

Sample Question for HKAMP Engineering Physics
Part IIA Resident Physicists Certification Examination

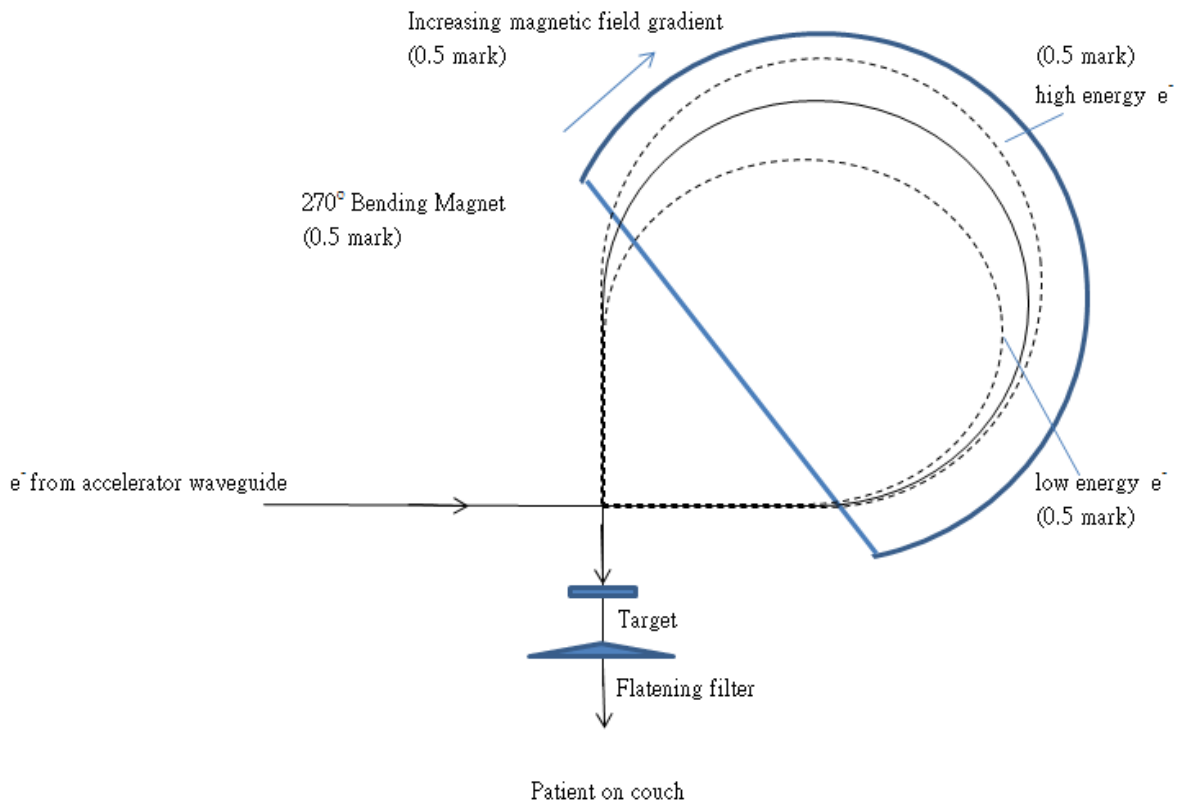
1a. Describe the application of bending magnet in medical linear accelerators. (2 marks)

Answer

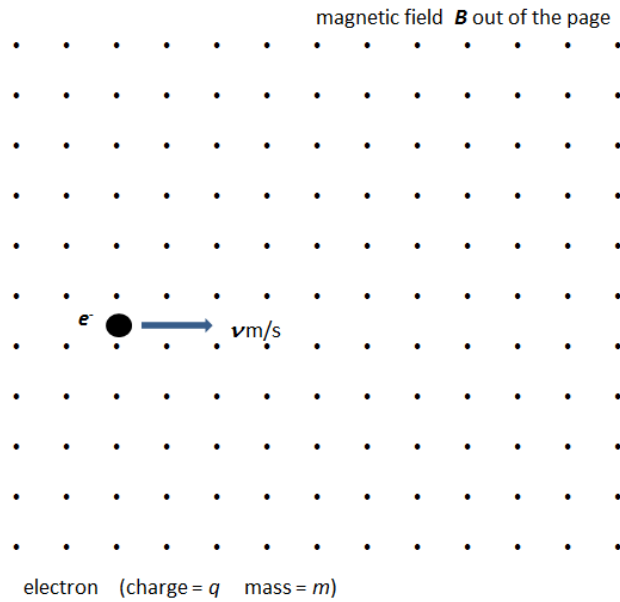
- (i) Direct high energy electron beam from the accelerator guide structure to the patient on the couch (1 mark)
- (ii) Spatially focusing beam with different injecting trajectories and energies to strike on target /flattening filter centrally and normally (1 mark)

1b. How a 270° bending magnet used by medical linear accelerators can help to serve the purpose described in previous question? (2 marks)

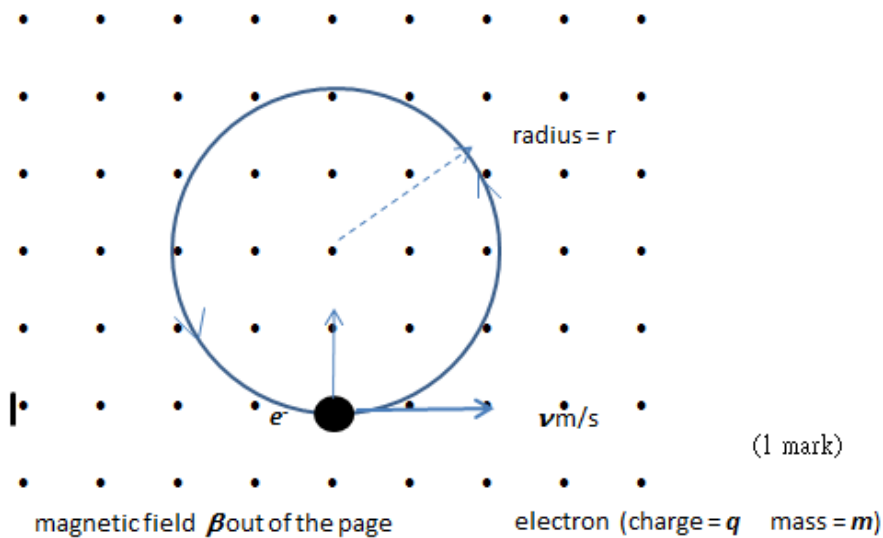
Answer



1c. Sketch the trajectory of an electron with velocity v injecting into an infinite vacuum space with uniform magnetic field. Formulate the trajectory with given physics quantities. (3 marks)



Answer



The electron will move in a circular path with radius r

Because

(i) magnetic force on a charge Q moving at right angle to the B field line is

$$F_Q = B Q v \quad (0.5 \text{ mark})$$

(ii) the charge will move in a circular path with the centripetal force provided by the magnetic field

$$F_Q = m v^2 / r \quad (0.5 \text{ mark})$$

Hence $B Q v = m v^2 / r$

$$r = (m v) / (B Q) \quad (1 \text{ mark})$$

1d. Explain why uniform magnet field in the bending magnet is not commonly used in nowadays medical linear accelerator design. (3 marks)

Answer

Deflection radius R of charged particle due to magnet field

$R = mv/BQ$ where m: mass of particle v: injecting velocity of particle

Q: charge of particle B: magnet field

If B is uniform along the trajectory in the bending magnet, R will not be the same if injecting velocity is different. Particles emerged from bending magnet cannot strike on the target and flattening filter in a common spot. Maintaining the stability of symmetry and flatness of the beam is a problem. (1.5 mark)

If B is designed with gradient so that as B is increased (or decreased) to compensate for the increase (decrease) of velocity v of the particles. Radius of deflection R can still be maintained more or less the same to enable emerging beam focuses onto target / flattening filter centrally and normally. Symmetry and flatness can be maintained with good stability. (1.5 mark)