Nuclear Radius Questions

1. When a deuterium nucleus and a tritium nucleus overcome their Coulomb barrier and fuse together they may be considered as charged spheres in contact. The constant r_0 which relates the nuclear radius, R, to the cube root of the mass number A may be assumed to be 1.3 fm.

(a) (i) Calculate the radius of the deuterium nucleus R_D and the radius of the tritium nucleus R_T before fusion.

(ii) Calculate the minimum energy, in MeV, which must be supplied to the deuterium nucleus and the tritium nucleus when they fuse together.

(5)

(b) Estimate the temperature at which deuterium and tritium nuclei would have enough kinetic energy to undergo fusion.

(3)
(Total 8 marks)

2. (a) Show that the kinetic energy of an α particle travelling at 2.00×10^{7} ms^{-1} is 1.33×10^{-12}J when relativistic effects are ignored.

(2)

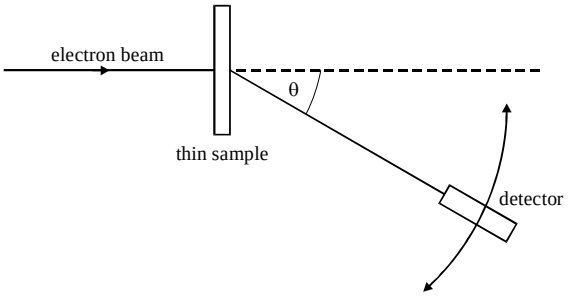
(b) Calculate the closest distance of approach for a head-on collision between the α particle referred to in part (a) and a gold nucleus for which the proton number is 79.
Assume that the gold nucleus remains stationary during the collision.

(4)

(c) State **one** reason why methods other than α particle scattering are used to determine nuclear radii.

(1)
(Total 7 marks)

3. Nuclear radii can be determined by observing the diffraction of high energy electrons, as shown in the diagram.



(a) On the axes below, sketch a graph of the results expected from such an electron diffraction experiment.

(2)

(b) State why high energy electrons are used in determining nuclear size.

(1)

(c) Electron diffraction experiments have been performed on a range of different nuclei to give information about **nuclear density** and **average separation of particles** in the nucleus. Give the main conclusion in each case.

(2)

(d) Sketch a graph of the relationship between the radius of a nucleus and its nucleon number.

(1)

(e) Given that the radius of the $^{12}_{6}$C nucleus is 3.04×10^{-15}m, calculate the radius of the $^{16}_{8}$O nucleus.

(3)
(Total 9 marks)

4. The radius of a nucleus, *R*, is related to its nucleon number, *A*, by

$R = r_0 A^{1/3}$, where r_0 is a constant.

The table lists values of nuclear radius for various isotopes.

Element	$R/10^{-15}$m	A	
carbon	2.66	12	
silicon	3.43	28	
iron	4.35	56	
tin	5.49	120	
lead	6.66	208	

(a) Use the data to plot a straight line graph and use it to estimate the value of r_0.

(8)

(b) Assuming that the mass of a nucleon is 1.67×10^{-27} kg, calculate the approximate density of nuclear matter, stating **one** assumption you have made.

(4)

(Total 12 marks)