Part I

1. When +3.0 C of charge moves from point A to point B in an electric field, the potential energy is decreased by 27 J. It can be concluded that point B is

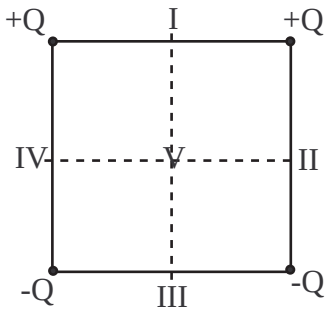
   (a) 9.0 V lower in potential than point A.

   (b) 9.0 V higher in potential than point A.

   (c) 81 V higher in potential than point A.

   (d) 81 V lower in potential than point A.

2. Four charges are arranged on the four corners of a square as shown in the diagram. If the electric potential is defined to be zero at infinity then it is also zero at



   (a) point V only.

   (b) points II and IV and V.

   (c) points I and III.

   (d) none of the labeled points.

3. A small positive charge q is brought from far away to a distance r from a positive charge Q. In order to pass through the same potential difference a charge $2q$ should be brought how close to the charge Q. (Assume the initial charge q has been removed.)

   (a) a distance $r/2$.

   (b) a distance r.

   (c) a distance $2r$.

   (d) a distance $4r$.

4. Consider two different charged spherical conductors, Sphere A with radius $r = a$ and Sphere B radius $r = b$ with $b > a$. If the conductors are brought into contact then which of the following statements are true:

   (a) Sphere A has more charge and higher charge density.

   (b) Sphere A has more charge but lower charge density.

   (c) Sphere A has less charge but higher charge density.

   (d) Sphere A has less charge and lower charge density.

Part II

1. A gold nucleus has a radius of 3×10^{-15} m and carries a charge of $79e$?

   (a) What is the electric field strength at its surface?

   (b) What is the potential at its surface?

   (c) How much energy in electron volts would be required to bring a proton from a large distance up to the surface of the gold nucleus.

   (d) What would the initial velocity of the proton need to be in order to come this close to the gold nucleus? (Assume the gold nucleus does not recoil.)

2. A potential difference of 10,000 V exists between two parallel plates which are separated by 10 cm. An electron is released from the negative plate at the same instant a proton is released from the positive plate.

   (a) What is the kinetic energy of each particle as they reach the opposite sides? State your answer in units of Joules and electron volts.

   (b) With what velocity does each of the particles hit the opposite plates?

   (c) What is the electric field strength between the plates?

   (d) What is the acceleration of each particle?

Part III

1. Consider parallel plates, each with area A separated by distance d. The plates are charged with $+Q$ on one plate and $-Q$ on the other and isolated. Write down an expression for each of the following variables in terms of A, d and Q as needed.

   (a) The charge density on the plates.

   (b) The electric field between the two plates.

   (c) The potential difference between the two plates.

   (d) If the distance between the plates were halved what, if anything would happen to each of the above quantities?

2. Now suppose the same plates with area A and separation d.are connected to opposite terminals of a battery with potential V_0. Write down an expression for each of the following variables in terms of A, d and V_0 as needed.

   (a) The potential difference between the two plates.

   (b) The electric field between the two plates.

   (c) The charge density on the plates.

   (d) If the distance between the plates were halved what, if anything would happen to each of the above quantities?

3. Using the formulas you have written in question 1. or 2. write down and simplify an expression for the ratio $\frac{Q}{\Delta V}$ in terms of A and d. How would this quantity change (if at all) if the following changes are made to the parallel plates?

   (a) The distance between the plates is halved?

   (b) The area of the plates is halved?

   (c) The charge on the plates is halved?

   (d) The potential difference across the plates is halved?