May 2007

INSTRUCTIONS

- There are a total of SIX questions.
- Write your answers in the book provided.
- All questions are of equal value.
- All questions are to be attempted.
- You may use diagrams, tables or lists in your answers.
- Answers should be given from a radiotherapeutic physics viewpoint.

1.
   (a) With the aid of diagrams describe the challenges associated with junctioning two adjacent radiation beams, in the case where:
      i. both fields are megavoltage photon fields
      ii. one of the fields is a megavoltage photon field and the other an electron field (5 marks)
   (b) When treating the craniospinal axis, a junction is required between the lateral cranial fields and the posterior spinal field (i.e. an orthogonal field junction). Again with the aid of diagrams, briefly describe two techniques than can be used to successfully junction the fields.(5 marks)

2. Total Body Irradiation is a technique used for some patients being treated with bone marrow transplantation.
   (a) As a part of the treatment a perspex screen is placed close to the patient to reduce the skin sparing that occurs with megavoltage beams. Explain why skin sparing occurs with megavoltage beams. (3 marks)
   (b) One technique for delivering TBI is to use large opposed lateral fields with the patient in a semi reclined position, arms by side and knees bent. Describe the factors that might lead to dose inhomogeneity within the target volume (i.e. the body) and the methods that can be used to minimise this dose variation. (5 marks)
   (c) A dose uniformity of +/- 10% is acceptable for total body irradiation. Briefly describe how the dose uniformity is measured in vivo?(2 marks)

3. An x-ray tube with generating potential of 200 KVp has an inherent filtration of 1mm of aluminium.
   (a) Draw the expected energy spectrum of such a beam on the existing tube and explain why this beam must be modified for clinical use. (2 marks)
   (b) Describe a suitable method of modifying the beam, using diagrams to show how the spectrum is altered. (3 marks)
   (c) Draw an isodose curve for the beam as modified in b) above (field defined by an open-ended cone in contact with the surface of a water phantom). Compare this with the isodose curve for a 6 MeV electron beam (field defined by an applicator at 5cm from the surface of a water phantom).(5 marks)

4. A patient has been prescribed an HDR brachytherapy dose of 30Gy using an Ir192 seed source. A kink in the catheter used to insert the seed causes the seed to be positioned 26cm from the target site. The error was not discovered until the treatment had been completed. Identify
   (a) the cause of the event and factors contributing to the event becoming a radiation accident (5 mark)
   (b) remedial action that could be taken for the patient (1 mark)
   (c) what remedial action should be taken for future implants to avoid this scenario? (4 marks)

5.
   (a) Explain the concept of radioactive equilibrium using Strontium 90 as an example (3 marks)
   (b) Strontium-90 applicators are used to treat superficial regions on the skin or eye.
      i. Explain the source construction of Strontium-90 applicators (2 marks)
      ii. Explain the processes involved to achieve the treatment dose (2 marks)
   (c) What precautions should be taken with handling and cleaning strontium applicators to minimise unnecessary radiation doses to personnel and to the patient? (3 marks)

6.
   (a) Describe the parameters that need to be considered in the determination of a PTV. (2 marks)
   (b) Describe the methods that can be used to quantify these parameters and to reduce their magnitude. (3 marks)
   (c) List the benefits from the use of an electronic portal imaging device in treatment verification. (2 marks)
   (d) Describe the ways in which the prescribed treatment is accurately delivered over a fractionated course. (2 marks)