Answer TWO questions

The following may used:

Speed of light	$c = 2.9979 \times 10^{8}$ m/s
Electron charge	$e = 1.6 \times 10^{-19}$ C
Boltzman's constant	$k = 1.38 \times 10^{-23}$ J/K
Planck's constant	$h = 6.626 \times 10^{-34}$ J.s

Question 1

Define the terms *total cross section* and *elastic differential cross section* when applied to the scattering of electrons from atoms and molecules **4**

Describe the nature of the Ramsauer-Townsend effect for electrons. Give the physical reasons for its existence and observation. **6**

Describe how the Ramsauer Townsend effect may be experimentally observed. Would this apparatus be suitable for;
(i) measuring differential cross sections?
(ii) measuring resonance structure in the total cross section?
Give reasons. **6**

A 5 nanoamp electron beam incident upon a gas beam (10^{12} atoms/cm^2/s) scatters 2.5×10^{3} electrons per second into a detector of solid angle 0.04 steraradians. Assuming an isotropic angular dependence what is the total scattering cross section? **4**

Question 2;

Briefly describe the possible collision processes when an electron is incident upon a molecular target. **4**

Describe, in some detail, an experimental apparatus to measure the differential cross section of a diatomic molecular target. **6**

State the Franck-Condon principle. Explain how the Franck-Condon principle may be invoked to explain electron impact dissociation of molecules. How do the kinetic energies of the dissociation fragments depend upon the route of dissociation? **6**

In an electron impact experiment on CO_2 oxygen atoms are produced in an excited metastable state with a lifetime of $\tau = 180\mu s$ and excited carbon monoxide molecules in a metastable state of lifetime $\tau = 1ms$. If initially twice as many oxygen atoms are produced as carbon monoxide molecules, after what time will the resulting composite beam comprise equal numbers of excited O atoms and CO molecules? **4**

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Question 3:

Describe carefully the differences in the basic interactions of electrons and positrons with atomic and molecular targets. How are these differences reflected in the measured total scattering cross sections of positrons from the rare gases? **4**

Discuss the two possible ground state configurations of positronium and describe their natural modes of decay. **4**

Describe, in some detail, an experiment to measure positronium scattering cross sections from atomic targets. **6**

Briefly discuss the Vestler-Ulbricht hypothesis for the origin of chirality of biological molecules. Describe an experiment to demonstrate the validity of this hypothesis. **6**

END OF PAPER