

WAYNE STATE UNIVERSITY

SCHOOL OF MEDICINE

WSU ABR Oral Exam Review 2008

Below is a description of the exam format followed by some tips on how to enhance your chances of success.

Exam Description

The exam will be 2.5 hours in length and is divided into half hour sessions with five different examiners. You will be examined by each examiner individually in his/her hotel room. The candidate is seated in front of the computer monitor and shown a series of pictures / formulas / data / questions. This arrangement (candidate facing the monitor) means that you cannot always see the examiner's facial expressions. You may find it beneficial to view the screen briefly to understand the question and then turn to the examiner to answer it. Some examiners provide feedback (either verbal or by expression) and direct the questioning while others will just allow the candidate to talk. However, it should be noted that examiners are not supposed to provide feedback about the candidate's performance, so do not expect to be told that you are doing well or doing poorly.

Each examiner will grade you on a question or questions from the 5 sections outlined in the study guide:

- 1) Radiation protection and patient safety
- 2) Patient related measurements
- 3) Image acquisition, processing and display
- 4) Calibration, quality control and quality assurance
- 5) Equipment

An initial question or questions will be on the computer monitor and the examiner will guide the follow-up questioning after that. The questions are designed to be answered in five minutes each. After 25 minutes, a bell will ring in the hallway to notify the examiners that only 5 minutes remain. All candidates report to their pre-assigned rooms at every half hour. Start times for different candidates vary, so one might have a break or multiple breaks during the session. The order of the questions is rotated so that it is not possible to run out of time on more than one question from the same category.

For the majority of questions, you will have a good idea of what the line of questioning will be as soon as the picture comes up. In this sense, it is somewhat like a written exam given in oral form. (In contrast to more general oral exams (e.g., Ph.D. qualifying exams) in which the questioning is free-flowing and can turn in a variety of directions.) The candidate is graded by the examiner on a scale of 1-5 for each section (this is, of course, never shared with the examinee.) Once you have demonstrated sufficient

knowledge, the examiner will move on to the next question. Thus, one way to know that you have graded well on a specific question is that the examiner will move on after less than 5 minutes. It is also possible, therefore, to be released early by an individual examiner, thereby giving you some time to relax before the next room.

Below are some tips which will hopefully be helpful to you:

Be Confident

- 1) Imagine that you are explaining to a colleague how you have done something in the clinic, or how you understand some technical procedure or theoretical concept. Thinking of explaining this to one of your colleagues should help put you more at ease. Don't be intimidated by the fact that you think that the examiner is very well known in the field and/or very senior to you. After all, it is likely that you work with, or have worked with, at least one very senior / well-known person in medical physics, and that you were very at ease talking with this person.
- 2) By this point, you have had graduate training and at least several years of clinical experience. Be confident in what you know. In some cases, you may know more than the examiner about a particular topic. Remember that they don't choose the questions they ask (at least not the primary ones), and it is possible that they may not have had as much experience as you within the particular topic. This fact should also remind you that you should be very careful to clarify anything which is very new or that you think may seem unconventional to the examiner. If some textbooks say to do something a specific way, or you think that this is the common perception, you should be very specific about why you might choose to describe an alternative way. For example, you might say, "I know that conventional wisdom says to do *this*, but these days many of us are doing *this* (or we have studied this extensively at our center and found that it is better to do it *this* way instead)." One reason that this is very important is that you have relatively little time on each question and the examiner likely will not give you specific feedback on this, but may be thinking in his/her head "That is not the conventional way to do this. I'm not sure this examinee knows what he/she is talking about." If a topic is somewhat controversial, try to discuss the merits of both sides of the issue (at which point the examiner may push you to take a side and defend it, but will already be impressed that you know both sides of the issue.)
- 3) Don't assume that the absence of a response from the examiner is a negative sign. We are used to receiving feedback from the listener when answering questions in oral form, such as the nodding of the head when we are on the right track. The examiner may not provide any feedback at all. Do not let this interrupt your train of thought by assuming that because the examiner is not providing positive feedback, he/she is by default disagreeing with what you are saying.
- 4) You have prepared a great deal (hopefully!) and have committed a large amount of information to memory. You may know more broad-scoped trivia about medical physics right now than at any other point in your career. Rest assured

that the examiner has likely not committed all of the trivia to memory that you have. Let this fact help boost your confidence.

- 5) The examiner wants you to do well. He/she wants to hear good answers and to feel comfortable with the knowledge and capabilities of those who are entering the profession. You, the examinees, will someday be the leaders of this field after he/she retires. In addition, if you answer every question very well, he/she will release you early and might get 10 or 15 minutes to relax!

Be Prepared

- 6) Studying a great deal for this exam is not enough to be an excellent oral examinee. You need practice answering oral questions. Try to get together with other candidates and question each other, or ask your colleagues if they would be willing to give you some practice questions.
- 7) A big part of preparing for oral exam questions is thinking about how you will start each question. Once you get on a roll, the answers will flow, and the time will fly by. However, a long, uncomfortable silence after the question has been asked will seem to take an eternity. This is analogous to the way a writer stares at that blank first page of the novel. Once the story begins, it just flows. Try not to allow long periods of silence in your answers! Not only will these seem to last for hours, they tend to shake your confidence (and the examiners confidence in your ability to handle the pressure of an unknown question being fired at you, which is a very common occurrence in clinical practice.) In order to assure that these do not arise (likely at the beginning of your answer), you must spend some time thinking about how you will begin your answers. Be ready to begin your response to any question reasonably quickly. This will make the examiner feel that you can't wait to tell him/her the answer to anything asked, but it also requires practice and preparation. Here are a few more specific tips:
 - a. One of the best ways to begin an answer is to explain that you have done this before and describe how. This is more compelling to the examiner than any book knowledge. Picture yourself doing it as you explain it so that you can remember and state each step. (Of course, if you have done it, you probably won't have to pause and think!)
 - b. If you haven't done it, are you aware of a report on it (AAPM TG, NCRP, ICRU, etc.)? This tells the examiner that although you haven't done it, you are not going to go and re-invent the wheel yourself. If you know the number, great; if not, just knowing where to go to find this information helps convince the examiner that you are a responsible and safe physicist. If you have extra study time, you might even download lists of reports from the various organizations and mark and memorize the important ones.
 - c. If you don't know anything about it, at least say that you would check to see if there is a task group or other type of report. Where would you go for answers? Do you know of a book or paper about it? Do you have a colleague who has done this? Do you even know of another institution that does this whom you could call? Give some significant thought to how

you will respond in this situation. After a little preparation, you will find that you will like your answer much better than what you will blurt out if you just try to answer this type of question “off the cuff”. Plan for the case in which you know little or nothing about the specific topic. What will you say? “I have no idea what you are talking about” will likely buy you a return ticket to Part III next year (dead silence will also!)

One final note is needed to put the above discussion into its proper context. While long pauses are not recommended, they are certainly preferable to quickly firing off a poor answer! The examiner needs to know that you think before you speak (and act!) If you really need to think it out to be able to clearly formulate your answer, go ahead and do so. However, you may consider talking through your thought process aloud so the examiner knows that you are thinking it through and that you have not just given up, fallen asleep, or decided to wait for time to expire.

- 8) Most importantly, the examiner needs to know that you are competent and that you are safe. Once you convince the examiner of these two things, you are in very good shape. There is no point in convincing him/her of how smart you are until you have demonstrated that you know your way around the field and that you are not going to hurt patients or staff. Your goal is to demonstrate that you are fundamentally sound. Once this is done you can go ahead and impress the examiner with your intelligence, wit, and wisdom.
- 9) Get to the point as fast as you can. You only get five minutes to make your impression on the examiner during each question. Do not beat around the bush!
- 10) Don't forget the big picture. The examiner has a good understanding of what is really important in the field, but likely has not committed to memory all of the many bits of trivia that you have (see number 4 above). Do not forget to mention why you need to know these little details and how they fit into the larger picture. Don't get lost in the minutiae (see “don't beat around the bush” above)! A good understanding of the principles of medical physics is far more important than whether you have memorized some specific numbers or trivia! (Especially since you probably won't remember them a few weeks after the exam.)

Good luck!

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NOTE: The above document was given at the ABR type mock review held at the Wayne State University Dept. of Radiation Oncology on May 15, 2008. I highly recommend attending such a mock review held in your area or if there is nothing available set one up. Being examined under exam type conditions prepare you for the actual test and also highlights the weak points in your knowledge as well as answering methods. – Ravi

2008 Therapy Oral Type Questions

1. Describe of characteristics of broad beam and narrow beam? How do they affect our shielding design (i.e. HVL values)? Which should be used for shielding
2. Shown a Magnetron graph. Explain how RF is generated? What is the difference between Klystron and magnetron in life-span, cost and size?
3. Shown a graph of a Farmer's chamber. Explain the name or function of each structure. Why do we design the shape as cylinder rather than something else?
4. Shown T&O of HDR. All notations were erased from the film. Explain each part (Blade and Foley catheter) and how to define points of bladder and rectum. What do you call the device equivalent to the metal blade we used for LDR? What is the size of Foley catheter? Can we choose different size?
5. Shown three groups of CT, MRI and fused CT/MRI. Explain the advantages and disadvantages of CT and MRI. How do image registration and fusion work?
6. Shown a plot of a PDD. Explain the buildup region, D_{max} and the attenuation. What is the definition of KERMA and difference between KERMA and dose?
7. Explain where the ion chambers are inside of LINAC. How do they work and how to commission them? When would you know the ion chambers are malfunction? Explain triax cable?
8. Shown the Fig.1 on TG51. Explain the plots, i.e. the difference between PDI and PDD and why would electron beams differ from photon beams?
9. Flattening filter in LINAC: Location and what it does. Explain why we can't get rid of the two horns at d_{max} ?
10. Explain the difference between absorbed dose, dose equivalent and effective dose equivalent? Explain the beam quality factors for various beams? Explain the weighting factors of gonads, breast, lung and skin? Why don't we calculate the effective dose equivalent in most of the treatment we gave to patients, for example, pelvis?
11. Shown a plot of LINAC room design with surrounding area, office, waiting area...What is the permissible dose for each area and how do you calculate the shielding required for each area? When do you consider neutron shielding and how to measure neutron beams?
12. Shown a figure of CT-simulation. Explain each device does in the room and how to commission CT-sim?
13. IMRT: Shown a plot of mathematical 3-D (x,y and z) plot. How does optimization work? How many local maximums and global maximum? How do we know whether we are on local or global max? Can we implement an ideal IMRT plan?
14. Shown a group of CT axial, sagittal and coronal views. This patient has a normal upper body and big around stomach. Explain the contrast to noise ratio difference between the two areas on axial planes. Bigger patient has poor signal to noise ration, thus the image contrast is worse than normal size patient.
15. Explain the release instruction of prostate implant patients.
16. Compare the commission difference between I-125 and Ir-192 (both are LDR). Also is there any difference in surveying?
17. Why do we survey and check interlocks for a new LINAC first? What steps do you do for acceptance of a new LINAC?

18. HDR daily QA. How to do it and what is used. What should be done before patient treatment.
19. Shown three plans on lung for the same patient. Explain the difference between the three calculation algorithms. One has no homogeneity correction and the other two have homogeneity correction. Still need to differentiate the two. Which is more realistic?
20. Shown a PORT film v.s. DRR of prostate. Which one is Port? Why does a port film have worse contrast than a DRR. How is DRR produced? How do you improve the contrast for both types of films? What type of material has twice amount of electron density than water? Later on the other examiner asked me a DRR and Port film of a lung case. I was asked whether I can see any shift between the two.
21. A DVH with lung, heart and PTV was shown. What is the max dose for each organ? Why does the PTV coverage have a round edge at 90% level instead of a sharp coverage? I mentioned the lack of lateral scattering between PTV and lungs.
22. QA for EPID.
23. Film questions: Contents, size of the grains and what affect the speed? Explain net O.D. H-D curves for multiple beams (50kV all the way to Co-60) were shown. Explain the difference between them and which one we should use for LINAC?
24. Two images -- what are they? (one was double exposure image, one was single exposure.)
25. Diagram of a CT-sim. What are the commissioning aspects? Shielding? QA?
26. Three plans shown -- same beams, patient, scan, just calculated different. What is the difference?
27. Name of phantom used for CT to ED file?
28. Two images -- a DRR and a port film. Why the difference in image quality? Is the patient lined up correctly?
29. Describe the function of the dose chambers in the accelerator. How do you commission them? How can you tell if they are failing? What if they fail and the interlocks fail and the machine doesn't stop treatment? (wanted me to say "the therapists should notice that something is wrong and stop the machine." not sure how they are to notice since he said to imagine that the machine isn't showing a problem though!!)
30. Diagram of a farmer chamber. Describe its function.
31. What device would you take to an I-125 implant? What if an Ir-192 implant?
32. Fusion question. How much does the brain move? (less than resolution of CT -- less than 1mm) What kind of scan is PET? (he was looking for "functional" -- I said it reflected metabolic activity so he said I was on the right track)
33. Two brain plans shown with isodoses and contours. What are the contours? Which plan is better?
34. Film calibration curves by energy for XV film. Why do we use this film? Describe the curves you would need if you were going to use film for profiles.

1. Basic physics : a question returning to simple B.Sc. level physics will be asked that has to do with medical physics. I highly recommend reading E.B. Podgorsak's book, Radiation Physics for Medical Physicists published by

Springer in the Biological and Medical Physics Biomedical Engineering series. It was published in 2006. I would recommend reading it 6 months before the exam. This is all stuff we should already know, but need a refresher. The question I was asked wanted us to explain the link between atomic physics, energy wells and MRI. I was also asked to explain why the difference in image quality between diagnostic and portal imaging. Another question asked was on dose kernels. I was not that well prepared in that subject, and based my answer on presentations I had seen on the subject in past medical physics conferences.

2. Equipment : Know the basics of x-ray and orthovoltage tubes, accelerator design, EPID design. Also know how the dose measuring equipment we use in clinic works. The book edited by Van Dyk (Modern Technology Of Radiation Oncology: A Compendium for Medical Physicists and Radiation Oncologists) is the best. I was asked to identify a diode and triode electron gun and explain how both worked. I was also asked to identify a diode and describe how it works and its limits in clinical use. Which out of all in vivo detectors is best and why.
3. Shielding: Read NCRP 151 and practice doing shielding calculations for linacs, HDR vaults, diagnostic room. I was asked three questions on shielding. Know the different equations and typical values and the impact on these values of specialized techniques. Know how to plan a cancer center so as to limit costs. Know different solutions to limit space requirements.
4. Clinical good practice: review AAPM'S Task Groups. TG-51 is a given, so is TG-40, TG-53 and TG-66. Read as many as you can in the year leading to your exam (we should already be reading them when they are published). I was asked how to calibrate an electron beam, to identify a test for a CT and describe other tests, two questions on annual QA (specifically what is measured with an ionization chamber and what is measured for dosimetry).
5. Radiation Safety: I watched many presentations on the AAPM's virtual library on 10CFR20, 10CFR35... Know limits established by the NRC. Know the rules and regulations. When to report to the NRC. I was asked what would I do if acting as a consultant I discovered that a linac had a calibration error less than 5%, between 5-10% and more than 10%. How would I approach the situation. I was also asked to describe different personnel dose monitors and how they were used. Another question was regarding control of low dose rate brachytherapy sources and what to do in the event of a lost source.
6. Clinical: These should be bread and butter questions. Get involved in your clinic and go and see specialized procedures if they are not done at your site. I was shown a breast dosimetry and asked to evaluate it, how to improve it and also say if there was an inhomogeneity calculation. I was shown a prostate dosimetry where I had to determine the organs at risk, give their limits and then describe IMRT and IMRT QA. I was shown a fused image between MR and CT. I needed to give resolution limits and questions of concern to discuss with the doctors. I was shown a picture of a set of tandem, ovoids and colpostats. Had to identify, describe use in clinic and dosimetry (Manchester system).

Tips to pass the Oral Exams:

1. Start preparing at least 6 months before the exam date. It is hard sometimes.
2. Take the AAPM therapy review courses conducted during the Annual meetings; they were very helpful when you hear from the experts. You can start taking them when you are taking your written exams
3. Be confident about the major TG reports
4. Try to really understand what you do in your clinic, why you do it that way etc.
5. Practice, practice, practice. Knowing about a subject is one thing and explaining it to some examiner is totally different. Make sure that your train of thoughts has minimal interruptions.
6. Mock exams are very useful. I joined the one at "Wayne state" which was very helpful. Contact your regional AAPM chapter to see if the senior physicists can do something like that
7. Reach Louisville at least 2 days before the exam that will help you to settle down and get ready especially if you are from a different time zone.

Examiner 1

Question 1 -Diagram showing the lay out of an 18 MV Linac with maze wall.

I talked about the primary, secondary, leakage shielding thickness calculations. Wrote down the equations and explained every parameter in the equation. Neutron dose and sky shine etc., for about 3 minutes and I was explaining the follow-up questions for the next 3-4 minutes. This question took a longer time for me to answer and surprisingly he let me go beyond 6 minutes on this first one.

Follow up questions

Linac primary beam orientation facing the maze? Which direction would you have the primary beam facing

Talk about Neutron shielding

Talked about the neutron energy spectra similar to the fission spectra

Energy of the capture gamma rays at the door.

Where will you have the air ducts placed in the room? - Maze area

How much margin you give for the patient scatter at the primary beam thickness?-A foot

Question 2-MRI and CT fused image of brain site shown and asked to talk about it.

Follow up questions

Why Fusion? – Electron density-CT, Proton density MRI

Explain T1 & T2 MRI Images

More Stereotactic questions- slice thickness

Image fusion Algorithms used- Maximization of mutual information

Touched upon PET, Ultrasound

Question 3 -Three images of the accelerated electrons entering the Bending magnet

- Asked to explain what I see

First Image with the electrons bending too quickly

Second image with electrons bending slowly or taking a longer curvature

Third Image with electrons bending pretty uniformly before hitting the target

Explained the $Bqv = mv^2/r$

Asked about the vector in the equation

Follow-up questions:

What does the Bending magnet actually do?

What is Energy switch, Explain?

Is the magnet strength same for Low energy and high energy Linac etc.

Question 4- Shown a picture of DRR and Scout image with image slice selections on it
(If my memory is right)

What is a DRR and its Use? Define and explain

How you generate a DRR, Name the Algorithm used.

Why can't you use a Scout image as a DRR?

Can you use a scout image for block cutting etc?

Question 5 - There was just a question. No Picture on the screen.

In TG-51, why do we use the lead foil in Linac calibration, explain the setup and how you would do during calibration.

Follow up-Questions

Draw Kerma/Dose curves-explain equilibrium

Explain buildup region

Touched on Cavity theory

Examiner 2

Question 1 - Shown a spread sheet with Sc, Sp, wedge factors, flatness and symmetry tables. One for the previous year and the other done recently. Question asked, this is what you see when you go to a different site as a new physicist- Comment on this

It looked like the annual QA for a Linac. I went through each and every item and said it looked ok and I found that the wedge factors were off by 4% for a particular wedge and I suggested repeating the measurements. It took me about a minute to find out what was wrong in the sheet and the examiner seemed to be expecting more and I had to talk him through the Annual QA steps how I do it in my center and I guess he was ok with that. Follow up questions, Define flatness, reference and its tolerance value etc. Difference between Acceptance tests and Annual QA

Question 2 – HDR Shielding parameters- Shown Lay out of a HDR room and was told that the room is on the tenth floor of the building.

Explained the Permissible limits, HDR Shielding calculations, Staff education

Occupancy factors in the ceiling and floor (11th and 9th floor)

Energy spectrum of Ir-192

HVLs of Ir-192, Storage of the unit when not in use

Question 3 - Image fusion question

I felt that I just explained about the same question with my first examiner and repeated most of it and the follow up questions were different with this examiner.

Like, he touched on In-homogeneity corrections, is it really required.

Spent more time on Image fusion for stereotactic procedures

Question 4 –Atmospheric Pressure correction for the altitude for TG-51Calibration

How frequently you calibrate your barometer

What type for Barometer you use

Pressure correction formula

Airport pressure value etc

Question 5 – Shown Treatment of a Maxilla field with wedged pair-What happens if one wedge is flipped. Talked about the Isodose, unwanted hotspots, under dosing the tumor etc. Follow up questions include Type of wedges, Universal wedge, virtual wedge, STT tables, how do you commission it and check it monthly etc.

Examiner 3

Question 1 - Shown picture of the cross section of a Klystron unit.

I talked about Klystron as a micro wave amplifier talked about cavity theory, Buncher cavity, collector cavity etc.

Follow up questions, talk about Magnetron, why can't we use Magnetron for all Linacs, why some linacs use Klystron. Microwave frequency range, Side cavities etc

Question 2 – Picture of a Well type- Reentrant Chamber

Talked about HDR Calibration, Finding the sweet spot/Max reading spot, measuring current, Pressure temp corrections, Calibrations by ADCL, Acceptable % deviation of source activity, Dwell position distances etc

Question 3 – Misadministration and management

Talked about the Reportable event, Recordable event levels for nuclear med I-125 admin, Teletherapy total dose deviation, In a week deviation, Stereotactic procedure deviation

Talked about NRC, agreement states.

In the event of misadministration, will you inform the patient directly? I responded that I would leave the decision for the Physician to make. I think the examiner did not like it.

Question 4 - Graph of two H&D Curves

Graph of two H&D Curves talked about different type of films and their dose response characteristics.

Follow-up questions- IMRT EDR2, V films, Mammo films, Gafchromic films
Processor chemistry maintenance issues etc

Question 5 – Measurement of dose in buildup region

Follow up questions: Back scatter, Build up region, Kerma, Skin dose with electrons, photons etc

Examiner 4

Question 1-Diagram of different target volumes in different color shades

Talked about ICRU 50, ICRU 62 definitions and defined every target volume and the modalities used to find the target volumes like CT, PET etc. GTV, CTV, PTV, IV, TV and the typical margins that we use in any clinic for different sites and why more for chest and abdomen cases (Breathing).

Question 2- Talk about CT-Simulator and Simulator CT

Started with Sim-CT explaining about the simulation, Image intensifier, the daily QA, Annuals etc Moved on to CT-Sim, QA, CTDI etc

Question 3 -Can you convert a CT –Simulator room into a HDR Room?

I felt that I was going to answer the same thing for the third time and I explained the energy ranges of KV imaging and Ir-192 energy. Necessity of additional shielding and Ir-192 being a radioactive material etc

Question 4- When commissioning /Acceptance a new Linac how you find the head leakage and what do you do about it

Explained the leakage shielding equation, 0.1% value, Films, and meters used to quantify the dose Integral dose, Patient Internal scattering etc

Question 5 – Diagram of a Simulator and talk about the parts from bottom up

Explained the Image intensifier function, X-ray generator, cooling system, KV, mAs etc, Field wires etc

Examiner 5

Question 1-Picture/layout of Ir-192 procedure room with radiation levels in mR/hr at different locations

I had to start from the HDR shielding, occupancy and permissible dose limits- References of dose limitations. Asked to calculate the time a visitor can sit on a chair at the corner of the room where the radiation levels were given in mR/hr. I did work it out and was easy. Talked about moveable shielding trolleys, Minimal time to be spent by the staff, pocket dosimeter etc

Question 2-Two Plan comparison- 4 field Pelvis Isodose distribution

Talked about the Dose homogeneity Index, ratio of dose to the Midplane to the peripheries dependence on energy. Why to chose high energy for larger separation. Follow up questions- Skin sparing, Build up region.

- 1) The TLD reader system – what it is, how it works. When do you prefer the TLDs instead of diodes, how you analyze the TLDs before and after irradiation?
- 2) The classic LDR room, with 2 neighboring rooms, What if the LDR patient has to spend a full week in that room – how does it affect the limitations to the other rooms. Talk about the ALARA – and what you do for limiting the doses to the patients in the other rooms.
- 3) 2 H&D curves. Which is the faster, which has the highest latitude.
- 4) Give the position of the rectum calculation point for the T&O. Here it was no picture. The computer failed, so I had to draw everything on paper.
- 5) The classic 3 fields for a glioma treatment: 2 wedged laterals and 1 AP. The isodoses were shown contoured. It was a little bit confusing since I had to imagine the isodoses when: the wedges were removed / when the wedges were placed reversed.
- 6) A treatment room, with maze. The maze was on the up-down direction. The entrance was down-right. Where would you place the linac? I placed it on upper side, rotating on left (towards maze) and right of the screen. I placed the console down, right to the maze entrance. The FU question was where would you place the ducts? There were no other indications about the spaces surrounding the tx room, so I had to talk about possible options.
- 7) A fluoroscopy system. Asked to describe all components.
- 8) A CT and an MRI image (axial) of a head side by side. You could notice the screws from the frame on the CT. Asked to talk about, what are they used for. Do you use MRI for planning?
- 9) An image of a linac head, with a Pb foil in place. Explain why this setup. Do not forget to mention that you remove the Pb foil after finding the beam quality.
- 10) An MRI+CT checkerboard fusion. It was for the first time I saw this, but I talked about fusion. I was not very convinced, although I know the subject very well. I didn't repeat what I said to the previous examiner about the fusion (because of the stress), so I think I lost points here.
- 11) Asked how the TPS is computing the dose to the skin. What is the accuracy?
- 12) Two plans of a pelvis: one with higher energy, the other with lower energy. Asked which is which, and why. Talked about the dose to the femoral heads. How do you treat prostate in you clinic?
- 13) Again a room in the middle for HDR (!) treatments (he said), with values to the film reading room (left): 2 mR/hr; patient room (right): 7mR/hr; and corridor (down): 0.2mR/h. Talk about permissible doses.
- 14) An annual QA sheet, with values. Several values out of limits (~4%). Where do these limits come from (TG40)? What do you do in the case where the PDD at d=10cm for a 10x10 field is about 4% off? He said he would simply measure again.

- 15) The difference between a Sim-CT and a CT-Sim. Talk about the BEV and doing a CT with the 2D simulator. He didn't have the patience to listen to me from the moment when I move the table to localize the GTV. He seemed he was waiting for me to say "move the table".
 - 16) The image of a klystron – what it is and how it works. Basic stuff – not too much into details.
 - 17) 3 pictures with different electron beams going into a 270 deg bending magnet. First beam comes well steered. The middle one is spreading out of the accelerating structure and the bending magnet is focusing it. The third one is an unrealistic case, when the beam is totally defocused. Explain the achromatic phenomenon. Compare a 270 deg with a 90 deg. What is the main requirement for a beam coming into a 90 deg bending magnet. How do you achieve it? Which kind of accelerating structure do you need?
 - 18) The barometer is broken. What do you do? Call the airport? What do you get? What if you call the LOCAL airport? How do you correct? How does the humidity affect the reading? Mentioning things like "others" do check the pressure on Internet made him feel uncomfortable.
 - 19) Can you use a simulator room as an HDR room? What if your source coming has more than 10Ci? What does your license specifies if you have 2 sources in the house (the new one and the old one)?
 - 20) How do you define misadministration? Who do you inform? Who the RSO must inform? If you inform the doctor, who the doctor will inform at his turn? (The MD informs the patient and... the referring physician). What's the percentage to have misadministration for a 1 fraction treatment? What for SRS?
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- 1) Picture of a linac room w/maze-low energy. The question was how I would calculate the maze wall thickness. It seems that the examiner was looking for a comparison between the different kinds of radiation reaching the door (room wall scattered, patient scattered, leakage scattered, leakage transmitted). I answered that the transmitted leakage would be the one that I would use to calculate the maze thickness.

Peripheral questions:

- What the energy of a 90degrees-scattered beam would be.
 - Length of typical maze
 - Thickness of typical primary barrier
- 2) How would you shield an HDR unit? How would you calculate the workload? Floor plan of HDR & adjacent rooms (hardly visible). Identify controlled areas, uncontrolled areas; what are typical occupancy factors, dose limits.
How would you shield an HDR unit? How would you calculate the workload?
 - 3) HDR: the source wire is not properly attached to the channel, and falls on the floor. Distance of source from patient's feet is x cm, pelvis y cm and head z cm. The patient is exposed for a number of minutes. Is this a medical event?
(I started off trying to calculate the dose to different parts of the body, and he stopped me short saying that I am thinking of internally administered radionuclide.

He wanted me to talk about what % the px dose to the patient would be exceeded by.)

- 4) Radiobiology: Graph of survival fraction vs. Dose. One linear and one linear quadratic. Which one corresponds to a higher LET? What is D_q ? What is a stochastic event? What is a non-stochastic event? Give examples.
- 5) What is “effective dose equivalent”? I was given a table that had weighting factors for different tissues/organs and associated risks. I skipped the risks and said that I would multiply the dose to each organ with the weighting factor for this organ and summed them all up. Not the most elegant answer but it got me through.

2nd Examiner

- 1) Picture of a room with a maze-high energy. Primary barrier thickness calculation. Write down the formula and explain each term. What report would you use for shielding of megavoltage units (They DO want to hear “NCRP 151”!)
 - 2) Picture of an HDR gyn anterior film. I told him we don’t have an HDR unit. He told me to consider it an LDR. Describe what you see in the film; Points A and B. Talk about the whole process: OR, filming, planning, source loading, posted signs, survey.
 - 3) How would you justify to your hospital administrator shielding for 10% of annual limit? The only thing I could think of is that it incorporates the limit to pregnant workers. He seemed ok with that and asked me about the declared pregnancy radiation safety program.
 - 4) What is the #of counts below which you would allow access to a contaminated area (after you de-contaminate it, presumably)
I-131 spill. What do you do?
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1. PET fusion shown on the screen. Describe what it is, a lot of lateral questions, advantages, disadvantages, limitations of PET.
2. Gantry isocenter QA film is shown. Tell what it is, tolerances, describe the procedure, what about table and collimator.
3. A picture of cylindrical and PP ion chambers. What do you see on the picture, compare the two. Discuss point of measurement, effect of volume, etc.
4. Describe TP algorithm used in your clinic. Specific questions about inhomogeneity corrections.
5. Shown cell survival curves - from Hall book. Describe the differences between high LET radiation and low LET radiation, fractionated treatment. Discussion went into differences between single fraction total body irradiation and fractionated TBI. Need to know prescription doses, fatal dose in total body irradiation, etc.
6. Define end effect.
7. DRR of female pelvis. Describe combination of EBRT and HDR/LDR modalities. Doses for each. prescription doses. Identify organs on the film. What organs are typically treated with HDR/LDR.
8. How would you measure electron profile. Discuss advantages and disadvantages of film, ion chamber and diodes.

9. Schematic diagram of a diode - from Attix book. Identify the zones, type of diode, etc.
10. How would you calibrate Ir-192, I-125, Cs-137. Describe the procedure in detail, well ionization chamber, frequency, etc.
11. Describe HDR prostate implant. Prescription dose, prescription method, preferential loading, etc.
12. A question about medical event - what to do when you discover that the total dose >14% of the prescribed dose. Understand the difference between single fraction and multi-fractional treatments, understand the definition of an agreement state, the role of NRC. Asked me to describe both types of scenarios - for medical event and not. How to handle this inside the hospital. A lot of questions back and forth.
13. MLC is shown. Describe the differences between Varian and Siemens design. Double-focus and single-focus MLS, etc.
14. How to change photon energy on linac. Pushed me to describe the triode structure of the electron gun.
15. Describe shielding design of an HDR room.
16. Shown CT QA phantom. (a CT image). What is it? How to use it? Frequency, tolerance. What about other image modalities?
17. Shielding - a question about use factor, occupancy factor, asked for definitions, etc.
18. 10 MV PDD shown. Discuss the factors affecting surface dose:field size, SSD, etc.
19. Prostate IMRT plan -discuss QA issues.
20. Discuss beam quality factor, questions on TG-51.
21. Describe shielding considerations for the door. Neutrons, etc.
22. What is the difference between diagnostic and CT images – the examiner was pretty happy to hear about different patient setup.
23. Nasal cavity treatment - what is field arrangement - wedge pair or 3- field? What about inhomogeneity.
24. Standing wave wave-guide design. Describe.

1. HDR shielding: Shown a schematic of a room. Asked how to shield the room. And what things were needed in the room.
2. Silicon diode: Given the diagram from Kahn. Some of the information was missing & I had to identify what it was. Asked several questions about how it works & when it is used.
3. Linac shielding: Shown a schematic of a room. Asked about use factors for corridors, outside, control areas. Also asked about work loads & where that number was arrived from (NCRP 151)
4. MLC: Different types for different vendors. Double focused. Penumbra.
5. IMRT QA: Given a phantom with isodoses mapped onto it. Asked about how these are arrived at & general questions about IMRT QA.
6. Nasopharynx Tumor: Given an axial image with a volume drawn. Need to identify it as nasopharynx. Identify dose limiting structures. Explain the best treatment plan.

7. Ir-192 Implant: Is it a planar or volume implant? How far about are the catheters placed?
 8. Ir-192, Pd-103, I-125: Calibration. Done how often? Done using what?
 9. Parallel plate vs. cylindrical chamber: Advantages/Disadvantages. What each are used for.
 10. Female (GYN) Anatomy: Given an AP DRR with outlines. Had to identify rectum, nodes, bladder. Talk about treatment planning for this area.
 11. Low Contrast Resolution Test: Given a picture of the phantom. Had to identify what test it is. What the results should be, how often it is tested.
 12. End effect & Timer Linearity
 13. Changing Energy in a Standing Wave: Given a diagram of the standing wave with an energy change. Explain what the diagram is.
 14. Treatment Planning Algorithm: What does your TPS use? Explain how it works.
 15. Radiation/Mechanical Isocenter: Given a picture of the spoke shot for Gantry Isocentricity. Identify what it is, how it is measured, and how often.
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1. a. Two electrometers are shown side by side. What are they, what to measure, how to use them, what are the signal ranges, precision, accuracy?
 b. Shielding for a linac, considerations for different barriers, materials to be used, how do you determine what to use? Write down the formula for the primary barrier design. Explain neutron shielding principle, shielding materials, TVLs, neutron energy ranges in different layers, Gamma ray energy range,
 c. Linac beam alignment and tuning question, what causes field asymmetry?
 d. Farmer type chamber and PP chamber (Markus chamber) pictures are shown, what are these? Where do we use these? What is TG-51 recommendation? How do you measure surface dose?
2. a. About photon field abutment, electron beam & photon beam match. The case used for question was a breast chest wall + IMC + Sclav & axilla. Asked how to do the 3D plans, what techniques could be used, how to solve issues such as field overlap, hot spots, etc...
 b. A DRR and a portal image of esophagus case are shown side by side, what are they, recognize major boney land marks and how to use them.
 c. Electron ionization and PDD curves are shown, what are they, talk about them. How to convert Ionization to PDD?
 d. For an off-axis reference point in a blocked field (most of the field is blocked), how do you manually calculate dose for the point? What output factor should be used? How about if this is a half-beam block created by jaws?
 e. Showing breathing wave and CT slices, what are they? → How to do 4D CT reconstructions? How to do a gated CT scan? How to use them in the clinic (questions about 4D planning and delivery)?
3. a. An MRI and a CT axial slice (H&N) are shown side by side, several organ names are listed on the bottom. Point out each anatomy on both the images.

b. A direct shielding door and an old linac room is shown in a picture. Why use it? When plan to change the machine from 6X to a dual – 6X and 18X, what has to be considered?

c. Wedge field isodose lines are shown on an axial CT slice of thoracic area. What wedge angle is it? How is wedge angle defined? How is output factor defined? Talk about normalization methods.

d. Explain about anti-scatter grid, grid ratio and materials. Can we use the grid for film based simulation, fluoroscopy based setup with simulator, film portal imaging and EPID ?

4. a. About polarity effect of ion chamber, what are the causes? Is P_{pol} energy dependent? Why? For electron beams, for which beam P_{pol} is higher? Why?

b. Shielding design for a patient room next to a T & O LDR Tx room. How do you calculate the activity of the source in mCi from its labeled activity in mgRaeq ? How do you design the shielding?

c. Two axial slices are shown. What are they? (PET and CT) Talk about principle of PET. What is used for PET? (FDG-18) What is it? Talk about image registration issues.

d. Linac based SRS commissioning. How to measure beam data? What tools are used? What are the pros and cons?

e. Two sets of isodose lines are displayed on two axial CT slices respectively. Beams are going through lung. What are the differences? Talk about heterogeneity correction algorithms (two), pros and cons.

5. a. T & O LDR case. What are the important reference points? What do point A and B represent respectively? How do you define reference points for rectum and bladder respectively? What exposure level do you read at 2m away from the bed? How do you manage and handle LDR sources? Inventory, log in/out, documentation? What equipment(s) do you have in your inventory room.

b. Orthogonal X-ray images of an HDR case with many catheters are shown. What are these? Point out the major parts in the images. When you check the simulation films, what do you check? What is a new HDR source activity?

c. A magnetron and a klystron pictures are shown. How does the magnetron work? How does the klystron work? What are the major applications of them? What are their typical maximum output powers? For what energy levels are they used? Pros and cons?

1) 10 catheter HDR planar implant (ended up being an interstitial leg implant) – ap/lat radiographs, Rx = 500 cGy to 1 cm.

? – what is everything you see in this picture (let's skip the anatomy! – hard to tell it's a leg). Saw catheters, "buttons", and dummy source loading.

? – What type of QA would you perform to check the plan and check that the dose is correct.

? – QA of HDR delivery.

2.) Direct shielded door, 6 and 18X room.

? – What materials?

? – Why use a maze?

- ? – Better to have hanging or swinging door?
- ? – If you don't want a big bump in your wall b/w primary and scattered part of wall, what can you do?
- ? – Write down equation for thickness of shielding with the 1st and equivalent TVL

3.) Two pictures of isodose levels from AP field on transverse slice at level of lung/media.

- ? – What is the difference between these two images?
- ? – explain two inhomogeneity correction algorithms.

4.) Picture of dynamic wedge depth dose profile.

- ? – What energy x-ray
- ? – What is wedge angle
- ? – difference between physical and dynamic wedge – how would this depth dose profile change if it was a physical wedge
- ? – How to measure depth dose profile for a dynamic wedge field
- ? – For a physical wedge what happens in directions off axis perpendicular to the direction of the wedge angle (answer was something about beam hardening).

5.) Picture of really really old and kinda current electrometers

- ? – What are these
- ? – What type of instruments connect to these
- ? – Explain types of connections, BNC, TNC, triax
- ? – how do you calibrate the electrometer
- ? – necessary accuracy/precision of the electrometer calibration

6.) Typical activity (in mCi not mgRaEq) of Cs-137 LDR fletcher-suit-delcos implant.

- ? – How convert from mgRaEq
- ? – Dose rate expected at 2 m
- ? – How to calculate by hand if you wanted to
- ? – instructions for nurses
- ? – how to prepare room

7.) Regulations for handling, inventory control of brachytherapy sources.

- ? – What would you consider a “short half life” vs “long half life”
- ? – Describe the hot lab
- ? – How do you leak test a Cs-137 source

8.) Picture of 4D CT and phase binning

- ? – What is 4D CT
- ? – How do you do it?
- ? – If you don't phase bin after the fact, what other method can you use to do 4D CT?
- ? – What information do you get from 4DCT?
- ? – What do you do with that information?
- ? – Do you prefer gating vs use of ITV?
- ? – Benefits/pitfalls of gating

9.) Room shielding

- ? – Difference between primary and secondary barriers
- ? – What is dominant effect on secondary barriers
- ? – Data used for TVL and HVL – broad or narrow beam?
- ? – What is difference between broad and narrow beam?
- ? – Do you always have beam hardening, even for high energy beams? Why not?

10.) Cartoon picture of a patient with a scar over the breast (I think to delineate that it's a chestwall, not breast). Then there is a scv field, a field medially which may have been for IMN's, and a field over the rest of the chestwall.

- ? – What is this
- ? – How would you treat this
- ? – How do you handle the match between the fields
- ? – How does the scv field work? What depth?
- ? – Do you ever add another field to this treatment?
- ? – Are there any other sites that you treat with electrons?

11.) Explain mechanically how independent jaws work.

- ? – How do you measure the output factor for a field with a jaw asymmetrically at zero?
- ? – Range of X and Y jaws
- ? – What sites is this clinically useful for?

12.) Polarity correction

- ? – What is the phenomena of polarity effect?
- ? – Some causes of polarity effect
- ? – What is situation where it becomes more of an issue?
- ? – How do you correct for it?

13.) Film H&D curve with three types of film (XV, EDR, and one really fast one)

- ? – What is this
- ? – What film is the fastest and why
- ? – Which one do you think is the EDR film
- ? – If you were going to treat SRS to 20 Gy can you use any of these films to make a measurement? (The shoulder of the slowest field occurred at about 900 cGy).
- ? – If not, what can you use instead?
- ? – Benefits of GafChromic film over regular film?
- ? – What is dynamic range/latitude?

14.) What commissioning data would you need to obtain for a SRS system.

- ? – How would you calibrate the output?
- ? – What can you use to measure that data?
- ? – What do you have to be careful with with your detector?

15.) Pet and ct slice at level of top of kidney side by side, where there is a para-spinal mass contoured.

- ? – What are each of these images
 - ? – What is useful about each one
 - ? – What is contoured
-

1. How does IMRT optimization algorithm work? (Mention cost function.) How do you keep from being stuck in a local minima?
2. Draw attenuation curves for broad beam geometry and for narrow beam geometry. Discuss the differences. What causes these differences? What geometry do you use when doing your shielding calc? What geometry do you assume when doing your safety survey?
3. Shown Farmer chamber. Discuss use, materials, how it connects to cable. What is the function of the guard? What is the volume of the chamber? Why is it well-suited for Radiation Therapy measurements?
4. Shown 2 axial h&n slices with isodose distributions. Identify tumor and critical structures. What lobe of brain and what side is tumor? Discuss plans. The first was two lateral beams, the second was IMRT. In the lateral plan, how do we get the dose distribution only one the side with the tumor? How can you tell from the isodose lines whether the plan is weighted or mixed energies? In the IMRT plan, discuss quality. There was a lot of dose in the back of the brain- asked whether that was OK.
5. Shown three axial slices of a chest plan. The problem states the plans are for identical beams. Discuss differences. The last slice clearly showed no heterogeneity corrections. The first slice showed increased range and penumbra due to the lung, but the second slice showed only increased range- no penumbral widening. I said the first slice used heterogeneity corrections, but was stumped by the second. I said maybe it used a less correct algorithm for heterogeneity corrections, which prompted the examiner to ask if my TPS allowed us to use two different types of corrections...
6. Shown a graph of OD vs Dose. The graph showed several curves ranging from 28 keV to 1 MeV. It was labeled "Kodak XV Film". Asked what kind of film this was and what you would use it for. Asked if, as the graph shows, the sensitivity of film usually decreases with increasing energy. Asked if the film is used with a screen, based on the graph. Led into a discussion of H&D curves.
7. Shown the electron beam incident on the slab bone heterogeneity from Khan. I didn't get to answer this question (out of time), so not sure about FU questions.
8. Asked about discharge instructions for an I-125 prostate seed patient with a pregnant wife. What are limitations for time spent with wife or small children? (Be specific- how long do limitations, if any, need to be in place?) What if patient finds a seed in the toilet?
9. Asked about a new linac installation. After safety survey and mechanical safety

checks, what are the next tests you will do in an acceptance? I said mechanical iso, star shots, some PDD & flatness/symmetry measurements. The examiner asked "assume the same installer/vendor just put in a linac in an adjacent vault, and everything was done correctly. No adjustments needed to be made during acceptance. If you assume the same will be true for this linac, does it really matter in what order you do the acceptance tests?"

10. Shown an HDR Tandem and Ovoid. Asked to identify bladder, how much contrast should be in bladder? Asked to identify the function of the "metal blade" shown on the orthogs. Looked like a rectal shield. Wanted to know what acceptable doses to the bladder and rectum were.

11. I had a question about I-125 with a follow up about Ir-192 ribbons, but I don't remember the question anymore.

12. What HDR QA do you have to do daily? How do you do the tests?
Asked about limits for the tests too.

13. Describe a complete CT sim solution (including workstations, DRR printer). What tests you do need to perform to commission the system? What are the limits? Does the workstation require input about your linac if you are only going to use that software to design fields? What info?

14. Shown a DRR and a port film side by side of a prostate plan. Asked to identify the images. How do I know if the second image is a port film or an EPID? I said it was an EPID because it had a window and level control. He said it could be a digitized film... Asked about the function of the port film. What is it called when you leave a film in for the whole treatment instead of just delivering a few MU?

15. Shown a CT and MRI fusion. Asked why we do fusion. What images were which modality? What are drawbacks to fusion.

16. Shown a CT with six images. Three were of an area higher up in the chest (axial, sag, coronal), and three were of the same patient but down in the pelvis. The axial pelvis image had streak artifacts. Asked to discuss what caused the artifacts and how you would get rid of them of the physician wanted a new scan. I didn't see any hip implants, so that wasn't it. There was an area of high contrast anterior to the pelvic bones, but I don't know what it was. I said maybe it was the bladder with contrast in it. He asked if CT contrast would cause streaking.

Examiners 1

1. Just one-sentence question. How do you calibrate and verify a brachytherapy source? No specification on whether it is HDR or LDR source. Ask about the details of dose calibrators for HDR and LDR sources, especially the geometrical efficiency. How do

you QA these dose calibrators? What special attention should be paid when measuring the sources, also the acceptance criteria?

2. What are controlled, uncontrolled areas? Dose levels for each. Dose level that causes cataract.

3. A diagram of Rotterdam applicator shown (similar to Fletcher-Suite type but without shielding to reduce doses to the rectum and bladder). What is this applicator for?. Define point A and B, ICRU dose points, where are the rectum and bladder point, how you measure the doses there?

4. Describe an EPID and its working principle?

Examiner 2

1. What is a CT simulator? State its features. What you do to verify its geometric accuracy? Any issues you should pay attention to if the patient is scanned prone or feet first?

2. A diagram of Klystron shown, tell the working principle? Difference from a magnetron? What are power levels of these things?

3. What is the cross-section for an interaction? A diagram showing cross-sections against energy for Compton interaction. Explain the components of the Compton interactions, scattering and absorption. What is the relation between the cross-section and mass attenuation coefficient for Compton interactions?

4. A floor-plan of 3 patient rooms shown. Where to put a LDR patient and why? What need to be done for the radiation protection issues? Ask for some dose-rate values and etc. If you are provided with only one portable shield, where would you put it and why?

5. What is stereotactic radiosurgery (SRS)? Ask about the rationale behind it. Why there is a limit on the lesion size for SRS? What are the requirements on a linac to perform SRS? Typical dose given.

Examiner 3

1. A diagram of camera-based EPID was shown, explain the function of each component. Tell the differences between a camera-based and aSi flat panel EPID.

2. A diagram of TLD reader shown, tell the working principle. What is thermoluminescence and its theory? Explain what a glow curve is and its multiple peaks are.

3. What would you do if a patient tells you that he has flushed an I-125 seed through the toilet? Twenty 0.5 mCi seeds on the way to landfill, what would you do? Do you need to report this incidence to NRC or the state agency?

Examiner 4

1. A diagram of PET/CT images shown. Tell about the image fusion techniques available for PET/CT, point-based, mutual information and etc. What is FDG-PET, its working principle and etc

2. A diagram of thimble chamber shown, not farmer type but like IC-3 or IC-10 or PTW. Tell the different parts, the connections to the tri-axial cable. What are the materials for the guard ring (gold or Al), central electrode (Al) and cavity wall? Also need to need the voltage, electrode setting and ground connection?

3. Typical questions on shielding for a HDR room, a floor plan shown? What are the points A and point B? Shielding equations and etc. HVL layer (concrete) for Ir-192.

4. How to measure collimator scatter factor (Sc)? Variation of Sc with field size, how and why? Also questions on build-up caps for in- air measurements.

5. A photo showing the setup for measurement of mechanical isocenter of a linac. Define the mechanical isocenter of a linac. How to determine the geometric accuracy of the gantry, collimator and couch rotation. How about radiation isocenter? Ask about the details of spoke test.

Examiner 5

1. MR/CT images of a brain shown. Identify the temporal lobes, optical nerve and chiasm, ethmoid sinuses and internal carotid arteries. What is good of MR for RT planning. What MR is imaging (proton density, T1 and T2)? Why we need CT for RT planning?

2. What is stochastic/ non-stochastic effects? Name some examples and the dose levels for each.

3. A graph showing the response of GAFchromic (radiochromic film) against energy was displayed. What is GAF films? Its composition, working principle and dose response. Is it energy dependent? What is its clinical applications?

4. What is commissioning on a linac? What is acceptance test on a linac? Difference between the two. What you do in each? Ask about the beam data measurement? Symmetry and flatness of a photon beam, what value should we expect?

5. Describe and draw a typical electron depth dose curve. What are the R_{50} , R_p (extrapolated or practical range), E_0 mean energy), E_p (most probable energy) and etc.?

Define them. Write down the relation (equation) between them. Where does the Bremsstrahlung in a electron beam come from? Dose it change with the applicator size?

1. Shielding of a linear accelerator for a 6-18 MV. What would you change when you go from 6 MV room to an 18 MV room. Why not steel instead of concrete for the primary barriers.
2. Breast plan for with tangents, Scav and IM nodes. Field matching etc.
- 3 .DRR Single exposure and double exposure. Carina marked in the image what is this structure
4. Asymmetric jaws and their mechanical characteristics. How do you measure output for Asymmetric jaws

#2

1. PET images – what is the tracer used. What is the process for acquisition
2. Tandem and ovoid: nursing instructions
3. Lung with two isodose: Tissue inhomogeneity How would you advise your physician in terms of hot and cold spots when moving from homogenous plans to heterogeneous plans. Accuracy of algorithms
4. Polarity correction for TG 51. Does polarity correction increase or decrease with energy

3#

1. T1 image and CT image Identify whether T1 or T2 Identify anatomical structure – external auditory meatus. Turbines, nasopharynx, maxillary sinus, retro pharynx
2. Wedge field
3. Optical density : film response curve
4. Intricacies of a directly shielded door
5. Electron beam PDD . Difference between PDI and PDD. Difference between energies surface dose isodose lines etc.

#4

1. EPID – different layers of the EPID – different substrate/ spatial resolution of the EPID image
2. Klystron versus Magnetron
3. Reading at 2 meters for a cesium implant. Loading of a typical cesium implant Advise to be given to visitors >18 and <18 years of age
4. Image of a femur with catheters showing an interstitial implant. Asked to recognize the anatomy and give details on procedure
5. LDR questions on prostate implant

#5

1. Picture of an electrometers What can it measure? How is it connected to an ion chamber?
2. 4D CT
3. Retrospective imaging

4. Lead filter versus beam in different direction: straight on, oblique and off axis
 5. Commissioning measurements for stereotactic field.
-

Calibration and QA. Below are the nine of ten questions that I recall.

- 1) Shown a schematic of a water tank with 100cm SSD, chamber at 10cm. Describe the process of performing TG-51 calibration. How do you determine energy for photons and electrons? At what depth do you perform TG-51 calibration for electrons? What factors do you need to address when correcting your raw measurement?
- 2) Shown a radiograph of tib/fib with multiple catheters. What are we treating? What sort of dose constraints are we worried about. This is an HDR treatment, how do we know that the dose we wanted was actually delivered?
- 3) Shown photo of linac. How is isocenter defined? How do you check isocenter and what are the acceptable tolerances? How do you associate the mechanical and radiation isocenters?
- 4) Shown a graph of KERMA vs dose. What are we looking at? Describe what is happening in this graph? Is this for a photon or electron beam, and how would the other one look different?
- 5) Text only. Describe geometric and dosimetric penumbra. Which is the more significant contributor to total penumbra. How does the ratio of geometric to dosimetric penumbra vary with depth in tissue?....beam energy?
- 6) Shown photo of readypack film taped to a linac head. What are we looking at? Why are the films numbered? What would be possible causes of head leakage noted on film?
- 7) Shown radiograph of inserted vaginal cylinder. What is this? What are we treating and what doses are appropriate? How do we know that the desired dose was delivered? How many dwell positions may be employed with this treatment?
- 8) Shown graphs of KERMA and dose deposition with depth with heterogeneity. (water/air/water/bone/water). What is going on in this graph? Explain why there are differences in between the curves at the interfaces?
- 9) Shown schematic of linac with gantry, collimator, and table axes highlighted. How do you test the isocenter? What are the tolerances? How do you equate mechanical and radiation isocenters? If you find isocenter out of tolerance, what are some possible causes and what do you do about it.

***** End of Summary *****