On Rutherford's atom

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1. Read the following passage, taken from a lecture given by Lord Rutherford in 1936, and answer the questions which follow.

> In the early days, Dr Geiger found the majority of α particles passed through undeflected when fired at thin gold foil only a few atoms thick; only a small number diverged slightly off course. One day Geiger suggested that we set young Marsden to see if any α particles could be deflected through a large angle. I did not believe they would be, since we knew that the α particle was very fast and massive with lots of energy and unlikely, therefore, to suffer large deflections in uniform matter. Then, two or three days later, Geiger came to me in great excitement saying 'we have consistently seen some α particles (about 1 in 20 000) coming backwards'. It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15 inch shell at a piece of tissue paper and it came back and hit you.

   (a) What is an α particle?
   (b) Why did most of the α particles pass through the foil undeflected?
   (c) Why were some deflected slightly?
   (d) What is the largest angle through which a particle is scattered? How does this come about?
   (e) Why do bound electrons, in orbitals around the gold nucleus, have a negligible influence on the α particle trajectories?

2. (a) Sketch, on the same diagram, the paths of three alpha particles, of the same energy, which are directed towards a nucleus so that they are deflected though
      i. about 20°,
      ii. about 90° ,
      iii. 180°.
   (b) For the deflection of 180°, describe how
      i. the kinetic energy,
      ii. the potential energy,
      iii. the speed,

   of the alpha particle varies along its path.

3. Beams of electrons, protons and neutrons, each having the same velocity, are passed separately in a vacuum between two metal plates of positive and negative electrical charge.
   (a) Which of the three types of particle is deflected the most by the electric field between the charged plates? Give a reason for your answer and state the direction this type of particle is deflected.
   (b) Which of the three types of particle has the greatest penetration through a sheet of metal? Give a reason for your answer.