

1 Radiotherapy

1.1 Linear Accelerators

1.1.1 Sketch the main components of a linear accelerator.

1.1.2 Describe the theory of beam production and the part each component plays in the production of a clinically useful beam:

- Modulator
- Klystrons & Magnetron
- Electron Gun
- Accelerator Waveguide
- Bending Magnet
- Target
- Flattening Filter
- Collimation (primary & secondary)
- Monitor Ionisation Chambers
- Wedges (physical/flying/dynamic)

1.1.3 What changes are made to change the Linac from photon to electron mode?

1.1.4 What are the differences between the Varian 600C and the Siemens KD2?

1.1.5 Define absorbed dose

1.1.6 Describe a 270° bending magnet

1.1.7 Why do all electrons exit the magnet at the same point?

1.1.8 What would happen to low energy electrons?

1.1.9 What are the two types of EPIDs available?

1.1.10 Which is the most commonly used?

- 1.1.11 What else can be used to form images during treatment?
- 1.1.12 How does this work?
- 1.1.13 Why might this be of particular importance?
- 1.1.14 What is the difference between a dynamic wedge and an enhanced dynamic wedge?

1.2 Orthovoltage (Conventional) X-ray Machines

- 1.2.1 Describe the operation of a standard therapy x-ray machine.
- 1.2.2 What is the purpose of the beryllium window (how thick)?
- 1.2.3 How is most of the energy lost?
- 1.2.4 Describe how and why full wave rectification of the high voltage supply is necessary.
- 1.2.5 Sketch the radiation spectrum seen, with and without the effect of target filtration and additional filtration.
- 1.2.6 Explain the need for external filters.
- 1.2.7 What materials are used?
- 1.2.8 Why do applicators for x-rays ($>150\text{kVp}$) have a closed perspex end?
- 1.2.9 What is the 'Heel Effect'?
- 1.2.10 Sketch depth dose curves for 300, 100 and 50kV x-rays.
- 1.2.11 What are the approximate 90% depths for low and medium energies?

1.3 Ionisation Chambers

- 1.3.1 Sketch a free air ionisation chamber set-up.
- 1.3.2 What is the definition of exposure?

- 1.3.3 How does this affect the design of the free-air ionisation chamber?
- 1.3.4 What thickness of surrounding air is required at 200kV? 300kV?
- 1.3.5 Sketch a simple thimble chamber.
- 1.3.6 What is the air equivalent wall?
- 1.3.7 What is the calibration chain for ionisation chambers at your training hospital?
- 1.3.8 Describe the consistency checks using Strontium-90.

1.4 Photon/Electron Interactions & Depth Dose Characteristics

- 1.4.1 Describe the main photon interaction processes, their energy and atomic number dependence and threshold for domination using a graph.
- 1.4.2 Describe the main electron interaction processes.
- 1.4.3 Sketch depth dose curves and isodose distributions for kilovoltage, megavoltage and electron beams.
- 1.4.4 What is the 'rule of thumb' describing the relationship between dMAX and the photon/electron energy?
- 1.4.5 What are the advantages in terms of treatment planning of each of these types of radiation?

1.5 Exposure, Absorbed Dose and Air Kerma

- 1.5.1 Give the definitions and units of each of the above quantities.
- 1.5.2 How are the three related?
- 1.5.3 What calculations must be made to change dose in air to dose in water?

1.5.4 Sketch graphs indicating the differences at increasing energy for bone and tissue.

1.5.5 Under what conditions can air kerma and dose be considered identical, when not?

1.6 Brachytherapy

1.6.1 What is intracavity brachytherapy?

1.6.2 What are the advantages of this type of treatment?

1.6.3 Describe the properties of an ideal source and relate to currently used Cs-137 & Ra-226.

1.6.4 What are the advantages of afterloading brachytherapy devices?

1.6.5 What are the approximate dose rates for LDR, MDR & HDR afterloading systems?

1.6.6 What are biological effects of using a LDR or MDR machine?

1.6.7 Describe the Selectron suite and afterloading machine (plus applicators) at your training hospital.

1.6.8 What radiation protection devices are in place?

1.6.9 What is the purpose of catheterisation?

1.6.10 What are the anatomical origins and geometrical positions of points A & B in the Manchester system?

1.6.11 What are the dose limits to the rectal and bladder points?

1.6.12 What are the major features of the Paris system of dosimetry (9 Rules)?

1.6.13 How does this differ from the Manchester system?

1.6.14 What are the properties of Ir-192?

1.6.15 In dose calculations what are the basal doserate, the reference doserate and the treatment volume.

1.6.16 What is the effective length of the hairpin taken to be?

1.6.17 What is RAKR?

1.6.18 How is it defined?

1.6.19 Where is Point A on this brachytherapy treatment plan?

1.6.20 Explain the weighting between the ovoids and the tubes.

- 1.6.21 What is the reference air kerma rate for a brachytherapy source?
- 1.6.22 Why is the source activity not used?
- 1.6.23 What does RAKR mean?
- 1.6.24 Why is it used?
- 1.6.25 What does it take account of?
- 1.6.26 How would you calculate the dose to the A points?
- 1.6.27 Do you take into account attenuation caused by tissue or the applicator, give a ball park figure for these effects?

1.7 QA Procedures (Megavoltage)

- 1.7.1 List the daily checks performed and the tolerances for each result.
- 1.7.2 What additional checks are performed weekly?
- 1.7.3 List the checks performed monthly on the Linac (8).
- 1.7.4 What codes of practice are used?
- 1.7.5 Describe the experimental set-up including the field size, MU, build-up material, tolerances, etc. for each check.
- 1.7.6 What is the definition of TMR?
- 1.7.7 If you discover the lateral laser is 5mm below that on the opposite wall what would you do?
- 1.7.8 Is there anything else you should consider?
- 1.7.9 Can you explain the Linaccheck (daily output) check that is carried out during monthly QA?
- 1.7.10 How are the tolerance values determined?

- 1.7.11 When measuring the output from a linac, you discover that the measurement differs from that obtained the previous day by 5%. What do you do?
- 1.7.12 What may have affected this?
- 1.7.13 If you cannot find the fault what would you do?
- 1.7.14 What interlocks are in the therapy room?
- 1.7.15 How would you go about checking each of these?

1.8 QA Procedures (Kilovoltage)

- 1.8.1 What is the code of practice relating to kilovoltage output measurements?
- 1.8.2 How has this changed since the previous document?
- 1.8.3 How are the three energy ranges categorised?
- 1.8.4 Describe the procedure for checking the output reading.
- 1.8.5 What is the backscatter factor?
- 1.8.6 What corrections must be applied to the instrument reading? After multiplication by chamber calibration factor, mass absorption coefficient, ratio water/air, etc.
- 1.8.7 What are the differences between the measurement/calculation made for outputs at 90, 135 and 300kV?
- 1.8.8 What other QC procedures might be carried out on the kilovoltage unit (5)?
- 1.8.9 Describe the calibration chain for ionisation chambers & dosimeters.
- 1.8.10 Describe the procedure for consistency checks with Sr-90.
- 1.8.11 Briefly describe QC checks performed on the Selectron.
- 1.8.12 Draw an ionisation chamber.
- 1.8.13 What is it measuring?
- 1.8.14 Where is the charge collected?
- 1.8.15 What effects do temperature and pressure have on the readings?

- 1.8.16 Prior to an Sr-90 check, what else do you need to consider about the electrometer? (Leakage test).
- 1.8.17 Asked about the Heel Effect on the orthovoltage machine? What is it, explain the curve and how do we overcome this in our measurements?
- 1.8.18 Draw an electron depth dose curve.
- 1.8.19 Explain each part of the curve.
- 1.8.20 How does the curve vary with energy? Why?
- 1.8.21 Draw a treatment head (linac).
- 1.8.22 What are the purposes of the secondary collimators?
- 1.8.23 How is the field size defined? Is it a 10 x 10 cm field at the isocentre or at 100cm FSD?
- 1.8.24 How would you measure the field size? Film? (50%).
- 1.8.25 Can you determine the beam flatness from this film?
- 1.8.26 How would you do that?
- 1.8.27 Asked about head scatter measurements. Why are they performed?
- 1.8.28 Are they utilised in the treatment planning system?
- 1.8.29 Why do we do dmax profile scans and measurements?
- 1.8.30 If you had a particular area of a field blocked out, how would you calculate the required treatment time?
- 1.8.31 What is contained in IRR99 and IRMER?
- 1.8.32 Where does the medical physicist fit in?
- 1.8.33 What is the difference between the Manchester and Paris dosimetry systems for intracavitary brachytherapy?
- 1.8.34 How are the Basal Dose Rates and Reference Dose Rates defined?
- 1.8.35 Illustrate on a single plane interstitial implant the relative dose distribution obtained with the Paris system.
- 1.8.36 On the same diagram, what volume would the Manchester system address?

- 1.8.37 Define Air Kerma and Absorbed Dose. What are the units?
- 1.8.38 What does ICRU Report 50 address? Use a diagram to illustrate the different volumes.
- 1.8.39 What is the normalisation point?
- 1.8.40 Where is the reference isodose defined? (10 cm deep)
- 1.8.41 What is the Quality Index?
- 1.8.42 How is it measured?
- 1.8.43 How is this set-up different from measuring the HVL of a low kV beam? (Broad beam for QI, collimated for HVL).
- 1.8.44 Explain your choice of beam arrangement for the bladder plan in your Portfolio?
- 1.8.45 Why was a wedge necessary?
- 1.8.46 Why did you use three fields?
- 1.8.47 Why might growing a uniform CTV not be the best idea in some cases? (OARs, think about prostate plan).
- 1.8.48 What is ISO9000? How is it related to your RT centre?
- 1.8.49 How does it affect physicists and radiographers?
- 1.8.50 Describe the main features of a linear accelerator?
- 1.8.51 What type of magnet is used in beam bending? (270°)
- 1.8.52 Why is a 270° magnet used?
- 1.8.53 What is the difference between a sealed and an unsealed chamber?
- 1.8.54 In what situations would they be used?
- 1.8.55 What is the difference between the local secondary standard and a field instrument?
- 1.8.56 Why is Sr-90 used?
- 1.8.57 Describe the Sr-90 checks on a field instrument.
- 1.8.58 What are the errors involved?
- 1.8.59 Describe how you would determine the HVL for different orthovoltage energies?

- 1.8.60 Why are the metal sheets placed about midway between the tube and the ionisation chamber? (Backscatter).
- 1.8.61 What is the approximate shape of the radiation distribution in a plane parallel to the anode-cathode axis? (Heel Effect).
- 1.8.62 Briefly describe the role of CT simulation in treatment planning.
- 1.8.63 What is virtual simulation?
- 1.8.64 Why would you expect the dose calculations to be slightly different for manual and computerised planning?
- 1.8.65 Sketch the field layout for breast treatment based on two beams.
- 1.8.66 Based on the environmental survey in your portfolio – what is the dose limit for members of staff?
- 1.8.67 How could your measurements have been made more accurate? (More measurements).
- 1.8.68 What is a risk assessment? What should it address with respect to a RT department?
- 1.8.69 What placements did you do during your training? (Non-Ionising Radiations, Vascular Labs and Instrumentation, Nuclear Medicine).
- 1.8.70 What did you learn from Nuclear Medicine?
- 1.8.71 Briefly describe a daily QA procedure on a gamma camera.
- 1.8.72 What do you understand by Clinical Governance?

1.9 Dosimetry

- 1.9.1 What dosimetry codes of practice are in place?
- 1.9.2 What dates were these published?
- 1.9.3 What are the main differences between the 1996 and 2003 electron codes of practice?
- 1.9.4 What chamber should no longer be used for electron measurements?
- 1.9.5 If the difference in measurements between the two electron codes of practice was 5%, what impact would this have clinically?

- 1.9.6 When might orthovoltage photons be more useful than electrons for superficial treatments?
- 1.9.7 Can you describe how a calibration factor is derived for the field chamber?
- 1.9.8 What is the criterion for deciding if this should replace the previously determined calibration factor?
- 1.9.9 Codes of practice ensure consistency of calibrations across all radiotherapy centres. If no codes of practice were in place, how else might you assess consistency?
- 1.9.10 How would you go about implementing this in Scotland?
- 1.9.11 What are the pros and cons of diodes over TLD's?
- 1.9.12 When might a TLD be more suitable for measurements?
- 1.9.13 What kind of dose error can be expected on TLD dose measurements?
- 1.9.14 How might you improve this?
- 1.9.15 What might you do before and after sending a chamber to NPL for cross calibration?
- 1.9.16 Why would you do this?
- 1.9.17 What implications are there when using a β -emitting source for assessing the consistency of response of the chamber to photons?
- 1.9.18 What would you do if you discover the electrometer leakage measurement is out of tolerance?
- 1.9.19 You discover that the chamber has become wet. What do you do?
- 1.9.20 Why is it necessary to apply a temperature pressure correction factor?

- 1.9.21 If you don't apply this factor, what kind of output measurement would you expect on a very hot day? A day with high pressure?
- 1.9.22 Why is dosimetry important?
- 1.9.23 Explain the dosimetry calibration chain?
- 1.9.24 What's used as the primary standard - why is this good?
- 1.9.25 What are the limits we can accept when measuring output - and why?
- 1.9.26 Draw and explain a depth dose curve?
- 1.9.27 Why do we get d_{\max} ?
- 1.9.28 Why does the dose fall off?
- 1.9.29 Where does the surface dose come from?
- 1.9.30 Draw a treatment head.
- 1.9.31 If measuring flatness, what would the isodose curves look like using an air scanner and a water tank (at 5, 10 and 20 cm deep) and why?
- 1.9.32 Other than scatter, what can contribute a flat isodose curve at a depth of 10cm in water?
- 1.9.33 Explain beam hardening.
- 1.9.34 How can you change the output of the Pantak orthovoltage system?
- 1.9.35 Why do we use output factors?
- 1.9.36 Draw output factor vs. field size?
- 1.9.37 In a measurement of Pantak output factors all related back to air where they should all equal 1, there was a discrepancy with the data. Could you think of an explanation for this?
- 1.9.38 Why would someone use an ionisation chamber for a radiation survey?
- 1.9.39 If I were making measurements in the maze corridor would I use a GM tube?
- 1.9.40 How does a GM tube work? Explain dead time.
- 1.9.41 What is the pulse width of the output of the linac?
- 1.9.42 Of the different approaches to ISO9000 at the two hospitals where you trained, which did you prefer?
- 1.9.43 Is there any legislation relating to QC tests?
- 1.9.44 If a monitor unit is defined at d_{\max} , why would you not put the chamber at d_{\max} for dose monitor calibration checks?
- 1.9.45 What is the tolerance on standard output measurements?
- 1.9.46 What part of a linac might affect the output?

- 1.9.47 How is the symmetry of a radiation field defined, and over how much of the beam would you measure it?
- 1.9.48 How would you measure flatness with film?
- 1.9.49 What would happen if you only used a few MU?
- 1.9.50 What are the problems of using a diode array?
- 1.9.51 Why do linacs have two dose monitors? Describe their features.
- 1.9.52 Why would you use a Sr check source?
- 1.9.53 What tolerance would you expect on the calibration of a field instrument?
- 1.9.54 In brachytherapy, what is the energy of ^{192}Ir ?
- 1.9.55 At what energy is the secondary standard calibrated at NPL?
- 1.9.56 How is an X-ray spectrum affected by filtration?
- 1.9.57 What determines the energy of the characteristic X-rays?
- 1.9.58 How do you allow for timer error?
- 1.9.59 How do you define the energy on an orthovoltage unit?
- 1.9.60 What would a plot of filter thickness with output look like? Draw it
- 1.9.61 What would be possible reasons for a kink in the measured curve?
- 1.9.62 What factors affect beam output?
- 1.9.63 What happens if the electron gun current is too high?
- 1.9.64 What is the tolerance on the Sr-90 measurement?
- 1.9.65 Where would you go to find this if you didn't know?
- 1.9.66 How do you measure the energy of the output from a linac?
- 1.9.67 How would you measure this?
- 1.9.68 Why can't you just use the accelerating energy, i.e. 6 MV ?
- 1.9.69 Why do you need to know about beam quality?
- 1.9.70 What affects ionisation chamber measurements at high dose rates?
- 1.9.71 If you set 100MU on a linac where would you expect to measure 100cGv?

- 1.9.72 What setup would you use to perform routine calibration of a treatment machine?
- 1.9.73 Describe effective point of measurement in ionisation chamber?
- 1.9.74 Define TPR.
- 1.9.75 Have you had any involvement in QUART?
- 1.9.76 Explain the construction of an ionisation chamber and what it measures.
- 1.9.77 Why aren't flatness scans flat?
- 1.9.78 How would you calibrate a linac?
- 1.9.79 How do you measure output?
- 1.9.80 If the output was 3% different from yesterdays, what would you do?
- 1.9.81 What is a flattening filter?
- 1.9.82 If the beam wasn't flat, what might be the causes?
- 1.9.83 What would you do if an ^{131}I ablation dose capsule was lost?
- 1.9.84 Why are strontium checks performed?
- 1.9.85 What is leakage current and how would you prevent it?
- 1.9.86 Describe a thimble chamber and a Markus (Appearance, measuring volume)
- 1.9.87 Describe the qc procedure used to measure the light field-radiation field coincidence.
- 1.9.88 Why did you omit a T,P correction in the cross-calibration of your measuring assembly against the secondary standard?
- 1.9.89 How much is the BSF in kV calculations?
- 1.9.90 What is an operator?
What is your role as a physicist in radiotherapy?
- 1.9.91 What is ICRU 50 and explain its contents.
- 1.9.92 Where does the 7.5microSv/h come for in controlled areas?
- 1.9.93 What are the new dose limits?

1.10 Treatment Planning

- 1.10.1 Can you outline ICRU 52

1.10.2 How would you go about commissioning a CT scanner for a planning system?

1.10.3 How do you calculate electron density from CT numbers?

1.11 Radiation Protection

1.11.1 Why are risk assessments carried out?

1.11.2 Does any other legislation require this?

1.11.3 In the radiation dose survey you carried out, why is there a higher reading obtained for the 135kV photons compared with the 300kV?

1.11.4 What are the five roles defined in IRMER legislation?

1.11.5 Describe what each role entails

1.12 Planning:

1.12.1 Explain the role of the physicist in each stage of patient treatment.

1.12.2 How is the treatment planning system verified?

1.12.3 Describe a treatment plan check.

1.12.4 What is an enhanced dynamic wedge?

1.12.5 Why is it important to use the Y-axis wedge rather than the x-axis wedge?

1.12.6 Why might you use only the Y-axis jaw in a plan? (specific to portfolio)

1.12.7 How long does it take for the collimator head to rotate through an angle of 90°?

1.12.8 How would you determine the field size from an isodose plot?

1.12.9 What field size would you use for a certain tumour?

1.12.10 For an electron treatment, what energy would you use to treat up to 3 cm deep?

1.12.11 Can you treat to the surface?

1.12.12 In reference to a specific breast plan: why use tangential fields rather than parallel opposed?

- 1.12.13 What effect does it have on the isodose distribution if the beam traverses lung? Does the TPS account for this?
- 1.12.14 Referring to a 3 field neck plan: explain the use of wedges in this plan and why certain gantry angles were used?
- 1.12.15 What is the dose limit to spinal cord?
- 1.12.16 What information do you need to calculate the monitor units for a plan?
- 1.12.17 Why does wedge ratio vary with field size?
- 1.12.18 Do you have a feel for typical wedge angles that are used in various plans?
- 1.12.19 What could one use in a breast plan instead of wedges?
- 1.12.20 Describe how you can create a wedge dose distribution.
- 1.12.21 Why do we use TMR with photons but PDD with electrons?
- 1.12.22 Why does the TMR change when there is a wedge in the beam?
- 1.12.23 Why do we place filters in kV treatments
- 1.12.24 Describe the random and systematic errors in patient positioning. Give examples and magnitudes
- 1.12.25 What is the accuracy of TLD measurements?

1.13 Moderator

- 1.13.1 What minor attachments did you do?

Radiotherapy

- Draw a photon depth dose curve. Explain the build-up region.
- Draw wedged and unwedged treatment beams.
- What is the effect on PDD of changing field size and of changing FSD?
- What is d_{\max} for a 6 MV beam?
- What is the surface dose as a percentage of d_{\max} ?
- Who published the photon CoP and in which year?
- What's in IRR99 and IRMER?
- Describe the Paris system. What would you use it to treat? What is the basal dose rate?

Examiner: xxxxxx

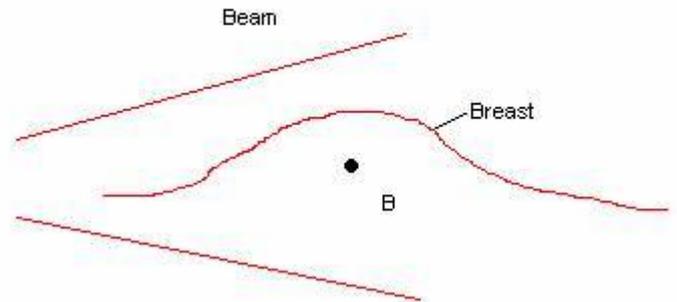
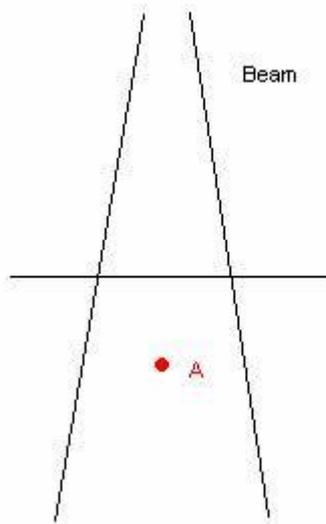
- Describe a simulator and its uses.
- What does a lung sim session involve / what do you need to consider when planning a lung treatment?
- What is the main advantage of collapsed cone algorithms over pencil beam? (something like that)
- Why is it not a good idea to prescribe to the isocentre in breast treatments?
- Can you describe a TSR?
- What action would you take if you found that a beam was delivered fully wedged instead of open?
- Why do you swap the ion chambers over when measuring an inter-comparison ratio?
- Why do you use a Perspex phantom?
- Why do you also use a hardboard phantom?

1. How does a magnetron work?
2. What is a klystron for?
3. Explain how a standing wave linac works differently from a travelling wave linac and how do electrons get accelerated?
4. How is a kV target different from a linac target?
5. What other bits are in the treatment head of the linac?
6. If you have two orthogonal films from a simulator how do you use them to be sure where the tumour is for planning?
7. Draw a linac treatment room and explain why it's like it is.
8. Draw an electron depth dose curve and explain what each bit of the curve relates to.
 - 8.1. If you were measuring this what measurement point would you use?
9. If a clinician asked you to plan an electron beam treatment what would you need to know from him?
10. If you were treating someone and were shielding their lungs how would the monitor units be different?
11. Daily calibration: Why do you plot output and pressure on a graph?
 - 11.1. What could be wrong with the machine if the output varied with pressure?
12. Why and how does the magnetron frequency effect the machine output?
13. What affects the symmetry and flatness of the beams?

14. TSR measurements: Why do you want your machines matched?
 - 14.1. What parameters do you want to match?
15. What are the units of RAKR?
16. How do you perform HDR source calibration?
 - 16.1. What are you calibrating against?
 - 16.2. If your value differed from the manufacturers value what would you do?
 - 16.3. How much tolerance is allowed?
17. Questions on individual projects will obviously be dependant on the particular project so the following have been 'generalised' to give a feel for the type of questions that can be asked.
 - 17.1. How was your dosimetry equipment calibrated?
 - 17.2. Could you have used any alternative dosimetry equipment?
 - 17.3. You presented your results in terms of 'x'. Does this allow for ease of comparison with the results from other centres?
 - 17.4. What is the tolerance of your results?
 - 17.5. When comparing measurements by two different methods. What do you think the difference in your results arises from?
 - 17.6. Why would you use one piece of equipment in preference to another?
 - 17.7. Why does one experimental set-up (including equipment) give a different answer from another? i.e. Justification of results.
18. Explain how machine output is calibrated for a megavoltage photon beam.
 - 18.1. What is the primary standard used for photon dosimetry?
19. Explain the procedure for adjusting linac calibration.
20. Explain how the plotting tank was set up for measuring beam data.
21. How would a depth dose curve change when measured at 150 cm SSD rather than 100 cm SSD?
22. What are the advantages/disadvantages of using a diode detector?
 - 22.1. How is the diode detector calibrated?
23. Shown a 3-field prostate plan – asked to comment on whether it was a “good” plan.
 - 23.1. What are the particular problems with prostate planning?
 - 23.2. How can dose to normal tissues be reduced?
24. Explain how IMRT is useful.
 - 24.1. What disadvantages does IMRT have?
25. How are the sources distributed for Manchester System gynaecological treatments?
 - 25.1. Why is there a higher activity source at the far end of the intra-uterine tube?
 - 25.2. What is the diameter of the ovoids?
26. How is dose reduced when handling radioactive sources?
 - 26.1. How long are the tongs you would use?
27. What regulations and guidelines are relevant to radiotherapy?
28. Describe the setup to obtain this low energy photon depth dose curve.
29. What is Mix-D made out of?
30. Draw the dose contours from a parallel opposed pair.

- 30.1 How would that change if the energy were decreased?
31. Draw an electron depth dose curve.
 - 31.1. How does this vary with field size?
 - 31.2. Draw a higher energy electron depth dose curve
32. What is an alternative to asymmetric collimation for breast treatments?
33. How is the position of images relative to the marker wires altered on CT scans?
34. What field size do you need for a 10cm tumour?
 - 34.1. For a parallel opposed pair?
 - 34.2. For a 4-field beam arrangement?
35. What factors are needed in a monitor unit calculation?
36. How did you carry out QA on the Target TPS?
 - 36.1. What should the tolerance on the error be if the plan was already saved on the system?
37. What and where are the prescription points in gynae treatments (A and B)?
 - 37.1. What unit is used for the source?
38. How do you convert RAKR to a clinically useful value?
39. What is the HDR source?
 - 39.1. How do you calibrate it?
40. What is the ion recombination factor?
 - 40.1. How would you measure it?
41. How would you check the centre of rotation of the gantry?
 - 41.1. Where does the 4mm sphere tolerance come from
42. What is the isocentre?
43. Compare the Block and Schuster beam symmetry measurement methods
 - 43.1. Draw a diagram of a profile for a symmetry measurement
44. How would you measure leakage through MLCs?
45. How are dose measurements obtained from film?
 - 45.1. What else do you need to correct for on film?
46. What is a solid water phantom made from?
47. How is the gamma image calculated for IMRT verification?
 - 47.1. What is set as 100%?
48. Why did you want an output factor for a 1 x 1 field?
49. What legislation is applicable in radiotherapy, and who are they relevant to?
50. What is the decay process of iodine-125?
51. Explain the process of electron capture?
52. What special precautions would you advise a prostate implant patient they should take after the procedure?
53. When carrying out an intercomparison of ion chambers against the standard, why do you swap the positions of the chambers half way through?
54. What is TSR?

55. What factors do you need to include in a monitor unit calculation.?
56. How might you correct for lung in a breast treatment?
57. Hand plan – I had included one in my portfolio and calculated the dose at the centre of the pvt and 4 points around the edge – where else might it be useful to know the dose?



58. Ignoring things like wedge factors, and that you would usually have a non-divergent beam edge, how might the calculation of monitor units at point A in the above diagram differ from the calculation of monitor units at point B?
59. When carrying out a wedge factor check, why do you take measurements with the collimator in 2 opposite positions?
60. Draw a farmer chamber
- 60.1. Explain why the materials of the chamber are chosen
 - 60.2. What voltages are they at?
 - 60.3. Why is the central electrode kept at a negative bias? Could it be at a positive bias?
 - 60.4. Why not use a lower voltage? Or a much higher voltage?
61. If you were planning a head and neck case, what changes could you make to the plan when using a shell?
62. Draw a beam profile for a 10x10 field 10cm deep in water.
- 62.1. Define flatness.
 - 62.2. Define symmetry.
 - 62.3. What would the profile look like at shallower depth?
 - 62.4. Why does the profile have ears at shallower depths?
63. Draw a 6MV electron depth dose curve.
- 63.1. Does the depth of the maximum change with energy?
 - 63.2. What is the rule of thumb for that?
 - 63.3. Draw a depth dose curve for a more energetic electron beam.
64. What would you need to know in order to calculate the dose to a point in Brachytherapy?
- 64.1. Is the fluence at the point the same in water as it would be in air? What would cause the differences?
65. You use Ci in your portfolio – what is it? What is the SI unit of activity? What is the relationship between the two?

- Describe a simulator and its uses.
- What does a lung sim session involve / what do you need to consider when planning a lung treatment?
- What is the main advantage of collapsed cone algorithms over pencil beam algorithms (and that)

- Why is it not a good idea to prescribe to the isocentre in breast treatments?
 - Can you describe a TSR?
 - What action would you take if you found that a beam was delivered fully wedged instead of open?
 - Why do you swap the ion chambers over when measuring an inter-comparison ratio?
 - Why do you use a Perspex phantom?
 - Why do you also use a hardboard phantom?
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- Draw a photon depth dose curve. Explain the build-up region.
 - Draw wedged and unwedged treatment beams.
 - What is the effect on PDD of changing field size and of changing FSD?
 - What is d_{max} for a 6 MV beam?
 - What is the surface dose as a percentage of d_{max} ?
 - Who published the photon CoP and in which year?
 - What's in IRR99 and IRMER?
 - Describe the Paris system. What would you use it to treat? What is the basal dose rate?

Linacs – how do we generate X-ray beams? Starting with the X-ray target, draw and explain the components of a linac treatment head. (I missed out the optical system.) Where is the light source for the optical system?

What is the isocentre? What QC checks do we do for the isocentre, and what is the tolerance on its position? Before EPIDs, what did we use to check the position of the X-ray isocentre?

What safety interlocks do we have in external beam radiotherapy? (Talked about MU checker terminating beam if it is too asymmetric or delivers too many MU...) How do we define 1 MU? What are the standard conditions for this definition?

Other interlocks – what stops people walking into treatment room when beam is on?

Why have I said in my portfolio that the maximum wedge angle for Elekta linacs is 55°? (Apparently Elekta linacs have 60° wedge angle as defined by ICRU, but Christie uses a different definition! I didn't know this.)

Isocentric treatments mean FSDs have got shorter. What 3 effects does this have on dose distribution?

Leaf fit in treatment planning – why do the MLCs not come right up to the edge of the PTV? (Field size is defined by 50% isodose, but we want PTV to be covered by 95% isodose.)

Pelvic treatment plan – do we correct for inhomogeneities? What inhomogeneities are there in this region? Do I know the relative density of the femoral heads (i.e. bone) compared to water? What about lung tissue?

Gamma analysis – why does the position of the normalisation point matter?

Projects – asked me to talk about errors on measurements because I didn't have error bars on my graphs.

Moderator – what legislation is there regarding ionising radiation? Are there additional documents we use for guidance?