Higher
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Fields
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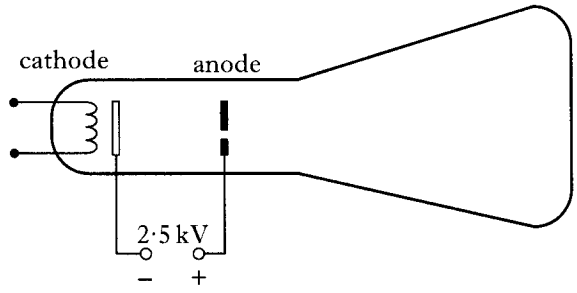
Past Paper questions
1991 - 2001

1999 Q33.

The diagram shows an arrangement which is used to accelerate electrons.
The potential difference between the cathode and the anode is 2.5 kV.

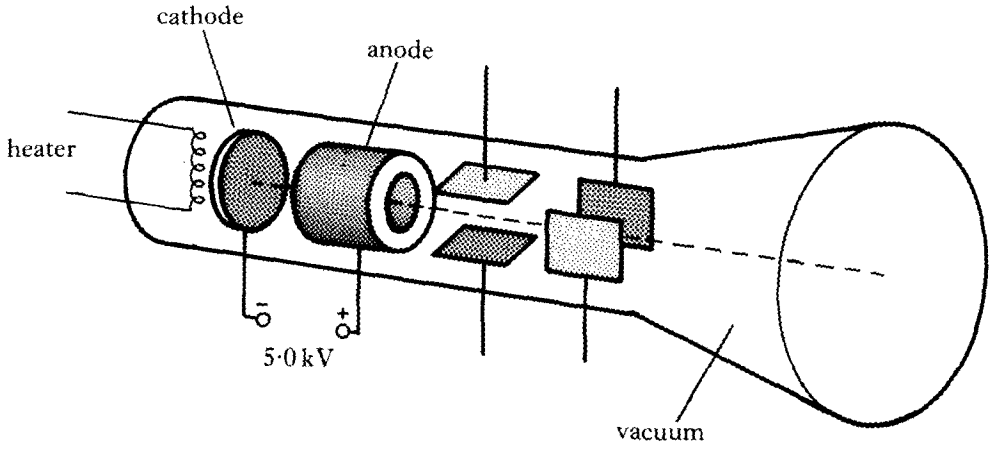


Assuming that the electrons start from rest at the cathode, calculate the speed of an electron just as it reaches the anode.

[DATA: e = -1.6 x 10^{-19}C, m_e = 9.11 x 10-31 kg]

1992 Q7.

The diagram illustrates a cathode ray tube used in an oscilloscope.



Electrons released from the hot cathode are accelerated by a p.d. of 5.0 kV between the cathode and anode.

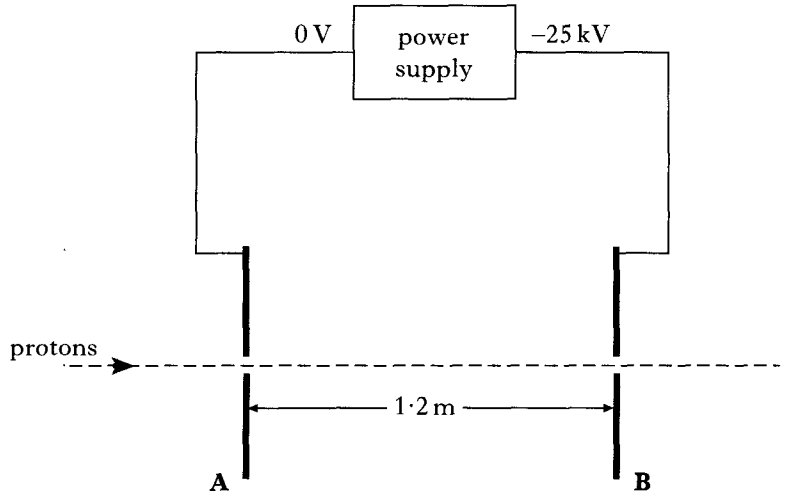
(a) (i) Assuming that an electron starts from rest at the cathode, calculate its speed just before it reaches the anode.

(ii) What is the effect on the speed of the electron just before it reaches the anode if the p.d. between the cathode and anode is halved?
Show your reasoning.

(b) If the electron beam current is 15 mA, how many electrons leave the cathode each second?
[Data:- Charge on an electron = 1.6x10^{-19} C, Mass of electron = 9.11x10^{-31} kg.]

1996 Q6.

A particle accelerator increases the speed of protons by accelerating them between a pair of parallel metal plates, **A** and **B**, connected to a power supply as shown below.



The potential difference between **A** and **B** is 25 kV.

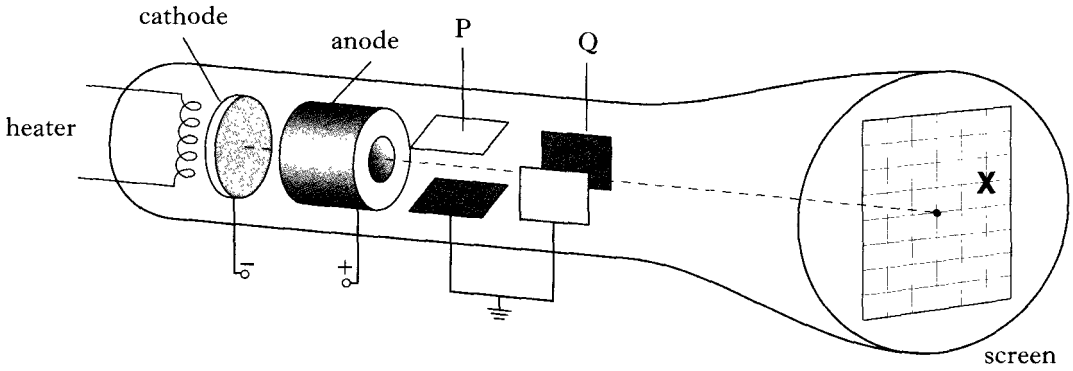
(a) Show that the kinetic energy gained by a proton between plates **A** and **B** is 4.0×10^{-15} J.

(b) The kinetic energy of a proton at plate **A** is 1.3×10^{-16} J.
Calculate the velocity of the proton on reaching plate **B**.

(c) The plates are separated by a distance of 1.2 m.
Calculate the force produced by the particle accelerator on a proton as it travels between plates **A** and **B**.
[Data: Mass of proton = 1.67×10^{-27} kg]

1998 Q7.

The diagram below shows a cathode ray tube used in an oscilloscope.



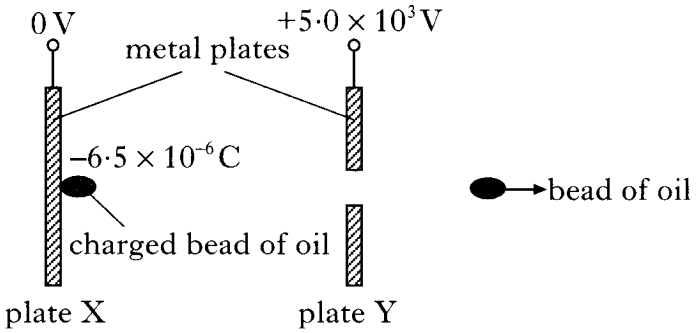
The electrons which are emitted from the cathode start from rest and reach the anode with a speed of 4.2×10^{7} ms^{-1}.

(a) (i) Calculate the kinetic energy in joules of each electron just before is reaches the anode.
(ii) Calculate the p.d. between the anode and the cathode.

(b) Describe how the spot at the centre of the screen produced by the electrons can be moved to position X.
Your answer must make reference to the relative sizes and polarity (signs) of the voltages applied to plates P and Q.

2001 Q23 (part)

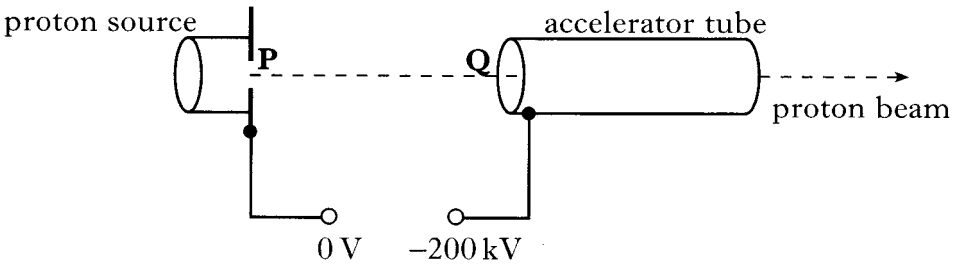
(b) A machine uses beads of oil and two metal plates X and Y.
The potential difference between these plates is 5.0×10^3 V.
Each bead of oil has a mass of 4.0×10^{-5} kg and is given a negative charge of 6.5×10^{-6} C.
The bead accelerates from rest at plate X and passes through a hole in plate Y



Neglecting air friction, calculate the speed of the bead at plate Y

2006 Q24.

The diagram below shows the basic features of a proton accelerator.
It is enclosed in an evacuated container.



Protons released from the proton source start from rest at **P**.
A potential difference of 200 kV is maintained between **P** and **Q**.

(a) What is meant by the term *potential difference of 200 kV*?

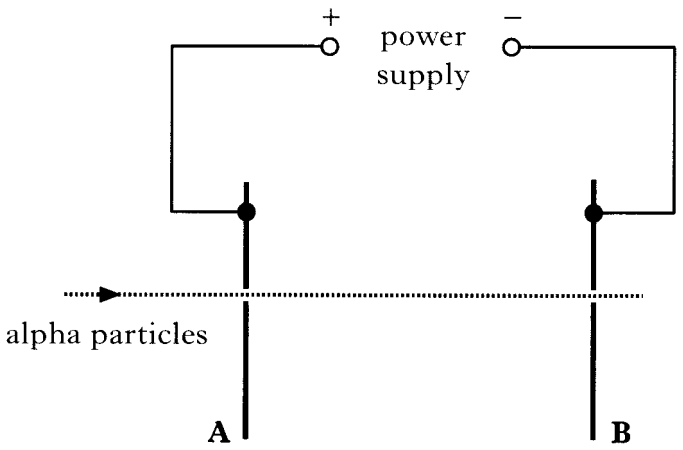
(b) Explain why protons released at **P** are accelerated towards **Q**.

(c) Calculate:
  (i) the work done on a proton as it accelerates from **P** to **Q**;
  (ii) the speed of a proton as it reaches **Q**.

(d) The distance between **P** and **Q** is now halved.
What effect, if any, does this change have on the speed of a proton as it reaches **Q**?
Justify your answer.

2007 Q24.

The apparatus shown in the diagram is designed to accelerate alpha particles.



An alpha particle travelling at a speed of 2.60×10^{6} ms^{-1} passes through a hole in plate A.

The mass of an alpha particle is 6.64×10^{-27} kg and its charge is 3.2×10^{-19} C.

(a) When the alpha particle reaches plate B, its kinetic energy has increased to 3.05×10^{-14} J.
Show that the work done on the alpha particle as it moves from plate A to plate B is 8.1×10^{15} J.

(b) Calculate the potential difference between plates A and B.

(c) The apparatus is now adapted to accelerate **electrons** from A to B through the same potential difference.
How does the increase in the kinetic energy of an electron compare with the increase in kinetic energy of the alpha particle in part (a)?
Justify your answer.