Hey Folks! Much Luck on the up and coming test and wish you success in your future endeavors while you are traveling your road. Keep up the good work! :) - Your Moderator

Folks, I will send you a finished copy of this once the test date arrives. So there is no need to select all and copy. I think thats why some of the colors are not showing up and some of the links I have added are no longer attached and additionally some of the comments have changed.

1. Please keep you font size at 10 pt.

2. Try to reduce any blank space and line spacing as possible

This is document for ABR Part 11 examination. I have already completed Part 1, but I am doing this to start a tradition for future users. CONTRIBUTE to the document and mark your answer in some other color (red!). This is to be used as a reference only, and please be careful who you distribute the document to. We are all in this process together. Good luck to all. Please utilize the UNDO option if unintended changes are applied.

So, I 'll use the Red color SR

I can use purple: VJ

I will use brown: Ahmad

I will try to start putting in my answers from next week, will be using green: YY

I will use this color: BB

I will use this color - KA

The Moderator

I will use this color:sc

Can someone help finding out 2010 questions?

I will start putting my answer when I come back from AAPM meeting : SL

I will use this color. Thanks so much, Moderator, for starting this; I was looking exactly for this today! -RS

I will use this color: ZqxB

I will use this color: YZ

My color is gone again. SH

I will use this color:part2_abr

My color is gone - LY

I will use this color: MM

I will use:BH

I will Use This Color - YC

Requests for Information on Specific Topics or Discussion on Specific Question

really the dicussions button above could be used for this - one can click resolve when done

Anyone Have 2010 Style Q's

More problems are added at the end

ANYBODY USING RESPIRATORY GATING? Please write couple lines about PROSPECT & RETROSPECT. Thanks

Comments on how a klystron and magentron generate microwaves are attached as a link below

https://docs.google.com/leaf?id=0B_4hOY9x9TbxZmUwMWFkZDgtOGVlMS00ZTE3LTg4MTMtM2I0NDM0MjFhMDBl&hl=en_US

Its taken from Metcalfe, "The Physics of Radiotherapy X-Rays from Linear Accelerators"

Therapeutic Radiological Physics Part II (Therapy Physics) Study Guide

Tips and Observations about the Exam:

- Shielding questions -- lots of them!
- Lots and lots of dosimetry calculations:
- If you have the PDD or TMR data, how many MUs required?
- Know when to use Mayneord F factor and when to ratio TMRs
- Know relative depth doses for all electrons and photons
- Know definition of terms in TG-51:
- Numerous gap calcs
- Lots of SSD and SAD treatments, max dose, midplane dose.
- One or two, electron beams problems. Not too many. All the fields were rectangle and you had an additional calculation to convert to the equivalent square. TG 51 questions but not difficult. Raphex is very good for the easy questions and Khan and McGinley are good

for the others. Lots of practice with the windows calculator. Some problems with long sets of calculations.

NOTE: No part of this study guide may be reproduced in print or electronic form and sold, bartered or tendered for profit. This document is solely for the use of the Yahoo Group members to gain practice for the Radiological Physics examinations. The Group and/or its owner(s) cannot be held responsible for the accuracy of the content of this document and you agree to use the material contained herein at your own risk.

Exam Type Questions:

1. Which of the following is used for palliative treatment of bone mets? Strontium 89 sr89 corrected

At our center, we use P32 for bone meta IORT (YY)

I believe Sr-90 above was a type-o see.... Sr-90 is typically used for lens of eye with direct application.

P.41 List of isotopes used: http://www-pub.iaea.org/MTCD/publications/PDF/te_1549_web.pdf

P-32 AND S-89 are the two workhorses for bone met isotope therapy dose is around 35-40Gy with 150MBq is typical. P-32 is associated with hematological toxisities more than the other options. There are isotopes for patients that have less bone marrow reserve etc... like Re-188 and Sm-153 where dose is around 87Gy from 2,590MBq **(all above is for palliation).

We use Quatramet (Sm-153, 46 hour half life), essentially pure beta emitter ,normal dosage arroud 100 mCi, intravenously injection, contamination risk, waste need to be held longer due to impurity issue, patient can be released if dosage <700 mCi or dose rate at 1 meter <30 mrem/hr, essentially you can release any Sm-153 patient.

2. The NRC requires HDR shielding to be surveyed: ____Initial_______, after source change.

every three months (YY)

That 3 month 'rule' is relative. It depends on how busy it is at the clinic. We exchange sources every two months. Why? Because the larger amount of Ci's provides shorter treatment times and more of a workload. However the other clinics associated with this one the source exchange is longer, one 4 months the other 5 months. The only other question I have is what sort of errors we might be introducing if we wait 5 months versus 3 or even 2 for that matter. Please note survey is different than inventory (3 months thing) Survey

Thanks for noticing. was just responding to the after source change.

Agree,New HDR source arrives with yellow II label, it shall be surveyed within 3 hours for radiation level and wipe test per NRC regulation.

3. What detector is best for calibrating an Ir-192 IVRT source?

what is a IVRT ??? IntraVascular Radiation Therapy ? Well counter or well chamber I agree I aggree I agree

4.What is the TG-40 photon field flatness spec? 2 I guess you mean less than or equal to 2%? I asked ABR if they would ask questions only from TG-142 now, and I got a bullshit noncommittal answer. Bastards.

Anything to keep it vague I guess :)

Hehe gotta love the purple answer.

Photon: flatness 2%, symmetry 3%

Electron: flatness 3%, symmetry 3%

4 (a). According to the report by Kersey (sp?), what is the attenuation TVL of linac neutrons in a maze? What is the question? maze distance 5 m or the door borinated polyethaline BPE 4-5 cm Its looking for the Tenth value layer for attenuation of neutrons. I need to brush up on my shielding :) :) :) Kersey report says 5 m. That report is here: share.https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B_4hOY9x9TbxZjcyZjVmMzctMDc4MS00MzVhLWJkZDMtOWNiZjM3MDYzMjIw&hl=en_US **you can find this number from NCRP 151 as well i guess. NCRP 151 P44** Great! which page though I agree I could do the search myself? I think the question asks for TVD (not TVL). Equation H = Ho/[d1^2 * 10^(d2 / 5)] Applies for neutron capture gamma rays, use Kersye's I am not able to find where I got the formula now. At the time, it looks like the right application. I list Kersey's equation now:

Application of this TVD = 5m: Neutron dose equivalent Hn = Ho (So/S1)(do/d1)^2 / 10^(d2/5)

Ho: neutron dose equivalent at a distance do from the target (normally do = 1 m at iso)

So/S1: ratio of the inner maze entrance cross sectional area to the cross-sectional area along the maze

d1: distance between the target and the entrance to the maze in meter

d2: length of the maze in meter

when the entrance and maze passage cross section is the same, and when do = 1 meter, Kersey equation becomes:

H = Ho/[d1^2*10^(d2/5)] --- This is the formula I listed before and It is a correct one, a simplified version of Kersey's formula

This is not neutron capture gamma equation as thought by green.

5. The largest contributor to dose at a point behind the gantry stand is ____:Leakage. in NCRP page 126 "Examining the computed

barrier thickness in this example, it is observed that the leakage-radiation thicknesses" How you get this? I think this is just one of those things that makes sense if you've done a bit of studying on shielding though I still need to brush up on it. The only thing that will contribute to exposure from behind the gantry is either back scatter which can be seen as leakage of sorts. I've been reading McGinley ch. 1-3 and I would also assume head leakage, but not sure. That sounds about right :) I agree

6. Electron virtual source- for linac with end of applicator at 100cm. Given ion chamber readings at several distances, the virtual source position is __ cm.
pg 316 in Khan (3rd edition) says to locate the virtual source distance we 'backproject' the 50% isodose line (imaging at different distances) using a 20 by 20 or greater.
1.00 0 (sqrt(Io/I))
20 1.5
40 2
Slope = y2-y1/x2-x1 =0.025
f=(1/slope)-dm=1/0.025=40-dm Aprrox 40 cm Thanks ---KA
Agree, the application of the virtual souce concept: Extended SSD Output Correction Factor
OCF = (SSDeff+dmax)^2 / (SSDeff+dmax+g)^2
while Gap g = SSD-100. Electron MU = prescribed dose / (PDD*Cone Factor*OCF*Cutout Factor)
7. AAPM Report 54 (TG-42? SRS)- What is the max size of a scanning ion chamber for SRS beams?
AAPM Report 54 (TG-42) page 50. "Aquire the beam profile data with a maximum detector dimension of 1-2mm for the linac and 0.5mm for the gamma knife unit." Agreed. Also, TG 101 (on sbrt) says: resolution <= 1mm, detector inner diameter <= half the field size. I read that for PDD Max size should be no more than 3 mm diameter. ALso for profiles, Film is the prefered method
8. According to NCRP-49, what is the max allowed exposure/dose for films in a storage area? 1 mR thanks bb
NCRP-49, p.g. 24, 5.1.3 states that "an exposure of less than 1 mR over a portion of film may produce undesirable shadows." it then mentions barrier thicknesses which will reduce exposure to 0.2 mR. If this is the correct number then D_{air}(μGy) = 8.76 x X(mR) = 0.2 μGy = 0.0002 rad.
1.3.1 Radiographic Films
Film storage containers must be adequately shielded to ensure that excessive exposure of film by X- rays does not occur. Sufficient film shielding must be in place to reduce the radiation level to stored film to less than 0.1 mGy over the storage period of the film.
http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code_35-securite/section-b1-eng.php

9. Pick out the false statement about TG-51 given a selection

10. For a H&N case, calculate couch kick given the field sizes to match the inferior borders to an SCLAV field. Tan= 0,5 inferior/ SSD ?? couch angle=arctan(.5L/100). pink is correct. Please look in khan v3 p 293 and Bentel rad therapy planning p389 -391, this is not clear to me. SCLAV same as cranial but more difficult. Any help? I don't have Bentel but I thought that this could be used for supraclav cases also. Can anyone else make any comments here?
I remember it as following: Couch Angle--> use Brain (or H&N) fld (SAD) , where as Col angle → use Spine fld (SSD)
Which means, the answer is: In case the Brain field is symmetric (usually the case):
Tan (theta)= 0.5 (Brain Fld) / 100 (SAD). In case col. Angle was required: Tan (theta) =0.5(Spine Fld) / 100 (SSD) FYI, the dosi practice exams had a similar problem, but both spine and cranial beams were SSD. And it gave the field sizes in "width" and "length", and you had to reason which was the sup/inf dimension (easy to tell for the spine), and know to use only the sup/inf dimension for FS in both equations. **I saw this question, you are absolutely true**
Cranialspinal Field or H&N/SCLAV field match:
Brain Lateral field Collimator rotation required: Tan (theta) = iso to superior border of spine field / SSD(normally 100cm)
Brain Lateral field Couch kick required: Tan (theta) = iso to inferior border of the brain field / SAD(100cm)orSSD(follow collimator setting)
11. Calculate the gantry angle for a half-beam blocked medial breast tangent beam, given a bunch of geometrical distances.
When half-beam block is used, given lateral oblique angle theta, the medial beam angle will be theta - 180; if block not used, need to calculate the divergence angle of the beam.
12. Question on how to calculate TVLs, Blx, Bsx for shielding needs. On one, the patient scatter area was 20 sq cm rather than 40 sq cm.

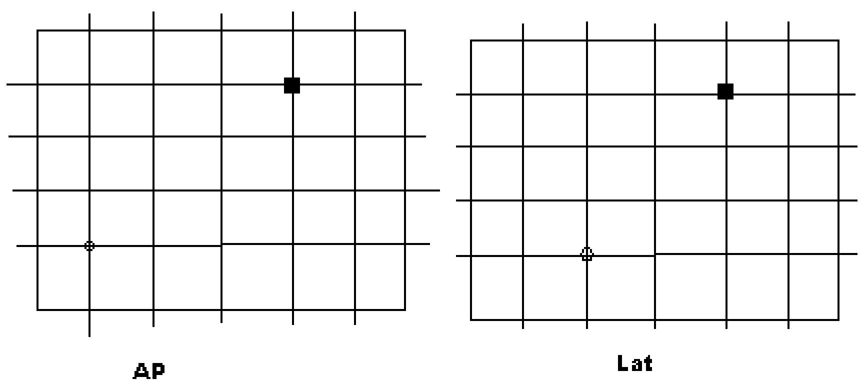
13. An I-125 implant gives 95% of the total dose in ____ days? 258 day I agree

14. Calculate Dy/Dx for a train of 10:10:10 mgRaeq sources at a spacing of 2cm, X and Y are 2cm off the transverse axis of the middle and an end needle. I believe that this is the same if not exact as the one below it. The questions aren't numbered. **uhm now they are.**
17:20 Agree
15. Be able to find cord dose given CAX dose from AP/PA treatments.
AP: Dose@CAX* [TMR(0.5*seperation+cord to central plane distance k)/TMR(0.5*seperation)]*[100/(100+k)]^2
PA: Dose@CAX* [TMR(0.5*seperation-cord to central plane distance k)/TMR(0.5*seperation)] * [(100-k)/100]^2

16. What is the range of a Sr-90 beta in air? Yahoo Group says to use the max energy of a beta decay (2.2 MeV in this case, see Khan p.550). They have an easy-sounding solution. Knowing the density (kg/m^3) of water is 833 times that of air (Khan page A-8), take the the range in water (0.5 cm/MeV), then multiply that by 833. That gives a range of **4.2 m/MeV in air**.
ALTERNATE SOLUTION: The electron density (#e-/m^3) for water is 922 times that of air (Khan p A-8). Multiplying 922 by the range in water gives **4.6 m/MeV in air**. Electron density is more important than physical density. Khan p 297 states: “In low atomic media such as water or tissues, electrons lose energy predominantly through ionizing events”. Khan p. 298 discusses ionization losses specifically: “The energy loss depends on the electron density of the medium.”
ALTERNATE SOLUTION: page 48.11 of *Encyclopaedia of Occupational Health and Safety, Volume 1* says beta range in air is **3.6 m/MeV**.
Source: http://books.google.com/books?id=Ceuq9P4hLJMC&pg=RA1-PT350&dq=beta+range+air&hl=en&ei=l8pBTpPuJqHhiAKx7-XJBQ&sa=X&oi=book_result&ct=result&resnum=4&sqi=2&ved=0CDsQ6AEwAw#v=onepage&q=electron%20range%20air&f=false
THEREFORE: Take your pick for beta range, I suppose.

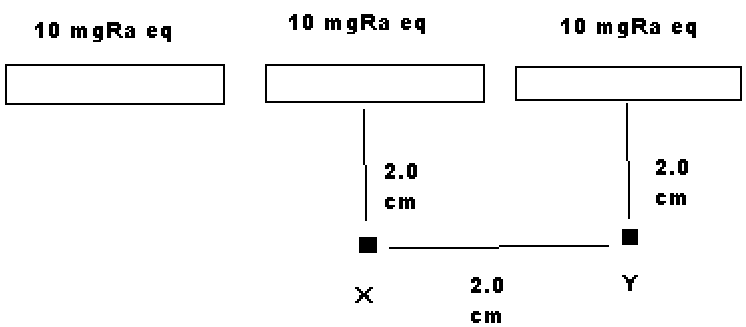
Since E_{Beta}=0.546MeV, then range = 3.6/2=1.8m (roughly) → please ignore this answer
The answer I hope it to be correct is:
After long discussion with Mr. SR, I will conclude:
if we considered max beta energy is 2.2 MeV, and from provided PDFs (by Mr SR), the range is 10.6m
so the answer does not need any calculation, it is simply a number we have to remember: 10.62 m is the range of the maximum Beta energy in air for the Sr-90 !! Agree with 800 - 1000 cm
Electron or beta particle Range in air (cm) = 0.5* E(MeV) / air density (0.00129) . remembering formula is more useful in case they change isotope or electron energy.

17. Given the grid in which every line intersection is at 1 cm. Determine the distance between the source (black dot) and the point of interest (white dot).



AP= SQRT (3^2 +3^2) = 4.24 cm
LAT = SQRT (2^2 + 3^2) = 3.6 cm
Should be SQRT(3^2+3^2+2^2)=4.7 cm 3d ok Agree

18. Given three linear sources as in the figure, determine the ratios of the dose at point Y respect to point X.



Dy / Dx = (distance for x)^2 / (distance for y)^2 = [2^2 + (2^2 +2^2) + (2^2 +2^2)] / [2^2 + (2^2 +2^2) + (2^2 +4^2)] = 5 * 2^2 / [4 * 2^2 + 4^2] = 5 / 8 = 0.625
Dy/Dx=(1/4+1/8+1/20)/(1/4+1/8+1/8)=0.85 Agree Right Answer --KA this is right scw
Not sure if I agree with this, D1*r1^2 = D2*r2^2 is the basic inverse square law?
Dy / Dx = (resultant distance for x)^2 / (resultant distance for y)^2
1/r1^2 +1/r2^2 + etc... => r1^2 *r2^2*etc.. / (r1^2 +r2^2 + etc...) is the resultant thanks :)

19. Tables of 4 MV and 6 MV PDD and TMR VS field size given. Also. BSF, not Normalized Peak Scatter Factors were given. Know

how to obtain MU settings for different field sizes:
#MU's (PDD) = Prescription per fraction / (1 cGy /MU * PDD /100 * Sc * Sp)   the backscatter factor (BSF) I think is used to calculate the Sp, Khan pg 180 - 3rd edition. And this is not including considerations of extended SSDs in which we will need to use the Mayneord's F factor, pg 167.
#MU's (TMR) = Prescription per fraction / (1 cGy /MU * TMR * Sc * Sp * Inverse Square Correction) this is used for isocentric calibrations instead of SSD calibrations for PDD.
Also we should know how to linear interpolate between TMR and PDD values because the field sizes are not always the standard tabulated values.
Sp(r) = BSF(r)/BSF(ro) = BSF(r) / BSF(10x10)

20. -In general: most of the time the calibrations were at SSD + dmax.
-In some problems the Scp was not given.
- Use of SAD and SSD setups, change in SSD´s (to require one to use the Mayneord factor to get the new PDD at a different SSD).
SSD setup: (SSD = 100cm)

MU = Prescribed Dose/[SSD Output(cGy/MU)*prescribed percentage*Tray factor*Sc*Sp*wedge factor*PDD*M Facor*Off axis factor]

SAD setup: (SAD = 100cm)

MU = Prescribed Dose/[SAD Output(cGy/MU)*prescribed percentage*Tray factor*Sc*Sp*wedge factor*TMR*Off axis factor]

SAD Output = SSD Output [(100+dmax)/100]^2.   M Factor = [(SSD2+dmax)/(SSD1+dmax)]^2 / [(SSD2+d)/(SSD1+d)]^2
Equivalent Square: 2 ab/(a+b)

Anyone know if we have to memorize the Mayneord f factor eqn? I intend to memorize it. **Memorize it as 2 1 1 2, i found it helpful. :)**
It may be a good to do. There are equations and other items that we all should probably know to be prepared for the test. If there is any extended SSD calcs to consider and its not given we will have to try to eliminate the obvious stuff. So just in case.
- Calculate the dose to cord at 4 cm, given every thing needed for a SAD setup.

21. Available space 36 inches. Required thickness of concrete was 66 inches. TVL for concrete = 13.6 inches. TVL for steel 3.8 inches. Determine how much of steel has to be in the 36 inches wall for the shielding to work out. # TVL= 66/13.6 = 4.853; X STEEL TVL, Y CONC TVL;
X+ Y = 4.853   … Eq 1 ; 3.8X + 13.6 Y = 36; Y~ 1.8, X ~ 3.05, steel needed 3.05x3.8 = 11.6 inches, concrete ~ 24.5 inches
This looks ok. Agree
22. How many fractions with a PA cord block if after the block is added the dose to cord is reduced to 18 % of what was being given without it. Total of dose to isocenter 6000 cGy, total dose to cord 212 cGy per fraction. Constraint: cord dose can not be more than 4500 cGy
There might be something missing but we should just go with what information is there. Here's how I would work this out. I'm not sure if this is correct but it seems reasonable given the information.
6000/200 for isocenter = 30 fractions (typically speaking)
then X + Y = 30 fractions
212 * X + (212 * 0.18) * Y = 4500
Y = 11 fractions with a PA cord block Agree
agree with 11 fx with rounding mathmatically but if you need to keep cord under 4500 then 11 fx will exceed 4500 . 10 fx will be more clinical choice
Great, Thank u
See dosi exams for this exact problem and solutions.

23. Two post oblique fields traverse 9 cm of lung. Detph of isocenter from the two posteriors is 18 cm. TMR given for 3, 5, 9, 12 and 18.
effective depth calculation, T_lung_eff = 0.33*T_lung; T_bone_eff = 1.65*T_bone → then use TMR

I get 9cm + 0.3*9cm = 11.7cm: $$CF = \frac{TMR(11.7cm)}{TMR(18cm)}$$

24. Calculate the thickness of a compensator, given the missing tissue = 5 cm. Density of compensator material and electronic densities of water and compensator material
$t_{comp}=t_{miss\ tissue}$ x (ρ_{water}/ρ_{comp}). It will be interesting to know how this will be solved if it was electron beam:
In Khan (Pg.: 307): there is a formula to find the equivalent depth in water to a given depth in other medium corresponding, which uses depth in medium multiplied by the ratio of R_{50}(water) to R_{50} (material).
missing tissue(cm)*0.7/density of compensator in g/cc Please explain the 0.7   0.7 is the average thickness ratio.-- KA See Khan p. 261.

Also, I don't think you can do compensators for electrons. I thought the scatter was too unpredictable. Khan page 327 alludes to that.
Khan states that the required thickness of a tissue-equivalent compensator along a ray divided by the missing tissue thickness along the same ray may be called density ratio or thickness ratio. Thickness ratio depends on: compensator-surface distance, thickness of missing tissue, field size, depth, and beam quality.We have found that an average value of 0.7 may be used for all irradiation conditions provided compensator-surface distance d>20 cm.

My spin on this subject is: If you use tissue equivalent material for your compensator, you simply mutiply missing tissue thickness by 0.7. But if you use other material, you have to convert the required tissue equivalent compensator thickness into the actual thickness of the compensator material by dividing by its density, hence the formula below:

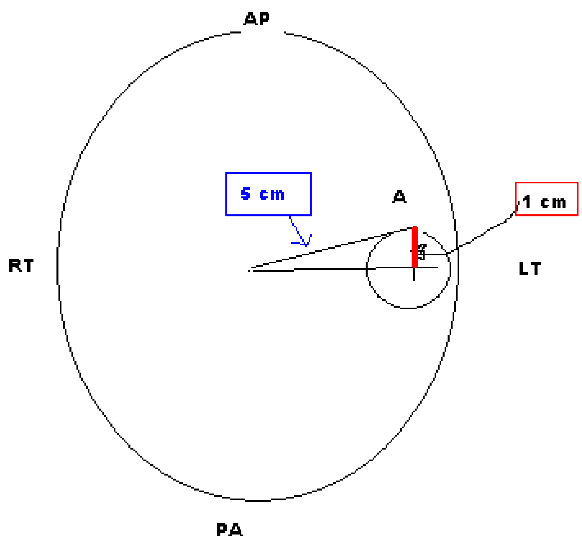
Required missing tissue compensator thickness = 0.7*thickness of missing tissue/density of compensator material

This formula says that you do not need inch for inch compensator, otherwise you overcompensate it.

25. When transferring a patient to a Co-60 unit after being simulated and treated in a SAD = 100 cm calculate the changes to the setup in linac. The treatment in Co-60 had to be done with SSD setup. Thickness of patient given.
80/100
Below is my best educated idea: I have no Co-60 unit experience
Goal is to maintain the same field size at patient depth D. Field size is defined at 100 cm from source for linac, Field size is defined at 80 cm from source for Co-60. It will be SSD =80 cm setup for Co-60 unit. The distance from depth D to source will be 80+D. The magnification of field size at depth D will be (80+D)/80. Therefore: the field size of Co-60 unit = [80/(80+D)]*field size of Linac.
THANKS
26. HDR scenario: Given activity of Ir-192 source 10 Ci, the exposure rate constant of Ir-192 was not given here, I used 4.6 R-cm2/(mCi –hr), then you had to know the f factor also for Ir-192. Balloon with 4 cm diameter. Calculate the approx. time to deliver 340 cGy´s at 1 cm from the surface of balloon.
I think I may have made this too simple but I don't think we need any f factor. oops 'spoke' too soon
340 cGy / [10 Ci * 0.877 rad / R * 1 cGy / 100 rads *4.6 R-cm^2/(mCi –hr) * (3 cm)^2] =33.9 *10^(-3) hrs = 0.0339 hrs * 3600 sec /hr = 122 secs. Sound reasonable anyone ?
10 Ci = 10000 mCi
approx time = 340 cGy / [10000 mCi* 4.6 R-cm^2 / (mCi-hr) * 1 cGy/ 1 rad * 0.877 rad/R * / (3 cm)^2] = 0.0758 hr * 3600 sec/hr = 273 sec Since you treat tumor not air, the time would be 273/1.11 = 246 (s) which matches 2010 ABR result. Convert exposure to air kerma by 0.876, you get cGy/hr in air, but that is not enough, you have to convert air kerma into tissue dose rate by dose rate constant ^, for Ir-192, ^ = 1.11 cGy/(hr*U). It looks like we have to remember 1.11 for Ir-192. Ugh....you're correct. 1 Gy =100 rads and it should be divided by 3 cm^2. Thanks for catching it.
This question came in <u>2010</u> exam, but with different phrasing :
Air Kerma Strength was given (40700 U), one should memorize the dose rate constant for the Ir-192 (1.11 cGy/(hr.U)).
The solution is similar to the exposure rate solution provided by the colleagues above:
Time (hr) = Dose / Dose Rate = 340 cGy / (Dose Rate Constant x Air Kerma Strength / (distance)^2)
Time (hr)=340 cGy / (1.11 x 40700 / 3^2) = 0.068 hr. Time (sec) = 244.8 sec.
I can't cancel out cm2 since dose rate consst has cGy/hr/U and there is distnce2 in denominator if i use dose rate consst as cGy cm2/ hr.U for calculation, is that right? since dose rate consst is formulated for 1cm distance any away. ----KA
Here cm2 is the dose rate at a distance, this is similar when you apply the Dose rate equation of TG-43, there is still cm^{-2}not cancelled out, because the dose rate was as a function of r & theta, does this make any sense?

27. The timer error of a orthovoltage unit is + 0.02 secs. The dose rate was 125 cGy/min in water. PDD was 60 % at 2 cm. Determine what is the maximum dose that can be delivered with less than 1 % error without having to take into account the + 0.02 secs.
Dose rate(t)/Dose rate x (t-0.02s)=1.01 solve for t=2.02s
125cGy/min x 0.6 x 1min/60sec x 2.02=2.525cGy
This is correct, but I do not understasnd from where you got 2.02?
I would solve: [Dose Rate (t=tsec) / Dose Rate (t=t-0.02)] = 1.01 à Dose Rate(t=t-0.02)=1.25 [cGy/(0.02sec)]
So, if we want to include the + 0.02 sec, add another 1.25cGy/0.02sec. Total error =2.5 cGy for +/- 0.02 sec. In case only + 0.02 is considered, it should be 1.25 cGy/0.02sec. I am not sure about this solution !!!
I agree with pink solution but solve for t=2s-Answer Should be 250 cGy as per above Disagree
125*0.6*0.02/(125*0.6*t) = 0.01, solve it, t=2 s, Dose = 125*(2/60)*0.6 =2.5 (cGy), The minimum dose that can be delivered with less than 1% error is 2.5 cGy. problem should say minimum dose instead of maximum dose.

28. Stereotactic radiosurgery scenario: Given a CT image with the rest of the info given in the picture that follows. How much and it what direction will the coverage move if the patient head is tilted 1 degree. The isocenter was centered on the origin from where the 5 cm are measured. This is a key issue for solvizng the problem.



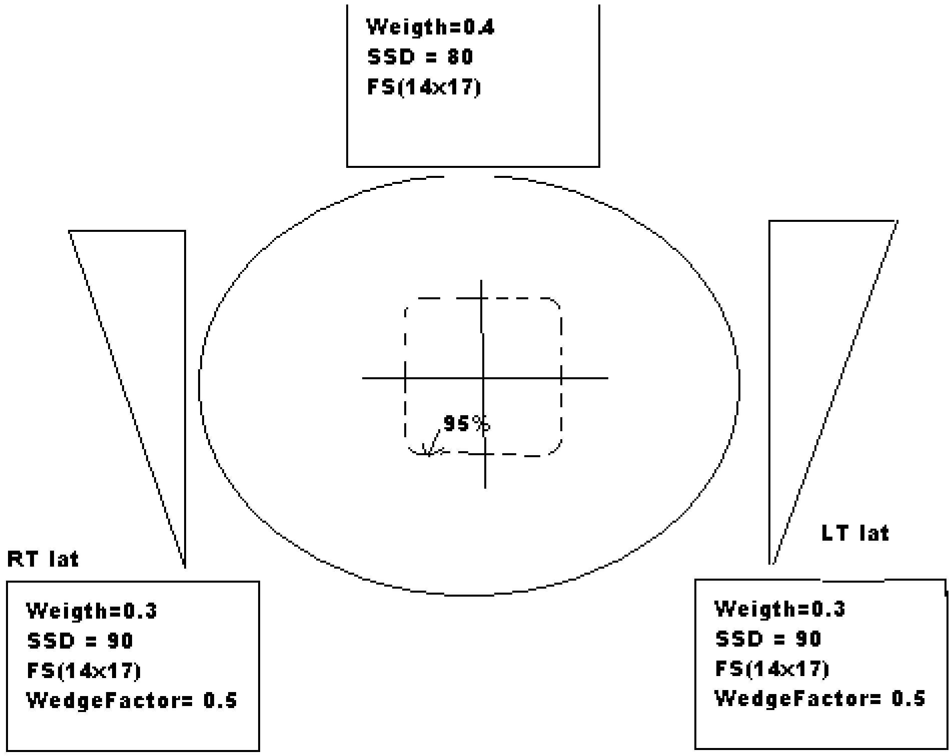
head tilt, beam stationary → coverage will move posteriorly for 1mm
5*tan1 = 0.087 cm ~ 1 mm
29. Have a 1 cm grid superimposed on a AP and Lateral Fletcher applicator. Determine the distance from one of the ovoids to a point. And calculate the dose rate to the point due to that source in that ovoid only. (mgRa eq for the source were given, 8.25 R-cm2/(mCi – hr) one had to know, I think f factor also was not given (source was Cs-137).
Dosr rate=f factor x activity/d^2 Dose rate = A(mgRa)*8.25*0.876*0.96/d^2 cGy/hr (note: mgRa=1 mCi)

30. Given a universal wedge with Wedge Factor = 0.5. Calculate the ratio of wedged / open field to make the wedge a 30 degree wedge.
I am not sure either. I think we may have to take a ratio of some sort using the WF1 = 0.5 Will have to look this up. However, I think this may be on the right track.
WF2 = I2 / I1 * 0.5 It seems that we need to know the attenuation ratio for something like 30 degree wedges. Ok how about this? This is based on a paper by Petti. B = Tan (30) / Tan (60) = 0.333 which would be the ratio of the wedged to open field. Here is the link to the article just for you [and anyone else who has access to this document :)]
https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B_4hOY9x9TbxNWYzZWE4NjYtYjlhZS00YmJlLWEwMWItNWVmMDQxNGM5ODI3&hl=en_US
page 990 of the paper under the conclusions portion last paragraph gives an explanation.
F = tan30/tan60 = 0.333, Wf = 0.5
MU wedge / MU open = F / [F + (1 - F) Wf] = 0.333 / [0.333 + (1 - 0.333) 0.5] = 0.5, 50%
Tan30 = [MUw*0.5/(MUw*0.5+MUo)]*Tan60. Substitute X= MUw/MUo, we have
Tan30=[0.5X/(0.5X+1)]*Tan60, solve it, we have result: X= MUw/MUo= 1, i.e the ratio of MU(wedged field over open field) = 100%
Please plug your numbers
0.5774 = [0.5X/(0.5X+1)]*1.7321
0.2887X+0.5774 = 0.8661X, X= 0.5774/(0.8661-0.2887) = 1
So, Please explain the meaning of X =1, the question is calc Mu wedged to MU open? Thank you
When we are asked to calculate the ratio of wedged MU/open MU, the answer does not have to be less than 1, it can be <1,=1 or >1.
X = MU wedge/MUopen =1, It means: when you give equal number of MU for both wedge field and open field, you get an effective 30 degree wedge out of a 60 degree physical wedge from a universal wedge system.
If you use a modified equation below, you will get the same answer: MUwedge/MUopen = 1
MUwedge / (MUopen + MUwedge) = F / [F + (1 - F) Wf]
let us use this eq
F = tan30/tan60 = 0.333, Wf = 0.5
MU wedge / MU open = F / [F + (1 - F) Wf] = 0.333 / [0.333 + (1 - 0.333) 0.5] = 0.5, 50%. Am I doing something wrong? see my comments right above.
Raphex has a similar question: We need same dose from 60 wedge (universal) and open field to create 30 wedge, so the MU ration for MU(60): MU (Open) should be 2:1.

Different wedge factors of the 60 degree wedge of your universal wedge system require different wedge dose over open dose ratio, you can not blankly say a certain ratio apply to all universal wedge systems. Did Raphex give the wedge factor of 0.5 as in our problem? So your answer to this question would be MUwedge/MUopen = 2 ? Are you sure it is not same MU? Do you remember which year is this question in? Now, we have 3 answers for MUwedge/MUopen: 0.5, 1, 2
I still vote for 1 and I will answer 1 if I see this question on Aug. 30. Could we have more person vote here and give reason(s) if you

can.
I am sorry, I do not remember year, I understand the wedge/open could be up to one
DOSEw/(DOSEw+DOSEo) = tan30/tang60 = ⅓ → DOSEw:DOSEo = 1:2; WF = 0.5 → MUw:MUo = 1/0.5 : 2 = 1:1 Thanks for the confirmation: MU wedge/MUopen = 1 I consider this question solved
This might help by going back to the basics. Wedge Factor is defined as the ratio of the absorbed dose measured in a tissue equivalent phantom at a depth of 10 cm on central axis with the wedge in place to the absorbed dose at same point without the wedge same SSD. I am sorry that this concept is NOT clear to some. I am clear on this basics You have to use the dose not the MU. This is the difference between the red and gray solution. I am not sure how to justify using the MUs ratios which we do not have. I am using the information was provided while the gray is insisting to use MU which was NOT provided. Thank you Disagree. the ratio in my equation [MUw*0.5/(MUw*0.5+MUo)] is a dose ratio in disguise, it looks like MU, but it is dose ratio, thinking of proportionality... Per your request, I asked one of my fellow ABR physicist to solve this problem, he got the same answer as mine: MUwedge/MUopen = 1. Please check into your formula: The left of your equation should be MUwedge/(MUopen+MUwedge) or MUwedge/MUtotal that is the reason you was not able to get the same answer with three of us now.
I finally reached wedges: you both guys (red & gray) got the same answer, but expressed differently. Disagree, red is different. **I totally agree with green.**Thanks for the confirmation.
In case dose ratio was required: WF should be included, dose ratio = 0.5 (Agree with red) Problem does not ask for dose ratio. nothing to agree to. red give result of 0.5 as MUwedge/MUopen, which is incorrect. You have to agree with either green or red, no middle ground please. The left of his equation is not correct, please read my comments above. If he correct his formula as I suggested, he will get same answer as ours. Counting you, we have 4 physicists on board, so far, I have not see any confirmation on his answer.
In case MU ratio was required: WF should be excluded, MU ratio=0.5/0.5=1.0 (Agree with gray)
31. Shielding calculation for a HDR room. Ir-192 source 10 Ci, exposure rate constant of Ir-192 given, weekly limit given (0.01 R/week), T = 1 given. And workload W = 100 min/week given. Distance 2.0 meters. Determine B.
100 min/wk = 1.67 hr/wk
W = 10000 mCi *4.6 R cm^2/mCi hr *1.67 hr/wk =76820 R cm^2/ wk
B= (Pd^2)/WT = [(0.01 R/wk)* 40000 cm^2] / [76820 R cm^2/ wk *1] = 0.00521Agree
Generally speaking B is equal to Pd^2 / WUT For Primary beams U is less than or equal to 1. But for scatter or leakage it is considered =1. Since U is not given it is assumed that the primary beam U factor is equal to 1 which means that the primary beam is everywhere and therefore always in use sort of speak.
Use factor U is a concept for Linac's primary beam, which is the time the primary beam aim at a specific wall over the total time the beam is on no matter which direction the beam aims within a week. Use factor give you a way to seperate total work load into a portion just for a particular shielding wall. For HDR shielding, no primary beam exist, radiation aims isotropically, not like Linac, you can aim the beam to a particular direction, hence Use factor does not apply, or you can say Use factor will always be 1. There is no conservative consideration here, just pure reality is considered. Hence for radioisotope such as HDR shielding : Attenuation Factor B = Pd^2/WT. So why this is true or not true? Hince shielding u need to be conservative
What red wrote in equations and blue wrote are correct and really conservative decisions are not the focus here. U is the use factor and it gives an estimate of how much a beam is used basically and in what direction. So for primary beams its a fractional amount. But U is not used for secondary or scatter or leakage because technically these aren't useful beams.. So instead of saying U = 0 since you can't have a zero in the denominator we equate to 1.Agree, another way to look at this for leakage and scatter U is always ONE Agree

32. What is the ratio of MU´s given the weights of AP = 0.4, RT lat and LT lat = 0.3 to deliver 200 cGy to 95 % Isodose line. Fsize for every was given. WFactor for lat. Fields given. SSD for every field given. Table with TMR´s (FS, depth). Calibration 1cGy/ MU at SSD + dmax.
Take ratio of (250x0.4)/(1cGy/mu x .95 x TMR20 x (101.5/100)^2) to (200x0.6)/1cGy/mu x .95 x TMR10 x (101.5/100)^2

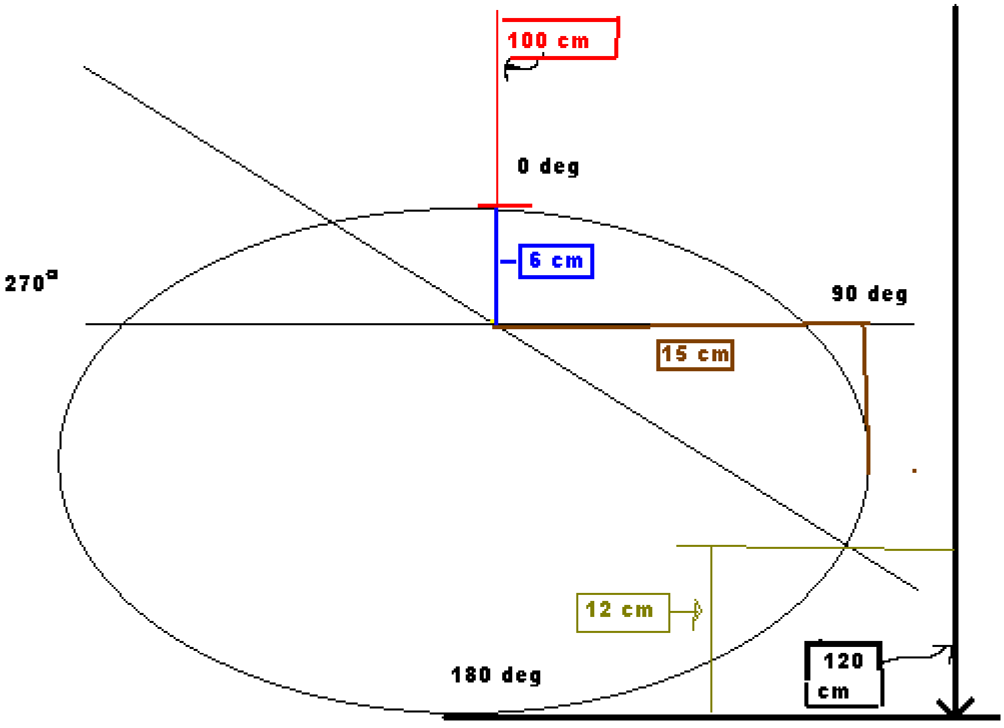


MUap = (0.4*200/0.95) / [TMR20cm*1*(100+dmax)^2/100^2]
MUlat = (0.3*200/0.95) / [TMR10cm*1*0.5*(100+dmax)^2/100^2]

33. Total dose at 2 cm from one seed of Pd-103 given its dose rate constant (0.868 cGy/hr), g(2cm) was given, Sk for the source was given= 2.5 U. Phi (anisotropy) = 0.939.
DR := Dose Rate = Dose Rate Constant * Source Strength * Anisotropy Factor * Radial Function * Geometry factor Dose Rate Constant should be normalized per U
So DR(2 cm) = 0.868 cGy / hr * 2.5 * 0.939 * g (2 cm) * 1 cm^2 / (2 cm)^2
= 0.509 * g (2 cm) in cGy / hr
What about total dose? this is only dose rate --- ---KA
Total Dose = DR *(mean lifetime) = DR*(1/decay constant) =DR*(T1/2/0.693) = 1.44*T1/2*DR= 1.44*17*24*DR = 587.52*DR (cGy) =587.52*0.509*g(2cm) = 299g(2cm) (cGy).

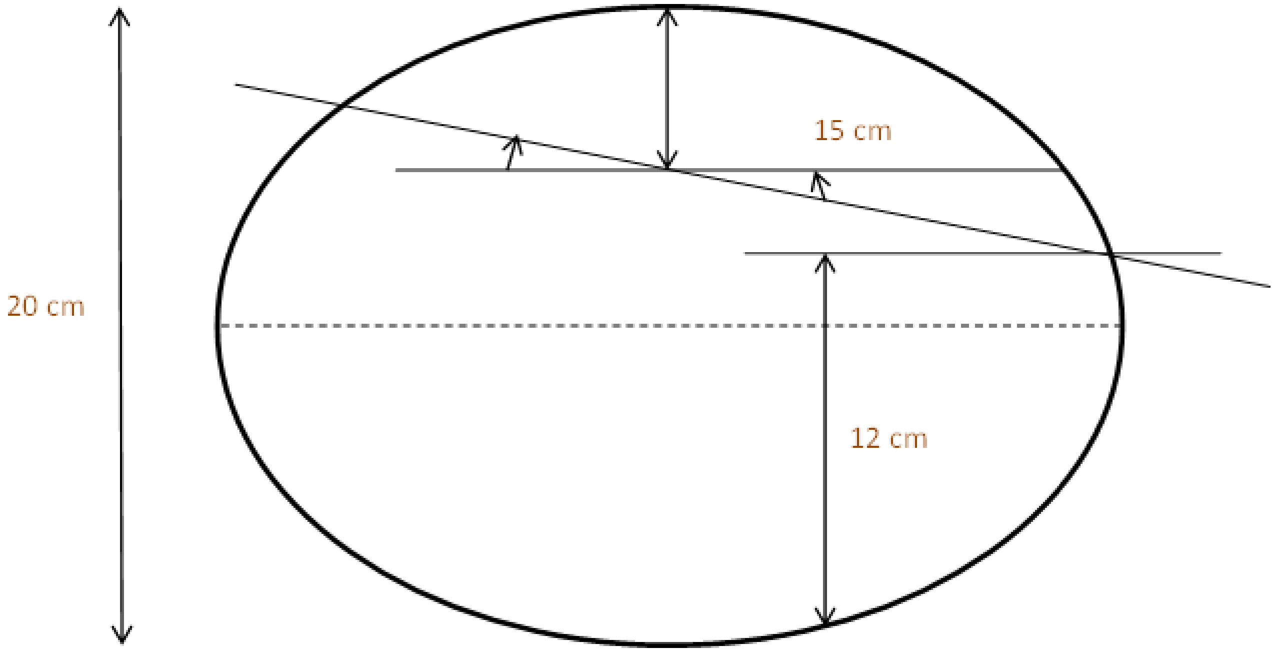
34. Determine the Effective SSD for 6 MeV electrons. Io = 100, at 20 cm gap reading was 44, and at 40 cm gap reading was 25. dmax for 6 MeV electrons not given. I think that the gap distances corresponding to their readings is not correct. The slope that the equation below should be a positive number. Refer to Khan page 317 in 3rd edition.
f = 1 / slope - dmax = 1 / [(44 -25) / (20 - 40)] - dmax
OK I forgot to find another factor So refer to **
dmax fo 6 MeV electron = 1.2 cm
** SQRT (Io / Ig) = SQRT (100 / 44) =1.5 and SQRT (100 / 25) = 2
f = 1 / slope - dmax = 1 / [(1.5 -2) / (20 - 40)] - dmax =38.8 cm ? seems too low
I got the same answer
there is an easy way: $(f+dmax)^2*100 = (f+dmax+40)^2*25 \rightarrow f+dmax = 40 \rightarrow f=40-1.2 = 38.8$cm. Agree? Agree, inverse square law. The application of Effective (or Virtual) SSD concept. smart move: use the concept itself to find its own value.
dmax [cm] ≈ $0.5\,E[MeV]^{0.7}$ nice to know this estimate, thanks

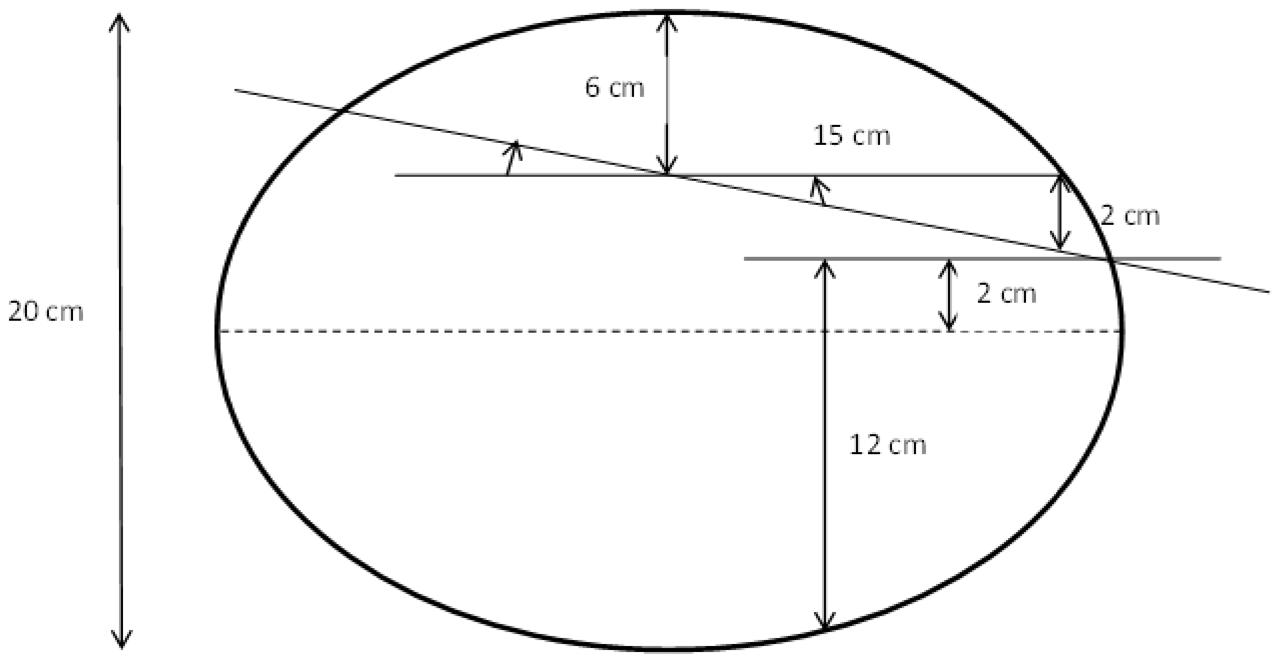
35. Determine the angle, following the IEC convention of angles, of the medial field, given the dimensions in the figure shown below.
120-100-6-12=2, theta is arctan (2/15)=7.59,



270+7.59=277.6

This diagram is out of scale, the following diagram is the scaled ones.





The first figure was with the scaled diagram and dimensions provided by the question.
The second diagram was with the dimensions extracted from the scaled diagram.
So: Tan (θ)=(2/15)=0.133, θ= 7.6 degrees, since the medial field angle is the required angle, and following the IEC convention: Medial Field Angle= 270+7.6 = 277.6 degrees. I hope this is correct.
Tan Q = 2/15, Q= 7.6 degree **From where you got 8 cm? please be clear when solving as much as possible?**(120-100-12) Please look at original diagram
In the original diagram 8 cm is to the surface (100cm ssd), but the angle you found the Tan for is not up to that level. You forgot to exclude the 6 cm from your 8 cm, please check the original diagram. You are right, I forgot to subtract out 6 cm, I corrected my original calculation. ***I think we forgot something very important in this question !!! this is SSD setup not SAD setup, and hence the angle should be takenm the 100 cm from the source, this means we have to ignore the 6 cm depth, because this info provided to***

confuse us only !! the answer is Tan theta = 8/15 , then theta =28.1

Lateral field = 90+7.6 = 97.6 degree

Medial field = 270+7.6 =277.6 degree

I agree the previous answers are correct

I feel it is the other way, It should be tan-1(6/15)=21.8 Which angle you are looking for?RAO so from where you got the 15 cm dimension?

Then add 270, 270 + 21.8 = 291.8 It is an SSD setup. It cannot be SAD, because usually the isocentre is placed at the center (centre of medial and lateral tangential) Ther is small red color horizontal marking on the skin surface indicating that it is att 100 cm SSD

It is confusing / May be you are right

I looked at this problem again. My original answer was correct. It is still SAD setup, not a SSD setup. 100 cm line extend into body and stop at medial / lateral beam axis line (iso), 6 cm body depth line is part of 100 cm SAD line. The 6 cm line is a distraction. I change my answer back to my original one:

TanQ = 8/15, Q = 28 degree

Lateral field = 90 +28 = 118

Medial field = 270+28 = 298

This is a typical SAD tangent angle set up for left breast patient. I checked a SAD tangent field angle for a left breast patient at our hospital, they are: Medial field: 300, Lateral field: 128. I agree with this. I got 298 for the medial as well.Thanks for confirmation

I will conclude my contribution to this question:

- This is SSD technique, not SAD setup, this can be easily seen by the original figure.

- Since this is SSD setup, we have to ignore the 6cm depth they provided to confuse us, we just need to use the following:

Tan (theta) = 8 / 15 → theta = 28 degrees → Medial Field Angle= 270+28= 298 degrees (SSD setup solution)

- In case it was SAD technique (suppose they made a mistake on the original diagram!):

My original solution (after the diagrams I attached) is 'what I think' is correct:

Tan (theta) = 2 / 15 → theta = 7.6 degrees → Medial Field Angle= 270+7.6= 277.6 degrees (SAD setup solution)

It is up to you guys, and again, as long as you can find you answer among the options, you are in peace !

36. What is the change expected in mmHg when reading at 50 meters of altitude from the airport level. **(ABR 2010)**

sea level: 765 mmHg, at 152 meter, 751 mmHg. (50/152)*14 = 4.6 mmHg (~5 mmHg)

Just a small clarification, the sea level is 760 or 765 **Sea level is 765. What about the level of the airport?**

Agree a rule of thumb every 10 meter ~ = 1mm

I think sea level is 760mmHg, and airport is 50 meters higer, which is 755 mmHg.which airport? Denver or New York airport?

37. Given the density of air 0.001293 g/cc, chamber with 0.19 cc, given 1 R = 2.58 e -04 C/kg. Calculate the approximate exposure calibration factor of the chamber in R/C.

Dimensional analysis ?

1 **R** / 2.58 e -04 **C** / kg / (0.001293 *10^(-3) kg/cc * 0.19 cc) = 9.5 * 10^(-4) R / C

0.001293x0.19(1kg/1000g)=2.45E-7kg, 1R=2.58E-4C/kg x 2.45E-7, calibration factor is 1.58E10 R/C Agree

Your first term is not correct. Just by looking at it what you wrote there shouldn't be any kilograms left over. But even if you were to correct that it still wouldn't be correct because 1 R = 2.58 e -04 **C** / kg ⇔ 1 R / 2.58 e -04 **C** / kg = 1

I needed to multiply instead of divide.

I think it may be solved as follows: 1R=2.58E-4 C/kg à what is the mass inside chamber? Mass= 0.001293 x 0.19 =2.4567E-4g=2.4567E-7kg, in order to have correct units:

([1R/2.58E-4 C] x kg) / (Mass inside IC:2.4567E-7kg)) = 0.3876 E4 (R.kg/C) / 2.4567E-7kg =1.577 E10 R/C (agree)

38. Given a graph of raw (not shifted) PDD´s VS depth shown. Diameter of chamber 0.6 mm. Determine the PDD(10 cm).

Shift raw PDD curve 0.6*r = 0.6*0.3 = 0.18 cm for photon, 0.5*r = 0.5*0.3 = 0.15 cm for electron up stream toward surface

39. What percent higher/lower difference is expected when going from TG21 to TG51

1% higher

TG51 photons is 1% higher. TG51 electron is 2% higher

40. What is the meaning of D90 = 110 Gy? Should say V90, not D90.Question is correct.

90%of the volume receive at least 110 Gy **Agree** Agree but not about the 'at least' portion. You should, otherwise your understanding of D90 is not complete. Very important concept in permanent prostate seed implant. Think about this: no single dose will cover large amount of volume, only a range of dose cover large amount of volume.

41. Scatter transmission factor B given distance to patient 1 m, distance to secondary barrier 5 m, field size 20 x 20, alpha= 0.001, W = 500 Gy/week, Xp = 0.02 mSv/week.

P= [(alpha * WT)/ (d^2 * d'^2] * F/400. B

0.02 mSv/wk = [0.001 * 500 Gy/wk *1000 mSv/Gy)/ (1 * 25)] (400/400) * B
B = 0.001 anybody? **(agree)** Agree
agreed.

42. A simulator shielding problem. Exposure rate at 1 m was given= 0.01 R/ mAs at 1 m. Workload = 600 mA-hour / week. U = 1/4, d = 3 meters. Xp = 0.01 R/week. Determine how many TVL´s given the exposure rate limit.
Attenuation factor requred B = (3^2 * 0.01) / (0.01* 600 *3600*0.25) = 1.6667e-5
# of TVL= (1/3.32)* (-lnB/0.693) =4.78 **Agree**

You can directly use Log10 instead of converting from Ln e to Log10; Log10(1/1.6667e-5) = 4.78 I deliberately did this way for me to reinforce the relationship between TVL and HVL in my mind,which is quick and handy when needed
43. What is the main difference between Magnetron and Klystron.
The magnetron produces microwaves whereas the klystron is a microwave amplifier, Khan page 43 and 44
Early (low energy) model LINACS used a **magnetron** to **produce** **AND AMPLIFY** microwaves. The magnetron was used as a source and an amplifier, it was adjusted by turning a very little moder which changed the size of the cavity physically. You didn't really get much amplification from them and they were less tunable and more sensitive to reflected energy (went off frequency easily).
Agree
Newer (high energy) generation models use a solid state device refered to as an "RF source" which is far more stable and tunable.
Klystrons are used for **amplification** of the microwave and can be run in two modes: **saturation** or **linear**.
Early (low energy) model LINAC's ran their klystron in saturation mode and used a "magic T" to dump undesired microwave energy to a water load. Current model LINAC's run the klystron in linear (KLM - High or Low) mode; in this mode the **gain is the same**, not adjustable, however you vary the input RF power (from the RF Source) to increase or decrease the power (high/low mode) there is no extra energy so no water load or magic T are needed. The Klystron is protected by a **circulator** which isolates the klystron from reflected energy to prevent the frequency of the klystron output from drifting. Circulators are "traffic cops" they have ferride bearings with a magnetic coil that changes RF direction in the wave guide by 90 degrees.
Klystrons are **cooled** by a dialectric oil .** This was a recall question in previous years (which is not water cooled)
-Source Service Engineer (freelance). My service engineer says the klystrons is water-cooled, and showed me the water hoses leading into and out of the klystron. He says nothing in the modulator cabinet is water-cooled, so the answer would be something in there (ie, thyratron). This is possible the oil could be cooled by the water, modulator cabinet is air cooled.
Thanks :) This is quite detailed. Perhaps too much but it will help for orals too for some..
Yes. Thats why it helps to have a small font but not too small. :) :)
Ok I need to add some comments here. I THINK THE MAIN DIFFERENCE IS THAT THE KLYSTRON AMPLIFIES BY WAY OF THE ELECTRIC FIELD ACROSS THE CAVITIES AND DRIFT TUBES VERSUS A MAGNETRON (AS THE NAME IMPLIES) CREATES AND AMPLIFIES MICROWAVES WITH THE MAGNETIC FIELD.
44. Select proper order of parts in a LINAC.
e-: electron, collimator 1, foil 1, foil 2, MU chamber, collimator 2
photon: electron, target, collimator 1, flattening filter, MU chamber, collimator 2
45. Penumbra calculation from LINAC given target surface distance, target block distance, depth in patient and target dimensions.
Penumbra thickness=FS(SSD+d+SCD)/SCD Penumbra = FS (SSD - SCD + d) / SCD agree with green, Please note SCD same as SDD, Do not let them confuse you

46. Radionuclide and energy emission from Sr-90 eye applicator.
Beta, .54 Mev(max) decays to Y-90 energy 2.2 Mev(max)Agree
47. The only factor less than 1 in TG-51. **PgrQ** **report says PgrQ is unity for parallel plate chambers**
I believe it is k_Q Agree
48. Flatness and symmetry tolerance figure according to TG-40
2%,, 3% respectively for photon, 3%, 3% for electron
49. What percent of a batch of seeds has to be checked in a prostate seed implant procedure. 10% ? AgreeThank you Nitin for showing me this, and I still remember it!

50. Tolerance for deviation between light and radiation field according to TG-40.
TG40 2mm or 1% on a sideAgree
51. Necessary thickness of lead for 6MeV electron cut-off . 6/2 +1 mm = 4 mm Khan state : The minimum thickness of lead required for blocking in millimeters is given by the electron energy in MeV incident on lead divided by 2. Another millimeter of lead may be added as a safety margin. The required thickness of Cerrobend is approximately 20% greater than that of pure lead.
Khan E4, Ch. 14, pg 293
This is also explained in a little more detail in TG 25 p. 101

52. Which components of a LINAC are pulsed after Thyratron is fired? wave guide?
Electron gun and Klystron The thyratron directly pulses the Klystron. It directly pulses either the klystron or magnetron after it reaches the pulse step up transformer which amplifies the signal then is sent to either the klystron or magnetron depending on the machine

manufacture.r

53. A tumor is reduced because of what property?
Tumor cells die when trying to divide, so I would say: Mitotic divisionAgree
not sure what the question but I might use apoptosis
54. What info PET can't deliver about the tumor
size? or tumor delineation i.e. contouring capabilities, active, relative anatomic position to other tissue or bone structure. PET/CT fix the deficiency of PET Geometric info- KA Concise
55. An error of 2 mm in MLC opening causes an error of xx % in 2cm radiation field
0.2cm/2cm =10% (Please check) <-This assumes the 2mm error is at iso. I read it as a 2mm error in the jaws, which makes it a problem of similar triangles when you have the source-to-mlc distance. what is the final answer???- KA
Source to MLC bottom distance is 53.8 cm(AAPM Report No 72), 2 mm error in MLC openning projects at 100 cm:
2* 100/53.8 = 3.72 mm, 3.72/20 = 18.6%

56. What condition is not required for collimator output factor Sc..
No phantom is needed Appropriate Buildup cap for the energy is needed, ensure fully irradiated especially for small field
Does not have to be measured at 100 cm
All of the above are correct
57. What doesn't change by reducing field size in electron beam.
Rp -- Electron Practical Range Agree
58. TVL for neutron attenuation in maze is: 5 meters the more correct term should be tenth value distance (TVD) in air **Agree**Agree

59. Energy at which theoretically neutrons can be produced a neutron in LINAC. above 10 MV
Generally not considered significant to shielding uneless energies at or above 15MV - McGinely
Look up and memorize the energy of the neutrons at the maze entrance and at the end of the maze. Which energies? From ARC neutron energy 100 - 200 kev when get to the door. I hope this help
10 MV is only a practical value for starting point consideration. Lead (gamma, neutron) theoretical threshold is 7.4 MeV which is derived by both binding energy and rest energy model - Ervin B. Podgorsak, Radiation Physics for Medical Physicist
My vote: 7.4 MeV and I will cast my final vote at exam based on information present then. Just be prepared to have two potential answers ready, 10 MeV or 7.4 MeV (I do not mean electron, I mean maximum x-ray energy in the photon spectrum because they are looking for theoretical value) It is my understanding neutron production (may be not correct word) is above 10 MV, more significant at 15 and very concerning at 20MV. To add a little falvor to this issue, we know that one R produce 1.6 x 10^15 ion pair. said at ARC we were told will have 1.2 x 10 ^12 neutrons per Gy. the morak of the story, we do not know much about neutrons and yes is the ARC information is valid. Then we realize how scary this field. We have more neutrons than we can handle or want to handle.
10 MV theoretically speaking is the where we start to consider neutron production. MV is a spectrum, theoretically we need an exact value. Problem#308 give us clue what the final answer is for this problem.they are looking for "8 MV" You are correct thanks and I understand the MV is a spectrum. However, 10 is the possible max. You are right
60. Given a graph of ionization current vs polarization voltage with different areas marked select which detector works at specific area

61. Measurement of the crack in a LINAC vault with high volume IC. Chamber over the crack measures 1 mR/h and far from the crack 0.5 mR/h. Estimate what would be the actual exposure rate **(ABR 2010)**
Due to partial volume irradiation of the IC, IC survey meter underestimate exposure rate near the crack since it was calibrated under fully irradiated condition, it will be greater than 1 mR/hr.
This question was asked in the main Yahoo group forum, and I did answer this using the inverse square
X1 * R1^2 = X2 * R2^2 => R1 = 1 and R2 = SQRT (2) No distances are provided, how do you use ISL?
Then use extrapolation equation to extrapolate to CAX or where the distance is zero.
y (x*) = y_(k-1) + (x* - x_(k-1)) /(x_k - x_(k - 1)) * (y_k -y_(k - 1))
y(x*) = 2 mR / hr or something like this And yes its greater than 1 mR /hr Its a good idea to know the extrapolation equation though this one maybe a bit abstract. It does not look like the problem provided enough information to calculate. Some of the distances are zero because we are extrapolating to zero distance which implies CAX.I doubt the result of 2 mrem/hr is reliable. we really do not know how high the reading would be, we only know it will be greater than 1 mR/hr. Then I guess we should eliminate any extrapolation equations and any calcs using this (we use this in a few situations in medical physics at least thats what I have seen in the literature) , albiet a rough estimate. its not intended to be the most accurate calc out there. :)
62. Calculate the time required to achieved 95% of the total dose for a I-125 permanent implant
0.05 remaining = EXP(-lambda * time)
lambda = 0.693 / T_1/2 (60 days)
Ln(0.05) = -lambda * time
- Ln(0.05) / lambda = time = 259 days
AgreeAgree
63. Permanent implant of Pd-103. Activity was given. Calculate total dose delivered.

Need the time to calculate the total dose delivered.
One way, we know activity, const exp 1.5 (R-cm2/mCi-hr), half life 17 days, 10 half lifes = 170 days
Another way total dose = initial dose rate x 1.44 t ave
Ok once all the dose is delivered which means close to 10 half lifes. I can see your point. So exp (- lambda * time) will approximate to zero. So the general equation is D = DR / lambda * (1 - exp (- lambda * time))
Total dose = Meanlife*initial dose rate =1.44*T1/2*initial dose rate
You are correct thanks
64. What can be said about TBI. (select from a variety of properties).
TBI - there are several methods this can be done.
- If the room is big enough coll 45 and gantry 90 w/ patient on other side of the room lying/sitting
- There is another method involving lying down on a low table with matching fields..
- Body thickness varies with feet and head being the least and the abdomen containing lungs (air) these are compensated for by adding brass strips at the LINAC head. Anyone remember the equation? tc=TD*(tau/rho), Khan E3 P.461
- Children can be done under sedation (lymphoma) - i.e. for causing hematopoetic syndrome to prep patient for bone marrow transplant (can change pt's blood type and immunities).

66. What is the meaning of a phase-space file in Monte Carlo calculations?
The Phase space file is a binary file which contain the information about the particle position, direction, charge etc., for all those particles crossing the scoring plane. It is the output generated from the scoring plane in monte carlo simulation. The phase space can be used as a source for further simulation.

Anyone know the cutoff energy typically used ? - This was a recall question in previous years
I think it is 10 keV Agree **I also heard that there is no fixed value for this cutoff energy, user can specify.**

67. The definition of Sliding window in IMRT means ____
It is simply: Leaves movement while beam is on, because as you know for RapidArc technique: leaves move in both directions, while for fixed angle IMRT it is moving from left to right
The corresponding(opposing) leaves sweep simultaneously and unidirectionally, each with a different velocity as a funtion of time. The period that the aperture between leaves remain open (dwell time) allows the delivery of variable intensity to different points in the field. --- Khan's The Physics of Radiation Therapy, P433, 4th edition
68. Given a set of CT numbers, Select proper order of tissues that correspond with the order of these CT numbers.

69. A DVH graph was given with a point on the DVH curve was marked. Select proper meaning of this point.
that point corresponds to where that percent volume or less is receiving that dose. DVH stands for dose volume histogram though I guess it doesn't have to be in percent volume. Usually the volume is along the y axis and the dose along the x axis (though not necessarily in percent doses) If its not in percent dose then we have set the dose as absolute dose on the DVH curve. For a given point, that percent got that much dose or more. Alternatively: for a given point, that percent got AT LEAST that much dose.Agree

70. For what purpose is a beam spoiler for 10MV breast treatment used ? superficial treatment?
To raise the dose at the builup region (Please check), Agree. it is used mainly for TBI, to get rid of the build up region and dose will be homogenous along the patient box ! Khan p 281 talks about using a beam spoiler for h&n. We use bolus, but not what Khan calls a beam spoiler (ie "a low atomic number absorber such as a Lucite shadow tray"). Does anyone's clinic use a beam spoiler for breasts?
Spoiler will increse the dose in buildup region but still mainstain skin sparing as compare to bolus.

71. Amount of X-ray contamination for a 18 MeV beam is around ___. %. Khan 3rd table p318 14.2 15 Mev 0.9 and 20 Mev 1.4 % of Dmax in theory. page In a modern linear accelerator, typical x-ray contamination dose to a patient ranges from approximately 0.5% to 1% in the energy range of 6 to 12 MeV; 1% to 2%, from 12 to 15 MeV; and 2% to 5%, from 15 to 20 MeV. a modern linear accelerator, typical x-ray contamination dose to a patient ranges from approximately 0.5% to 1% in the energy range of 6 to 12 MeV; 1% to 2%, from 12 to 15 MeV; and 2% to 5%, from 15 to 20 MeV. 2%, from 12 to 15 MeV; and 2% to 5%, from 15 to 20 MeV. 2% to 5%, from 15 to 20 MeV.

72. Dose limits for the public for frequent and infrequent exposure is ____
depends on if its whole body or extremities, probably whole body, which will then be 100 mrem per year or 2 mR per any given hour. Agree 100 mrem frequent and 500 mrem infrequent in a year Agree

73. For what isotope is the ratio of dose at d=5 cm to the dose at d=1 cm the lowest? LOWEST energy may need to consider if it is beta or photon Pd-103

74. How often are electron energies checked according to TG-40? weekly (at my clinic we alternate, almost biweekly)
I think it is biweekly as per TG-40 **Not biweekly. all electron energies are to be checked at least twice weekly.**Agree

75. If a patient is prescribed 200 cGy a fraction with 30% open and 20% wedged for each field, what dose does the patient receive if the wedge is put in the wrong field? WTF=0.25. I
It seems two fields (30+20), 60% open and 40 % wedged, daily = 2(open + wedged)
Open = 0.60 x 200 =120 cGy . assume 1 cGy = 1 MU = >> 120 MU
Wedge= 0.4 x 200 = 80 cGy, and WF 0.25, so 80/0.25 = 320 MU
reversed/swapped

wedge 120 MU >>> 120 x .25 = 30 cGy

Open 320 MU >> 320 cGy

Total 320 + 30 = 350 cGy PLEASE correct me if I am wrong or miss-understood the q? I got the same answer and I think you are right.

I don't think this is correct. Why are you multiplying 120 MUs by 0.25? and why is your 320 MU considered corresponding to your open field? I must admit I am confused here.

The way I understood the problem opne MU's were used with wedge and the wedged MU's were treated open . I thought about this more " Why are you multiplying 120 MUs by 0.25?" my writing is not clear. Let me try again we know 120 MU = 120 cGy, so I am multiplying the 120 cGy byt 0.25 not the 120 MU. I hope this help

Total dose(200x0.6+ 200x0.4); 60% weighted beam receives only 30cGy since wedge has been inserted(120x0.25 = 30cGy) from wedge field has(200x0.4/0.25) cGy forgot to insert wedge but delivered wedge MU's. total = 320cGy(wedge forgotten field) + wrong wedge field receives only 30cGy(since it has open MU's but mistakely inserted wedge) only received 30 cGy. so 350- 200 = 150 cGy higher----------Is it right? The question was what dose does the patient receive if the wedge is put in the wrong field? Your conclusion is correct but that was not asked. Please take your time reading the questions in two weeks I agree with the answer in red

76. What is the definition of wedge angle?

The angle through which an isodose curve is titled at the central ray of a beam at a specified depth (the angle between the isodose curve and the normal to the central axis) Varian defines their wedge angle at 10 cm depth. -10cm(most recommended) Ok but could also be 50% isodose line

77. With 6 MV incident on x1 mm tissue then x2 mm bone then x3 mm lung, what is the dose to the proximal (or distal) part of the lung?

1+2(1.6)+3(0.3) =

Assume all thickness is in cm, at proximal part of lung, effective path length = 1*1 + 2*1.5 = 4 cm, physical path length is 3 cm, 1cm extra water equivalent length to attenuate the beam, thus about 3% less dose than that without inhomogeneity correction..

At distal part of the lung, effective path length = 1*1+2*1.5+ 3*0.3 = 4.9, physical path length = 6 cm, 1.1 cm meter less tissue equivalent length, thus about 3% more dose than that without inhomogeneity correction.

78. Shown CT with depths of tissue and lung, single direct field, and attenuation coefficients, what is the dose w/ and without heterogeneity corrections?

79. Given mixed energy, electron and photon, dose to surface = 40 Gy and PDDs at surface for each given, and dose to d=5 cm = 55 Gy, PDDs for each at d=5 given, what are the relative contributions of photons and electrons at dmax?

two equations for two unknows based on PDD

Dedmax * PDDeo + Dpdmax * PDDpo = 40, Dedmax * PDDe5 + Dpdmax * PDDp5 = 55

Photon contribution = Dpdmax / (Dpdmax + Dedmax), Electron contribution = Dedmax / (Dpdmax + Dedmax)

The issue is that Dpdmax and Dedmax may not be at same depth.

80. Mammosite balloon w/ diameter = 4 cm and Rx point at 1 cm from surface of balloon. What is the minimum balloon to skin distance to minimize the hot spot to 150%?
radius is 2 and add 1 cm that where 100%,, 3 cm will have 100% what is the distance where 150%
(1 / 3^2) / (1/ X ^ 2) = 100%/150%, X = 2.44 cm, so 2 .44 - 2 = 0.44 cm **Agree, thank you**Agree

81. What thickness of Al to compensate for 5 cm of missing tissue? AL density is 2.7 gm/cm^3 , 5/2.7 ~ =2? **5*0.7/2.7 = 1.3cm** Agree

82. Dose at point S is 6 mrem/hr. How much concrete shielding to get dose at point Z less than 2 mrem/hr. Point S is 6 m from iso and Point Z is 12 m from iso. Given TVL of concrete. ZERO, INVSQR **Agree**Agree

83. If the daily output is greater than what % is patient treatment suspended immediately according to TG-40? 5%Agree

84. What is the overall uncertainty in dose delivered to a point in a patient with all uncertainties taken into consideration? **5% (TG40)**

85. What method cannot be used to verify an IMRT plan? Film and point calc film can be used with a point ion chamber measurement, Please provide reference so, we can read it. The question asking about IMRT not SRS. Thank you

- what is right answer?point hand calculation

86. What is the purpose of the bending magnet?
energy selection to focus electron beam. Are all bending magnet has energy selection slits? I think some but not all anybody? I don't know if all machines have them but the energy selection slits are used to 'clean' the energy beam that has been selected. I was not very correct when with my first answer because the bending magnet does actually focus the beam and the actual energy selection occurs in the waveguide portion along with the electron gun current. Only practical way to mount the accelerator structure for high energy Well thats correct mostly only the waveguide is long. There are some Linacs that have the waveguide vertically mounted in which case there is no bending magnet. The horizontal ones need a bending magnet. I should say for high energy

87. Where are the electrons generated in a linac? **Filament Actually there is no filament in linac (Are you sure? the electron gun have to have thermionic emission) may be you mean they do not call it filament , only vacuum tube systems (like kV-Xrays have filament) has, the source of electrons in linac is the electron gun**
I disagree in part. It is a filament of sorts. The Catheter, which is a filament that is coiled, is heated to produce electrons. (thermionic emission) These are then focused and directed towards the anode and then exit at the port end of the anode and then enter the waveguide. By the way electrons are also generated in the klyston and magnetron. Once the HV is available to the corresponding cathodes then these cathodes emit electrons that are then collected moved and accelerated to produce E and M waves which are exactly the amplified microwaves.

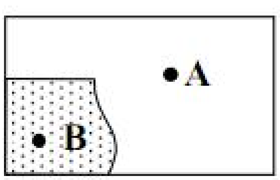
88. What does Gamma measure?
it measures the distance to agreement and dose agreement ? essentially its 3D, 2 distance and 1 dose agreement. It is a quantitative score to judge a point in IMRT field if it is acceptable. It is the square root of the sum of distance to agreement over 3mm squared and dose percent difference over 3% squared. If gamma result at a point is >1, it is a failure point. Normally only allow 5% of the points selected by a threshold of maximum dose such as above 5% of the maximum dose to fail.

89. Calculate collimator angle for opposite lateral brain fields to match the divergence from a spine field. Field size 27cm, Spine inferior 20cm and spine superior 17cm. I guess we need SSD of spine PA spine field is normally treated at SSD =100 cm., Tan Q = (0.5*17)/100, Q = 4.86 degree

90. Shown GTV, CTV and PTV asked to identify the PTV

- **A**
- **B**

91. Given the dose at A, find the dose under the block at the same depth at B.



Let us assume this a 8x10 rectangular, the blocked area can be approximated as 4x5 rectangular, Depth is Dab.

equivalent square for unblocked area = square root of (8x10 - 4x5) = 7.7, **Where did you get this equation for the unblocked area?** (I was asked by a therapist about one of their certification question which ask equivalent square value for an irregular shaped field with block, I used square root of the unblocked area and got the right answer, I recall similar experience with Raphex question. It is a reasonable method to estimate the equivalent square value for irregular shaped field in my mind. I was not able to recall from any classic textbooks which address this issue) **Thanks! in our center, we just visualize and estimate the length and width of the unblocked area and calculate the equivalent square.**

- Dose under the block is 20% of open field dose(ROT); ie open field dose 180cGy, dose under block is 36cGy. AM I RIGHT??? More to 15% if that much As a rule of thumb, it is right. But it is just a rough estimate. It depends on how the question is asked, if different depth involved and bunch of PDD data given to you, they ask for more detailed analysis because the dose under the block depends on the extend of the blocked area, overall field size, block thickness, depth, and location of the point under block. This question may have a trap: notice the point under block how close it is to the corner edge of the overall field and blocked area, the scatter contribution is not as significant as usual.

equivalent square for open field 8x10 = 2*8*10/(8+10) = 9 , equivalent square for blocked area = 2*4*5/(4+5) = 4.4

If there is no block, Dose at B for open field (8x10) = Dose at A * PDD(9x9, Dab) / PDD(8x8, Dab)

For blocked area, if there is no block, Dose at B for open field 4x4 = Dose at A* PDD(4x4, Dab) / PDD(8x8, Dab)

Assume Transmission factor for the block is T, then:

Dose at B = Dose at A * PDD(9x9,Dab) / PDD (8x8, Dab) - [Dose at A * PDD (4x4, Dab) / PDD(8x8,Dab)]*(1-T)

Reference: Example 8, D. Point under the block Page 199, Khan's The physics of Radiation Therapy, First Edition 1984
For latest Khan, it's on Page 171.

Thanks to yahoo group few weeks question was asked dose under the block of 5 -6 HVL or something like this. The answer was 15%. Ravi suggested to measure under a block and see for your self. Please do so. Just for fun the following is the question and asnwer

2008 raphex has a question something like this: dose under a 1.5cm width cord block (5HVL thickness) in a 15x15cm2 6MV beam at 5cm depth due to transmission plus scatter is approximately_____%of the dose in the open field
a. 3
b. 7
c. 15
d. 25
e. 50
chose 7% since it's the next largest answer from 5HVL transmission but that is wrong according to the answer sheet; 15% is given. The explanation is "5HVL's are equivalent to 3% transmission. The additional dose is due to scatter from the surrounding tissue". No shit! But why is it 15?.
92. When to check the wedge interlock Monthly

93. IMRT Head and Neck treatment. What are the dose constraints for critical organs.

Spinal cord 45 Gy, Parotid mean dose is 26 Gy (Corrected)

Parotid mean dose: 26 Gy, Brain Stem: 54 Gy (max), Oral Cavity: 30 Gy (mean), Lens: 5 Gy (max), Optic Chiasm: 54 Gy (max) **(I think this is 50 Gy, not like Optic Nerves)**, Optic nerves: 54 Gy, Cochlea/Middle Ear: 30 Gy (max) **(How about 50 Gy as maximum)**

Eye(45Gy,Max), **I think it can reach up to 50 Gy** - if there are 45Gy, 50Gy options, which one could be right answer?

mandible: 70 Gy (max), Spinal cord: 45(max), when I plan H&N IMRT, I try to keep mandible mean dose not too much above 40Gy, often it is not easy, could anyone share experience? Our physician normally prescribe total dose of 70 Gy (60Gy C1, 10Gy CD).

94. What is the tolerance dose for the kidney

Emami et 1991 1/3rd kidney 50 Gy, 2/3rd 30 Gy and 3/3 is 23 Gy. In clinics usually 1/3rd taken as 18 Gy Agree What does ""3/3 is 23 Gy mean? If the whole kidney is irradiated, tolerance is 23 Gy.

- 20Gy; 50% of combined both Kidneys, 70% of one Kindey if another NOT functional.

95. What is the reference depth used in photon beam calibrations (per TG-51) 10 cm

Linac
Storage
Office

A
B
96. Distances given: Linac to A=6m, Linac to B=12m. Survey meter measures 0.6 mrem/hr at point A. Dose delivered at each treatment is also given. How many patients can be treated to limit the exposure at point B to below 2 mRem/wkinvsq = 0.6/4 = 0.15 mrem/hr

0.6*(6/12)^2 =0.15 mrem/hr Normally "Linac" mean "Linac iso", if the radiation is from primary beam, you have to add 1 meter into distance since ISL always look for source point to interest point distance, hence: 0.6 *[(6+1)/(12+1)]^2 = 0.174 mrem/hr. if the radiation is from scatter from a patient, then: 0.6*(6/12)^2 = 0.15 mrem/hr. **I think it is 1 ft and not 1 m (Am i right)** SAD = 100 cm = 1 meter. **Ok, I got your point.** **Good point, thanks.**

Now we need to figure out how many patient we can treat:

Assume dose for each patient treatment is 200 cGy, PDD is 0.8 and Linac is set at 300 MU/min. let N be max number of patient can be treated in a week. When the problem say survey meter measures 0.6 mrem/hr at point A, it did not say a particular gantry angle, it also did not mention how the Linac is oriented in the room, so we can only take the distance given as source to interest point distance in this case as sort of "average source to point distance, because gantry angles are various. The measurement result is also an average reading.

N*(200/0.8) /(300*60) * 0.6 *(6^2/12^2) = 2, N = 960

Plenty of margin, we can treat 192 patient a day without exceeding 2 mrem/week.

98. IMRT dose verification using small volume chamber (0.1cc). What should it's resolution (or measured error) be in order to be able to use for dose verification

99. Beam abutment question. Patient treated with 10MV photons and 16MeV electrons. Field size given. At 5cm depth what would be the case with the dose distribution.

If it's abutment problem, then hotspot on photon side, coldspot on electron side;
If it's calculation problem, I will use: at 5cm, it's about 80% dose for 16MeV; about 2.5%/cm dose attenuation for 10MV

100. Describe the Morning (daily) QA for a HDR brachytherapy treatment source per TG-40

101. What are the Daily output tolerance for X-ray and electrons ? No treatment above 5%. 3% flag

102. $E_p = E_0$ (1-d/R_p) given that at depth d1, the energy is E1 and at depth d2 the energy is E2, at depth d3 what is the energy

E1 = Eo (1-d1/Rp), E2 = Eo(1-d2/Rp), solve for Eo and Rp. E3 = Eo (1-d3/Rp)

103. Question on backscattering using block for electron beams. How does it change with energy E and Z.

Backscatter will increase with increasing Z and decreasing E

104. If the thickness of a shielding barrier was calculated as per the 6 MV beam and the Exposure level was given at particular point. Calculate the exposure level if 18 MV beam is used for the same thickness. TVLs given.

Let dose rate at point A beyond shielding is DR6 with Attenuation factor B = (1/2)^t/HLV6 ,

Dose rate at point A without shielding = DR6* 2^t/HLV6

When they switch to 18 MV, Attenuation factor become B = (1/2)^t/HVL18 and Dose rate at point A is DR18

Dose rate at point A without shielding = DR18 * 2^t/HVL18

Since only energy level is changed, other parameter remain the same, dose rate at point A without shielding for both 6 MV and 18 MV should be the same, thus:

DR6*2^t/HVL6 = DR18*2^t/HVL18, DR18 = [2 ^(t/HVL6 - t/HVL18)]*DR6

105. Neutron dose equivalent (mSv) outside field per photon Gy at isocenter for 20MV beam. less than 0.5% Hendee's book, 3rd edition, p 351 says: *For xrays between about 15 and 25 MV, the neutron dose equivalent rate along the central axis of the beam is about **0.5%** of the xray dose equivalent rate and falls to about **0.1%** outside the primary beam.*
McGinley (1992a) has reported on accelerators operated at 18 MV and measured neutron production coefficients(R) of 19 uSv / (cGy*m^2) for lead -- NCRP Report No 151. This neutron yield outside field = 1.9 mSv/Gy

106. Scatter and leakage shielding thickness calculations are equal. The shielding that should then be used is?
In the 2010 ABR Exam, the options (answers) were given as multipliers of TVL (not number)
In case $t_{scat} = t_{leak} \Rightarrow nTVL = TVL + (n-1)TVL_e$ so: $nTVL - nTVL_e = TVL - TVL_e$, $n(TVL - TVL_e) = TVL - TVL_e$
$n = (TVL - TVL_e) / (TVL - TVL_e) = 1$
so: thivkness (scatter) = thickness (leakage) = nTVL = TVL
According to the two-source rule (NCRP 151: Pg 34) ⇒ "If the thickness of the required is about the same for each secondary component; 1 HVL is added to the larger of the two barriers" Khan p 411-412 has more details on this rule.
so: Thickness used = TVL + 1 HVL = TVL + (1 / 3.32) TVL = 1.33 TVL (or 4/3 TVL)   (TVL = 3.32 HVL)
Agree with + 1 HVL not sure about the meaning of the last line
The answers provided were in terms of TVLs, this is why I made it this way. Ok thanks
107. Parts definitely not included in EPID.
Ion Chamber is not in EPID

108. S/rho and rho given for lead. Calc thickness of lead used to shield 20MeV beam.
This can be solved either by the Khan's rule of thumb or using the information provided.
1. Khan's Rule of thumb: Pb thickness (mm) = [E (which is 20MeV) / 2] + 1mm (as a safety margin) = 11 mm
2. S/rho represents the energy attenuated per unit distance, if it was given use the interpolation to know how much the beam will be attenuated then subtract the attenuated energy from the total energy
Agree
109. How many TVL's in a linac head? 3
3 because the limit for leakage through the source housing is 0.1% Khan p. 411.

110. The PDD for wedge increases over open field due to what property of the wedge? Physical/BEAM hardening Only for physical wedges. Apparently for dynamic wedges beam hardening does not occur.

111. Define the purpose of the guard ring in a plane parallel chamber. leakage and equibrium,
I think this to define the measuring/collecting volume
I believe it is both to define the volume and prevent measurement of leakage currents. Podgorsak p. 309

112. Electrons at extended SSD, know the properties of the distribution and dose?
Electrons at extended SSD, which is true?
A. Width of the 90% extends proportionately B. Penumbra Increases, C. Output follows ISL with 100 to source...
The only thing I can think of here is that if we are treating at extended SSDs past 100 SSD that includes a 5 cm gap between end of cone and patient surface we are increasing the chances of lateral scatter of electrons. This actually became apparent recently when I was shooting an electron cutout and the number of MUs that was calculated by the measurements were really high. Then someone told me that for total body electron treatments the SSD is slightly larger than the 110 SSD I measured the cutout with. So that increased the chance that the skin surrounding the exit portion of the cone was getting higher doses than what could be if we kept it near 100 SSD. Also, conversely, if the cone end were to be positioned directly on the patient skin surface, apparently though I have never witnessed this thank goodness, there is an increase of brems spreading laterally. That I read from a text book. :) Also, on a more positive note 110 SSD allows minimal collisional occurrences. And of courze with increase of SSD the number of MUs will need to increase to deliver the prescribed dose.
May be asking effective SSD? Khan 3rd P. 317
113. Why does the equivalent square technique work? **It accounts for scatter**

114. TG51: what's upper limit for Pion? 5%

115. TG51: where is cylindrical chamber's center placed for photon beam calibration? center (isn't 0.6 rcav ?)

116. TG51: to cross calibrate parallel-plate chamber, what should use? high electron energy

117. TG51: KQ depends on what properties? energy or beam quality, and Ion chamber

118. TG51: What's energy specification for electron beams? R50? **Agree**

119. TG51: total consecutive measurements were done with 20% difference, the reason for this could be? 20% off is a bit much, has to be at wrong depth?

120. TG51: where is the effective point of measurement of parallel-plate chamber? front wall

121. How do you convert ionization curve to %dd curve? 0.6 and 0.5 R for photon and electron, For Electrons you would still need to convert I50 to R50 using the equations in TG51. for photons, the difference is insignifcant as per TG51.

122. Agent used in PET? FDG
I agree, and its not "Mr Smith" either. :) What do u mean? That is a joke for those who have watched the Matrix :)
123. 9MeV electron beam. At 4 cm depth, how much lead should be used to shield deeper structure? No other information.
Similar to Pb thickness questions, Pb Thickness(mm) = E/2 + 1mm = 5.5 mm
Correction, depth in tissue so 9/2 = 4.5 cm , also 4 x2 mev, At 4 cm we have 1 Mev, ½ + 1= 1.5 mm
At 4 cm, electron energy left = 9 - 4x2 = 1 Mev, lead shield needed = 0.5 * 1 = 0.5 mm
Ez=E0(1-z/Rp) = 9(1-4/4.5) = 1, 1 MeV at 4 cm depth; Pb needed= E/2 + 1 = 0.5+1 = 1.5 mm Agree where do you place it?
What is the purpose of shielding using Pb? is it to block areas outside the **target? if we added a 2mm or 0.5 mm Pb, what happen to the area of the skin just below the Pb shielding? it will receive unnecessary dose !!**
Electron energy to skin in case of 2mm Pb = 9MeV - 2mm*2(MeV/mm) = 5MeV !!
In case 0.5mm: Electron energy to skin in case of 0.5 mm Pb = 9 - 0.5mm*2(MeV/mm)=8 MeV
So what is the purpose of the Pb Shielding?
In case the dose to deeper structure needed to be reduced simply reduce the electron energy. If the tumor is deep, you can not add Pb to shield them, you just need to accept the increase in dose due to higher PDD of higher E electrons.
When using the Pb we are not modulating the beam like IMRT to spare deeper structures, we are blocking areas outside the target, right? dose deeper will be reduced only by selecting proper energies.
You need to lower electron energy to protect structure below 4 cm. If you lower it to next lower level of 6 MeV, it will not reach 4 cm deep, so this option is not feasible. The thin sheet of lead is used to micro adjust electron energy. If 2mm lead is used, then 9 MeV electron becomes 5 MeV after penetrating the 2 mm lead, which can only reach 2.5 cm deep. 2mm is too thick for this purpose. Now if we use 0.5 mm lead, 9 MeV electron becomes 8 MeV after passing through the 0.5 mm thick lead, which can reach 4 cm deep and not deeper, so structure deeper than 4 cm are protected. Although I never saw its application at our hospital . Logically it is feasible.
Doesn't this question refer to internal shielding? It says, at 4 cm depth how much lead should be used. I take it that the lead is going to be placed at 4 cm depth, which could make sense some sort of lip lesion and blocking behind it. That is not quite 4 cm thick, I can hardly imaging a case that we place a thin sheet of lead at depth of 4 cm of tissue. On a photon case, our head and neck physician did want to place a thin lead between lip and teeth to reduce dose to the gum of a H&N patient, I advised him against its use based on my thought of secondary electron and bremsstrahlung produced nearby cause more dose than that saved due to shielding effect plus hygiene issue. Can someone give us an example how the internal shielding works? I agree with 0.5 mm + 1mm safety margin. Where would you place the 1.5mm lead shielding?
Page 705 Handbook of Radiotherapy Physics by Philip Mayles et al gave an example how to use internal shielding with a 2mm lead for 9Mev electron beam to treat a basa cell carcinoma on the cheek.
One can also use a bolus to increase the or bring the dose up to the surface. But that's not what the question is asking. I have to think about this one.
124. Difference between physical wedge and dynamic wedge is?
Physical wedge: Beam hardening, PDD changes From a dosi test question, differences are: dynamic wedge can produce any wedge angle, dynamic wedge gives sharper penumbra, and WF can differ significantly depending on field size for dynamic wedge.
Ok but I also agree with the simplistic version of beam hardening results of the physical wedge compared to the dynamic wedge, which apparently doesn't have this occurring. so PDD does not change in dynamic wedge?
125. IMRT: Difference between simulated annealing and gradient reduction in IMRT?
Inverse planning vs forward planning Which is which? What are these weird terms
Inverse planning (simulated annealing): In sliding window IMRT planning, you preset your dose targets for both treatment site and normal organ protection, then run the simulated annealing process to gradually approach your goals such as H&N IMRT. Gradient reduction (forward planning): In poorman's IMRT- field in field (step and shoot) planning, just look for hot spot, use different field size to smooth dose gradient/reduce hot spot, one try after another, move forward and hope you get a good plan with enough uniform coverage, such as Breast IMRT. Thanks.
Both are related to thermodynamics and they differ in their method. Simulated annealing: Gradual reduction I see, you mean slow. Gradual reduction is different from dose gradient reduction. Only simulated annealing is a borrowed concept from thermodynamics.
to my knowledge, both are for inverse planning, (inverse planning is the right term, you are right)simulated anealing: slow, but good for global minimum, gradient reduction, fast but may not be globally optimum. simulated anealing: slow, but good for global minimum, gradient reduction, fast but may not be globally optimum.--- this statement sounds true to me, which is different from my first thought. I removed my sentence about planning speed of the two methods above.

126. Shown an IMRT fluence map for a 5 fields prostate IMRT, identify the various fields.
Hendee P276 shows a 5-field prostate IMRT plan and corresponding fluence maps.

127. What is the Klystron's function. Rf amplifications microwave amplification

128. Which part of the linac will give rise to a low gas pressure fault? Waveguide Agree. The waveguide contains SF_6.

129. If a Linac's outputs are off the same way for all the beams, what could be the problem?
MU ion chamber. **Agree** If the gun current is low, it would lower all outputs. But this should be caught by the ion chambers.
I disagree in part, remember it could be the daily QA detector that is faulty also, though I am uncertain that all the beams will be off the same way but it sounds reasonable to suggest that it does.
130. What's the definition of a PTV?
PTV is a volume that encompasses CTV and margins that account for organ motion and setup error.
Agree.
131. Which organ shows partial volume effect? Kidney ? Anything where a DVH is useful, as opposed to an organ where only the max dose is clinically relevant: bladder, heart, liver, lungs, rectum

132. Photon field abuts electron field, where is the location of the hot spot and why?photon, lateral scater

133. Define the The Transport Index represents the exposure rate
The value of maximum dose equivalent rate at 1m from the surface of a package in unit of mrem/hr I disagree. The transportatin Index measures the exposure at 1 m from the surface of the package.Notice that I used "Value" to indicate that TI has no unit displayed, but mrem/hr implied. Please be tight and specific in your understanding of Transport Index. Usually yellow 2 package label requires that the reading be less than 1 mR/hr though when you look a the package it won't display the units. So when you go to measure at 1m you should recieve the same number or less.(in what unit?) That way you know where or not the radioactive material has 'spilled' out of its container. You detect surface contamination (spill) by wipe test to ensure <22000 dpm/100 cm^2. You measure dose rate at 1 meter to ensure shipper labeled package correctly and inside shielding condition did not change during transport. True but the is not units labeled on the package but the understanding is mR/hr and I used the word 'spill' for lack of better terms. :) Here is the definition of transport Index from 49CFR173.403: For nonfissile material packages,the number determined by multiplying the maximum radiation level in milliSievert(s) per hour at one meter (3.3 feet) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at one meter (3.3 feet))
It is dose equivalent rate (mrem/hr), not exposure rate (mR/hr) in the definition.
I agree partially, bot sure what was the exact question but for completeness

Label	Surface Radiation Level	Radiation Level at 1 Meter (Transport Index)
White 1	Does not exceed 0.5 millirem/hour	Not applicable (TI < 0.05) should be at background level
Yellow 2	Does not exceed 50 millirems/hour &	Does not exceed 1 millirem/hour
Yellow 3	Exceeds 50 millirems/hour,but<200 mrem/hr OR	Exceeds 1 millirem/hour but < 10 mrem/hr
Exclusive use	> 200 mrem/hr OR	> 10 mrem/hr, but < 10 mrem /hr at 2 meter

The addition of Radioactive material label definition is helpful for complete understanding of basic DOT regulation on Radioactive material transport. We need to have this basic understanding since we receive HDR source with yellow II labeling. We have to fulfill the responsibility of receiving surveys (radiation at 1 meter and wipe test on surface of package) within 3 hours of receiving by NRC regulation. I-125 prostate implant seeds are shipped as Limited Quantity, they are not labeled radioactive material package as above, survey requirements does not apply.
There are package A and Package B,(which is a seperate issue: packaging, not radioactive material labeling issue) I think above mentioned suffice
rem is dose not exposure technically speaking, if the TI that was found as the definition is stated in rems then its because 1 rem is approximately equal to 1 rad which is approximately equal to 1 R, since the f-factor is approximately 1 for soft tissue. True, it is a round off, but when we are discussing definition of TI, we need to be precise what we are talking about. You are correct thanks.
mrem is for dose equivalent not exposure. not going to argue over semantics. this is precise thanks :)

134. What parameters affect the Mayneord's F Factor and when is it most accurate? MFF ignores scatter. Therefore it's LESS accurate where there is increased scatter: low energies, large field sizes, and deep depths. It's also LESS accurate for big changes in SSD. Agree

135. What "stereotactic" means in stereotactic radiosurgery 3D
stereo – three-dimensional
tact, taxi – 1. indicating movement towards or away from a specified stimulus 2. orientation
stereotactic – movement in space (Greek)
Found this from yahoo group which I agree better: Precise positioning in 3 dimensional space

136. TG43: what is ^ ? **Dosimetry of interstitial brachytherapy sources**
Dose rate constant which converts air kerma rate (should be air kerma strength you are right, but it is more intuitive for me to say rate) in U (i.e. cGy cm^2/hr) into tissue dose rate in cGy cm^2/hr
Dose rate constant ^ = [D water at (r=1cm, theta = 90 degree)] / Sk
Sk= Air Kerma Rate of NIST measurement. For example, ^ = 1.11 cGy/(hr U) for Ir-192.
Agree, its Dose Rate constant in a medium using air kerma Strength normalization. (cGy?hrU)
137. Tolerance for simulator laser vs. gantry center **2 mm?** Agree

138. Amount of X-ray contamination of 18 MeV electron beam?4.5 - **5%?**
2-5%, Khan p. 318

139. IMRT shielding: how much more shielding needed in addition to a regular linac shielding Depends on the imrt factor in the workload calculation. NCRP 151 says the imrt factor can range from 2 – 10. **And only affect secondary shielding for leakage - agree**. and/or scatter The imrt factor is a correction for W, which appears in primary shielding calculations too.Good point, it will increase beam on time due to increased use of MU. This challenge the assertion of IMRT does not have impact to primary barrier. IMRT actually has impact to all barriers.

140. If you were going to use a thimble chamber to calibrate an Ir192 source what type of beam would need to be used in determining the calibration factor? Co60?

141. Given a 45Gy photon treatment to neck. Choose electron energy for boost to treat nodes at 3cm depth and spare cord at 5cm depth.
9 MeV (Therapeutic depth E/3 = 9/3 = 3 cm depth) Range: E/2 = 9/2 = 4.5 cm Cord is saved

142. Treat 4.3 cm depth with 12 MeV and 200 cGy, what is the dose at dmax.
The therapeutic depth is 90%, so this 200cGy is delivered to the 90% depth.
Dose to dmx = 200/0.9 = 222.2 cGy
PDD at 4.3 cm for 12 Mev is about 0.79, so dose at dmax = 200/0.79 = 253 cGy. **I do not think we should memorize the PDD(4.3cm, 12MeV), so, according to the provided information we should consider 4.3 cm depth as our 90% or 80% (depends on the definition of the therapeutic depth), TG-25 states that the therapeutic depth is 90%.** I did not memorize the PDD, I checked it out. Do you think they will provide us with PDD information or there is a rough rule of thumb for us to apply? **Right, rule of thumb is required in these cases, but if yo have time, youhave to memorize some PDDs and consider them as rule of thumb, especially PDD (10, 10x10) for all energies.**
No pdd memorization is required. You just have to know which rules of thumb they are using. Khan p. 307 gives: 90% idl = E/3.2, 80% idl = E/2.8. ABR apparently goes by this, since 2.8 is the exact factor in this problem. Good point Smart

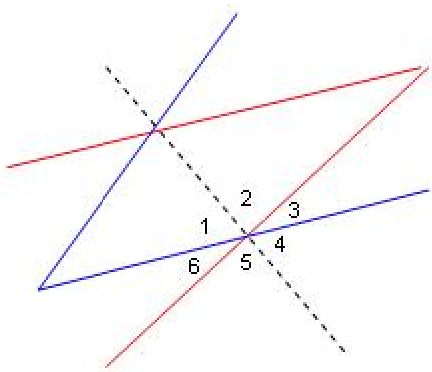
143. Shielding: What's peak energy of photons near door? 511 Kv
In a vault with a maze the average energy of the neutrons and photons at the door is about 100 KeV - 200 KeV Gamma rays produced by neutrons capture have energy up to 8MV (MV or MeV) (Khan p 413) you are correct Thank you

144. Shielding: Electron only machine has 4 electron energies, each with 3.5%, 2%, 1.5%, and 1% X-ray contamination. Workload 200 Gy/week, what is weekly workload for photon contamination?
0.035*200 = 7 Gy/week

145. What is the decay rate of 192Ir per day. 1% Agree

146. Weekly dose limit for unrestricted area. 0.02 mSv/week (McGinley pg. 12 bottom) Agree, Please note freq and infreq are diff Please note what? I didn't understand that. sorry, I meant to say there are frequent and infrequent limits, I look up the exact number 100 and 500 mrem 100mrem and 500mrem are annual public exposure limits. Khan p.407 gives 100 mrem/wk to controlled areas, and 10 mrem/week This one does not apply to shielding design to uncontrolled areas (ie, the annual limit divided by 50). How can Khan and McGinley disagree(McGinley is right here in terms of shielding design)? Apparently there is also a limit of 2 mrem in an hour (as opposed to an instantaneous dose rate of 2 mrem/hr) some, but I don't have a source. Can someone with a copy of NCRP 151 clear this up?500mrem/year is a special case allowed by NRC and it does not apply to shielding design. For shielding purpose, uncontrolled area is limited at 2 mrem/week (i.e. 100 mrem/year) and less than 2 mrem within any hour. NRC did allow special cases for some members of general public to use higher limit of 500mrem/year, such as relatives of high dose I-131 inpatient. But 2 mrem/ week shall be used for shielding design for uncontrolled area. We shall follow NRC regulation on this, which limit members of public annual dose at 100 mrem/year. Another NRC regulation (10CFR20) is that you have to limit radiation within any hour to less than 2 mrem for uncontrolled area to protect members of general public. Federal law 10CFR20 is the authority on this, not even NCRP which is an advisory body to NRC who can take its recommendation, or leave it alone. I do believe NCRP 151 say the same thing as 10CFR20 because when they updated NCRP 49 published in 1988 into NCRP 151on December 31, 2005, they must have reviewed 10CFR20. But the langhuage there NCRP 151 may not be as clear as 10CFR20. In actual design, we do not use 100mrem/week for controled

area, we implement ALARA principle and push limit down. We actually used 10 mrem/week (500 mrem/year) for controlled area. In shielding , occupational limit (100mrem/week) is easy to achieve, but you should consider ALARA. To protect members of public, the limits you have to abide by are two: Number 1 is 2mrem/week with occupancy factor and use factor allowed, Number 2 is less than 2mrem within any hour with use factor allowed, but occupancy factor of 1. In other words, you have to assume someone is going to be at the interest point all the time to judge if you exceeded 2 mrem within any hour or not. Not all people are aware of these technical details in the legal language of 10 CFR 20. These shielding criteria make sense in terms of protecting members of public. They are well thought out ones.
Good comments!
147. What are the properties of a GM counter. **Avalanche effect. Used in survey. Sensitive to less number of photons?**
Dead time cause paralyse of GM counter with intense radiation level, it will stop respond properly
Used to count decays per time but not for which material is being detected (i,e, its not sensitive enough to energy discriminate).
Actually, it is very sensitive but does NOT differentiate/discriminate energy. It will detect events. some might have slide window to detect beta. again MIGHT. very low efficiency.
148. Breast Tangent pair. Field widths at 100 SAD = 10.5 cm. LAO has gantry angle 45 degrees. What gantry angle does RPO have such that posterior borders will be parallel? tano = .5 L/SSD = 3 degree. opposite of LAO 45 is 225, so 225+3 = 228 degree . Thanks purple and gray , I like ur diagram. Correction to my answer, RPO = LAO + 180 - 2 arct ….= 45 + 180 - 6 = 219
LAO field divergence = tan^-1 (0.5*L / SAD) = tan^-1(0.5*10.5 / 100) = 3 degree
RPO = LAO + 180 - 2*field divergence = 45 + 180 - 2*3 = 219 degree



This is my diagram, not to scale. Each number stands for the angle between the lines shown, and there are six angles of interest. The red lines are the LAO beam, and the blue lines are the RAO beam directly opposed to the LAO. The dashed line is at 100 SAD for both beams. From the diagram, the degrees to which RAO will be tilted to align posterior borders is equal to angle #3.
From geometry, we know 2=5 and 1=4. We also know clinically that RAO and LAO beams are identical, so 1=2. Therefore 1=2=4=5. We also know from geometry that 2+3+4=180 degrees.
From the problem, angle #2 = arctan(100/5.3) = 87.0 degrees. Then, angle #3 = 180 degrees - angle #2 - angle #4 = 180-87-87 = 6 degrees. RAO directly opposed to 45 degrees is 225 degrees. By aligning posterior borders, we subtract 6 degrees to get **219 degrees.**
You are right, I should subtract 2xdivergency from the opposite angle for RPO, I updated my answer, thank you. For LPO, we need to add 2xdivergency from the opposite angle for LPO. Nice diagram vj. In the past, I summarized as two formula below:
RPO = LAO + 180 - 2arctan (0.5*L/100)
LPO = RAO - 180 + 2arctan (0.5*L/100)
I had these two formula on my flash card, but I did not check my initial answer carefully.
Very impressive work team.
149. What is the difference between Acceptance Testing and Commissionning of Linac.
Acceptance test: Checking whether the vendors given specifications are matching with the measurement / test performed on site.
Commissiong of Linac: All those tests / measurements required to for clinical use.
Agree
Partial disagreement Acceptance is when you compare the purchased specification matching delivered equipment. It is like did I get what I paid for or agreed on buying. This is important for vendor. when you accept the equipment or sign off means the vendor will get paid their final payment. Sorry for the lengthy detail but it is good to know. when you purchase an equipment try to put as much specification as you necessary.
150. Tolerance for deviation in a light field for a CT sim **2mm**

151. How much total dose is given by an I-125 seed 145 Gy from total implant, so 145 Gy / # of seeds Agree some uses 160 or 165 could you provide the information source? I calculated for 1 mCi at 1cm the total dose is about 24 Gy. What is the typical activity of an I125 seed?

152. What is the dose rate at 1m from a patient receiving external beam treatment? not sure what the q may scatter at 1 m 0.1% it depends on the scatter angle. if its > 30 degree, factor a should be on the scale of 10^-3

153. If the high voltage power source is pushing too much, what is the most likely observed result on the accelerator.
Not sure since its the Thyratron that is the switch. Once up to 500 mA is detected from the pulse forming network, which is a capacitor/ inductor and stores the charge, and then is discharged by the Thyratron. And the repetition frequency network provides information on how often it should repeat the process and is connected to the Thyratron. So if the HV is pushed too much means that the Repetition frequency is too often then the cathodes to the Klystron or Magnetron will maybe increase the number of electrons emitted increasing the microwave output then sent to the accelerator portion, waveguide may contain increase of number of microwaves thereby reducing the overall RF through the waveguide. Apparently, that is why the electron gun current is kept relatively low for energy selection of electrons and the waveguide's active length is shortened for energy selection of xrays and increasing the electron gun current. So in summary the energy selection portion may not work if the HV is pushed.
154. Which modality (photons or electrons) and energy is used to cross calibrate a parallel-plate chamber with a cylindrical chamber.
18 MeV high energy electrons
155. What is the Electron beam quality is specified by? R 50

156. Given a table of PDD's 4 MV and 18 MV what is the ratio of max dose 4MV/18MV. Trick question? The dose is 1 cGy/MU at dmax for each energy. Given identical MU, the ratio is 1:1.

157. What is the effect on point outside treatment field when using dynamic wedge versus hard wedge. Increased scatter for hard wedge. Therefore, don't use it for a medial breast field. Is that what this question is getting at? In our hospital, we are not allowed to use physical wedge in breast treatment fields for women under 50 years old due to concerns of scatter dose from hard wedge

158. HDR, three dwell positions (1, 2 and 3 – 2 in middle) 1cm apart in single channel. Dose points A, B and C 1cm perpendicular to dwell positions 1, 2 and 3 respectively. Dwell time in 1 and 3 are the same. What is the ratio of dwell times 1 to 2 to make dose A equal dose B?
(ABR2004)
T1=T3
Da = T1/1^2 + T2 / 2 + T3 / 5, Db = T1 / 2 + T2 / 1^2 + T3 / 2, Let Da = Db and substitute T1 = T3, solve the equation, we have answer:
2.5 I agree. Dwell #1 is 2.5 times greater than dwell #2.
159. AP/PA doses given from each field to cord for 200 cGy to tumor (62cGy, 150cGy respectively). Cord block put in PA, new cord dose is 18% of original. How many fractions need cord block to limit cord dose to 40Gy? See practice dosi exam.
160. A lead pig with 2 cm wall thickness is inside a 30cm diameter polyurethane foam shipping drum. HVL of lead was given (=5.5mm). Exposure rate constant of 192 Ir was given (0.32 mR/mCi hr at 1 meter). Calculate max activity to keep exposure rate below 50mR/hr on the drum surface. Assuming source is in center of drum, drum surface = 15 cm. Activity there (neglecting lead) is 0.32/.15^2 = 14.2 mR/mCi hr. There are 20/5.5 = 3.63 HVLs, so the exposure rate at the drum surface is 14.2*0.5^3.63 = 1.14 mR/mCi hr. Max activity = 50/1.14 = **43.9 mCi**. I got 43.7 mCi which confirms above
I think the 2cm from the lead pig should be included in inverse square. No. the 2 cm is part of 15 cm, so no need to add in ISL calculation.

161. TBI, diode reading 450cGy on surface, prescribed midline 600cGy POP laterals, 30cm separation. TMRs were given with 350cmSSD. What is error in midline dose?

Suppose I am the physicist who did the diode dose measurement, I would have placed a bolus with thickness of dmax on top to the diode, so the result of diode would be close to true Dmax.

Two fields in consideration: Dmax + D(30cm) = 450 cGy, (though Dmax is a single field one)
Single field in consideration: D(30cm) = Dmax*TMR(30cm)*(350/380)^2 **The Dmax is at 350 + dmax, so there is a little error with the ISL here** The distance is large enough for us to ignore that. **good point**
Dose at midline (15cm) = 2*Dmax *TMR(15cm) * (350/365)^2 **same for here, other than that, i will do this problem the same way**
Welcome on board, glad to have your seal of approve.
Error in midline dose = 600 - 2 * Dmax * TMR(15cm) * (350/365)^2

Agree with the methodology but not sure how you will find Dmax and other TMR.The Dmax in my equation is only a best proximate to it limited by the conditions the problem provided. So depending how much they give information.
I like to use the following I think this simple eventhough there is a lot of writting. Problem mention that TMRs will be given.
(Entrance + exit) / (Midplane dose) = error Disagree. you have to calculate your midline dose and compare with prescription 600cGy to get the error asked for. Yes Not sure what is your issue, I guess you are saying you do not like this No, I just can not follow you clearly
(Entrance + exit) / (Midplane dose) = error ? is this correct?This does not make logical sense to me

We know Mid planned (600) and entrance measured (450) find exit from the following

AP Dose 2 at 30 (exit) = dose 1(surface) [TMR2/TMR1] [SAD1 / SAD2]^2 450 cGy is not just entrance dose, it is the sum of entrance dose and exit dose, I could not follow the logic of your formula.? I added another problem 279 might help understanding some issue?

X = 450 x [TMR2/TMR1] x [350/380]^2

(Entrance + exit) / (Midplane dose) = error

(450 + X) /600 = error

There are at least 2-3 or more ways to do this and there is no time to write thesis or to show off..no intention or need to show off, I know the limits of my capability and knowledge. That is why I just want to share and learn candidly which is the purpose of this group as I understand. When I make an error, someone pointed out to me, I learn from it, correct myself, so I will not make the same error in the future. I seek benefits from group review. That is why I wrote all my thought out, not for show off as you label it, but to let others to review and correct. I also seek confirmation if I think I am right. I am here to learn and share, nothing to show off. I wish more people share more here and we all will benefit from the experience.

Logically

cumbersome Dmax similar to shade gray, second find MUs then convert to dose … etc

my prefernce TMR, SAD and dose ratio, for example TMR1 skin, TMR 2 Iso, TMR 3 exit, dose 1, dose 2, dose 3, SAD1, SAD2, and SAD3

Dose 2 = dose 1 [TMR2/TMR1] [SAD1 / SAD2]^2. If 450 entrance and exit then the problem is much easier. Need to find measured and/or calc dose … The Dmax issue rose above indicate overseeing of the diodes principle. All diodes have to be measured at Dmax either built in or you have to set-up. I used both. The question make more sense if the 450 using TLD. Diodes are directional (if not all at least my experience). Congratulations with your "seal of approve." when is the party?

If you read carefully, I mean: dark green gave me "seal of approve" and agree with the way I calculated. It is really hard for me to track your line of thoughts.

I am going to have a second thought on this problem:

TMR (25x25, 15) = 0.741

The diode dose measurement result is Dose at dmax with one field irradiation: Dmax = 450 cGy

Dose at midline for one field = 450 * TMR(15) * (350/365)^2 = 450 * 0.741 * (350/365)^2 = 306.6 cGy

Total dose at midline = 2*306.6 = 613.2

Error = (613.2 - 600) / 600 = 2.2 %

This is my final answer to the problem

162. Three isocentric beams 120 deg apart, AP and post obliques. Each goes through 15 cm depth to isocenter. 180Gy at isocenter weighted equally for three beams. Post beams transfer 9cm lung (electron density= 0.33), TMRs given at 3,6,9,12,15 cm. Calculate MU(post obliques)/MU(AP).

163. Ratio of Maximum Dose between 25MV and 4MV for same dose to midline using POP setup with SSD =100cm. PDD's given.

164. Given Kersey's formula and the distances and ratio of maze areas, neutron dose at isocenter (mSv) per photon cGy at isocenter, what is neutron dose (mSv) at door per photon cGy at iso. given TVL of maze for neutrons is 5m.

H = Ho* (So/S1)*(1/d1)*1/10^(d2/5) So--entrance cross section area, S1-maze cross section, d1-- target to maze entrance distance d2 -- maze length

165. HDR 192Ir. Patient treated with time 420sec with Activity 3.75Ci on Aug 1st. Source got replaced with activity 9.43Ci on Aug 16th. Calculate treatment time on Aug 21st. No 192Ir half life given.

$T_{1/2}$ (Ir-192) should always be memorized.

Actually this problem can be simply solved by proportionality between Activity & Treatment Time.

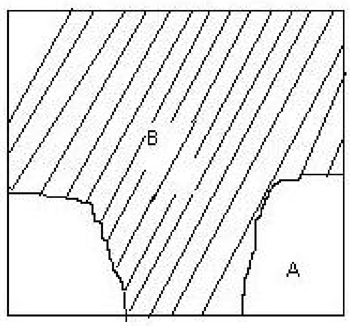
So:

A1=3.75 Ci, T1=420 sec, A2=A_0*exp(-0.693*5days/74days)=9 Ci (we care about A after 5 days (Aug16 - 21)

A1/T2 = A2/T1 So: 3.75/T2 = 9/420 → → T2 = 175 sec

Time = 420 x (3.75/9) = 175 Sec, Agree with the aboveAgree

166. Given dose to point A 200 cGy, calculate thickness of block to achieve point B dose 90 cGy. TMR, %DD, and HVL given, depth may be different for B.



I am considering removing the segment below due to the more through and correct answer provided below it. In particular having taken into account for the phantom scatter of the open portions of the field.

Sounds a bit confusing I really wonder if they gave both TMR and %DD or if they gave one for A and the other for B or something strange. Also there are many possibilities here depths of A and B are different, they have different OAR, different SSD (curved surface), or given values %DDa but TMRd.

ex.1 Assume B and A are same depth and OAR:

The the fraction of the field dose you need to block is: 90/200 = 0.45 → (1/2)^n=0.45 → n=1.15 → 1.15*HVL(mm)

ex. 2 Assume B and A are diff depth and same OAR: then you must adjust at least one of the doses given to a standard reference like Dmax... I'd work it like this

Db/Da = Block Factor *(1)a=b **IF a/=b** (Db/Da)(factor) = %Block →Db = [MU/(factors for pt.B PDD etc..)] *[%Block]

LET depths a/=b, same OAR:

Db/Da = (PDDa/PDDb) *(% need to block) → (Db/Da)(PDDb/PDDa) = %Block =(1/2)^n FIND **n** → n*HVL(mm)

ex. 3 Assume %DDa but TMRb: ex. pt. B is 10cm SSD is 90 and Pt. A is 15cm and TMRb is given, PDDa(100SSD)

from above the same equations are used however they get more complicated because additional correction factors may be needed: ex. PDD could be for diff SSD like 100cm: (Db/Da){ [PDDa * (90/100)^2] / TMRb} umm they could give you more information which would cause you to have to include more factors to convert the SAD and SSD mu calc formulas

Agree with the first two the 3rd too tired to think. for the first two somehow to account for 15% scatter. We know if we have 6 - 7 HVL still measure 10 - 15 % scatter dose.

Let us assume some basic dimensions first : this is a 15x15 cm square, open area A is approximately as 5x7 cm rectangular, the area of blocked area is (8x15 + 5x7).

The equivalent square of open area A = 2x5x7/(5+7) = 5.8 , the equivalent square of blocked area =square root of (8x15+5x7) = 12.4

point A depth is da, point B depth is db

If there is no block, the open field 15x15, Dose at B point = 200 * PDD (15x15,db)/PDD(6x6, da) = Db(15x15)

For just the blocked area, if there is no block, the open field of 12x12, Dose at B point = 200* PDD(12x12, db)/PDD(6x6,da) = Db(12x12)

Suppose the transmission factor for the block is T, then

Dose under block at point **B = Db(15x15) - Db(12x12)*(1-T) = 90**, thus, **Agreed** Thank you.

T = [Db(12x12)+90-Db(15x15)] / Db (12x12),

\# of HVL needed = ln T /(-0.693).

Reference: Example 8, D. Point under the block Page 199, Khan's The physics of Radiation Therapy, First Edition 1984

Kahn's 4th Edition p.171 gives three methods using the described method above and TAR ratios.

Notice the block is very large relative to the open field and B is at the center of the block, I wonder if we really need to go through the trouble of negative fields for this one. Maybe just the transmission fraction and PDD will yield accurate enough results. Good point, could you give details how would you handle this case? Just calculate the dose at B as if there is no block, and then apply the transmission fraction. It is a very rough approach. However, I think it is also a very rough approximation when estimating the equivalent field size for the block.

167. 36 inch space is available for 6 TVL shielding. Given Pb TVL (2 inch) and Concrete TVL (18 inch), what is the minimum thickness of Pb needed?

This can be solved using two equations:

36 inch = 2 n + 18 m → → Eqn 1, , , where n & m represent the number of TVL for lead and concrete, respectively.

6 = n + m → → Eqn 2 → → n = 6 - m substitute this in equation 1

36 = 2 (6 - m) +18 m → → m = 1.5 , n = 4.5 So the min thickness of Pb is 4.5 TVL.

Does that make any sense !!

To be honest this to me is little bit hard to believe in, to have the thickness of Pb three times thicker than the concrete, can anyone suggest a way to solve this problem

You are correct. Take 2 inches and multiply by the number of TVLs for lead. That gives you 9 inches of lead versus 27 inches of concrete. So I would say this is still a good way to solve this.

I did this the same way. Agreed.

\# TVL L + # TVL C = 6, L for lead and C for concrete, or 1/10^6 = 1/ 10 ^ (L+C)

2L + 18C = 36,

Above is correct, Agree with 4.5 and 1.5 Agree

168. Sim film taken at 102cm SSD, SFD 140cm. Want to treat at 120cm SSD. What distance to film should be used when cutting blocks.
Magnif. = 140/102 = 1.3725 → → Same magnification =1.3725 = SFD_{New} / 120 → → SFD_{New}= 120*1.3725 = 164.7cm
Agree
Now thats clever :) :) **Thanks !!** that was referring to the bright green response I do not know why it is so small. **I am confused !**
never mind **:)**
169. Field size is measured 56 cm on patient skin and collimator 40 cm with table at its lowest position 167 cm from the source. What's patient size (including setup bag etc.)?
56/40 = SSD/100, SSD = 56*100/40 = 140 cm. Patient seperation including setup bag = 167 - 140 = 27 cm
Agreed.

170. Given diagram of one dimension blocked field with distance from CAX and table of SARs (0cm 6cm 9cm 10cm etc), calculate SAR.
See dosi exam #1 problem #8 and exam #4 problem #28 for SAR issues.

171. Superficial X-ray, measurement at end of cone gives a reading of 150. Measurement at 10cm from the end of the cone gives a reading of 52.3. What is the effective SSD at the end of the cone?
(X/X+10)^2 = 52.3/150
We have to solve X
((X+10)/X)^2 = 150/52.3
X^2 + 20X + 100 = 2.86X^2
1.86^2 - 20X - 100 = 0
a=1.86; b = -20;c=100
X = 14.4 cm (3.7 ignore)

Simple solution: (X/X+10) = 0.59
1+10/X = 1.69
10/X = 0.69
0.69X =10
X=10/0.69=14.4 Agree

172. Dose to cord from AP/PA 100 SAD setup. Given 22cm separation, cord 4cm deep, and 200cGy to isocenter.
AP: 100* [TMR(18)/TMR(11)]*[100/(107)]^2
PA: 100* [TMR(4)/TMR(11)] * [100/93]^2
for PA, I got 100* [TMR(4)/TMR(11)] * [100/93]^2You are right, I put it upside down. I corrected it. Thanks.

173. Film exposed for dosimetry. Given transmitted light is 200 times smaller than original, what is the dose? OD vs dose table is given.

OD = log(Io/I) = log(Io*200/Io) = log(200) = 2.3
Then, correlate the corresponding dose from the table.

174. Single field 125 cm SSD, 4x17. 300cGy was prescribed to 5cm deep. Given PDD table and TMR table, calculate MU. No Output factor vs. field size or calibration condition provided.
Assume calibration to 100SSD for 1cGy/MU?
Equivalent square = 2*4*17/(4+17) = 6.5, use linear extrapolation to get PDD(6.5x6.5, 5)
Assume SAD calibration output = 1 cGy/MU at dmax
#of MU = {300 /[TMR(6.5x6.5,5)]}* [(125+5)/100]^2

175. 15 x 20 POP, calculate MU for dose required. No Output factor vs. field size or calibration condition provided.

176. Multiple beams plan: AP weighted to 100% at dmax, laterals weighted to 100% at dmax. 200 cGy delivered to 238% isodose line. What is the dose delivered by AP beam?
Assuming 3 beams (AP & 2 laterals): (200/3)* (238/200)= 79.3 cGy (not sure)
my try: 200 / 238% = 84.03cGy I gave this problem to one of our ABR physicist who got the same answer as ours, so I consider this one solved.
My try too: [200/(238/300)]/3 = 84.03 (cGy)
each field 100% at dmax. total dose line would be at 300%, prescribed at 238%, equivalent at 238/300 = 79.3333% isodoseline. 200 cGy prescribed at 79.3333% line, actual total dose delivered would be 200/0.793333 = 252.1 cGy, AP dose = 252.1/3 = 84.03 cGy.

177. Given readings at 10 cm depth for 10 x 10 and 20 x 20 fields with 100 cm SAD, and two TMRs, calculate the Scp(20).
Scp(20) = Reading@dmax with 20x20 / Reading@dmax with 10x10

= (Reading@10 cm / TMR@10cm with 20x20) / (Reading@10cm / TMR@10cm with 10x10)

178. 15 x 15 field with 3 x 15 block in the center, which has 5% transmission factor. Depth at 7 cm, dose to point A given with 1.01 OCR, calculate dose to CAX under block, given table like:

FS	5, 7, 10, 15, 20	
OF		
TMR(7cm)		
%dd(7cm)		

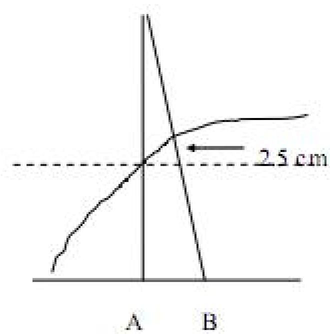
179. Point A and B are candidates for machine isocenter. Point C is outside the primary shielding and distances AC(=7m) and BC(=5m) are given. If isocenter is set at A, measurement at C is within the MPD specification. If isocenter is changed to B, how much more shielding (TVL) is needed for the wall to maintain same reading at C, given TVL. **(ABR 2010)**
Dose increase factor = (7/5)^2 = 1.96, (1/10)^x = 1/1.96, x ln (0.1) = -ln1.96 = -0.673, x = -0.673/ln0.1 = 0.29 (TVL)
C
B
A

181. From source to point A, there are: 100 cm SSD to surface, then 3 cm tissue, 2 cm inhomogeneity (e=0.25), 3 cm tissue, another 3 cm inhomogeneity (e=2.5), finally 4 cm tissue. So depth is 15 cm. 4MV beam delivers 200 cGy to point A with inhomogeneities. What's the dose to point A without the inhomogeneities? TMRs were given.

A'
d = 15 cm
A
Density = 0.25
Density = 2.5
2 cm
2 cm
2 cm
3 cm
t' = 3+2*0.25+3+3*2.5+4 = 18 cm
D_unif = D_inhomo * TMR(d=15)/TMR(d=18)

182. Given primary workload, distance to office, and TVL, calculate shielding thickness to achieve 1/10 of MPD. U, T, MPD were not given.

183. If dose to point A (depth 10 cm) is 200 cGy, calculate dose to point B ignore beam divergence. %DD(10)=65%, %DD(12.5)=56%, 100 SSD alone CAX.



Dose 2 = Dose 1 (PDD2 / PDD1) = 200 (0.56 / 0.65) = 173.3 cGy **(here you just need to include the Inv Sq Law $[(SSD+d_{max})/(SSD-2.5+d_{max})]^2$ to get the same answer purple got). Minus sign is due to the tissue excess, in case it is deficit it will be positive.** There is a new concept/assumption they're specifically testing. See Khan p. 245. Here's my understanding of it:
dmax_rayA = 200/.65=307.69cGy. Then dmax_rayB is computed from IVS from dmax_rayA. Let's assume dmax is at 1.5 cm depth. Then: dmax_rayB = 307.69*(101.5/99)^2=323.429. Then: doseB = 323.429*0.56 = **181.1 cGy**. Does anyone agree? Did anyone else interperet this section from Khan in a different way?
Agree with Purple answer

Agree with purple too.

For point B: SSD = 100 - 2.5 (ignore beam divergence as per instruction) = 97.5 cm
PDD2/PDD1 = [(97.5+1.5)/(100+1.5)]^2 / [(97.5+12.5) / (100+12.5)]^2 = 0.995 <-- I agree that MFF gives a more accurate answer. However, I want to use the same assumptions/equations as the testwriters. Khan p. 245 instructs to leave out MFF. I do sometimes find all the *assumptions* confusing. well said
For ray A, Dose at dmax = 200/0.65 = 307.69 cGy
For ray B, Dose at dmax = 307.69* (101.5/99)^2 = 323.43 cGy
Dose at B = 323.43*0.56*0.995 = 180.2 cGy

184. Lung correction given dose with no correction - the corrected dose has 2 cm of lung and 4 cm of dense medium (4x tissue) - what is the dose at that second point?
Needs to know the energy of the beam. then calculate equivalent depth.
185. Orthovoltage shielding calculation given the workload.

186. What would cause the biggest change of the depth of the 80% IDL for a 9 MeV electron? (choices included: add 1 cm bolus, change to 18 MeV, increase FS) 80% idl change from 1 cm bolus is 1 cm. Change from energy change is: 18/2.8 - 9/2.8 = **3.2 cm**. Change from FS increase is given in Khan p 314 Fig 14.7. The data is for 8 MeV, and from a basically open FS down to FS=1.5 cm diameter, the 80% idl shifts about 1cm.

187. Order written for 30 fractions, AP/PA, 180cGy/fx SAD. When will the cord dose reach 4500cGy?
TAR PDD and TMR tables given, Separation is 12 cm, Cord is 5cm posterior
PA to cord = 90/TMR(6cm) x TMR(5cm)
AP to cord = 90/TMR(6cm) x TMR(7 cm)
fx = 4500/(PAtocord +APtocord)

AP cord dose = 90*[TMR(7)/TMR(6)]*[100/(100+6-5)]^2 you probably should put the isc as [100/(100-6+7)]^2 same thing,I count forward to posterior skin,then back to spine, your count backward to anterior skin, then forward to spine, same result.I see, thanks

PA cord dose = 90*[TMR(5)/TMR(6)]*[100/(100-6+5)]^2

188. What is the dose for irreparable damage to the kidney? 2400 cGy when given homogeneously to both kidney will cause renal failure
My understanding is different center has different constrains, are we supposed to just follow EMAMI for exam?

189. Two isotopes Pd and I-125 half life is 17 days for Pd and 60 days for I125. After 120 days what is the ratio of doses?
Assume both sources have the same initial dose rate D0.
the ratio = 1.44*17*(1-exp(-0.693/17*120) / 1.44*60*(1-exp(-0.693/60*120) = 0.37
190. Given a diagram of a DVH that shows critical organs, PTV and GTV curves. Choose which curve represents the GTV

191. 13.05 nC exposure,   W/e = 33.3J/c   2.58 x 10 R/C What is the volume of gas in the chamber?

33.3 J per one C
Energy per 13.05 nC → Energy deposited = 33.3 J x 13.05 nC / 1C = 434.565 nJ
Dose = J/m → Dose
W/e data is a distraction.   2.58 x 10 R/C does not make sense. Assume 10 R is delivered
Volume* Air density* Exposure = Charge collected,   V(cc) * 0.00129E-3 (kg/cc)* 2.58E-4 (C/kg) = 13.05E-9 (C)
V (cc) = 13.05E-9 / (0.00129E-3*2.58E-3) = 3.92 (cc) **(You have assumed that 13.05 nC is the charge for 1R)**
(FM Khan Page 85 third edition: Q = Exposure * Density (air) * volume (cc), I think we need to convert the given exposure to C/Kg using 1R = 2.58E-4C/Kg. X should have been given in the equation.
192. TG51 calculation. You have to calculate Ppol, Pion and TPC (in kPA). Mraw high and low given,.
Ppol =
193. What is the range of a Y 80 beta 2.2Mev in air?
Should be Y-90.   Range in water = 0.5 *E = 0.5 * 2.2 = 1.1 cm, Range in air = range in water *density of water/density of air
= 1.1 cm *1/0.00129 = 853 cm = 8.5 m

194. Effective energy of an electron Ez 4 Mev, depth is 1.7cm and an Eo is7.1 Mev.
Asking for Rp? E = Eo (1-d/Rp), Rp = d/(1-E/Eo) = 1.7 / (1-4/7.1) = 3.89 (cm)

195. Picture of squares, 3cm, then 2 cm then 1 cm which equals tissue, bone and air. What is the effective depth when the beam is directed through each material.
3x1+2*1.5+1*0 = 6 cm -- P. 77 Medical Dosimetry Certification Study Guide by K.N. Govinda Rajan
196. A universal wedge has a 0.65 wedge factor. A 60 degree wedge is needed. 100 Mu are given for open and 200 Mu given for the wedge field. What is the average WF?
(100+200*.65)/(300) = 0.76 Agree

197. If the collimator rotation is off 1.2mm, the couch rotation is off 1.4mm and the gantry rotation is off 1.5, according to AAPM what is the overall uncertainty?
The uncertainties add up quadraturely: Overall Uncertainty = Square root of $((1.2^2)+(1.4^2)+(1.5^2))$=2.4 mm

198. Gap calculation: SAD 90 depth =10, FS = 24cm , but the treatment distance is changed to 100 SAD, d=10, FS=32cm
S=S1+S2=0.5L1x(d/SSD1)+0.5L2x(d/SSD2), 0.5(24)x(10/90)+0.5(32)x(10/100)=1.33+1.6=2.93cm
Gap = d (0.5L1/SAD1 + 0.5L2/SAD2) = 10*(0.5*24/90 + 0.5*32/100) = 2.93 (cm)
When field size is given at SAD(i.e. field collimator setting): Gap = d (0.5L1/SAD1 + 0.5L2/SAD2)
When field size is given at skin: Gap = d (0.5 skin field size1 / SSD1 + 0.5 skin field size2 /SSD2).

199. Calculate the steradian of a 50cm diameter area on a standard linear accelerator.
2m Omega = 2*pi*(1-cos(theta), theta=arc(sin(0.5/2), omega=0.187
theta should be arc(tan(0.25)), as field size is always defined at iso. But result is very similar given the small angle.
Area is π*r^2 = 3.14*0.25^2 = 0.196 m^2. Assume distance from the radiation source is 2 m. Definition: 1 steradian = solid angle underneath area r^2. Therefore steradians = 0.196/2^2 = **0.049**
Here's some Wiki info as to what theta is
http://en.wikipedia.org/wiki/Steradian I added this because a group member asked for this in the chat session

200. HDR shielding question. How much thickness for 10 patients per week, 5 days a week, 500cGy/patient. The drawing showed a distance of 2 meters (I think that's what it meant).

6 ft

6 ft
X
A
B
Assume W=5000cGy/wk @ 1m, T=1, U=1, d=2m, and P=0.1cGy/wk (limit to controlled area). B=Pd^2/(WUT)=0.1*2^2/(5000*1*1) =8E-5. Convert that to whatever thickness info they give. for controlled area, P=0.01 cGy/wkThis is not a permissible level for controlled (restricted) area, you can use it as an unofficial ALAR level for controlled area shielding design. This level has no legal significance. The right one is as stated by purple.

201. For an instantaneous exposure it gives 30 mR. If a secretary is sitting at point B and the wall is shielded for 6X how many patients a week can be treated for a weekly dose of 0.02mSv?

202. Shielding question that gives a thickness of concrete and the room is shielded for 6X. How much more shielding is required for 18X? we know the TVL for the 6X ~ 14"- 15' for the 18X 16" - 18", Roughly 2" x n TVL
I think this is the same as question No. , from the provided concrete thickness, we have to find out how many TVLs needed for the 6MV (n). Then, this n should be used but this time for TVL (18X). Agree

203. Why do the doctors leave a strip around each side of the treated area on a sarcoma?

204. Incomplete diagram here:
____ _____ ____ _____ _____ 4 cm
2 cm
B

What is the dose to point B?

205. What is the Range of Sr90 in air 800- 1000 cm

206. Universal Wedge, WF = 0.2, what % MU needed for 30 degree effective wedge
F = tan30/tan60 = 0.5774/1.7321= 0.3333
MU wedge/MU total = F/[F+(1-F)*WF] = 0.3333/[0.3333+(1-0.3333)*0.2] = 0.3333/0.4666 = 0.7143 = 71.4%

Agree with this Ans.

207. What does a fMRI measure **Funcational imaging (for studying brain activity)**
Detects the changes in blood oxygenation and flow that occurs during the response to neutral activity.
When brain is active it consumes more oxygen to meet this, blood flow increases.
208. What is primary purpose of a bending magnet? **to rotate the electrons to hit perpendicularly the target, and to make the electron beam as pencil as possible (excuse my language !!)**
It only rotates if waveguide is not situated vertically in the gantry. But most of the time the waveguide is situated horizontally as it needs quite a bit of length. Thats when the e beams need to rotate.
209. 1 R delivered, 3x10-10 C measured, what's the size of the chamber?
1R = 2.58E-4 C/kg, air density = 0.00129 g/cc = 1.29E-6 kg/cc Volume*density* Exposure = charge collected
V* 1.29E-6 *2.58E-4 = 3E-10, V = (3E-10)/(1.29E-6*2.58E-4) = 0.9 (cc)

30 cm2 field directed at roof, what is sold angle subtended at a point on the ground?

Assume this question ask for solid angle of a 30x30 cm field
From Wikipedia:

The solid angle of a four-sided right rectangular pyramid with apex angles a and b (dihedral angles measured to the opposite side faces of the pyramid) is

$$\Omega = 4\arcsin\left(\sin\frac{a}{2}\sin\frac{b}{2}\right).$$

If both the side lengths (α and β) of the base of the pyramid and the distance (d) from the center of the base rectangle to the apex of the pyramid (the center of the sphere) are known, then the above equation can be manipulated to give

$$\Omega = 4\arctan\frac{\alpha\beta}{2d\sqrt{4d^2+\alpha^2+\beta^2}}.$$

Solid Angle = 4*arctan {30*30 / [2*100*(4*100^2+30^2+30^2)^1/2]} = 0.08798 **(My answer is 5.04 degrees)** Is your answer in degree**?** **Thanks** You are welcome.
Sorry, I am slightly confused are you sure, that the resultant of the equation of the equation is in degrees and not in radians Depend on how you set your calculator, mine is set to degree, so I always have to watch out for conversion
Your angle is in degree, you should convert it into radians: 5.04 *3.14/180 = 0.08792 (radians), we have the same answer. **(Thank you)**
We can use the first equation given in your answer because whatever be the distance is, your angle is going to be same.
So, using first equation, 4(sin-1(sin(8.5)*sin(8.5))=5.04 degrees = 0.089 (after converting)
Using your second equation, i am getting the same answer 5.04.degrees = 0.089 (after converting)
Thank you for your confirmation. If we see the same problem on Aug. 30, I will go to answers and pick it up without thinking to save time for new type of questions. Yes, by working out more problems we can save lot of time.
Once we finish these questions, we can add more, so we are fully loaded with prepared answers. From what I heard and experience with Part I exam, chances of old question repeating are pretty good.
Your are correct, i think solid angle is a usual question, which creates confuses, especially in understanding in what units it should be expressed (though it is simple).
The fundamental unit of solid angle is steradian. The definition of steradian is a 3-dimensional extension of the definition of radian. Just as there are 2π radians in a complete circle (since circle circumference is 2πr), there are 4π steradians in a complete sphere (since sphere surface area is 4πr^2). Understand the steradian, and you shouldn't need to remember formulas.
Thanks. Going by your way, Could you please tell how you calculate the solid angle for this problem without remembering the formula.
Solid angle = Area / r^2 = 0.09 Sr (Which is same as my previous answer). I prefer to use multiple methods to arrive at a result. Which gives more confidence than just with a single method and choose the methods which is more simpler and less time consuming for the exam.
Do you have any other way of doing this? I don't think this exam will ask anything more difficult than applying Area/r^2.

210. HDR Cylinder with 5 sources 1 cm apart. Point A is midline, 4 cm from sources and receives 200 cGy. Point B is 2 cm lateral to Point A. What is Point B dose?
Thumb rule Point B is 1/3rd of Point A; roughy 67 cGy (Please check)

Let S be source related item
Dose at A = S/4^2 +2*(S/17) + 2*(S/20) = 200 cGy, solve it , S =714.03
Dose at B = S/4^2 + S/17 + S/20 + S/25 + S/32 = 714.03*(1/16 + 1/17 + 1/25 + 1/32) = 173.2 (cGy) **(Agree)**

Does your thumb rule apply here? Does your thumb rule specify the same # of source and same distance parameters? My suspician is that the thumb rule you use does not apply for this case.

211. Increasing the current to the magnetron does what?
Increasing current increases #electrons/time.....which should increase the amount of microwave output?
Ok I agree. Increasing the current means that there should be more microwave output. :)
212. Retrofit a linac to perform IMRT… how much shielding do you need to add?
About 2 HV for 50% IMRT   I agree with this statement someone else wrote.
Interesting comment here, not quite sure what to make of it though :) I did not write this, someone else did it, I cleaned it Maybe testing IMRT factor here?
213. What is the source of electrons in an electron treatment? Filament , electron gun Agree

214. Given density of lead and mass atten coef for a random energy… what is TVL? mass att μ/ρ cm^2/gm, we know the lead (ρ) density => μ= μ/ρ x ρ, we know TVL = (Ln 10) / μ

215. You check the source strength from the vendor 2 weeks after receipt. Given calibration factor, and reading…   how far is the vendor off?

216. SRS treatment, 4mm cone… what is max dose? Answers 20 cGy - 25 cGy What is relationship between cone size and max dose?
From clinical , we use 4mm cone upto 90Gy treatment?

217. Treating with parallel opposed wedge fields for 60 Gy in 30 fxs and the MU per beam in 160 MU. After 10 fx you realize WF was not in calc. How many MUs required for remaining 20 fxs to get to 60 Gy? Assume wedge factor is 0.8 again like in question 263
[(6000-200*0.8*10)/(20*2)]*(160/100*0.8) = 220 MU

This question is kind of the reverse case of question 263.   In this question, mistake was made in physics/dosimetry while mistake was made in therapist group in question 263. A spun off question would be: Are these two cases medical events ?
Assuming each beam is equally weighted, I also got 220MU per beam. Thanks for the confirmation, could you look at #263 to see if you get the same result?

219. Electron Eo = 7.1 Mev, mean E at 2 cm = 4 Mev. what is range?
Apply: **$E(d=2cm)=E_0(1-d/R_P)$, Given: $E(d=2cm)$, E_0, d=2 cm, solve for R_P** R_P = 4.6 cm
220. According to TG51 you need to adjust you %DD by what? 0.6Rcav and 0.5 Rcac

221. What happens to surface dose and %DD by adding a physical wedge? surface decrease and %DD increase I would guess increased electron contamination from the wedge would increase surface dose. Khan p207 says pdd and TMR should be assumed unchanged for small depths (d<10cm) . Dosi Exam #2 problem #22 states that 6MV pdd is not significantly altered, there is slight increase in TAR for all xray beams, and pdd is especially altered at high energies and deeper depths.
Agree with surface dose decease (scatter from head is blocked, scattering e from the head is more predominant than from wedge), %DD increase (beam hardening) I see. It acts as an electron filter.

223. Why cant MRI be used for hetero corrections? No electron density

224. Why should you convince the doctor to not use a 25 cm x 3 cm electron cutout? no dose uniformity/ equlbrium
Depth Coverage! If the smallest opening is > E/3 (in cm) then the PDD of the cutout will approximate an open field. However if the gap is less than E/3 then the PDD is different than an open field and the physician's intuition on depth coverage (ie Rx. to 95% etc..) is all wrong. Kahn has a more exact rule like 0.8SQRT(E) or something.   **Khan P279** When we have to use a small field that violates these rules, we don't remeasure pdd. My chief physicisist says electrons are not that accurate anyway. But she still enforces a very strict 3mm minimum width.
I asked Prof about this, he told me that advice your rad onc. not to use cutouts less size than 3 cm, because there will be no electronic equilibrium, and the dose can not be measured accurately (I know this depends on the chamber colume, but this what he told me.
225. You have a half beam 6 MV photon beam and a parallel 9 Mev electron that match on skin surface… where is hot spot? Photon

226. What is definition of EUD? Equivalent Uniform Dose (EUD), something to do with biological killing and dose uniformity
It is defined as the uniform dose that is equivalent biologically to the non-uniform dose distribution.

227. What is definition of integral effective dose? This is not same as integral dose but rather has to do with accumulative dose over some time

228. What part of curve is an ion chamber used for calibration operated in? Saturation? i think also known as ionization chamber plateau
Ionization region
229. Why would a doctor use Pd103 instead of I125 for prostate implant? faster treatment, may for aggressive disease
Here Pd-103 is used when the patient will also be receiving external beam therapy; I-125 is used when that will be the only radiation the patient will be receiving to the prostate. reference please, I know many centers use I-125 with external
We use I-125 with/without external, depends on the tumor.

We use Pd and I for with/without external. I-125 is more poplular. I ask the senior physicist, there are no enough data showing one is better than the other. Shorter HL is the main difference I guess, sometimes patient will ask for Pd.

230. Which part of linac is not water cooled? are they asking where the SF6 or what the SF^ cool?Waveguide?
SF6 -is used to prevent dielectric brake-down in the wave guide (arcing, shorts) as a primary purpose. Recall the guide need not be at vacuum only the accelerating cavity. The SF6 gas primary function is not cooling. so , shall we take this sentence out? unles u feel different No!

That said LINAC's have an internal water cooling system that cools the target, magnets, and other heat producing devices. The internal water supply, deionized, is cooled by a chiller (or city water in emergencies) via a radiator like an air conditioner.. Some items are cooled by fans (air) transformers or oil like the klystron. It is possible that oil cooled systems can be cooled with an air radiator or via the internal water supply, but I don't know of any such system.
Please ask ur engineer about SF6 cooling. I have been told it does cool. Let us look into it
Where would it dump it's heat load there is no radiator or cooling system...
I asked the engineer and he answered me: SF6 is the gas used to cool the waveguide, not water see above please. **I think it functions as a cooling gas.** My engineer said only water cools the waveguide. He told me to consider everything in the gantry stand as being water-cooled.
SF6 is a dielectric gas that increases the dielectric strength of the waveguide. It essentially acts like an insulator especially when there's a bunch of E fields that can break the purpose of the waveguide, sort of speak. **(Agree)**Agree - Thats what I've been saying.
231. According to TG40… how often do you check wedge interlocks? You use a 3x3 electron cutout. what doesn't happen? Monthly

232. TG-51 calc. Given raw data. Need to calculate Pion and Ppol. Need to know standard pressure in kPa. Find dose at isocenter if 100 MU were given. Also given Rcav

233. HDR calculation using point source formalism from TG-43 (given dose rate constant, radial dose function)

235. Standard Gap Calc between a treatment with an SSD setup and a treatment with an SAD setup.
gap= d/2 (field/ssd) ….

When field size is given by collimator setting, i.e. field size at SAD:
Gap = d (iso1 to field border next to matching field/SAD1 + iso2 to field border next to matching field/SAD2)
Note: SAD1maybe=SAD2=100cm

When field size is given on skin:
Gap = d (CAX1to field border toward matching field/SSD1 + CAX2 to field border toward matching field/SSD2)

When field sizes are given mixed ways:
Gap = d (iso1 to field border next to matching field/SAD1 + CAX2 to field border toward matching field/SSD2)

With these 3 cases, we can cover all Gap calculations without confusion. At least it worked for me so far, I can not ensure it will work all the time, but I think it will.
Further simplification:
A matching field contribution to Gap on skin required to match two fields at depth d:
= d * (iso to field border next to the other matching field / SAD) when collimator setting is given,
or
= d * (distance from CAX to skin field border toward the other matching field / SSD) when field size is given on skin

The purpose here for me is to save time to draw picture and find similar triangle for a particular case. I find that use formula in textbooks, sometimes confuse me. I end up have to do from scratch by drawing diagram.

236. Concrete is used for neutron sheilding for what reason? higher cross section than lead concrete has higher hydrogen and hudrogen has very high cross section. Do you have a source I can read up on? I couldn't find info other than it's cheaper. in khan page 27
Because the neutrons released during fission are fast neutrons, they have to be slowed down to thermal energy (about 0.025 eV) by

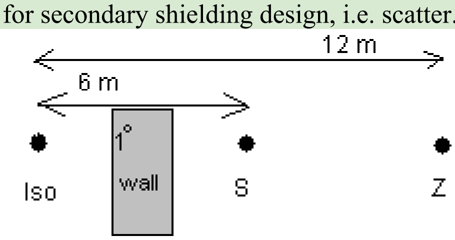
collisions with nuclei of low *Z* material. (edited by the Moderator)

Also in 5.12 khan Thus the most efficient absorbers of a neutron beam are the hydrogenous materials such as parafin wax or polyethylene. Lead, which is a very good absorber for x-rays, is a poor shielding material against neutrons. Lead can be used to thermalize neutrons for absorption by borated polyethylene. **NCRP 151 & McGinely book Inta Mutakid? yes, not clearly mentioned, but the main idea is due to the high absorption cross section of concrete for the neutrons (especially thermal neutrons)**

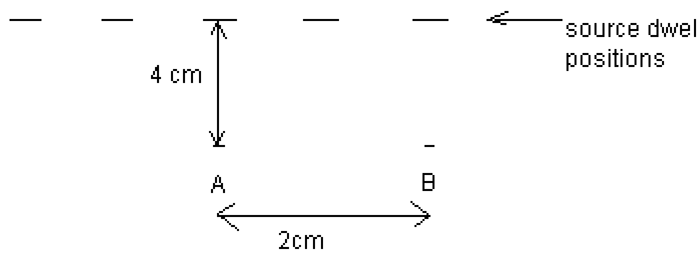
237. Using lead and concrete to shield Primary wall. From the inside, what is the order of the materials?
if there is a choice of concrete alone will be my lrst choice. if mix then I choose lead then concrete
This is explained in details in McGinley book (Pg 93-94): Concrete then lead then concrete. Why? Only for energies above 10 MeV; the neutron production is a concern from neutrons generated by the primary wall (not secondary) and the linac. In case of space limitation, a slab of metal (Lead (Pb) or Steel) is used. If Pb is inserted first, this layer will attenuate photons but will not absorb the linac neutrons and will produce neutrons that add dose to the patient under treatment (only for energies above 10 MeV). Having concrete first, will attenuate the photon beam energy, and absorb & attenuate neutrons. Then Pb layer will attenuate also the photon beam and also produce little neutrons from the attenuated photon beam (less probability now due to the attenuation through the concrete), but being sandwiched in concrete, neutrons produced from the Pb will be absorbed by the concrete layers. Similar to the order of door shielding reasoning.
Moderator: Please, remove this after 3 or 4 days. Everything you wrote is quite relevant So it seems reasonable to suggest **to keep this**
Pb is sanwiched between the concrete, but again at what level, Is it exactly centered or toward the isocenter or away from the isocenter.
I do not think it is mentioned in that much detailed, from what I understood from NCRP 151 & McGinley book, it should be this way, but they did not mention exactly how should it be, and how far. I heard from my friends that this was one of the question in the last year.
238. Given 125I half life of 59.4 days, given exposure rate constant in cGy/hr/U or cGy/U/hr. After 30 days what is the dose rate to the tumor in mSv/hr?

239. 200 keV beam. The density of copper is given in g/cm^3, and the μ/ρ for copper is given in cm^3/g. If 3 mm of copper attenuates the beam to 63% of its original intensity, what is the TVL for copper?
Find μ from density and μ/ρ, then TVL = ln10/ μ, another way I= Io e- (μx), 0.68 = e-3μ
0.37=e((-0.693/HVL)*3), HVL=2.09, TVL=2.09*3.32=6.9mm
0.63 = e((-2.303/TVL)*3), TVL=14.95 mm
240. Shielding: the distance from isocenter to point S is 6m, and iso to point Z is 12m. Point S is in a store room and point Z is in a room being considered as new office space. A survey meter measures 0.2? cGy/hr at point S. A beam is aimed toward this primary wall for 30 seconds per treatment. For a maximum dose of 0.08? cGy/week at point Z, what is the maximum number of patients you can treat per day? Consider only photon interactions.
Dose rate at Z: 0.2 cGy/hr * [(6+1)/(12+1)]^2 = 0.058 cG/hr
n is the maximum number of patients can be treated per day
n *5 *(30/3600)*0.058 = 0.08, n = 0.08*3600 / (5*30*0.058) = 33

In this problem, gantry angle is specified (aimed toward this primary wall), the distance count is different from Problem# 96. There is a trap set up here. i agree with everything stated here Thanks for your confirmation. Very good point! Thanks
When 1m(source to iso) should be taken into account? In shielding design, the typical workflow is pronounced at isocenter(1m from source).So I think the dose rate at Z=0.2*(6/12)^2=0.05cGy/hr. No. of patient per day=(((0.08/0.05)*3600)/30)/5=38.4~38 Disagree The way you calculated is for secondary shielding design, i.e. scatter. This question deal with primary wall.

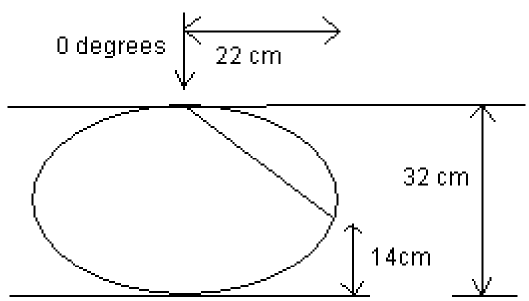


241. Given 5 HDR sources. 1 cm between each source dwell position. 4 cm between middle source and point A. The dose at point A is given. What is the dose at point B. Equal dwell times for all sources. (Also given source active length which is less than 2*distance)



dose at A = C/(4^2) + 2 C/ (4^2 +1^2) + 2 C/ (4^2 +2^2)
= C/16 + 2C/ 17 + 2C/ 20
SOLVE FOR C
dose at B = C/(4^2) + C/ (4^2 +1^2) + C/ (4^2 +2^2) + C/ (4^2 + 3^2) +C/ (4^2 + 4^2)
= C/16 + C/ 17 + C/ 20 + C/25 + C/32
The dose rate equation := DR = Dose Rate Constant per U* Source Strength * Normalized geometric factor * Normalized anisotropic factor * Normalized radial factor
D_A = C *(1/ r1^2 + 1/ r2^2 + etc...)
D_B = C *(1/ r3^2 + 1/ r4^2 + etc...)
D_A / (1/ r1^2 + 1/ r2^2 + etc...) = C
D_B / (1/ r3^2 + 1/ r4^2 + etc...) = C
D_A / (1/ r1^2 + 1/ r2^2 + etc...) = D_B / (1/ r3^2 + 1/ r4^2 + etc...) OK
my solution: D_B = 0.87*D_A
Find the ratio of D(at A) to D(at B) using the Inv. sq. law,
then use D(at A)/D(at B) = R^2(at A) / R^2(at B) → D(at B)=0.87 D(at A)=0.868 x 200 = 173.6 cGy
242. A setup calls for a 25 cm field length at 100 SAD. The SSD is 88 cm. However, the field requires a wedge that has a field size limit of 20 cm at isocenter. What must the new SSD be in order to accommodate the wedge?
New source to target distance = 100 *25/20 = 125 cm. New SSD = 125-(100-88)=113 cm. I get 113cm also.

Find the RPO angle given the following (diagram). The line represents the central ray of the beam through the patient.
arctan Q = (32-14)/22, Q = 39.3 degree. LPO = 90 + 39.3 = 129.3 degree, RAO = 270+39.3 = 309.3 **Agree (tan_1(18/22))**



243. Parallel opposed fields with equal weighting. 60 Gy in 30 fractions is prescribed to the isocenter. (SAD setup with iso at midsep). The patient separation is given, as well as the depth to the cord. The TMRs at three different depths are given. Find the maximum number of fractions that can be given with the limitation being the cord tolerance dose.

244. You measure a brachy source and get a measurement in air at 1 meter of (given)R/S. The chamber volume is given, the chamber calibration factor is given (in cGy/C?). You are given the density of air in kg/m^3. The stated activity from the manufacturer is given. Given 0.876cGy/R, given 33.95 J/C, NOT given 2.58E-4 C/Kg = 1R. What is the relationship between your measured dose rate and the dose rate stated by the manufacturer?

245. For a photon skyshine calc, What is the solid angle of a circular beam with a 50 cm diameter? theta = tan 25/100
A= 2pi r^2 (1- cos theta)

A=2pi(1-cos theta)?88

theta = arctan 25/100 = 14 degree, A = 2pi (1-cos theta) = 2*3.14*(1-cos 14) = 0.187
246. A beam travels through tissue (see diagram). What is the radiographic depth? Hu = o denisty 1 Hu= -1000 denisty 0 and Hu 1000, denisty 2
effect depth = 3+ 4x0.2 + 2 x 0.8 = 5.4 cm

Effective length = 3*1 +4*0.2 +2*0.8 = 5.4

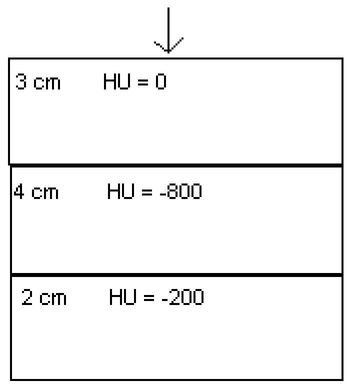
Due to the linear nature of the HU/ED calibration curve, we should use the linear interpolation as follows:

HU = -1000 → ρ= 0.2 (Almost lung) , HU = 0 → ρ=1.0 (Water), HU =100 0 → ρ=1.8 (Cortical bone)

For HU = -800 → ρ=? Using linear interpolation: [(-800 - 0) / (-1000 - 0)] = [(ρ-1) / (0.2 - 1)] , ρ=0.34 Similarly: For HU =200, ρ=0.84 , So: Effective Depth = 3x1.0 + 4x0.34 + 2x0.84 = 6.04 cm

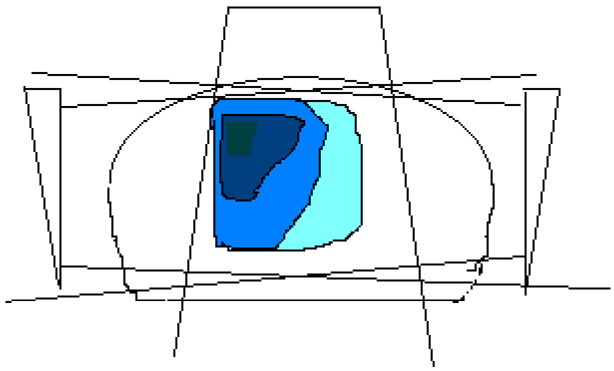
HU -800 is close to 0.2 and -1000 is close to 0.

http://www.cablon.nl/CMSDL/467.pdf



247. A Shielding calculation was performed assuming no IMRT. If you will now be doing 50% IMRT, how much additional shielding will you need to add? Incomplete question? NCRP 151 overview powerpoint (from AAPM website) says imrt factor ranges from 2-10.
This is a complete question:
IMRT does not change primary shielding thickness, but it require more secondary shielding for scatter or leakage radiation. The ratio of MU number of IMRT plan over 3D plan is about 5. Did you assume 5 to solve the problem, or is this a known constant?(Assumption based on estimate from experience. Yes, we need more commonly accepted specific ratio of IMRT MU / 3D MU to use for shielding calculation. What number would you use if not given?Now I know why you said this problem is incomplete) So assume total number of MU used in a week for shielding design without IMRT is A, then the total number of MU used in a week if 50% plans becomes IMRT plans = 0.5A+5x0.5A = 3A. Workload increase = 3A/A = 3.Suppose additional X HVL is required to accommodate the increase of workload, then (0.5)^X= 1 / 3, solve it, X = 1.59.
about additional 1.6 HVL shielding will be needed.
NCRP151p57. IMRT will only increase the workload for leakage shielding. I do not understand the reason behind that statement in NCRP 151. Patient scatter is much more significant problem than leakage when IMRT is involved. We all know that. I don't agree. IMRT should only add to leakage workload. the dose received by patients should not change, neither should the patient scatter workload.Shielding is to protect people outside treatment room, not inside the treatment room, our eyes should concentrate on them to see if they will receive more dose if you give more MU inside the treatment room while giving same prescription dose to the patient. We also need to realize that much larger portion of the patient receive more dose than 3D plan when we do IMRT to patient, more secondary cancer risks are on some people's mind due to the extra irradiation which also produce more scatters. Google doc is not the best way to communicate the arguments. It is widely accepted at least by academic settings that IMRT factor is only considered for leakage workload. We don't want confuse other members in the study group for the exam purpose.You are right, it may cause confusion for exam purpose.

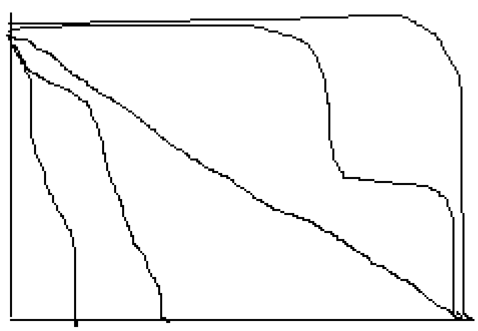
248. A universal wedge with a wedge factor of 0.25 is used to deliver a beam with and effective wedge factor of 30 degrees. What is the fraction of MU's delivered by the wedged portion of the field.
B= tan 30 / tan 60
MUw/MUtot = B / [B+(1-B)Wf]= 0.333 / [0.333 + (1 - 0.333) 0.25] = 0.333/ 0.49975 = 0.667 , .67% wedged Wedged MU is 67% of total MU delivered. Agreed
B = dose weighting for wedged beam = tan 30 / tan 60 = 0.333
as a ratio, wedged dose:open dose = 1:2
as a ratio, wedged MU:open MU = 1/.25 : 2 = 4:2
as a percentage, wedged MU / total MU = 4/6 = **67%**
good way to look at this. What will you get using this method for question 272? Thanks
249. Shown a setup with AP, Lt Lat, and Rt Lat fields. The Rt and Lt Laterals were wedged. The isodose distribution looks like the picture below. Another picture with a uniform isodose distribution is shown. You must choose which field weights and wedge weights to change in order to make the picture below look like a uniform isodose distribution:
Increase left lateral field weight, increase right lateral field wedge angle



250. Electrons are produced in a linac by what process. filament, e gun

251. When the current in the magnetron increases what is the resulting change: frequency, increase e

252. Shown DVH and must choose the DVH line representing most heterogeneous dose distribution



the farthest right curve? I think the middle (3) linear

I also think it is the one in the middle. Why? because heterogeneous means non-uniform, and the range of dose inside the organ in the middle varies from very low dose to very high, while all other organs have short range of dose. strictly speaking this is not the case. The far right curve and the one right next to it are also large dose ranges.

I see your point though. And I was thinking homogeneity (which would be more for a target structure) versus heterogeneity (which would be more for a critical structure) I think. The Dose line is along x. But the volume is what we might want to take a look at. **I think its the curve next to the far right one**

I think, the dose homogeniety means the deviation of voxels from the mean dose inside the target or OAR, understanding this, means that for the furthest (left target) almost 100% volume received almost 90% of the prescribed dose, only 10% volume is receiving dose ranges from 90% dose to 105%, which means it is homogenous dose.

For the curve you mentioned, about 95% vol receives almost 70% dose, then dose drops down and then it is also homogenous (50% vol received dose from70%-100% dose). Where as for the curve I mentioned, the target mean is clearly 50% of the target prescribed dose, and about 50% of voxels are below the 50% dose, and the other 50% vol is above the 50% dose. I do not want to go through debate ofcourse, and this question is single point question, so, I hope we both are correct !! For what it's worth I'm voting middle line because it covers a large range of dose and volumes ie... horizontal lines mean good uniform coverage of target to goal and the vertical line means great fall off (no hotspots). (a great PTV is a step function) the most hetero should be the middle ground a 45 degree line.

Ok sounds reasonable. :) Agree on middle line

1. Which structure does line 2 represent on this DVH for an IMRT plan?

PTV?Agree Agree

Yes, I also think it is PTV, and the sharp edge curve on top of it represents GTV. I agree, in follow previous 251, line 2 PTV is uniform/homogeneous distribution while the other two lines has wider range (HETEROGENEOUS)

253. When treating a lung tumor, what is the dose associated with radiation pneumonitis?
  > than 35% of lung volume receiving 20Gy. Agree

254. Neutron dose from 15 MV photons

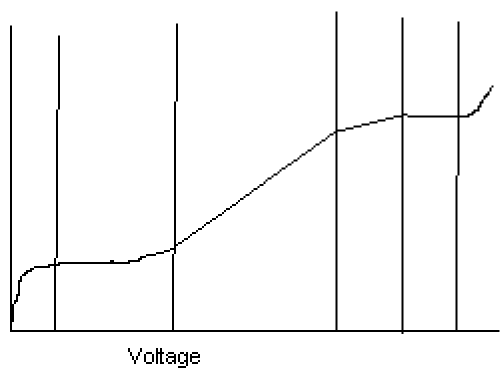
0.5 % on the central axes

255. When an electron beam has an oblique incidence on the surface, what happens? increase surface, move Dmax toward surface **Agree**

256. According to Bragg-gray cavity theory, the diameter of the air cavity should be what? greater than the range of e-

The diameter of the air cavity should be sufficiently small to avoid disturb the number or the distribution of the electrons that would exist without the air cavity. (Khan 4th, p101)

257. In which region would a cylindrical ion chamber be operated on a voltage versus ion pairs collected graph?



Region 2? **agree**

Recombination - Ionization - Proportional - Limited Proportional - G.M. Region - Continious Discharge

Ion chamber operate in Ionization region where all ions are collected without a chance to recombine themselves. Slight operating voltage change does not have impact on output.

258. In Monte Carlo Treatment Planning Algorithms, what is the cutoff energy under which the path a particle will no longer be mapped discretely, and instead it will be lumped in with a general energy distribution function.

Anyone have any ideas? General energy distribution function definition too?

I do not have reference but I read at couple of time 10 kev, **I am sure it is 10 keV** I will take 10 kev

259. How much do shift your Ionization curve to get a PDD curve? 0.6 Rcav photons and 0.5 Rcav e

260. What is the purpose of the bending magnet and where is it located? focus **To bend the beam 270 degrees.** The beam is already well focused coming out of the accelerator cavity. **Focusing = Solenoid**: Solenoids wrapped around the accelerator cavity such that the magnetic field goes in the same direction as the accelerated electrons is used to counteract Coulomb repulsion of the elctrons in the bunches. Any electron trying to deviate form a focused bunch gets a force from the solenoid such that the electrons follow a helical path. Also as the e- approach the speed of light they create a relativistic B field which actually overcomes Coulomb repulsion and pulls the electrons together. Older LINAC's (low energy) had the accelerator pointed straight down with no bending magnet. The inclusion of a bending magnet provides **SEVERAL BENIFITS**: longer acceleration path for higher energies, inclusion of energy slit (nice safety feature), additional steering coils. -what I remember from Green's accelerator book

261. On fluoro images in the simulator, wires used toward the outer edges of the field of view can appear to be (farther apart?) than they actually are. This is due to what? *Pincushion* Thats the name for it. For more on distortions the joint AAPM/RSNA residency training.... **"Pincushion distortion is a geometric, nonlinear magnification across the image. The magnification**

difference at the periphery of the image results from the projection of the x-ray beam onto a curved input surface."
http://radiographics.rsna.org/content/20/5/1471.figures-only

262. A dose calc where you have SSD, Dose rate at Dmax for 100 ssd setup, and a depth of 10 (PDD given). For the given setup, they give you the MU required to give the dose. For the same dose delivered to an SAD field at a depth of 10 (They stated the TMR), how many MU's do you need?

SSD Output = "dose rate at Dmax" = A (cGy/MU), SSD setup: MU ssd = Dose/(PDD10*A), Dose = MUssd*PDD10*A
SAD Output = [(100+dmax)^2 / 100^2] *A = B, MUsad = Dose/(TMR10*B) = MUssd*PDD10*A / (TMR10*B)
Note: Sc, Sp difference are ignored since no data is provided.

263. Prescription is 200 cGy/day delivered by parallel opposed, equally weighted beams. They say they gave 147 MU per beam, but left out a wedge factor of 0.8 for the first 10 treatments. The patient is to receive 30 treatments total. What is the MU required (per beam) for the remaining 20 treatments in order to deliver the prescribed dose for the entire course of treatment? my understanding let us say while hand calc they forgot to account for the WF (left out). The question did NOT say forgot to insert the wedge.
Planned mu per beam = 100 cGy/ (X x 0.8) =
given 147 = 100 cgy/X , X = o.68
Planned 100 cGy/ (0.68 x 0.8) = 184 MU **(Does this mean that therapists changed MU from 184 to 147?)** good see above
MU missed per field for the first 10 184- 147 = 37 mu = 370 mu total
370/20 = ~ 19
Mu required for the remaining 184+ 19 = 203
let me try another way this seems long
right mu 147/0.8 = 184
Planned 180 x30 = 5520
given 147x10 = 1470
(5520 - 1470)/ 20 = 203 or 202 mu **(This means that MU is increased from 147, while patient already received extra dose)**
I have different understanding for this case:
The therapists forgot to insert the physical wedge, which means that the MU with wedge factor is 147, but the wedge was not inserted. So therapists did not (and they are not allowed to change the MU for any plan, this is a mistake and MU calculated should be 147 with wedge, and they just forgot it)
Depending on this understanding:
First step to find the output factor: 100cGy → → MU=Dose/(O.F x WF) → → O.F. = 100 / (147x0.8) = 0.85 cGy/MU
Dose W/ Wedge (per field per fraction) = 100 cGy = 147 x 0.85 x 0.8
Dose W/out Wedge (per field per fraction)= ? = 147*0.85 = 125 cGy (Which is higher than the dose with wedge)
Which means for the first 10 fractions (dose/fraction) = 250 cGy
Prescribed Dose = 200 cGy /fr → Total dose = 30 x 200 = 6000 cGy
So, forgetting the wedge increased the dose by (25 (cGy/fld) x 2 (flds/fr.) x 10 fr) = 500 cGy.
The question was what should be the new MU to compensate for this increase in dose due to the unwedged beam?
so: 6000(from 30 fr) = 2500 (which is the dose from the first 10 fr. from the unwedged beam) + d x 20 fr.
solve for d: d = 175 cGy/fr (this d represents the corrected dose per fraction)
Corrected dose per field = 175 / 2 = 85 cGy (because they are equally weighted)
Now finally let us go back to the MU per field of the coming 20 fractions (what is actually required):
MU = 85 / (0.85 *0.8) = 125 MU ******** Does this make any sense to you guys? ********
This solution may look too long, but I am sure if you repeated it many times you will understand it and be efficient and quick during the exam.
your solution for the proposed problem is correct, BUT I have a different understanding of the problem. **As long as you can find the answer among the options, you are in peace.**
{[6000 - (200/0.8)*10] / (20*2)} * (147/100) = 128.6 MU ~ 129 MU
Agree with 129MU if the question is saying wedge factor was used in MU calc but not used in the first 10 Tx.
Thank you for the confirmation. Wording "they say they gave 147 MU per beam..." indicates therapist's mistake to me.
Thats a good catch green

Since we've already solved this problem with WF left out of the calculation (in #217), it's useful to do it now with the wedge left out of treatment. I agree **129MU per beam**. Good, I just want to make sure our understanding of the problem is the same, thank you for your confirmation. So could we say this one is solved?

I have to add few more questions came in the board as well but not here (Questions from 264- 271):.

264. What is the energy of a 12 MeV electron beam at 0.5 cm thick lead slab?
According to figure (14.33 in Khan's book, page 331), 2 MeV energy of electron beam is attenuated after 1mm of lead, (remember that for water the attenuation rate is 2 MeV after 1 cm of water), so:

2 MeV is attenuated after 1mm of lead, how much attenuated after 5mm? 5x2=10 MeV is attenuated energy, so the energy of the e-beam after these 5 mm = 12-10 = 2 MeV

265. The given dose to a patient is 54 Gy through 30 fractions. The doctor wants to do accelerated fractions to 20 fractions, so that the patient will get the same radiobiology effect. The therapeutic ratio (I think they mean here the (alpha/beta) ratio) is 10. What is the new dose?
BED = n x d (1+(d/(alpha/beta))) , BED (Conventional) = 30 x 1.8 (1+(1.8/10)) = 63.72 Gy
to get the same BED, we will use this 63.72 Gy to find out how much dose per fraction needed (d=?) when n=20 for the new fractionation, so:
63.72 = 20 x d (1+d/10) → → d^2 + 10d - 31.86 = 0, to be honest to solve this equation, I prefered to substitute expected values until you get the result to be zero. let us expect d=2.2: we will get 26.84-31.86 !=0,
so let us try 2.5: we will get 31.25-36.86 (almost there, so the answer maybe 2.55 Gy/fr or 2.5 Gy/fr.
will this work x=(-b+-sqrt(b2-4ac))/2a
I tried it but to be honest could not get any where !!
I solved the equation and got answer of 254 cGy, **yes you are right, I tried it again it was 2..54 Gy.fr** **agree with 254**
266. A 5.4 cc target in SRS has a conformity index of 2.3. How much normal tissue received the prescription dose?
Conformity Index = (Presc. Dose Volume / Target Volume) Prescribed Dose Volume = Vnormal irradiated + Vtarget
Presc Dose Vol. = 2.3*5.4 = 12.42 cc → → Normal Tissue volume irradiated = 12.42 - 5.4 = 7.02 cc Agree CI = 1+ Vnormal/ Vtarget
The main problem here, is that there are many definitions for the CI, there is RTOG CI, conventional CI, and two more, which one to use, this is the question !!
I think there is a similar problem from RAPHEX, and according to their correct answer. they are using CI = Vnormal/Vtarget. I trust both RTOG and Raphex. Which Raphex problem are you referring to? I think T114 of Raphex 2011 was referred to. It is added here as Problem #316 What is the RTOG definition?
RTOG CI = (Spillage Factor) x (Cover factor)
Spill factor= (1-(Vol. of dose>Presc Dose outside PTV / Tot Vol of presc dose))
Cover Factor = (Vol of Presc dose Inside PTV/PTV Volume) to me this is the most accurate CI definition, because it also calculates how much dose spilled outside the target, and also what volume is covered by the prescribed dose.

267. Given 7mSv/hr at 1 m from source. What is the wall thickness required to get less than 0.02 mSv/hr at 1m beyond wall.
B=Attenuated beam / Unattenuated Beam = 0.02 / 7 = 0.00286 , n=-LogB =-Log(0.00286) = 2.54 TVLs.
Note: If TVL is given

268. For a 4 slice CT scanner with 1 mm slice thickness, a pitch of 1.5 and gantry rotation of 0.5 sec. How long will it take to scan 100 mm body?
Pitch = (Distance Travelled Per Rotation) / Beam Size , → → Distance Travelled = 1.5 x 4 (slice CT) x 1mm = 6 mm/Rotation
one rotation takes 0.5 sec, distance travelled per rotation = 0.5 sec
100 mm travelled in how many seconds? Time required to scan 100 mm = 0.5 x 100 / 6 = 8.33 sec Agree you made this clear,thanks Agree Agree
269. Field size is measured 56 cm on patient skin and collimator 40 cm. With the table at its lowest position 167cm from the source. What is the patient thickness?
When collimator size is 40cm, this mean at 100 cm field size is 40 cm, Magnification = 56 / 40 = 1.4
Magnification = SSD / 100 → → SSD = 1.4 X 100 cm =140 cm, → → patient thickness = lowest table position - SSD = 167-140 = 27 cm Agree

270. Why there is no questions about converting dose from SSD to SAD ?

271. Retrofitting a machine to perform IMRT. What is the increase in workload? Given 65% IMRT, Ratio of MU IMRT/no IMRT = 4, average PDD = 60%, 200cGy/patient, 30 pt/day.
Note: NCRP 151. (Pg:57-58) states: " ***The increase in monitor units required by IMRT does not significantly increase the workload for the primary barrier, or for the patient and wall-scattered radiation components of secondary barrier. This is because the absorbed doses to the patient for IMRT and conventional radiotherapy are similar. However, the contribution to the leakage radiation workload is significantly higher by a factor as large as the IMRT factor, depending on the fraction of the patients treated with IMRT."***
W_{Conv}=0.35 (% of 3D treatments) x 200 (cGy/Patient) x (30 Patient/day) x (5 days/wk) = 10500 cGy/wk
W_{IMRT}=0.65 (% of IMRT treatments) x 4 (IMRT F.) x 200 (cGy/Patient) x (30 Patient/day) x (5 days/wk) = 78000cGy/wk

$W_{increase}$=78000 - 10500 = 67500 cGy/wk only for the leakage barrier.

Workload should be expressed in MU here, IMRT deliver same dose with 4 times # of MU:
When all patient were 3D plan patient,
Workload (MU/week) = 30*5*(200/0.60)*1 MU/cGy = 50000 (MU/week) = 50000(cGy/week)
When 65% of the 30 patient a day becomes IMRT plan patient,
Workload(MU) for 3D patients per week = 0.35 *30*5*(200/0.6)* 1 MU/cGy = 17500 (MU/week) = 17500 (cGy/week)
Workload(MU) for IMRT patients per week = 0.65*30*5*4*(200/0.6) * 1MU/cGy = 130000 (MU/week) = 130000 (cGy/week)
Total work load = 130000 + 17500 = 147500 (MU/week) = 147500 (cGy/week)

Notice: I calculated MU in a week at first, at the end of calculation, simply change the unit MU/week into cGy/week (1 MU = 1 cGy)
The reason is that workload eventually needs to be compared with permissible dose limit (such as 2 mrem/week), 1 cGy = 1000 mrem.

Workload increase = (147500 - 50000)/50000 = 1.95 = 195% as conventional workload increase expression, where the ratio of new workload over old workload (1.95+1= 2.95) should be considered for leakage and scatter shielding increase I would find workload increase as: Total new work load/workload when all patients were 3D plan = 147500/50000 = 2.95 = 295% Thanks I replaced IMRT workload 130000 (MU/week) with Total workload 147500(MU/week) in my calculation for workload increase
workload new = W_{3D} + imrtfactor*(W_{imrt}) = 0.35*W_{old} + 4*0.63*W_{old} = 2.95*W_{old} This is a easier way in this case. I did this way in problem #247 (typo 0.63 should be 0.65). The underlining principle of this analysis is MU calculation

Additional leakage and scattering shielding required: (1/2)^x = 1 / 2.95, solve it, X = 1.56 (HVL)
It is very late for me, but I wish i could see the logic by using MUs, Work load never in Mu unless you are trying to find the IMRT ratio
For secondary source(scatter and leakage), radiation level outside vault is in direct proportion relationship with how many MU you are going to use, otherwise, there will be no difference in secondary shielding design weather you do IMRT or not. Take it easy Yong

Please read NCRP 151, pG 123, IT STATES THAT THE INCREASE IN w WHEN imrt IS USED IS GIVEN IN TERMS OF CgY/WK

A clue to that we need use MU for our analysis in the problem is that PDD information is provided. I think the test preparation person have MU in mind, they know what is needed for considering workload. If not, what is PDD used for? just for distraction? I think not.

Bottomline: I will use MU analysis for workload increase calculation in exam. at end of calculation, simply change unit from MU/week into cGy/week since 1 MU = 1 cGy. I also use shortcut way if applicable as I did in problem#247. But I will never use just sum of patient prescription as workload.

I would like to add a few questions from others below

272. A universal wedge (WF = 0.25) was used in treating a tangential breast with the wedge and open field shown below. If the dose calculation was performed correctly but in the treatment delivery, the open field was treated with the wedge field and viceversa. What is the dose to the iso if the prescription dose is 200 cGy. **(ABR 2010)**
mid open 30% mid wedge 20% Lat open 30% Lat wedge 20%
Choices: a) 130 cGy, b) 175 cGy c) 200 cGy d) 250 cGy
Similar qustion above
no diagram, not sure if we need % of wedged to open field, MISSING info. OK 40 % wedged and 60% open
W = 0.4x200 = 80 cGy ---> 80 cGy/ 0.25 =320 MU Total =====> lateral 160 MU & med 160
O = 0.6 x 200 = 120 cGy == 120 MU Total ==========> lateral 60 and Med 60
Reversed treated
W 120 MU = = > 120 MU x 0.25 = 30 cGy Total ====> lateral 15 cGy & Med 15 cGy
O 320 MU === > 320 cGY total ============> lateral 160 cGy & med 160 cGy
Total dose is 320 + 30 = 350 cGy and 175 cGy lateral and 175 cGy Medial

1. Let us assume 30%, 20% means MU fraction:
Let MU = MUtotal = MUopen+MUwedge
wedge field dose/(open field dose+wedge field dose) = [20/(20+30)]*MU*0.25 /{ [30/(20+30)]*MU+[20/(20+30)]*MU*0.25}
= 0.1/(0.6+0.1) = 0.1428.

For either medial or lateral field:

wedge field dose = 0.1428*(open field dose + wedge field dose) = 0.1428 * 200/2 = 14.3cGy
open field dose = 200/2 -14.3 = 85.7 cGy

When wedge field was treated with open field MU: Dose = {[30/(20+30)]* MU/ [MU*20/(20+30)]}*14.3 = 21.5 cGy **85.7*0.25 = 21.425**
When open field was treated with wedge field MU: Dose = {[20/(20+30)]*MU/ [MU*30/(20+30)]}*85.7 = (0.4/0.6)*85.7 = 57.1 cGy **14.3/0.25 = 57.2** **(**The way you thought here is not intuitive to me, even though it came out OK, I think it will confuse youself too in the heat of battle)

Dose to the iso = 2*(21.5+57.1) = **157.2** cGy **(57.2+21.425)*2=157.25cGy** (even though your total matches,the way you calculated is not straight forward to me, and I think it will even not be easy for you to carry it out)

Speculation: It might be that one of the answer is 157 cGy instead of 175 cGy. If the answers are stated four, I will select 175 cGy since it is the closest one to my own answer.

The question is : Are the 30%, 20% are MU ratios or dose ratios? Good question, do you agree with the way I calculated if the 30%, 20% is for MU? When the open field was treated with wedge field, MU is the subject, i.e, when the open field was treated with wedge field MU. Therapist deal with MU not dose.

I agree with your MUs calculations. Finally, I got a long-waited confirmation, thank you.

2. Let us assume 30%, 20% means dose fraction relative to prescription dose of 200 cGy:

For either medial or lateral field:
wedge field dose = 0.2*200 = 40 cGy --- MU = 40/0.25 = 160
open field dose = 0.3*200 = 60 cGy ---- MU = 60

Now therapist treat wedge field with open field MU= 60, Dose delivered this way = (60/160)*40 = 15 cGy
Therapist treat open field with wedge field MU = 160, Dose delivered this way = (160/60)*60 = 160 cGy

Total Dose to iso = 2*(15+160) = **350** cGy

This is just for demonstration, I do not like this assumption as therapist deal with MU, they do not deal with dose. In this problem, therapist made a mistake.

Interesting problem! Weighting always refers to dose, not MU.
Before the switch, the doses from each field were: medial open=0.3*200=60cGy, medial wedged=0.2*200=40cGy, lat open=0.3*200=60cGy, and lat wedged=0.2*200=40cGy.
After the switch, the doses from each field are: medial open=60*0.25=15cGy, medial wedged=40/0.25=160cGy, lat open=60*0.25=15cGy, and lat wedged=40/0.25=160cGy. Adding up the doses after the switch: 15+160+15+160= **350 cGy** **Go bearcat**
You think it is this case, I think it is either 1 or 3 depending on what we see at exam and how we digest the problem. Good thing is that the result of both case 1 or 3 ask me to pick total dose to the iso as 175 cGy, so my strategy is that if the problem is presented as is, I will select 175 cGy as my final answer.

3. Let us assume WF=0.25 means weighting factor which is the fraction of wedge dose over total dose of the field

Wedge factor (wf) = 0.25 is unusually low. Where can I find a 60 degree physical wedge with wedge factor of 0.25? I am speculating that WF in problem does not mean wedge factor, rather WF means weighting factor which is the fraction of wedge dose over total dose of the field. If this assumption is true, then

For either medial or lateral field, wedge field dose = 100*0.25 = 25 cGy, open field dose = 100 - 25 = 75 cGy

When wedge field was treated with open field MU: Dose = {[30/(20+30)]* MU/ [MU*20/(20+30)]}*25 = 37.5 cGy
When open field was treated with wedge field MU: Dose = {[20/(20+30)]*MU/ [MU*30/(20+30)]}*75 = (0.4/0.6)*75 = 50 cGy
Dose to the iso = 2*(37.5 + 50) = **175** cGy. This answer matches with one of the 4 answers.

If this is the case, the problem should specifically state that weighting factor = 0.25, or wedge dose fraction = 0.25, rather than wedge factor = 0.25.
I think the percentage is for dose, so you get 100% dose to the isocenter where dose was prescribed, agree with 175cGy I do not understand what you stated. which percentage you refer to? **I mean the 20% 30% in the problem, they are referring to dose in stead of MU.**

(0.3*0.25+0.2/0.25)*2*100cGy = 175cGy Thanks If you think 30%, 20% refer to dose, your total dose to iso should be 350 cGy, not 175 cGy as I demonstrated. **No, I still think it's 175cGy, 200cGy was prescribe to iso, meaning 100 from each angle.**
You only calculated one field by (0.3*0.25+0.2/0.25)*2*100cGy = 175cGy. The right equation for you would be:
Total dose at iso = 2*(0.3*0.25+0.2/0.25)*200 = 350. Think about this way, if there is no switch: Dose = 2*(0.3 + 0.2)*200 = 200 cGy
Thanks, i think you are right.
This might help by going back to the basics. Wedge Factor is defined as the ratio of the absorbed dose measured in a tissue equivalent phantom at a depth of 10 cm on central axis with the wedge in place to the absorbed dose at same point without the wedge same SSD. I am sorry that this concept is NOT clear to some.I am clear on this basics, check to see how many other wedge related problems I solved and other physicists confirmed. You have to use the dose not the MU. This is the difference between the red and gray solution. I am not sure how to justify using the MUs ratios which we do not have. I am using the information was provided while the gray is insisting to use MU which was NOT provided. Thank you Disagree. the ratio in my equation [20/(20+30)]*MU*0.25 /{ [30/(20+30)]*MU+[20/(20+30)]*MU*0.25}is a dose ratio in disguise, it looks like MU, but it is dose ratio, thinking of proportionality...

273. Tissue deficit is 5 cm. To use Al to compensate given electron density of water & AL, and density of H2O & AL, how thick AL should be? (**ABR 2010) ratio I think the density of al is 2.7 g.cm3 so 5 x (1/2.7) = 1.85 and apply electron density Z Na / A for water / e density A for AL. Agree w/below as far as reduction 15-30 %**
Thickness of Compensator (cm) = 0.7*Tissue deficit *(density of tissue/ density of compensator) = 0.7*5*(1 / 2.7) = 1.3 cm
You are correct compensator have to be reduced 15 - 30 % and have to be (15- 30 cm) away from the skin to preserve skin
Very good question, we need to know the objectives of using tissue compensator:
1. overcome the uneveness of irregular or sloping body surface which produces skewing of the isodose curves, produce isodose curves within the patient that duplicate as closely as possible, those as if we place tissue equivalent material directly on patient body surface to make up missing tissue , so as to make body surface even.
2. preserve skin sparing effect for MV X-ray beam.

274. What you will use to measure Time error? --KA
Let me try, It depends on for linac it is the end effect or timer error for Co-60. For linac let us say we want to use 100 MU, then we give 25 mu for different time without stopping or resting the electrometer, same thing for Co-60 let say we count four sets of 15 sec
If you mean time error with Linac, we do monthly check to ensure machine stops at preset time. We preset 100 MU and time at 15 second, shoot the machine at 300MU/min, machine should stop at arround 75 MU left. We more or less look for beam stops before MU run out.
Time accuracy is less of priority per say for Linac, than MU accuracy, it is just a backup function in case MU count malfuntions.
For HDR time error, we use stopwatch, start it when I see red dot light up, stop it when it dims. stopwatch is accurate to 100th of a second, more than enough for clinical use. I know that a medical center use ion chamber to measure charge proportionality to check against HDR timer accuracy. To me, it is overkill.
For completion will take an example: let us say we ran 100 MU in a A sec and we ran 4 sequence 25 MU without resting timer =B sec
The difference will be 100 x (B - A) / (4A - B) Thanks to ARC

275. Calibration of a linac was performed for 4MV beam, using SSD setup, 10X10 field size, depth of 10 cm, PDD(10cm)=61.6%. IC Read.=10.66 nC, $k_{T,P}$=1.078, k_{pol}=1.001, k_{ion}=1.001, k_{elec}=1.000. $^{Co\text{-}60}N_{D,W}$=0.05299 Gy/nC. TMR (10X10, 5cm)= 0.915
Then the physicist noticed that the calibration should be done using SAD setup, depth=5 cm. What is the absolute dose at depth=5 cm, for this SAD setup? (ABR 2010)

1. SSD Setup:
Dose (at d=dmax)={[Mraw x kT,P x kpol x kion x kelec] x Co-60ND,W }/PDD(10cm) =[10.66x1.078x1.001x1.001x1.0](nC)x5.299(cGy/nC)/0.616 Dose (at d=dmax)=99.05 cGy (per 100MU)

2. SAD Setup:
Dose (SAD at d=dmax)=Dose (SSD at d=dmax) x (101/100)2= 101.04 cGy Here is the step moving dmax from 101 to 100 cm to source

Dose (SAD at d=5cm)=Dose (SAD at d=dmax) x TMR (10x10, 5cm) = 101.04 cGy* 0.915 = 92.45 cGy
Agree (second time put it on) I get same answer as brown.Is it 92.45 cGy? Thank you for confirmation, The 100 MU is implied because we deliver 100 MU dose so that we can get 1cGy per MU (So it does not need to be stated)
So far the method is correct. The PDD implicitly incorporates the inverse correction. And since essentially the TMR is to some extent independent of SSD then we need to correct for any inverse corrections in the equation. The only error that maybe here is the actual inverse distances. I think we need to use the Mayneord's F factor here to convert PDD at 100 SSD to PDD at 95 SSD.
PDD (95) =0.610764 then Dose ={[M_{raw} x $k_{T,P}$ x k_{pol} x k_{ion} x k_{elec}] x $_{Co\text{-}60}N_{D,W}$ }/PDD(at 95 SSD) = 99.8997 cGyIs 99.8997 your dose at depth of 5 cm SAD setup? If so, it does not look good to me then continue Once we convert to SAD output, we do not need PPD any more, as long as we have TMR data. No its not yet I didn't finish the calc and you're correct bout the last sentence. I just didn't

finish. Please finish your thought, it is very important.
After consulting two ABR physicist, they both had the same answer but different than my nswer, so I will write theirion and you guys judge, ok:
But regarding the conversion from SSD to SAD was the problem: I think here, the TMR is used incorrectly if we assume the TMR is defined for standard SAD100, obviously 95+1 is assuming SAD=100 setup. but 100+1 is not the Dmax with SAD=100, so i think this is not very accurate. In fact, it is incorrect way to use TMR concept, I agree with your analysis.
ISL = $((100+1)/(95+1))^2=(101/96)^2=1.1068$
Dose (d=5cm, SAD)=(0.99cGy/MU)x1.1068x0.915=1.0028 cGy/MU I think I know why they did it incorrectly now, they should have calculated this way following their thought process:

1. When iso is placed at 5cm depth, SSD = 95 cm, the dose at dmax = 0.99 cG/MU * [(100+1)/(95+1)]^2 --- they did this step correctly.

2. But this dmax point is only (95+1) cm away from source, we need to know Dose at dmax with 100 cm distance from the source in order to use TMR, so let us convert this dose into that with 100 cm distance from the source: multiply result from 1 by [(95+1)/100]^2 ---- they failed to perform this step. I failed to recognize this and went along with it after all. Fellow physicist here guided me back on the right track. To me, this experience is precious and much more useful and effective than reading textbook by myself.

3. Now, we can directly multiply result from 2 by TMR to obtain Dose at 5 cm depth with 100 cm distance from the source.

Therefore, their equation should look like this:
Dose (d=5cm, SAD) = (0.99cGy/MU) * [(100+1)/(95+1)]^2 * **[(95+1)/100]^2** * TMR = 0.99 * 1.1068 * **0.9216** * 0.915 = 0.924 (cGy/MU)
They left **0.9216** out in the equation, that is why their answer is incorrect.

Conclusion:
1. 1st one should find the dose from dmax SSD to dmax SAD, so apply the ISL=$[(100+1)/(95+1)]^2$ ISL = $[(100+1)/100]^2$
2. Then use the given TMR(5, 10x10) to find out the effect of the 5cm water attenuation on the dose from dmax
I have a different approach. I did a Mayneord's Factor conversion of the PDD at different SSDs which then produced Dose (95 SSD)
PDD(100 SSD) *((95 +1)/(100+1))^2 *((100+10)/(95+10))^2= 0.616 * 0.9915 =0.610764 =PDD(95 SSD)
[10.66x1.078x1.001x1.001x1.0](nC)x5.299(cGy/nC)/0.610764 *TMR= 99.8997 *0.915 = 91.4 cGy =Dose at 5 cm depth your result is very close to 92.45 cGy which makes me feel comfortable as an independent verification. Thank you for the effort. The difference is due to inherent MF inaccuracy about scatter. I guess so...
I gave this problem to our chief medical physicist and another ABR medical physicist seperately, both of them independently came up with this result: 92.46 cGy/100MU, they say even if the problem has TPR(10x10, 5cm) = 0.915, rather than TMR(10x10,5cm) = 0.915, they would come up with the same result of 92.46 cGy/100MU. The way they solved the problem is the same as Ahmad wrote initially.
OK thanks :)

f photo-electric interactions.
From my understanding: when using the kV range for imaging, Photoelectric is the dominant process. Also, the difference in bone attenuation of the photon beam in kV is much clear than the attenuation of the MV photon beam in bones, the difference in attenuation in case of the MV beam can barely be detected by the MV detectors, while it can be clearly detected in the kV detector.
Optic density OD = log Io/I, Contrast = log(Io/I)bone - Log(Io/I)soft tissue = log [(Io/I)bone / (Io/I)soft tissue]
The ratio of attenuation of bone over soft tissue in photo-electric interaction is much larger than that in compton scattering which dominates in MV range while photo-electric interaction prevail in KV range. Also, scattered photon contribute to foggy images which further reduce contrast. When photons go through photo-electric process, they lose all their energy and disappear, no foggy image issue.
PE proptional to sqr E / Z cub, There is higher % of PE (30-140 kV) in the diagnostic range than higher energy
277. Where we have to place a Pb shield inside a concrete to reduce the concrete thickness for a primary barrier wall.
concrete, lead, concrete
This question was answered in details in Q(237)

278. 50 Gy is prescribed to 90% isoline, find the dose at 50% isoline

Dose at 50% isoline = 50 Gy*(50/90) = 27.8 Gy Agree

JUST FOR FUN

279. A patient who is 30 cm wide at umbilicus level is to be treated at an SAD of 400 cm with an 18 MV X ray beam which has been calibrated at d-max at an SSD of 100 cm. Typical vales would be: $S_c = 1.10$, $S_p = 1.01$, TMR(depth-15, FS=30_2) = 0.815. Tray = 0.98, Spoiler = 0.96, OAF = 1.00(central axis) and 75 cGy per field. How many Mu are needed

maybe just to repeat it here: (103.5/400)^2 = 0.067, ignore the distance between dmax and midplane (I only ignored surface to dmax in comparison to SSD of 350 cm in problem 161). To be honest, I would not ignore 11.5 cm here.

treating with POP: 75/(0.067*1.01*1.1*0.815*0.98*0.96) = 1314MU for each beam, Thanks good work, As was sent to me

Below is my solution:

SAD is a typo,There were no typo it should be SSD = 400 cm. There is no such machine with SAD = 400cm to my knowledge. **Please be aware that I did not write the question. your Methodology is correct.** Please correct me if you think I did something incorrectly in the detail of my solution, or did not match the intention of the problem.

MU = 75 * [(400+3.5)/(100+3.5)]^2 * 1/0.815 * [(400+15)/(400+3.5)]^2 * [1/(1.10*1.01*0.98*0.96)] = 75 * 15.1986 * 1.2270 * 1.0578 * 0.9567

output adjustment TMR Mid plan vs dmax all other adjustment

= 1415.4 per field ~ 1415 per field.

I hope my equation is clear Please see the green solution a result of 1314 and without rounding off the (103.5/400)^2 will be a little higher (using the . 0.0669515 instead of 0.067/ This is a typical not finding the correct answer but close. I imagine some might get 1320 or even 1330 depending on rounding off.

New question, I have been asked, the q is as follow

280 What is the activity needed of 198Au (mCi) for a patient is to receive a single plane implant with gold seeds using the Paterson-Parker technique. The area of implant is 10 cm^2 and a total dose of 5000 cGy is to be delivered. Use the Paterson-Parker tables/

Thanks for trying to solve

My try: We will also need the treating distance, Assume 0.5cm to treat microscopic disease. based on the table we need 235mg-h/1000R, this is roughly equivalent to 235mg-h/900cGy → 235 * 5000/900 = 1306mg-h → 1306mg-h * 8.25Rcm^2/mg-h = 10770Rcm^2 → 10770 / 2.38 = 4.5Ci-h (this unit is bit confusing... and 4.5Ci is a lot of activity...) Thank you, I got same

Below is my solution:

10 cm^2 treatment area, 5000 cGy prescription. Assume treatment distance is 0.5 cm. Patterson-Parker Planar Implant Table give 235 Milligram-Hours per 1000 R

Total Radium miligram hour = Total Ra mCi hour = 235 * 5000/(1000*0.876*0.95) = 1412. where is 0.95 comes from?(0.876: R to cGy in air 0.95: cGy in air to cGy in tissue conversion, note: I added R to cGy in air conversion factor of 0.876 which I missed earlier)

Radium gamma constant = 8.25 Rcm^2/mCi-hr

Au-198 gamma constant = 2.38 Rcm^2/mCi-hr

Total Au mCi hour = 1412 * 8.25 / 2.38 = 4894.5 mCi hr

Au-198 is a permanent interstitial implant

Au-198 meanlife = 1.44*T1/2 = 1.44*2.7*24 = 93.312 hours. Au-198 Activity needed = 4894.5 mCi-hr / 93.312 hr = 52.5 (mCi)

Thanks! i hope all these constants are given, i can only remember 8.25Rcm^2/mCi-hr... :) me too

You can derive meanlife = 1/lamda = T1/2 / 0.693 = 1.443 T1/2 THANKS you are welcome.

281. In tissue from a 0.46-mCi permanent implant I-125 seed, what is the total dose to 1 cm distance?

Apparent Activity Aapp = 0.46 mCi, Distance D = 1 cm along axis at source center perpenticular to source.

Air Kerma Strength Sk = Aapp * Gamma Factor * (W/e) = 0.46 * 1.45 * 0.876 = 0.5843 (cGy cm^2 / hr) = 0.5843 (U)

Dose rate at 1 cm D(1cm) = Sk*Dose rate constant = 0.5843 * 0.965 = 0.5638 (cGy/hr) We already had 0.5843 cGy/hr at 1 cm. Where did 0.965 come from? 0.5843 cGy/hr is air kerma strength, 0.965 (dose rate constant for I-125) convert it into dose rate in tissue. remember f med factor? Ah. Khan p272-274 discusses dose in water, and says at short distances (<5cm), dose in air is almost identical to dose in water. Fig 15.13 enforces this, by showing that dose fall-off matches inverse square in air. Low energy sources (those that decay by EC) are the exception, as they show further attenuation. I have a general picture of that graph in my mind rather than knowing the specific value, so our approaches are similar. Where exactly did the 0.965 value come from? This dose rate factor is a NIST measurement for I-125 seed Model 6711 (2004 TG-43) ^ = Dwater/Sk,n99, Dwater is TLD measurement, Sk,n99 is NIST free air chamber measurement. TG-43 came in to overcome low energy photon emitter dosimetry issues. In 1995, TG-43 determined dose rate constant is 0.88, while pre TG-43 era, in 1983, dose rate factor was determined to be 1.0355. The most recent TG-43 2004 determined dose rate constant for model 6711 I-125 seed as 0.964. as you can see, it varied a lot. and we wave with them together each time they change their mind.

Total dose = mean life * initial dose rate = 1.44 *T1/2 * initial dose rate = 1.44 * 59.4 * 24 * 0.5638 = 1157.4 (cGy).Agree Thanks I had an almost identical approach, and got a similar answer. However, this is sample question #4 on ABR's website, and the answer is supposed to be 13.2 Gy. Let me check on their website. Why the difference? I am puzzled. I did check into it and found that they neglected (W/e) factor to convert exposure to air kerma, i.e. they did 1 R ~ 1 cGy conversion. If you divide 1157.4 by 0.876, you get 1321.2 cGy = 13.2 Gy.
I believe an oversight error was made in this sample question answer on their website.

282. I-125 seed, Dose Rate Constant = 0.5 cGy/hr per U, Sk = 0.7 U. 87 seeds were used to cover 95% of the prostate volume to a dose of 145 Gy. If the same number of Pd-103 seeds were used to cover the same volume to 90 Gy (Pd-103 dose rate constant= 0.7 cGy/hr per U), What air kerma strength Sk should be?
Set the Sk for Pb-103 is X. 145/(0.5*0.7)=90/(0.7*X), X=0.25U, forget the mean life.
Below is my solution:
I-125: Total Dose = 0.5 * 0.7*1.44*59.4*24
Pa-103: Total Dose = 0.7*Sk*1.44*17*24 = 90/145 (I-125 Total Dose) = 90/145(0.5*0.7*1.44*59.4*24)
Sk = 90 *59.4*0.5*0.7/145*0.7*17 = 1.084 (U)
meanlife is an important concept, we have to watch out for.Agree. Thanks for correction you are welcome, we all forget things, but we will avoid it next round.

283. An SRS case use 5mm cone, prescribed dose is 90 Gy. Plan using twelve equaly weighed 120 degree arcs. Each arc can deliver up to 999 MU max. Max MU per degree is 19.99 (at the iso, TPR = 0.75). How many passes each arch should go in the treatment delivery? (the output factor for 5mm cone is 0.82)
Donot understand the question completely.
Dose per degree=90/120=0.75Gy, If assume each arc has same length, MU per degree=0.75*100/(0.75*082)=122MU in one arc,Total no of arc=122/19.99=6.1, clinically choose 7?

No issue for the presentation of the problem to me, question is OK You mean pass 7 times?
Let me try. If I give each arch the maximum MU (999) allowed, what would be the dose to the iso? 999/120 = 8.325 < 19.99 I am fine.
12 * 999 * 0.75 * 0.82 = 7373 (cGy) = 73.73 (Gy) < 90 Gy
One pass is not enough to deliver 90 Gy at iso. We need two passes. The answer I think is 2. Use of 999 MU for estimate calculation is OK, we know we need 2 passes, MU burden will be shared between the two passes. **(Thanks for making it clear)**
thanks, make sense. never seen SRS Tx with arcs, so the question wasn't very clear to me. So you mean for the 12 arcs, each needs to go back then forth for twice? Yes
90Gy/12 arcs = 7.5Gy/arc
MU required/arc = 7500cGy/(0.75*0.82) =1220 MU exceeds the maximum limit of 999 MU for a given arc and hence 2 passes are required per arc. (Assuming, the output for 10x10 is 1cGy/MU)

Purple, I added Max in fron of MU per degree is 19.99 to make it clear.

284. C B A AC= 7m, BC = 5 m. If iso is at A, Dose rate at point C meet the requirement of 0.02mSv/week. If iso change to B, how many TVL of shielding should be added?
Assume same WUT, B=(0.02*(1/12)^2)/(1/5)^2=3.47e-03, TVL=-log(B)=2.46TVL

We think completely differently on this one again, but our results are different:
Dose rate increase factor : (7/5)^2 = 1.96 (1/10)^X = 1/1.96, X ln0.1 = - ln 1.96 = - 0.673 X = -0.673/ln0.1 = 0.29 (TVL)
My mistake, I though AB=7m rather than AC=7m,and also 0.02mSv/wk should no change as well. Thanks for correction.Ans is 0.29TVL
So we have confirmation now on this one.Yes

285. I-131 patient, what is the max activity level for the patient to be released after administration based on dose rate level at 1 meter?
Do we usually think about dose rate for permanently implant? is that should be 2mrem/hr at 1 meter?

This is oral administration of I-131 pill for thyroid cancer treatment. No, for I-125 permanent implant, release criteria is 1 mrem/hr at 1 meter. For I-131 radiopharmaceutical administration, dose rate release criteria is 7 mrem/hr at 1 meter.
Gamma Constant for I-131 = 0.22 mR/hr per mCi at 1meter, let A = I-131 activity (mCi)
A*0.22 *0.876*0.96 = 7, A = 7/(0.22*0.876*0.96) = 37.8 (mCi)

286. Fetus dose for women treated mantle technique, which is the major contribution of the fetus dose?
A. Block scatter, B. Internal scatter, C. Fetus position
Internal scatter Agree agreescw

287 Gap calculation. Spine fields. Sup field treated with depth 7 cm, SSD 93 cm, field size = 12 cm. The inf field SSD = 100 depth = 4.5 cm, length = 10 cm. If the two field join at depth of 6 cm, what is the gap at surface?
gap = (6/100 + 5/100)*6 = 0.66cm
at depth of 6 cm, sup field FSZ=(12*99)/100=11.9cm, inf field FSZ=(10*106)/104.5=10.1cm. so gap@ 6cm=(0.5*11.9/99+0.5*10.1/106)*6=0.65cm

gap = 6 [(12/2)/100 + (10/2)/100] = 0.66 (cm)
Both field size are given in collimator setting, both fields are symmetric fields. I have yet to see an asymetric field match gap calculation.
Purple, I am glad to see that we think differently, but our results confirm each other, it is a good place to be.
Gap=6*((12/2)/93)+(10/2)/100)=0.69 cm (I assume the idea behind the gap calculation is the similar triangles at surface for SSD setup) I think in this case no need to think about the field Disagree, first item, divide by 100, not 93 because field collimator size is given which is at 100 cm, do not use SSD here, use SAD instead. That is why your answer is different from three of us. This can be confusing.

288. What is stem effect of ion chamber?
I would like to answer many problems here but it took me almost two hours to answer three questions, which is time consuming. wish you all best
Stem effect is caused by the contribution of ionization measured by a chamber system was produced outside the chamber in the body of the stem. Khan's 4th Edition pg 77 scw SCW you are very helpful by citing your reference.

289 What is V45?
Volume that received 45% of prescription dose Disagree
% (could be cc too, but % most popular) of interested organ or target volume received **at least** 45Gy dose Agree with this statement scw
An example is closely watched V20 for lung cancer treatment either 3D plan or IMRT plan: % lung volume received at least 20Gy V20 should be less than 30% and V5 should be less than 50% for lung cancer treatment plan.
So i guess we are supposed to see V45 and V45% then? We will not see V45% which is not a standard expression of DVH.

290 What is the dose tolerance of chiasm ?
54 Gy, same for Brainstem, and optic nerve, Agree, it is maxmium dose.

291 If the total dose delivered is 120 Gy, what is the dose rate at 30 days from a 0.46 mCi Pd source (given T1/2 = 17 days)?
1.44*17*D0=120 → D0 = 4.9Gy/d → 4.9*exp(-0.693/17*30) = 1.44 Gy/d Agree
it is too late for me but the numbers seems low
292 The seminal vesicles are located ______ and ______ to the prostate
Superior and posterior Agree Agree

293 Which has a larger value for the radial function beyond 1 cm, I-125 or Pa-103?
I-125 agree Agree Khan 4th Edition pg 332 scw

294 For which isotope do Monte Carlo calculation account that photoelectric interaction and compton scatter cancel out so that only primaries are considered?
Ir and Au Agree. Green: could you share your thoughts on how you get your answer?
Is it possible the question about I-125 where energy 50% CS and 50% PE?
To me, at I-125 photon energy level (28 kev), photoelectric process attenuate much more than compton can compensate. The reason is that photoelectric process eat photons, while compton process scatter photon isotropically, it takes a whole lot more compton interactions to make up photoelectric interaction loss at a reference point.. I do not have much experince with MC but I like to bring to the group in khan erd edition page 74 a table The relative importance of various types of interactions is presented in Table 5.2. Again, I do not know if this relevant to MC or not. From the table at 25 kev there is 50 % PE and 50% CS. I imagine with the computational process will a have a problem counting these events. The computational creteria might.

Brachytherapy Guru Dr. Jeffrey Williamson at Virginia Commonwealth University state that:
Above 200 kev: All photon emitters have same depth dose regardless of medium
Below 100 kev: photoelectric effect induces up to two fold heterogeneity correction

My bet is Ir-192 (Average 380 kev). That is why HDR planning software such as Nucletron's BrachyOncentra treat patient volume as uniform water medium. No scatters are considered, only primary is in consideration.(inverse square law). I have to check into if it accounts for tissue attenuation, our chief physicist told me before that it will not account for tissue attenuation. I just learned that varian Brachyvision HDR planning does not account for tissue attenuation either.

Au-198 (412 kev) also fall in this catergory.
So, I will pay attention to isotope photon energy, use 200kev as threshold to guide my selection.

295 What is Neutron dose equivalent ratio 18 MV vs 15 MV? a. 1 b. 2 c. 5 d. 10 e 100
NCRP151 table B9: for varian machine: 18MV H0 = 1.02-1.6 mSv/Gy; 15MV H0 = 0.79-1.3 mSv/Gy, so the ratio is about 1.2 ...

296. What is not true about TBI?
A. Dose Uniformity < 15% B. Tissue equivalent compensators are used C. High SSD D. AP preferred over Lateral
A. Does uniformity within 10% **agree**Agree

297. Considering a dual ion chamber scanning water tank, an error in the PDD (a shift up or down) is not due to:
A. incorrect zero-ie set above water level B. RF interference C. water/air temperature differential D. Stepper motors not calibrated correctly
C. **agree**

298. I 50 ionization depth of an electron beam is 5.1 cm, The energy of the beam is ?
12MeV, the range of 12MeV is about 6cm and it falls off pretty quickly, so this would be my answer. **(That would be my answer too scw)**
How about the following: R50=1.029I50 - 0.06=5.188. → → Mean Incident Energy **E=2.33R50=12MeV (Nice thinking green)**
Agree
299. Breast Tangent pair. Field widths at 100 SAD =10.5 cm. LAO has gantry angle 45 degrees. What gantry angle does RPO have such that posterior borders will be parallel?
do we have this quesiton before? RPO=45+180-2*arctha(0.5*10.5/100) **219degree**
You are right, this is a repeat, I forgot it.

300. A survey points a linac beam at a primary wall and measures 5 mR/hr. Is this OK? at 30 cm off the primary wall
5mR/hr*0.001*0.876cGy/R*1=4.38E-3Sv/hr..
what you trying to convert to?to mSv/hr
1 mSv = 100 mrem , 1 mR = 1*0.876 mrad = 0.876 m cGy = 8.76uSv=8.76E-3mSv, It should be 0.0438 mSv/hr
Thanks, now I got it. 0.0438*8*5=1.752mSv/wk. Is that right? what is your limit? yes, but you overlooked something U and T for U, you have to consider beam on time in addition to ¼ (4 walls), beam is not on all the time, ignore d now, you already got your measured radiation level. you have to think how many patient you treat, how long beam on for each patient. T is not 1, no one is there all the time. figure out total beam on time for a week, reasonable assumptions, you got it. you still overlooked another aspect 1/16 you used, conservative value, 1/16 is fine. You also need to evaluate 2 mrem in any hour requirement which you can only use U and beam on time. This question test you more on this aspect. You answer would be OK, due to limited beam on time within any hour and beam is not always on this wall (U=0.25). Limit is not instantaneous one like 2 mrem/hr. Lot of people mix the concepts. no, again, you can take beam on time into consideration plus U factor, after that, your dose in any hour will be less than 2 mrem.
My limit is 0.1mSv/hr for controlled and 0.02mSv/wk for uncontrolled. the 0.02mSv/wk should be the one. Let's say U=1/4, T=1,d=30cm
if 40 patients per day, 30sec to 1 min per patient, total treatment time=40*1*5=200min/wk=3.33hr/wk
0.0438*3.33*0.25*0.0625=2.28e-3mSv/wk<0.02mSv/wk. Thanks for help. OK change to T=1/32?
for dose rate in any hour, for 2mR/hr, it is 2mR/hr*0.876(cGy/R)=0.0175mSv/hr=1.75mren/hr<2mrem/hr. it is OK. But for 5mR/hr, it is 0.0438mSv/hr=4.38mrem/hr, it is high.
301. Dose 10 cm deep 5cm outside field is A. 1% B. 2% C. 3% D. 4% E. 5%
this will depend on energy as well?

302. Apparent mCi is less/more/same as mCi
LessAgree

303 When new HDR source arrives at your site for source exchange, do you need to do any survey(s)? If so what survey(s)? How do you know your survey results are good? and when do you have to do the survey(s)?
this looks like oral question...
need to do a survey with ion chamber outside the shield of the room, we do this after every source change which usually is quarterly
we also need to do wipe test, and the limit is 5nCi

The HDR source is normally labeled as yellow II package, within 3 hours of receiving, you have to perform and document:

1. Radiation level at 1 meter (mrem/hr) to see if your result match approximately the index value on the package, this is to ensure the shipper labeled the source package correctly and shielding inside did not change some how during transportation
2. Wipe test, the result have to be less than 22000dmp/100cm^2. This is to ensure that no contamination occurred on the surface.

HDR unit shielding survey is a seperate issue.
Source leak test limit is 5 nCi, that is for source object itself wipe test, not for shipped package surface wipe test.

304 IMRT shielding: how much more shielding needed?
A. All wall +TVL, B. Primary + TVL C. Secondary + HVL, D. Secondary + TVL
D Agree
C
In problem#247, I calculated additional shielding of 1.6 HVL that is needed if 50% of patient volume become IMRT treatment.
To be conservative, I would like just add like close to 2 HVL, but no such choice available. D. sounds overkill, but C a little bit short. I am going to check into NCRP 151 to see if I can find some related statement. If someone already did, please share. I think I am going to select D, since TVL = 3.32 HVL which is not that much more than 1.6 HVL, considering IMRT percentage could be higher, Therefore add a TVL to secondary shielding is a good choice. My final answer is D.

305 IMRT dose verification using small volume chamber (0.1cc). What should be it's resolution(or measured error) be in order to be able to use for dose verification? A. 0.1% B. 0.5% C. 1% D 3% E 10%
A **Could you please give some details? Thanks**
B Just talked to one of your physicist, he said this would be his pick, he thinks 0.1% would be a little bit too much
At first, I saw the following description from Yahoo group. I though if it is CC01 with 2mm diameter, it is possible to reach 0.1% measurement error. But I developed later that CC01 has 0.01cc volume. So now I am not quite sure.The uncertainty from NIST is around 1.0%~1.6% for therapy ionchamber.
it is generally assumed that the dosimetric accuracy is around 3% for IMRT (sliding window) fields using smaller chambers. Obviously, it has to be at least this to get a gamma value using 3%/3mm, so the higher number (10%) is definitely wrong.
If the accuracy of an IMRT QA plan is to be within 3% or 5% (depending on your institution) that doesn't mean that the ion chamber itself has an accuracy of 3% or 5%. This is a combination in the error of the TPS, theerror created in the deliver-ability of the plan by the machine, the setup error, and the ion chamber accuracy. Think about calibrating output with a NIST Traceable Ion Chamber. If the accuracy of the output is expected to be tuned to within 0.5% then the accuracy of the ion chamber must be either0.1% or 0.5%.
I would say 0.1% citing I would not use the % we tune our machine to in order to figure out this problem, the question I would ask myself is how much measurement error allow me to get a 3% accuracy assuming our machine output is on par. We have to isolate error contribution to just ion chamber to figure out this problem. It is tough to get 0.1% measurement error in clinical setting, positioning error alone may take that already. I am leaning toward 1%, but can not exclude 0.5%.

306 Beam abutment . Patient treated with 10 MV photons and 16 MeV electrons. Field size given. At 5 cm depth what would be the case?
photon side hot spot: electron side cold spot, photon side cold spot:electron side hot spot, both sides hot spots, both sides cold spots, no hot spots

307. PET can not bring information about : A. metabolism B. metastasis C. pathology D. TX follow up, E. Tumor
C

308 Energy at which theoretically can be produced a neutron in LINAC : A. 6 B. 8 C 12 D 16 E 20 MV
B This problem provide clue to final answer of problem# 59 (8 is close to 7.4)
I would choose B also. Is 7.4 the nominal energy?No, it is calculated theoretical photon energy in MeV based on binding and rest energy models to produce (photon, neutron) event in lead. reference was given in previous problem on this subject. To me, nominal energy MV seems not fit. I did not see the reference though I did not go through of the problems. Great work ! :)

309 Which of the following isotope has equal effect from both Compton&photoelectric effect: I-125, Ir-192, Co-60, Cs-137
equal effect, then it's different from the previous problem, I-125

310 To increase the energy in the accelerator, what do you do? A. Increase the current in the magnetron B increase the voltage in the magnetron, C. increase the current in the Thyratron D. increase the current to the gun
B Agree

311 What is ITV? **Internal target volume which counts for internal motion**
ITV = CTV + internal margin (internal physiologic movements and variation in size, shape, and position)
312 What is the best survey meter fo-r lost I-125 seed? A. Cutie Pie, B GM tube C. Thin window GM tube D Scintillation detector

D Agree

313 How are inhomogeneity corrections handled in the superposition convolution algorithm?
adjust dose kernel radiological path length

314 What is the dose rate constant for a 2 mCi Ir-192 source? (ABR 2009)
1.12cGy/U-hr 1.11

315 What is TD5/5 for parotid , esophagus, heart, skin, bowel, liver, larynx ?
32Gy for parotid; 55Gy for esophagus; 40Gy for heart; 50Gy for 100cm^2 skin; 40Gy for small bowel; 45Gy for large bowel; 30Gy for liver; 45Gy for larynx

Esophagus: 58 Gy Heart: 40 Gy, Skin: 55 Gy 100cm^2

316. For a radiosurgical treatment of an AVM, the conformality index corresponding to the 14 Gy prescription dose, as calculated by the planning system, is 1.3. The DVH for the target indicates that V(14Gy) is 95%. The AVM volume is measured to be 23.5 cc. The volume of brain tissue receiving **at least** 14 Gy is ____ cc.
A. 30.6 B 29.0 C 22.3 D 14.0
B Agree If I do not have 4 answers in front of me, I would use CI = 1+ Vnormal / Vtarget, which will give me a different result. Instead I reverse engineered this problem, use CI = Vnormal/Varget to get the right answer of 29 cc. Lesson learned: two CI definitions may be involved.
CI=Pres.DoseVolume/Target Volume
1.3=PresDoseVolume/23.5 Presc.Dose Volume=30.55cc
Question asks for at least 14Gy which is from DVH is 95% then .95*30.55cc=29.07 cc scw

317. A patient is set up for treatment at 100 cm SAD mid-plane. Blocking is drawn on the film that measures 5 cm into the field on the film. A 5 cm magnification ring on the patient's skin measures 8 cm on the film. The patient's seperation measures 16 cm. How far into the field should the block be placed on the tray at 62 cm distance from the source?
from info of the ring: 5/8 = (100-8)/SFD → SFD = 147.2; 62/147.2 = X/5 → X = 2.1cm Agree

318 storage room 6m away from iso in primary direction reading 0.06mSv/hr for 6MV beam, if add 18MV beam and wanted the office next to storage room and 12m away from iso, if want the reading at office below 0.02mSv/wk, how many patient can treat everyday. Beam on time for each patient on this direction is 30 sec.
TVL(6X)= 13.7inches, 18X = 17.8inches, 6x:18x = 70%:30%, Existing Thickness= 36 inches.

HVL(6x) = 13.7/3.32 = 4.1 inches, HVL(18x)=17.8/3.32 = 5.36 inches
For 18 MV
Using the result from problem#104
Dose rate at 6 meter from iso = 2^(t/HVL6 - t/HVL18) = 2^(36/4.1 - 36/5.36)*0.06 = 2^(8.78-6.71)*0.06 =4.2*0.06 = 0.25 (mSv/hr)
Dose rate at 12 meter from iso = 0.25*1/4 = 0.0625 (mSv/hr)
For 6 MV
Dose rate at 12 meter from iso = 0.06*1/4 = 0.015 (mSv/hr)

Total dose rate at 12 meter from iso = 0.7*0.015+0.3*0.0625 = 0.0293 (mSv/hr)
Let n be number of patient each day: 5*n*(30/3600)*0.0293 = 0.02 , solve it , we have n = 0.02*3600/(5*30*0.0293) = 16.4 ~ 16

319. A Tx room has no office on the top of it. the dose rate is 40mSv/wk. If an office to be established over that room and the dose rate to be 0.02mSv/wk. What is the thickness of the steel layer that should be added to the concrete ceiling? Both TVL's were given.
Tvl = 3.9 inches for steel and 13.8 for concrete.

First let us see what is the attenuation factor we need B = 0.02/(40*1*0.25) = 0.002 (use factor of 0.25, occupancy factor T = 1)
# of TVL needed = log (-0.002) = 2.7, Thickness of Steel (inch) needed = 2.7*3.9 = 10.53 (inches), too thick, you may need Lead.

320. From ABR website: A 4-MV, 10x10 cm with 45 deg wedge, to deliver 200 cgy (100 cm SAD) at 10 cm depth given:
output at 100 ssd at dmax 1.2 cm =1.04, WF = 0.7, BSF = 1.03, PDD = 60 %, TAR =0.75, MU = ??
MU= 200/(1.04*0.7*(0.75/1.03)*(101.2/100)^2) = 364 cGy (which is the correct answer they have)

TMR = TAR(Tissue Air Ratio)/PSF(Peakscatter Factor) = (Dose at depth in medium/Dose at same point in free space)*(Dose at same point in free space/Dose at dmax in medium) = Dose at depth in medium / Dose at dmax in medium = 0.75/1.034 = 0.7253
For 10x10 field, 1.25 MeV PSF = 1.04, 10 MV PSF = 1.02, at 4 MV, PSF = 1.02+ (1.04-1.02)*6/(10-1.25) = 1.034

SAD output = [(100+dmax)/100] ^2* SSD output = [(100+1.2)/100]^2*1.04 = 1.065

MU = Dose / (TMR*WF*SAD output) = 200 / (0.7253*0.7*1.065) = 369.9 ~370 **agree**

321- For a xray tube with 100 mA and 100 KvP, the HU has a sigma of 1.5, if the current raised to 400 mA, what is the new sigma of HU?
HU= 100 ma * 100 KvP = 10000, for 400 ma, HU = 40000 sigma => sigma = 1.5 (40000)/10000 = 6 ? Anyone Agrees?
This would be my guess as well BUT is this a therapy question?

Below is my educated speculation:
To me, HU is proportional to the # of photon received by CT detector, hence is related to the current,
The standard deviation (sigma) of HU = C * I^0.5, when I =100 mA, 1.5 = C * 100^0.5, C = 0.15, **YongZhu, could you please give the reference for this equation? Thanks.** Just a speculation as I indicated above, I searched for it, but could not get relavent ones.
% sigma = 1.5/100 = 1.5%

When I = 400 mA, sigma = 0.15*400^0.5 = 3
% sigma = 3/400 = 0.75%

When CT current increase, the percent sigma of HU decrease. This make sense
I do not understand how voltage gets involved proportionally in their solution.

Isn't HU only related to linear attenuation coefficient? yes, that is the filter to control how much photon the detector will receive, but the # of photon detector receive is in proportion of total photons supplied by CT current I. You increase CT current to 400%, the detector will receive 4 times photons at same reference point with same linear attenuation coefficient in place. standard deviation should be in proportion to the square root of the # of photon CT detector received. The C factor is trying to define the proportionality using given information (sigma =1.5 when I=100mA).

322 Three beams 120 degree apart, AP and post obliques, each 15 cm depth to calc point, 60 cG from each beam to be delivered to calc point. Post beams have 9cm lung, e density = 0.33, TMR (3,6,9,12,15) = 1, 0.939, 0.863, 0.791, 0.723, What is MU ratio of post field over anterior field?
For AP beam, depth = 15cm; For post obliques, depth = 6+9/3 = 9cm → MU_{AP} = 60/0.723 = 83MU; MU_{po} = 60/0.863 = 69.5 → MU_{AP} / MU_{po} = 1.19 MU po/MUap = 1/1.19=0.84 Agree demonstrated: 1 cm missing tissue amount to about 3% dose difference due to less tissue attenuation

323 What is pacemaker dose limit? A. 100 cGy **B. 200 cGy** C. 300 cGy D. 500 cGy E. other
Agree
324 what measurement device is best for a simulation room survey?
A. ion chamber B. ion chamber w/electrometer C. GM D. Scintillation counter
Agree

325 What is maximum detector size (diameter) allowed for Linac based SRS beam profile scanning? **A. 1mm** B. 2mm C. 3mm D. 3.5mm
need confirmation on this... anyone?My try is D
Page 460, 4th edition, Khan states: It has been shown that with a detector size of 3.5 mm diameter, the beam profiles of circular fields in the range of 12.5 to 30 mm in diameter can be measured accurately within 1 mm.
This 3.5mm stuck in my mind for a while, I am surprized to see the detector size requirement as little as 1 mm diameter

I guess this is not the best question, different clinic will treat different FS with SRS, so this is based on what treatment we will do on this machine, if we are only treating tumors in cm range, or if we will treat tumors in mm range, the calibration requirements will be different...
How would you image the possible presentation of the question in exam? I would say they can only test general well known study result and popular treatment applications. It is almost impossible to consider every special application of SRS at various clinics to present question, do field sizes 12.5 to 30 mm cover majority of the SRS cases? If the answer is yes, I incline to go with D. D is a well known study result by Dawson et al and Rice et al cited by Khan. The question ask for max, not better detector size, it is a minimum requirement.
The smallest ion chamber diameter we have is 2.5 mm (0.007cc). We use diode to scan SRS beams, we also use film.

I read Khan's statement again, seems he stated that 3.5 mm diameter detector can provide resolution of 1 mm, did I translate that correctly?

326 15x15 (cm) field with 3x15 (cm)block in the center, which has 5% transmission factor. Depth at 7 cm, dose to point A given as 90 cGy with 1.01 OCR, calculate dose to CAX under block (ABR2007)

Field size(cm)	5	7	10	15	20
TMR (7cm)	0.834	0.848	0.865	0.878	0.889
%DD (7cm)	0.755	0.768	0.782	0.795	0.801

(Values above are real machine data from our site)

Feq(15x6) = 8.6cm, Feq(15x3) = 5
assume A is under one of the two open fields, and assume no scatter from the other open field, output =1cGy/MU @ SAD=100
TMR(8.6cm) = 0.848 + (0.865-0.848)*1.6/3 = 0.857
MU = 90/(1.01*1*0.857) = 103.98MU
DOSEcax = 103.98 * TMR(15,7) - 103.98*TMR(5,7)*(1-0.05) = 103.98*0.878 - 103.98*0.834*0.95 = 8.9cGy

Below is my solution:

Equivalent square for open area with A: 2x15x6/(15+6) = 8.6, Equivalent square for blocked area: 2x3x15/(3+15) = 5 cm
For open field 15x15: Dose at B = (90/1.01)*PDD(15x15,7)/PDD(8.6x8.6,7) = (90/1.01)*0.795/0.7755 = 91.35 cGy
[PDD(8.6) = 0.768+(0.782-0.768)*1.6/3 =0.7755]
For just blocked area, open field 3x15: Dose at B = (90/1.01) * PDD(5x5,7)/PDD(8.6x8.6,7)= 0.755/0.7755 = 86.75 cGy

Dose under block at point B = 91.35 - 86.75(1-0.05) = 91.35-82.41 = 8.94 cGy

327. A given dose rate in air at 40” from the superficial x-ray source 125kVp, 10R/mA-s. what is the dose rate at 2cm depth (pdd = 0.6; BSF = 1.15; fmed=0.9)
Suppose dose rate in air at 40” is 100 cGy/min, dose rate at skin with focus skin distance of 40“ = 100 cGy/min * BSF*fmed = 100*1.15*0.9 = 103.5 cGy/min in tissue.
Assume focus to surface distance(FSD) is 40”, dose rate at 2 cm depth = 103.5 *PDD = 103.5*0.6 = 62.1 cGy/min.
fmed is a factor to convert exposure to dose, so the given might be expose rate at 40”, the rest looks reasonable to me...
Disagree, the given is air kerma strength which is not expoure rate, it is air dose rate as stated in the problem. fmed convert air dose rate into tissue dose rate. (W/e) =0.876 convert exposure into air dose.
YongZhu, fmed is defined in Khan, it is also named roentgen-to-rad conversion factor... please check chapter 8 in Khan, latest edition would be P98

328. a Tx room is designed for 6 MVphoton and the primary thinkness wall is 30 inches if want to upgrade to 18 MV. what is new thickness for uncontrolled area? TVL6 = 13.8 inches, TVL18 = 17.7 inches.

First, let us calculate what is the # of TVL for existing 6x shielding: # of TVL = 30/13.6 = 2.2
Now if we upgrade machine to 18x, let us evaluate what is the situation. If there are no shielding for both energy, at the same distance from the machine, dose rates would be the same since we calibrate them at same output, say 400MU/min, the differece is that 18x is more panetrating than 6x. Only when we put up shielding, the difference will show up. at same point with same thickness in inch of shielding wall,dose rate would be high for 18x because it is more panetrating. Now let us say, instead of use same thickness in inch to shield either 6x or 18x, we change our strategy, we use same # of TVL to shield either 6x or 18x, the attenuation would be the same, and the shielding effect would be the same, and the dose rate at same point would be the same. Now, since we used 2.2 TVL for 6x, let use also use 2.2 TVL for 18x. The physical thickness for 18x would be greater than that for 6x because TVL value is larger for 18x:
New shielding physical thickness for 18x = 2.2*TVL18 = 2.2*17.7 = 38.94 (inches)

You reached the end PLEASE contribute: solve 1 -2 problems

Additional Papers that might elucidate the understanding.

Additional Questions for Review - 2D & 3D.pdf

https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B_4hOY9x9TbxM2JmMjhjMmYtYWU5NS00ZmY3LWFkNmQtMzc4MzVjYzZjMzU5&hl=en_US

MDCB practice test Exam _1.pdf

https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B_4hOY9x9TbxMmQ4ZmI2Y2EtZmNkNy00YWQ0LTlkMTktMzYzODIwMGIxMTA0&hl=en_US

Mock Exam _1.pdf

https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B_4hOY9x9TbxMThiMjI4NzEtYjlkMS00YWUyLTg1OGEtNzg4Mzk2NmYzMGFj&hl=en_US

Mock Exam _2.pdf

https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B_4hOY9x9TbxYzBkZGM5OTctNjZiZC00ZmViLWFiZmQtMGY3YjIyMjcxMTEz&hl=en_US

Mock Exam _3.pdf

https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B_4hOY9x9TbxNzM1OGJlNTctNGNkZS00NzczLWIzZmQtZTIxNmZlYjAzZWZh&hl=en_US

Alternative Online Resources

Details on different types of treatments with information about disease and even MRI/CT pictures- http://www.aboutcancer.com/bone_mets1.htm Thanks

Sample Questions from ABR website:

PART 2: Therapeutic Medical Physics
COMPLEX QUESTIONS

1. A 4-MV linac beam, 10 cm x 10 cm with a 45° wedge, is used to deliver 200 cGy to a tumor located at the isocenter (100 cm SAD) at 10-cm depth. Given the following:
   1. output at 100 cm SSD at d max 1.2 cm is 1.04 cGy/MU
   2. wedge factor 0.70
   3. back-scatter-factor 1.03
   4. percent depth dose 60%
   5. tissue-air-ratio 0.75

   What is the number of monitor units (MU) required for this treatment?

   1. 206
   2. 258
   3. 296
   4. 366
   5. 468

   SAD Output = SSD Output*[(100+1.2)/100]^2 = 1.04*1.024 = 1.065

   TMR = TAR/BSF = 0.75/1.03 = 0.7282, MU=200/(TMR*WF*SAD Output) = 200/(0.7282*0.7*1.065) = 368, select 4

2. A single field 6-MV beam is used to deliver 200 cGy at the isocenter (100 cm SAD), which is at a depth of 10 cm. The patient thickness is 20 cm. Using the factors given below, calculate the dose at 5-cm depth.
   1. 245 cGy
   2. 255 cGy
   3. 261 cGy
   4. 268 cGy

5. 281 cGy

Dose at 5cm = Dose at iso *[TMR(5)/TMR(10)]*[100/(100-5)]^2 = 200*(0.93/0.79)*(100/95)^2 = 261, select 3

%DD for 100 cm SSD, 5-cm depth	87%
%DD for 100 cm SSD, 10-cm depth	68%
TMR 5-cm depth	0.93
TMR 10-cm depth	0.79
TMR 15-cm depth	0.65
TMR 20-cm depth	0.53

3. A lesion extending to 1-cm depth in tissue is to be treated with a 6-MeV electron beam with bolus. A dose of 1.5 Gy to 80% is prescribed. If the output is 1cGy/MU, the SSD is 104 cm and the cone factor is 0.97, what should the thickness of the bolus be, and how many MU should be delivered?

1. 0 cm, 153 MU
2. 0 cm, 170 MU
3. 1 cm, 209 MU
4. 1 cm, 270 MU
5. 2 cm, 302 MU

dmax = 1.3 cm, 80% is at 6/2.8=2.1 cm, we need 1 cm bolus since lesion is at 1 cm depth
Output at SSD104 = 1*[(100+1.3)/(104+1.3)]^2 = 0.9255 (cG/MU) (SSD 104 cm is to the top of bolus)
MU = 150/(0.8*0.97*0.9255) = 209, select 3

4. In tissue from a 0.46-mCi permanent implant I-125 seed, what is the total dose to 1 cm distance?

1. 55 Gy
2. 10.5 Gy
3. 13.2 Gy
4. 30.5 Gy
5. 50.0 Gy

This is our problem# 281. Select 3 even though we know the right answer is 13.2*0.876=11.6 Gy understanding that they missed 0.876 factor

5. An isocentric 10-MV oblique photon beam has depth of 12 cm, of which 6 cm is muscle tissue and 6 cm is lung. Without lung correction, the actual delivered dose at the isocenter compared to the calculated dose at the same point would be _____.

1. 20% higher
2. 10% higher
3. 5% higher
4. 10% lower
5. 20% lower

Radiological path length = 6*1+6*0.33 = 8, 12-8 = 4 cm, each 1 cm missing tissue amount to about 3% dose increase, I will have to select 2. 2 is correct, have to read twice to understand what they asked for.