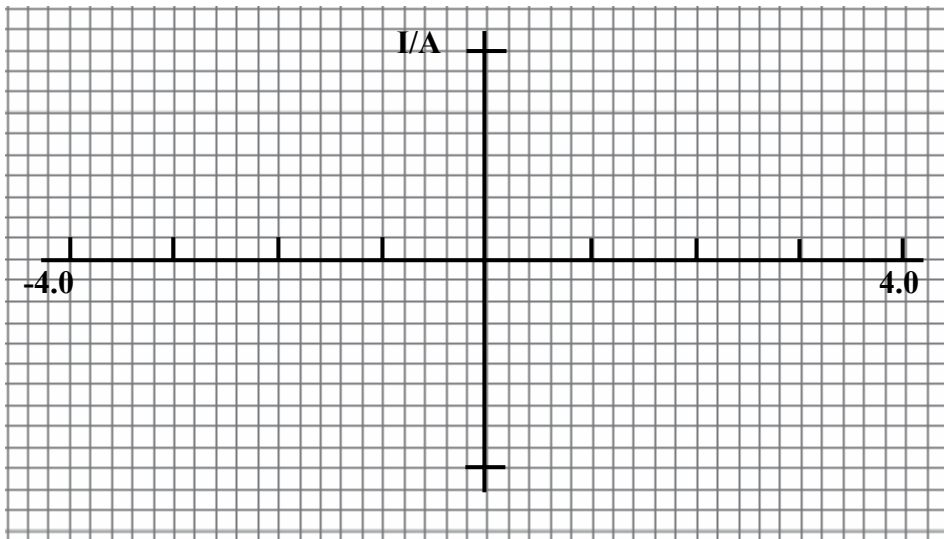
work function = .....

(5 marks)

**Total 12 marks**

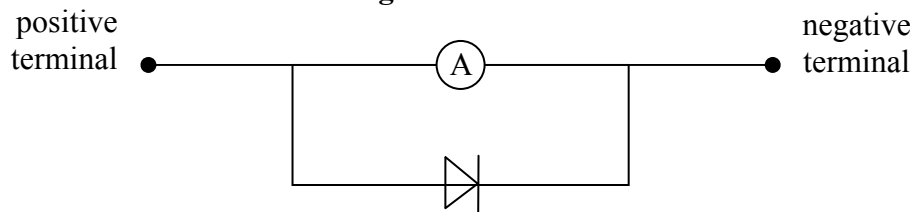
- 5 (a) (i) On the axes in **Figure 2** draw the I – V characteristic for a silicon semiconductor diode, giving any relevant voltage values.

**Figure 2**



- (ii) A very sensitive ammeter can be protected using a silicon semiconductor diode as shown in **Figure 3**. Use the characteristic in **Figure 2** to explain how the ammeter is protected when it is connected in a circuit carrying too much current for it to measure.

**Figure 3**



.....

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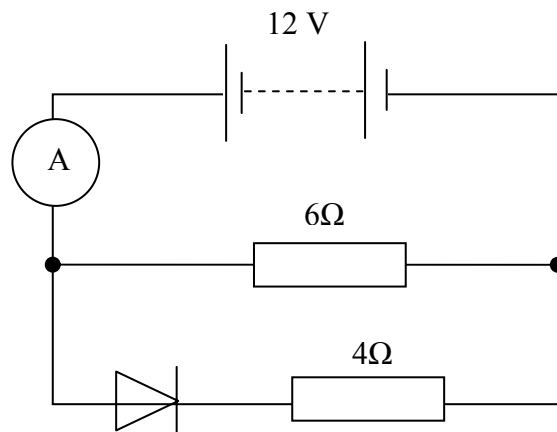
.....

.....

(6 marks)

(b) Determine the current flowing through the ammeter in **Figure 4**.

**Figure 4**



current = .....

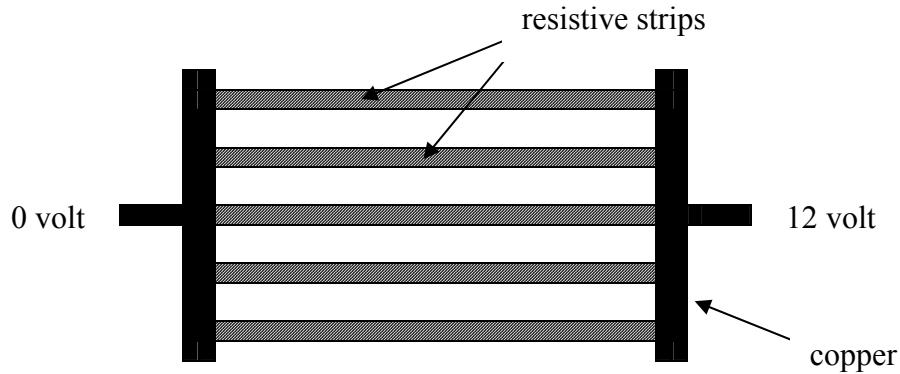
*(5 marks)*

**Total 11 marks**



- 6 A heating unit as used on the rear window of a car consists of five strips of resistive material joined at either end by strips of copper of negligible resistance, shown in **Figure 5**. Heat is generated at a rate of 45 W when the unit is connected to a 12 V car battery.

**Figure 5**



- (a) (i) Calculate the total resistance of the unit.

total resistance = .....

- (ii) Show that the resistance of each strip is about  $16\Omega$ .

*(4 marks)*

- (b) If each resistive strip is 2.5 mm wide and of length 0.80 m, determine the thickness of each strip.

Resistivity of the resistive material =  $5.0 \times 10^{-5}\Omega\text{m}$ .

thickness = .....

*(3 marks)*

- (c) The rear window heater on a car is sometimes set to be switched off automatically after a period of time to prevent draining the battery.  
If the charge stored in a fully charged battery is  $1.44 \times 10^5 \text{C}$ , how long, in hours, would it take to fully drain the battery with the heater?

time = ..... hours

*(3 marks)*

**Total 10 marks**

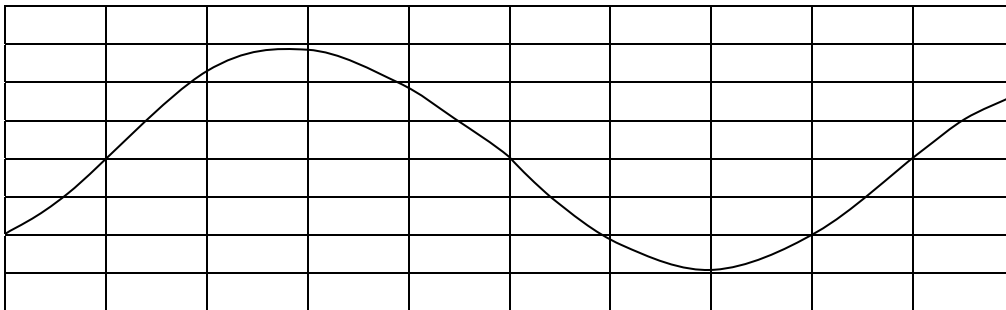
7 An oscilloscope is connected to an alternating voltage source of rms value 4.2 V at a frequency of 2.5 kHz.

(a) Calculate the peak-to-peak alternating voltage.

peak-to-peak voltage = .....  
(2 marks)

(b) **Figure 6** represents the screen of the oscilloscope.

**Figure 6**



Determine

(i) the voltage sensitivity of the oscilloscope,

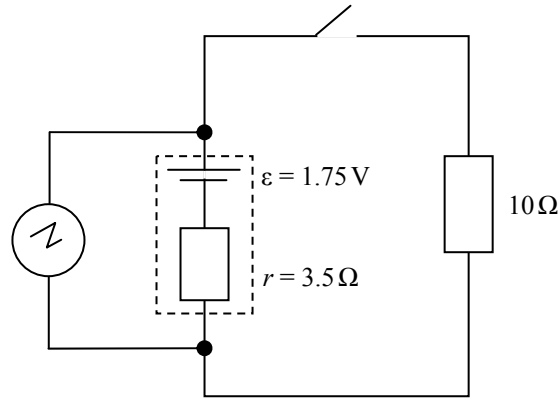
voltage sensitivity = .....

(ii) the time base setting of the oscilloscope.

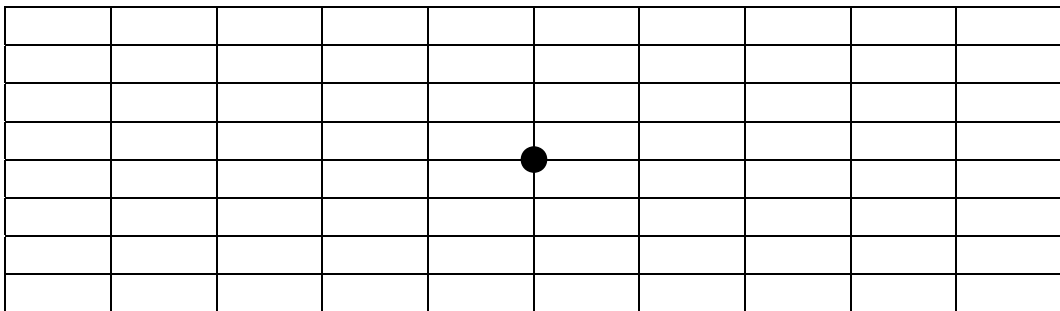
time base setting = .....  
(3 marks)

- (c) The time base of the oscilloscope is switched off and the voltage sensitivity is set to  $0.5 \text{ V div}^{-1}$ . The oscilloscope is connected across a  $1.75 \text{ V}$  battery of internal resistance  $3.5 \Omega$  which is connected to a  $10 \Omega$  resistor as shown in **Figure 7**. **Figure 8** represents the screen of the oscilloscope which shows the spot when registering zero volts.

**Figure 7**



**Figure 8**



- (i) Draw a spot on **Figure 8** showing the appearance on the screen when the switch is open. Label this spot O.
- (ii) When the switch is closed determine the current flowing through the  $10 \Omega$  resistor.

current = .....

- (iii) Draw a spot on **Figure 8** showing the appearance on the screen when the switch is closed. Label this spot C.

(5 marks)

**Total 10 marks**