Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic: Particle And Radiation

Name of the Student:____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

A radioactive source emits alpha particles each with 8.1×10^{-13} J of kinetic energy.

(a) Show that the velocity of an alpha particle with kinetic energy 8.1×10^{-13} J is approximately 2×10^{7} m s^{-1}

specific charge of an alpha particle = 4.81×10^{7} C kg^{-1}

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(2)

(b) The alpha particles travel through air in straight lines with a range of 3.5 cm

Calculate the average force exerted on an alpha particle as it is stopped by the air.

average force = ____________________ N

(2)

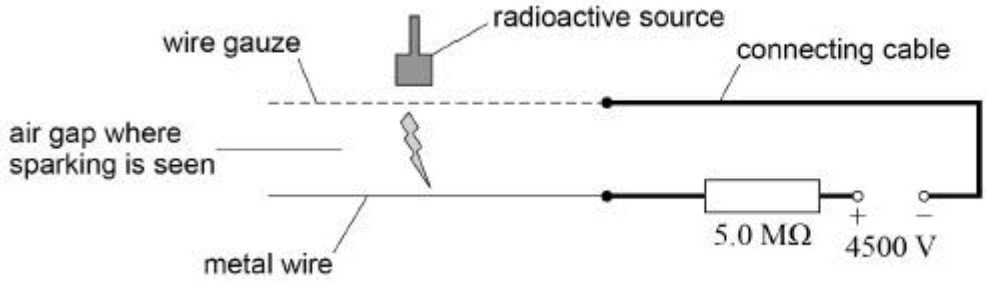
(c) An alpha particle transfers all its kinetic energy to air molecules and produces 5.1×10^{4} ions per centimetre over its range of 3.5 cm

Calculate the average ionisation energy, in eV, of a molecule of air.

ionisation energy = ____________________ eV

(3)

(d) A spark counter consists of a wire gauze separated from a metal wire by a small air gap. A power supply with an output of 4500 V is connected in series with a 5.0 MΩ resistor and the spark counter as shown in the diagram. When the radioactive source is moved close to the wire gauze, sparking is seen in the air gap.



Sparks are produced when alpha particles produce ionisation in the air gap.

One ionisation event produces a current of 0.85 mA for a time of 1.2 ns

Calculate the number of charge carriers that pass a point in the connecting cable during this ionisation event.

number of charge carriers = ____________________

(2)

(e) The radioactive source was positioned 10 cm above the wire gauze before being moved slowly towards the wire gauze leading to the ionisation event in part **(d)**.

Discuss how the potential difference across the air gap varied as the radioactive source was moved over this distance.

Assume the power supply has negligible internal resistance.

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(3)
(Total 12 marks)

Q2.

Figure 1 shows an arrangement used to investigate double slit interference using microwaves.
Figure 2 shows the view from above.

Figure 1

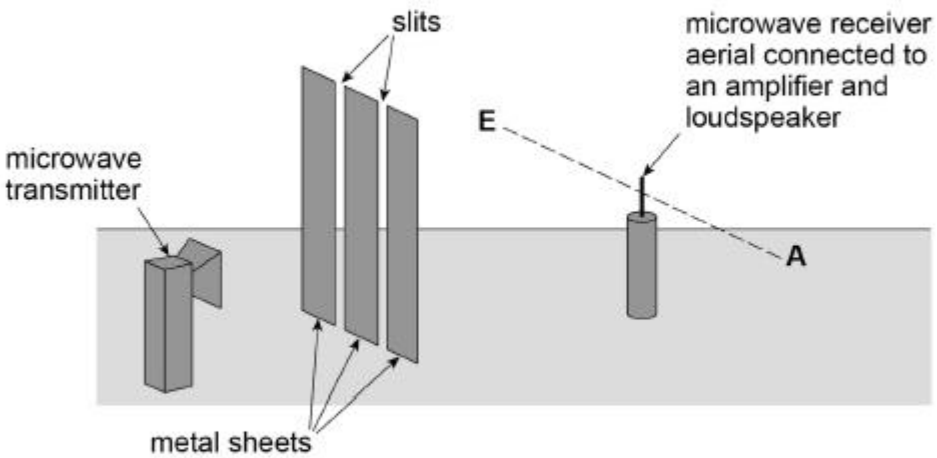
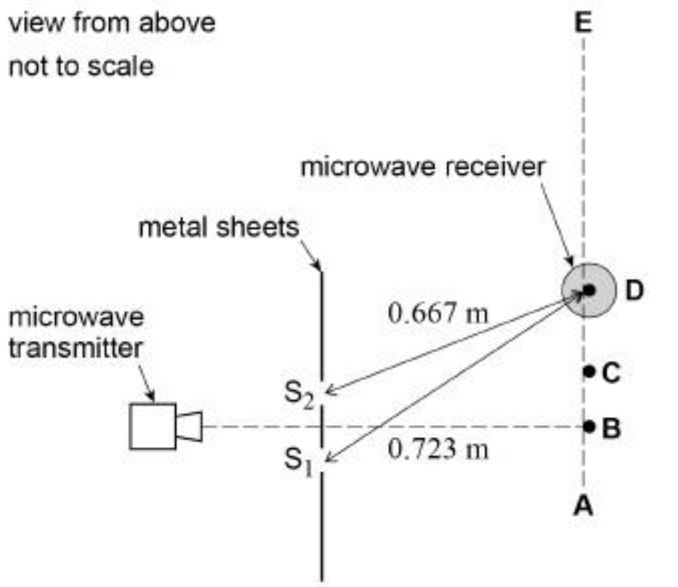


Figure 2



The microwaves from the transmitter are polarised. These waves are detected by the aerial in the microwave receiver (probe). The aerial is a vertical metal rod.

The receiver is moved along the dotted line **AE**. As it is moved, maximum and minimum signals are detected. Maximum signals are first detected at points **B** and **C**. The next maximum signal is detected at the position **D** shown in **Figure 2**.

Figure 2 shows the distances between each of the two slits, S_1 and S_2, and the microwave receiver when the aerial is in position **D**.
S_1D is 0.723 m and S_2D is 0.667 m.

(a) Explain why the signal strength falls to a minimum between **B** and **C**, and between **C** and **D**.

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(3)

(b) Determine the frequency of the microwaves that are transmitted.

frequency = ______________________________ Hz

(3)

(c) The intensity of the waves passing through each slit is the same.

Explain why the minimum intensity between **C** and **D** is not zero.

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(2)

(d) The vertical aerial is placed at position **B** and is rotated slowly through 90° until it lies along the direction **AE**.

State and explain the effect on the signal strength as it is rotated.

(3)

(Total 11 marks)