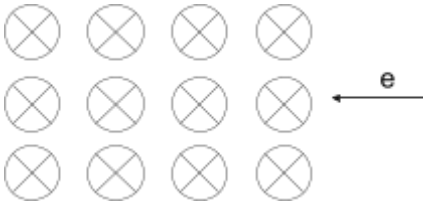
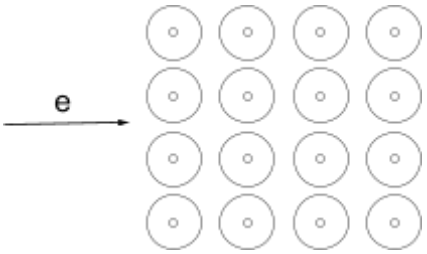
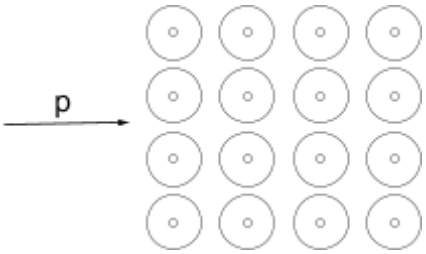
Particles and Waves

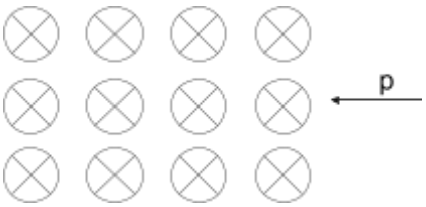
Particle Accelerators

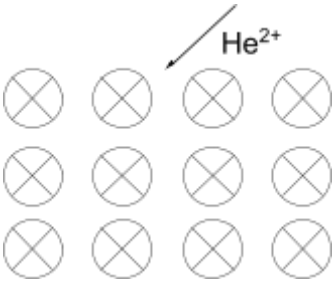
1) In the diagrams below use the right or left hand rules to determine the direction of the force experienced by a charged particle in the magnetic field.

a) 

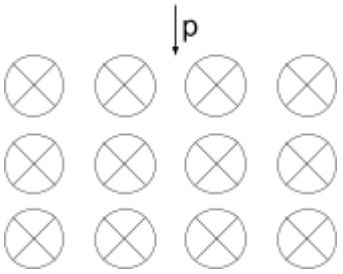
b) 

c) 

d) 

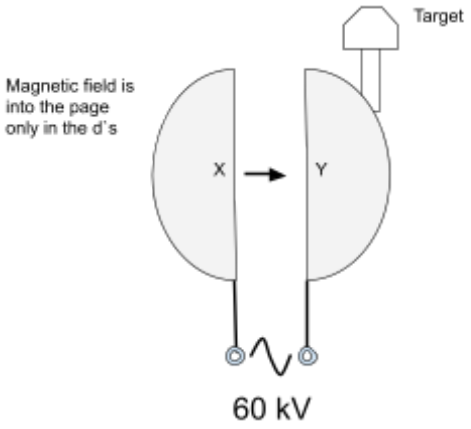
e) 

2) Which of the following is true about a proton entering into a magnetic field as shown below:



i) The proton will experience a force to the left and increase its speed
ii) The proton will increase its speed and experience a force to the right
iii) The proton will experience a force to the right and not increase its speed.

3) A cyclotron is a type of particle accelerator that uses an alternating electric field between two metal D shaped hollow containers which have a magnetic field into the diagram.



a) Explain why the Ds are connected to an alternating voltage supply.

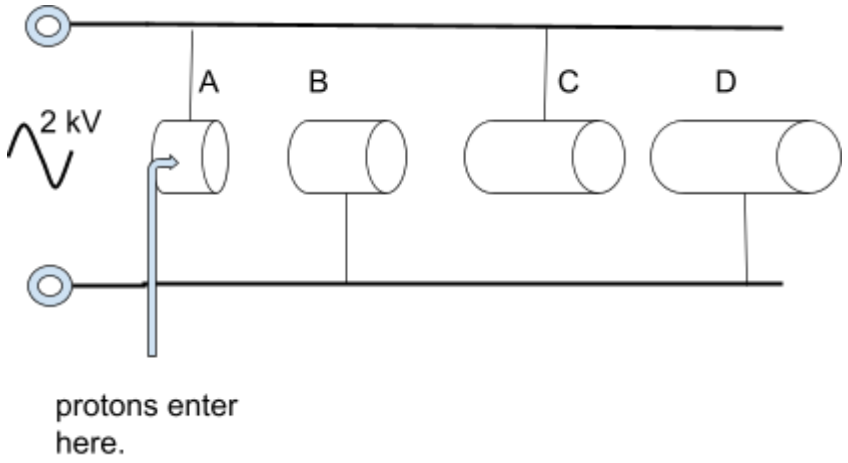
b) Sketch the path of a proton as it moves across the gap XY and enters the second D.

c) Determine the kinetic energy gained by each traverse of the D gap.

d) The proton makes 3 transitions through the gap. Find the speed of the proton at the end of its third transit.

e) Explain why the cyclotron is limited in size.

4) Here is the diagram of a linear accelerator.



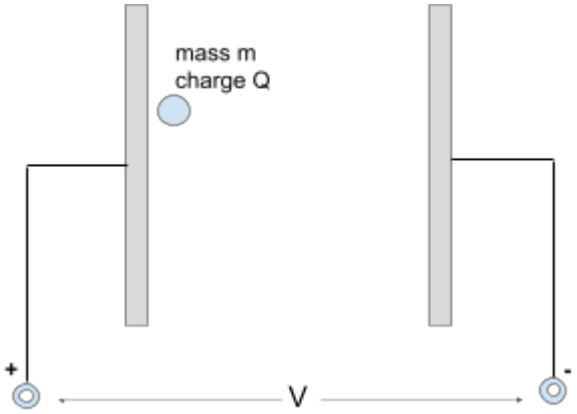
a) Protons enter through electrode A. State the polarity of the electrodes A and B for the proton to move between A and B.

b) Determine the energy gained by the proton when it is accelerated along the electric field between A and B.

c) Find the total energy gained by the proton as it leaves electrode D.

d) Assuming the speed of the proton entering electrode A is zero, determine the speed of the proton as it leaves electrode D.

5) A particle of charge Q is accelerated in the electric field between two metal plates as shown.



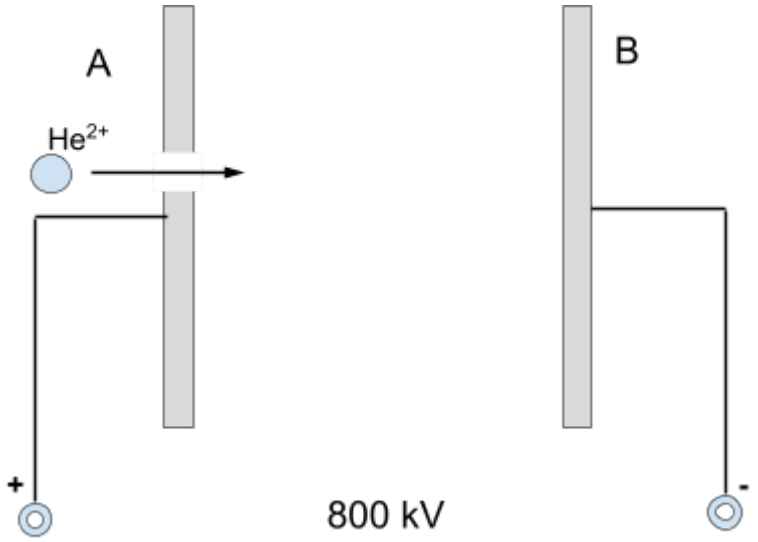
Show that the velocity of the charged particle when it reaches the other plate is given by

$$v = \sqrt{\frac{2QV}{m}}$$

6) Determine the speed gained by a proton when it is accelerated in the electric field between two metal plates which has a potential difference of 3kV.
mass of proton = 1.67 x 10^{-27} kg and it has a charge of size 1.6 x 10^{-19} C

7) A proton of mass 1.67 x 10^{-27} kg reaches a speed of 6.0 x 10^{6} m s^{-1} from rest when it passes through an electric field between two metal plates.
Determine the size of the potential difference between the metal plates.
Charge on proton = 1.6 x10^{-19} C.

8) An alpha particle of mass 6.64 x 10^{-27} kg and electric charge 3.2 X 10^{-19} C enters an electric field between two metal plates through a gap at position A with a speed of 2 x 10^{6} m s^{-1} . The potential difference between the plates A and B is 800 kV.



a) Find the kinetic energy of the alpha particle as it enters the gap in plate A

b) Find the energy gained by the alpha particle when it reaches plate B

c) Find the **total** kinetic energy of the alpha particle at plate B.

d) A magnetic is brought near the plates such that the magnetic field lines are ***into*** the diagram. State what direction the alpha particle would now take between the plates.