Dear Friends,

Ahmet and I were discussing to have a shared place for part 2. We therefore created this google document, and put the part 2 question downloaded from yahoo. Please feel free to answer the questions, and put your thought, as well as inviting other people.

Good luck to all of us,

Ken and Ahmet

***To new friends, please keep the existed format to put your comments, so it will be clear and convenient to everyone. Also pls be aware that Google doc has size limit, try to condense your answer and don't put much empty space.**
***If you see the solution not making sense, please feel free to add your comment so that it will help the people spending time and writing down the solution to be aware of their mistakes.**

1. 2009 recall is included 07/31/11 (I tried to take out the repeated question, KW)
2. 2002 recall is included 08/1/11 (Only very few questions available and all of them are repeated I therefore incorporated them into the yahoo study guide, KW)
3. Very limited 2010 recall is included 08/04/11 (KW)
4. Very few non-repeatable 2006 & 2008 recall is included 08/09/11 (KW)
5. Non-repeatable 2007 recall is included 08/10/11 (KW)
6. Non-repeatable 2005 recall is included 08/12/11 (KW)
7. Non-repeatable 2004 recall is included 08/15/11 (KW)
8. **Additional questions not belong to the above set are added in the end. If you have any recall, (please do search first), and not included in this document, please add in the end 08/20/11 (KW)**

Therapeutic Radiological Physics Part II (Therapy Physics) Study Guide

Exam Type Questions:

1. Which of the following is used for palliative treatment of bone mets? Sr-89, I-125, P-32 (from 2002 recall)
I think the problem could also be asking which isotope is used to treat Bone Meta. If so, my answer would be Sr-89 or P-32. (YY)
Sr-89 and Sm-153 are given by Handbook of evidence-based radiation oncology 2nd p681, (KW)
Sr-89 (JPS)

2. The NRC requires HDR shielding to be surveyed: daily, weekly, monthly, annually, after source change(from 2002 recall). **every 3 months? (YY).**
After every source change before it is used. Must check the housing shielding with the source in it, and check the walls with the source exposed. From 10CFR35. KMW
From 2002 recall, "after source change" is actually a choice, so it can be the answer (KW)
After every source change (JPS)

3. What detector is best for calibrating an Ir-192 IVRT source? **Re-entrant well chamber (YY)**
Agree. KMW
Yes JPS

4. What is the TG-40 photon field flatness spec? From TG40, Table II, photon flatness constancy is 2 % (KW)
Agree. KMW
Yes JPS

5. According to the report by Kersey (sp?), what is the attenuation TVL of linac neutrons in a maze?

The correct paper can be Kersey R. (1979) Medicamundi 24, 151. The TVD for neutron according to Kersey is 5 m. (McGinley p69-74)(KW)

Linear Accelerators for Radiation Therapy by David Greene, P.C. WIlliams, Page 208: For a maze with a cross sectional area of 6 m^2, the first TVL is approximately 3 m and subsequent TVLs are 5 m (the first TVL is less because the neutrons have not slowed down very much at this point) (HL)

5 meters according to Kersey JPS

Kersey's original paper (1979) also cited in NCRP 151 Page 43-44 stated 5 m as TVD/or TVL(tenth-value lenth). However, in 1991, they think 5 m is a conservative way so they used modified Kersey method TVD = 2.06 sqrt(S1) = 3.4 if 6 m^2 cross sectional area. But I think this question may ask the TVD from Kersey's 1979 paper if there is no maze cross sectional area provided (KW)

6. The largest contributor to dose at a point behind the gantry stand is patient scatter, head leakage, neutrons from (gamma,n) in the walls (from 2002 recall)?
My vote is the "Leakage radiation from source", because for MV linac, leakage photon energy is higher than scattered photon. (Kahn 4th p363, & Metcalfe p779) (KW)
Agree. KMW
I would also say Head Leakage JPS

7. Electron virtual source- for linac with end of applicator at 100cm. Given ion chamber readings at several distances, the virtual source position is __ cm.
Solve effective SSD, using I_{dmax}/I_{airgap} = [(SSD + dmax + airgap)/(SSD + dmax)]^2 (KW)
Yes JPS

8. AAPM Report 54 (TG-42? SRS)- What is the max size of a scanning ion chamber for SRS beams?
TG42: Linac based SRS: 2 mm or less as the detector diameter for profile
3 mm or less as the detector diameter for TMR and output factor
Gamma knife: 1 x 1 x 1 mm^3 detector dimension (KW)
Which page? P21 - 22
Agree. KMW

9. According to NCRP-49, what is the max allowed exposure/dose for films in a storage area?
I found some old answer: 0.1mGy/month; 0.025mGy/wk, but I don't know the reference... anyone? (YY)

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. Once films are loaded into cassettes, radiation exposure levels should be less than 0.5 µGy. (HL) (http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code_35-securite/section-b1-eng.php)

10. Pick out the false statement about TG-51 given a selection (applicable to 3-50 MeV e-?, from 2002 recall)
Photon: Co60 - 50 MV
Electron 4 - 50 MeV (KW)

11. For a H&N case, calculate couch kick given the field sizes to match the inferior **(superior?)** borders to an SCLAV field.
It can be the 2 lateral field + 1 anterior SCV field treatment. (Fig. 9.15 Bentel, KW)

Not sure if this expression is applicable to this problem $\Theta_{couch} = arcTan(\frac{L}{2*SAD})$ **JPS**

12. Calculate the gantry angle for a half-beam blocked medial breast tangent beam, given a bunch of geometrical

distances.

13. 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.

14. An I-125 implant gives 95% of the total dose in ____ days?
I-125 half life is 59.6 days. (0.5)^(n/59.6) = 0.05, n = 258 days. (KW)
Another way: 0.95 = 1- exp(-0.693/59.6*T) → T = 257.6 (YY)
Yes JPS

16. Be able to find cord dose given CAX dose from AP/PA treatments.

17. What is the range of a Sr-90 beta in air?
The main therapeutic beta of Sr-90 is the 2.28MeV from Y-90. In tissue, 2.28MeV electron has a range of about 1.1cm. Air density is about 1/1000 of tissue, so the range in air is about 11meter. (YY)
Agree 2.28 MeV is more accurate (KW)

Range of Y-80 beta (2.2 MeV) in air: dE/dx = 2.2 MeV/cm in H20 or 0.002 MeV/cm in air so 2.2 MeV/0.002 ~ 11 meters JPS

Range of Beta particle is more accurate calculated by using 1 MeV traveling 4 m in air, so 2.28MeV x 4 = 9 meter (KW)
Please this link http://www.alpharubicon.com/basicnbc/article16radiological71.htm
15. Calculate Dy/Dx for a train of 10:10:10 mgRa eq sources at a spacing of 2cm, X and Y are 2cm off the transverse axis of the middle and an end needle.

2cm 2cm
(1)-----------(2)------------(3)

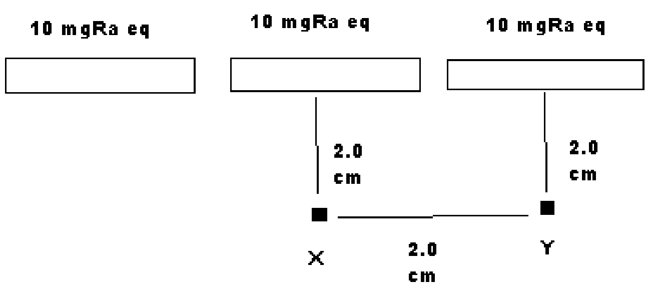
Dx = K(1/(r_X to 1)^2 + 1/(r_X to 2)^2 + 1/(r_X to 3)^2)
Dy = K(1/(r_Y to 1)^2 + 1/(r_Y to 2)^2 + 1/(r_Y to 3)^2)

2cm 2cm

X Y

Dy/Dx = 17/20 JPS

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



The dose are calculated at the points X and Y which is => 2 cm away from the sources with active length less than < 2 cm. According to Kahn Fig. 15.11, the dose fall off from a linear source at the distance > 1 cm, we can approximate it as a point source following inverse square law. The dose ratio of Y/X = (1+1/2+1/5)/(1+2*1/2) = 17/20 (KW)
Inverse square law → Y/X = (1/4+1/8+1/20) / (1/4+2*1/8) =17/20 (YY)

20. 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:

-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).
- 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.
66"/13.6" = 4.85 TVL = nconc + nsteel
nconc * 13.6 + nsteel*3.8 <=36"
solve for nsteel to get 3.05 TVL (AA)
Agree. KMW
11.6 inches about 3.05 TVL
I went about this in a very similar fashion but arrive at a slightly different answer. Perhaps I'm missing something pretty stupid:
(Thickness of concrete) + (Thickness of steel) <= 36"
(#TVLs concrete) + ((#TVLs steel) = 4.85
1 TVL of concrete = 1/(3.58) TVL of steel

#TVLs steel + 1/(3.58) TVLs of steel = 4.85
#TVLs of steel = 3.79

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
My guess: this could be an easy type of question. I think the total fraction number was missing. Assume it's 30x200cGy. then: X+Y = 30; 212*X+212*0.18*Y=4500 → Y is at least 11 fractions (YY)
Agree. KMW
Yes. JPS

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.

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.
(Khan P232) T_c = TD x (Tau / Rho_c), here Tau = 0.7; my understanding for Rho_c is the density (in stead of electronic density), please correct me if i'm wrong. (YY)
I agree. rho_c is the physical density. (AA)
Yes. JPS

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.

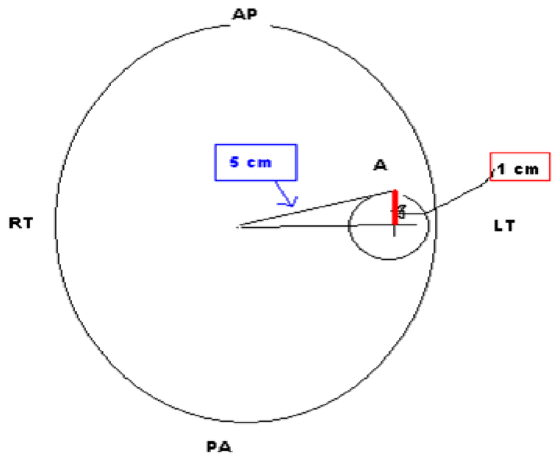
Agreed. JPS
The notations are all different, very confusing @_@

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.
[(340)(3^2/(1.134cGy/Ci/s)(1.11)]/10Ci= 243 sec.
for Ir-192: 4.69 R-cm^2/mCi-h; f factor is 0.971cGy/R; 340 / (4.60*10^4/9) = 4 mins (YY)
Yes. JPS

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.

@2cm, the dose rate is 75cGy/min → 1.25cGy/sec; 1.25*0.02 / 0.01 = 2.5cGy (YY)
Should not this question be asking "minimum dose" that can be delivered withh less 1% error? AA

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 solving the problem.

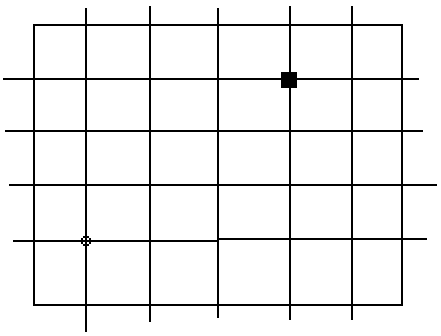


My guess: the coverage will shift posteriorly for 1cm based on this plot... (YY)
If the patient rotates 1 degree in counterclockwise (LT to AP), and I assumed the circle is the coverage, and the cross is in the center, the distance from the iso to the center of the coverage is sqrt(25 - 1) = 4.9 cm. If the patient head tilted 1 degree counterclockwise, the coverage should move Rt-Lat (4.9 - 4.9 x cos(1)) ~ 0 mm, and Anterior 4.9xsin(1) ~ 0.85 ~ 1 mm. (KW)
I got the same thing as YY. Anyone else?
sin(theta) = 1 cm/5 cm → theta = 11.5 deg
Tilt 1 deg → theta_new = 12.5 deg
Assume 5 cm radius remains the same.
sin(12.5) = x/5 → x = 1.1 cm post in the head - head moves, dose stationary
I agree with blue solution, but i guess the coverage moves posteriorly for 1mm (1.1cm - 1cm)
I agree. JPS
My thought is that when patient head tilts, coverage should move to cover the target, such as cyber knife case. (KW)

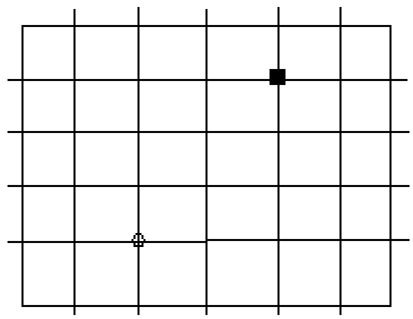
29. Have a 1 cm grid superimposed on a AP and Lateral Fletcher applicator. Determine the distance from one of the ovoids to a point. And calculate the dose rate to the point due to that source in that ovoid only. (mgRa eq for the source were given, 8.25 R-cm2/(mCi – hr) one had to know, I think f factor also was not given (source was Cs-137).
My guess for this is just about inverse square. (YY)

Yes. Just use X/t = (GAMMA)*(A)/r^2 X/t: Dose Rate (R/h), GAMMA: exposure rate constant, A: Activity (mCi) and of course watch your units JPS

18. 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



Lat

sqrt(3^2 + 3^2 + 3^2) = 5.2 (KW)

I think these 2 are from the same question set. If so, the distance = 4.7 cm, and I assumed the given mg-Ra-eq is S, and f factor for Cs-137, 662 keV = 0.971 cGy/R (Kahn table 8.1), the dose rate at point of interest = S(mg-Ra-eq) x 8.25 R cm2/(mg hr) x (1/5.2^22) x(1/60) x 0.971 cGy/R = 5 x 10^(-3) S (cGy/min) (KW)

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.2:1

Universal wedge is 60 degree. (YY) 1:1

The fraction of wedge field for the universal wedge, w2/(w1+w2) = tan(30)/tan(60), where w2 and w1 is the weight of wedge and open field, so the ratio of the w2/w1 -> w2/w1 / (w2/w1 + 1) = tan(30)/tan(60), where w2/w1 = ½ (Green, linear accelerator for radiation therapy, p85 KW)

After a lot of searching for an expression for universal wedge calculations I arrived at the same solution JPS (w/w+o) = tan(desired wedge angle)/tan(60)

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.

B = P*d^2/WUT (YY)

Exposure rate constant for Ir-192 is 4.69 R cm^2/(mCi - h), and the formula can be written as
10 x 10^3 (mCi) x 4.69 R cm^2/(mCi hr) x 100/60 (hr/wk) x (1/200)^2xB = 0.01 R/wk, B = 5 x 10 ^-3, (KW)

Agree. KMW

Yes. JPS

Did you use the 2m distance?I am not getting the same answer.

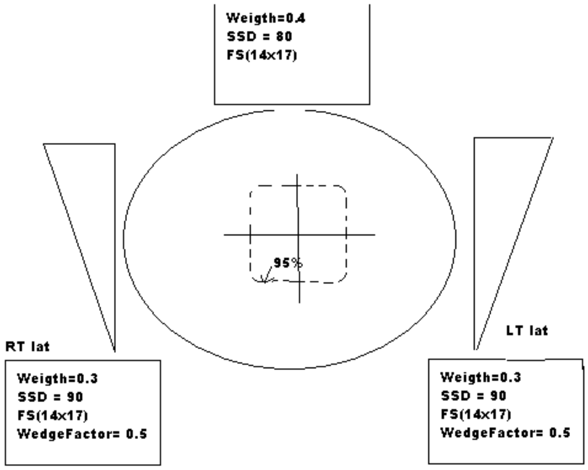
Thanks, I forgot put inverse square law here, but the answer includes the inverse law (KW)

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.

My guess: this could just be SAD MU calc. (YY)

Agree. KMW

Yes **but be careful; The SCD is given at SSD+dmax not at SAD=100cm**. JPS



Assuming this is isocentric 15x treatment, but the calibration was done at dmax + SSD. The output should be corrected by inverse square as 1 cGy/MU x ((100+2.5)/100)^2 = 1.05 cGy/MU

Equivalent square field size = 2 x 14 x 17 / (14+17) ~ 15
Dose for AP at iso (D_AP) = 200 x 0.4 /0.95
Dose for RT Lat at iso (D_RT) = 200 x 0.3 /0.95
Dose for LT Lat at iso (D_LT) = 200 x 0.3/0.95

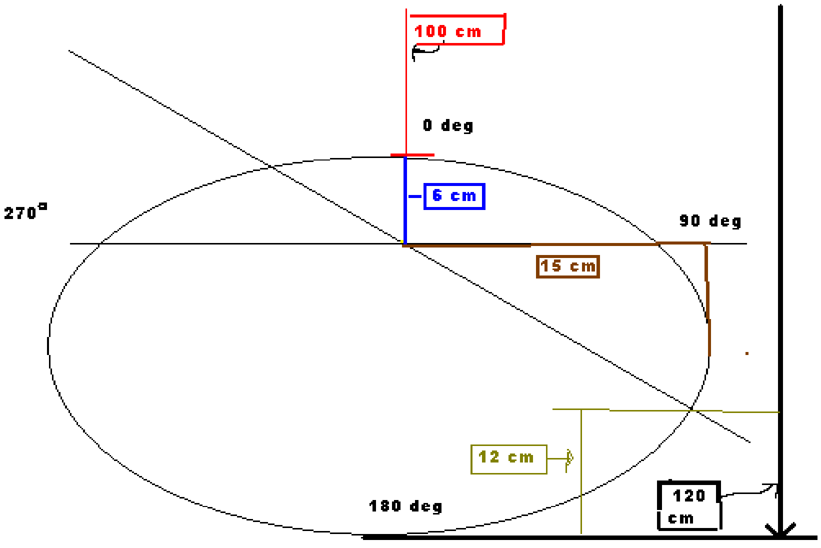
MU_AP = D_AP/(1.05 x TMR(d=20,15) x Sc(15) x Sp(15))
MU_RT = D_RT/(1.05 x TMR(d=10,15) x Sc(15) x Sp(15) x 0.5)
MU_LT = D_LT/(1.05 x TMR(d=10,15) x Sc(15) x Sp(15) x 0.5)

The ratio of MU = 0.4/TMR(20,15) : 0.6/TMR(10,15) : 0.6/TMR(10,15) (KW)

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.
D0 = 2.5*0.868*g*0.939/4; total dose = 1.44*17d*D0; (YY)
The dose rate constant for Pd-103 should be 0.686 cGy/(h U) Kahn Table 15.4 (KW)
TG 43 formula KMW
Yes JPS

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.
(f+20)^2 * 44 = (f+40)^2 * 25 → f = 41.26cm (YY)
I assumed the reading obtained from dmax 1.5 cm for 6 MeV, so sqrt(44/25) = (SSD + 40 + 1.5)/(SSD+20 +1.5), SSD = 39.1 cm. (KW) **Thanks**
Yes JPS

35. Determine the angle, following the IEC convention of angles, of the medial field, given the dimensions in the figure shown below.



120-12-100= 8cm , use triangle of 15cm x 8cm to get $\tan^{-1}$ 8/15= 28°
med 270+28 = 298°.
Lat 118°
if you want to match the lower border , then $\tan^{-1}$(7/100)=4 deg
lat angle=298-180-(2*4)=110 deg ((anyone wants to check geometry????)
How do you get the half field size 7 cm? (KW) .
I estimated the width of the field based on the graph and limited info as 120-12=108, it is an SAD, depth of 8cm, distance from med entry perpendicular to CAX line is ~6cm, I added them to get 14 cm width of field, ⇒ tan-1(7/100). I hope this helps.
I agree with your method, hopefully the real problem gives better figure. :) (YY)
This diagram is not clear and out of scale but it should be 120-100-12-6=2cm, arctan 2/15=7.56, 270+7.56=277.6 or 278 (SC) Agree with SC if it's HBB, KW
You can't have width of tangent fields as 4cm even if it is HBB!!!

36. What is the change expected in mmHg when reading at 50 meters of altitude from the airport level.
Need help with this one, there must be some rule of thumb; i would use very complicated equation got from wikipedia...(YY)
http://www.engineeringtoolbox.com/air-altitude-pressure-d_462.html
From this table looks like from -1800 to 1500 m, the pressure is change 0.09 mm Hg along with 1 meter; (KW)

Here you can use the expression P = (RHO_{air})*(g)*(h) where RHO_{air} is the denisity of air, g is the gravitational constant and h is the height in meters. So DELTA P = (RHO_{air})*(g)*(DELTA h) = (1.293 KG/m^3)*(9.81m/s^2) *(50meters) = 634 N/m^2 = 0.634 KPa = 6.34 Torr JPS

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.
1R = 2.58 *10^-4 C/kg * 1.293*10^-6 kg/cc *0.19cc = 0.634E(-10)C → 1.58E10 R/C(YY)
1R x cm^3 x 1 x 1 = 158x10^8R/C ?
2.58x10^-4 C/kg 0.001293g 1 kg/1000g 0.19 cm^3
0.001293 g/cc x 0.19cc(1kg/1000g)=2.45E-7kg, 1R=2.58E-4C/kg x 2.45E-7, calibration factor is 1.58E10R/C (SC)
Yes. JPS

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 upstream for 0.6*0.3mm (YY) TG51
Agree. 0.6*rcav KMW
Yes. JPS

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

TG51 gives 1-2% higher reading than TG21 (YY)

For photon the reading is around 0.5 - 1.5% higher for TG51,
& for electron the reading is around 2 - 3 % higher for TG51. Ref: Med. Phys. 27, p1217 (2000) & Med. Phys. 28, p46 (2001), (KW)

Agree. KMW

Yes. It also has a slight energy dependence. JPS

40. What is the meaning of D90 = 110 Gy?

90 % of the volume get 110 cGy (should be cGy) (KW)

Agree. But could be Gy if you are considering PSI dose. KMW

Yes. JPS

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.

B = (0.02 x 1^2 x 5^2 x 400/400) /(0.001 x 500 x 1000), B = 0.001, assuming T = 1 (KW)

Agree. KMW

Yes. JPS

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.

I think Xp is the dose limit we would like to achieve after the barrier,
600x3600 (mAs/ wk) x ¼ x 1/9 x 0.01 R/mAs x 10^(-s) = 0.01 (R/wk), s = 4.78 TVL (KW)

Yes. JPS

43. What is the main difference between Magnetron and Klystron (from 2005 recall Hint: Klystron is not a microwave generator).

Klystron is essentially an amplifier with a low-power microwave input, while the magnetron is a self-oscillator, producing the microwave in response to a DC input.
Klystrons are usually used to power high-energy linacs; magnetrons are used for lower energy linacs.
Klystron and magnetron and output is usually 5 and 2 MV peak power, respectively, for medical linac.
The operation life is 10,000, 2000 hour for klystron and magnetron, respectively.
The operation of magnetron is temperature dependent, but klystron is not.
Klystrons are large, which can not be mounted on the gantry, and magnetrons are mounted on the gantry.
Compared to a magnetron, the klystron is more stable, expensive, and complicated. (KW)

Agree. KMW

Yes. JPS

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 (SC)

45. Penumbra calculation from LINAC given target surface distance (SSD), target block distance (d1), depth in patient (d) and target dimensions (r).

We should calculate penumbra on surface or in patient depth? (YY)

The penumbra is calculated on the depth, which can be calculated as Penumbra = 2*r(SSD + d - d1)/(d1), here I assumed r is the target radius, (Kahn 3rd, sec 4.7.A.3, KW)

Yes. JPS

46. Radionuclide and energy emission from Sr-90 eye applicator.

90Sr undergoes β− decay with decay energy of 0.546 MeV distributed to an electron, an anti-neutrino, and the yttrium isotope 90Y, which in turn undergoes β− decay with half-life of 64 hours and decay energy 2.28 MeV distributed to an electron, an anti-neutrino, and 90Zr (zirconium), which is stable. Note that 90Sr/Y is almost a

perfectly pure beta source; the gamma photon emission from the decay of 90Y is so weak that it can normally be ignored. -- wikipedia (YY)

Sr-90/Y-90 which is usually in plaque form to treat superficial ocular lesions. (principle and practice of radiation oncology Table 19.1), KW

Here is the more complete question; How would you calibrate Sr-90 applicator in the clinic if you do not have the calibration certificate and also why is Sr-90 used for an eye applicator?
To calibrate the Sr-90/Y-90 opthalmic applicator, it can calibrated using re-entrant chamber, and it can be positioned at the top of the well when the central tube assembly is removed. (Kahn 22.4.A, KW). I think the reason to choose Sr-90 for eye treatment, because it's B emitter and the energy is 2.28 MeV so the R80 = 2.28/2.8 is only 0.8 cm which is suitable for eye treatment. Anyone? (KW), From Hendee p316, the dose rate from the beta applicator decreases to ~5% at the depth of 4 mm, the depth of the lens below the cornea.

Re-entrant chamber is well-type chamber which is commonly used for HDR source calibration
Yes. JPS

47. The only factor less than 1 in TG-51. (Select from Ptp, Pelec, Ppol, Pgrad. from 2005 recall)
PgrQ TG51 (YY) for the dref > dmax + 0.5r, (KW)
kQ for most chambers and beam Q is also less than 1 ! (See table-1I in TG51)! (AA) I found the same question with choice from 2005 recall which may be more clear (KW)
Yes. JPS

48. Flatness and symmetry tolerance figure according to TG-40
X-ray flatnees 2 % **constancy**
Electron flatness 3 % **constancy**
x-ray and electron symmetry 3% (TG40 table 2, KW)
Agree. KMW
Yes. JPS

49. What percent of a batch of seeds has to be checked in a prostate seed implant procedure.
10%
10% or 10 seeds per batch, ex: 120 seeds we check 12 seeds (KW)
Agree. TG 46 p12 KMW

50. Tolerance for deviation between light and radiation field according to TG-40.
2 mm or 1% on a side (TG40, table 2, KW)
Agree. KMW
Yes. JPS

51. Necessary thickness of lead for 6MeV electron cut-out
4mm(rule ½ of enrgy+1mm)
Yes. I have heard just ½ energy as a rule of thumb but we might as well be safe than sorry :) JPS

52. Which components of a LINAC are pulsed after Thyratron is fired?
electron gun and mangnetron/klystron (D. Greene, linear accelerators for radiation therapy, KW)
Yes. JPS

53. A tumor is reduced because of what property?

54. What info PET can't deliver about the tumor
density? KMW
Agree, One of possible answers electron density compared to CT (KW)
other structural information

Yes. PET just mainly gives metabolic information JPS

55. An error of 2 mm in MLC opening causes an error of xx % in 2cm radiation field
Not sure what % error means here. For Varian machine, the MLC is 53.5 cm relative to the target, and for Elekta and Siemens, the distance is around 37 & 38 cm. If 2 mm off in MLC positioning, for Varian, it will be around 4 mm in field size, which is 20% of the 2 cm field size. However, if for the DMLC field, using 1 cm slit with 1 mm position off for MLC for 10 cm field size, the dosimetry error is 10%. (Phys. Med. Biol. 47 N159, 2002), KW

The question can also ask the 2 mm gap error how much it will translate the dose error to a 2 cm nominal leaf gap instead of radiation field. The answer is as simple as 2 mm/20 mm = 10% reference (Med. Phys. 25, 1919 (1998)) Fig. 8 (KW)

56. What condition is not required for collimator output factor Sc. (Answer: phantom measurements from 2005 recall, KW)
Yes. JPS

57. What doesn't change by reducing field size in electron beam.(Answer: Rp from 2005 recall)
I guess energy, range, etc...?
Once the field size large enough for the lateral electron equilibrium, the % depth dose does not depend on the change of field size (Kahn Sec. 14.4.D, KW) rule of thumb minimum field diameter for lateral scatter equilibrium E/2.5 in cm (Kahn Sec. 14.6.C)
I think the answer should be: Practical range , Rp, does not change. See figure 8.4 in
(http://www-naweb.iaea.org/nahu/dmrp/pdf_files/Chapter8.pdf)
Agree, if Rp is one of the choices, it's a better answer.
Yes it's Rp (practical range). JPS

59. Energy at which theoretically neutrons can be produced a neutron in LINAC
> 10MV (NCRP151, KW)
Agree. KMW
Sorry I think 8 MV is more accurate (KW)
Above 8 MV, neutron can be produced. Above 10 MV, neutron dose become clinical significant.
Yes. The clnically signifcant energy for neutron prodution in the Linac head is 10MV. The cross section for photoproduction is non-zero below this energy. (McGinley) JPS

60. Given a graph of ionization current vs polarization voltage with different areas marked select which detector works at specific area
Fig. 4.1 Podgorsak, Review of radiation oncology physics: a handbook for teachers and students, (KW)

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
higher than 1mR/h
Why?
My guess: the trick is the high volume IC. the reading over the crack is 1mR/h and far from it the reading is only decreased by half. The IC is obviously not giving the correct exposure. so the IC could be under-respond.. ….(please correct me if i'm wrong)
I think you are right. I think the question is really after the saturation of the ion chamber response due to very high exposure rate. Far away from the crack where the exposure rate is below the saturation level, the reading is normal/correct.

63. Permanent implant of Pd-103. Activity was given. Calculate total dose delivered.
total dose = dose rate*($1.44T_{1/2}$)= 0.21Gy/hr*1.44*16.97*24= 123.2Gy.
I agree with the method but my version of the recall didn't give a specific value for the initial activity. JPS
One has to compute the dose rate!!
64. What can be said about TBI. (select from a variety of properties).

65. Detector resolution required for SRS field profile is __

2mm or less (diameter) **from Ken =)** (TG42)
TG-101 requires <1mm !!

66. What is the meaning of a phase-space file in Monte Carlo calculations?
According to Chris A, A phase-space file would contain the initial positions and momenta (magnitude and direction) of all the particles to be transported.
Agree. JPS

67. The definition of Sliding window in IMRT means ____
dynamic MLC, dose delivery while MLC moving simutaneously, MLC speed is also changing while moving (KW)
Agree. KMW
Agree. JPS

68. Given a set of CT numbers, Select proper order of tissues that correspond with the order of these CT numbers.
Typical CT numbers: Metal > 2000 HU **Hard bone → 1000; Femoral Head → 400; Breast prosthesis → 70; Mediastinum → 50; Water → 0; Fat → -100; Lung → -800; Air → -1000**

69. A DVH graph was given with a point on the DVH curve was marked. Select proper meaning of this point.

70. For what purpose is a beam spoiler for 10MV breast treatment used ?
Increase dose in build up region and preserve the skin sparing
I think the spoiler will decrease skin sparing compared to no spoiler but will increase skin sparing compared to using bolus. KMW
Agree, for breast treatment, skin sparing is not desirable. Beam spoiler will increase the dose to the superficial area and also move dmax toward surface therefore decrease skin sparing compared to without spoiler (Kahn sec 13.3 D KW)
I agree with the Khan-sian definition and function of a beam spoiler. JPS

71. Amount of X-ray contamination for a 18 MeV beam is around ___. %.
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% to2%, from 12 to 15 MeV; and 2% to 5%, from 15 to 20 MeV. Khan P281
Agree. JPS

72. Dose limits for the public for frequent and infrequent exposure is ____
1mSv/year frequent; 5mSv/year infrequent or 100mrem frequent and 500mrem infrequent same different unit (SC)
Agree. JPS

<u>**-----------**</u>73. For what isotope is the ratio of dose at d=5 cm to the dose at d=1 cm the lowest? (from 2006 recall, ? Co, Cs, I, Pd)
My try: Ir-192 or Au-198 (Khan figure 15.13)
This question may asked the opposite direction; which isotope decays fastest along the radial direction. Pd-103 is the fastest Fig. 2 in TG43. (KW)
Agree with Pd103. KMW
Agree with Pd-103. There is another related question comparing Radial dose function of Pd-103 to I-125 . JPS

74. How often are electron energies checked according to TG-40?
If it is output, it's at least twice / per week. If it's energy verification, it's monthly (TG40, table 2, KW)
I dont understand what does energy verification mean? my guess would be calibration ie TG51, so annual...(You check output at 10cm depth and take another reading at 20 cm depth, take the ratio R20/R10 ⇒ energy consistansy)I hope this helps.
The energy verification is to check the energy consistency at different depth, which is performed in monthly QA (KW)
Agree monthly. KMW
Agree. This is a monthly test. JPS

Agree. Monthly.

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 think this question is not complete.

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, khan P183
Agree. KMW
Agree. JPS

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?
Based on my memory, please correct me if i'm wrong. Lung has a density that's about ⅓ of soft tissue, bone is about 1.65 times the density of tissue. So 1+2*1.65+3/3 = 5.3mm. 6mm-5.3mm = 0.7mm; 6MV attenuates about 3% per cm → 3% * 0.07 =0.21%

This question can also ask inhomogeneity correction. TG65 Table 8, 6MV photon traveling in lung is about 3%/cm dose increase after lung, and for bone it is about decrease (-) 2%/cm, so -2/10 x 2% + 3/10 x 3% = 5%/10 = 0.5% (0.5% dose increase compared to homogeneity 6 mm tissue thickness), (KW)

78. Shown CT with depths of tissue and lung, single direct field, and attenuation coefficients, what is the dose w/ and without heterogeneity corrections?
I will do it in a similar way as last problem
If the question provides attenuation coefficient for water (mu_water) and physical depth in the tissue and lung (d_tissue, and d_lung), the ratio of the dose with and without corrections may be calculated as exp(-(mu_water x depth_tissue + mu_water x depth_lung/3))/exp(-mu_water x (depth_tissue + depth_lung)) = exp(mu_water x (2/3)depth_lung), (KW)

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?
My try: X*PDDe (surface) + Y*PDDx(surface) = 40; X*PDDe(5cm)+Y*PDDx(5cm) = 55

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%?
100% * 3^2 = 150% * X^2 → 0.449cm away at least. (Agree, KW)
0.4 cm from balloon surf KMW

81. What thickness of Al to compensate for 5 cm of missing tissue? 5/2.7 = 1.85 cm (aluminum density 2.7g/cm3) AA
(Khan P232) T_c = TD x (Tau / Rho_c), here Tau = 0.7; T_c = 5*(0.7/2.7) = 1.29cm, Khan didn't give the unit of Tau in his book, i'm assuming Tau has a unit of cm3/g... correct me if i'm wrong.
I did it the same way as YY - anyone else?
This seems reasonable. JPS

Here is my thought; Tau is a density ratio or thickness ratio which is dimensionless. The question should be 5 g/cm^2 of missing tissue instead of 5 cm. In this case, the units are consistent so T_c = 5 (g/cm^2) x (0.7 / (2.7 g/cm^3)) = 1.29 cm (Kahn 3rd sec.12.6.A and his original paper Radiology, 96, 187 (1970))

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.
6mrem/hr * (1/4) = 1.5 mrem/hr which is already <2mrem/hr. Can anyone comment? AA **Agree. KMW**
See the last problem on this page, i think they are similar problems. i guess the limit is 2mrem/wk.
Agree. JPS **Where did you get the ¼?we have 12m and 6m?**
please, clarify.
6mrem/hr * (6^2) / (12^2) = 6mrem/hr * (1/4) (or simply distance doubled ⇒ intensity reduced by square, so 1/4)

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

I think suspend immediately needs 5%, between 3% and 5% need to notify the oncologist and physicist.

I agree.

5%. TG-40, page 592,

"... . For these reasons, we recommend an additional clinical action level of 5% for daily radiation output checks. If this level is exceeded, no further treatment should be given until a radiation oncology physicist has assessed the problem. If the output
difference is in the range of 3% and 5%, then treatment may continue and the radiation oncology physicist is notified."

Agree. KMW

Agree. JPS

84. What is the overall uncertainty in dose delivered to a point in a patient with all uncertainties taken into consideration?

5% (TG40, KW)

Agree. KMW

Agree. JPS

85. What method cannot be used to verify an IMRT plan?

I suspect one of choices is MU hand calculation, just guess(KW) **same guess = D**

single ion chamber measurement. KMW

Agree with both of those "possible" choices. JPS

86. What is the purpose of the bending magnet and where is it located?

Used to bending electron path so that for high energy linac, it won't have unacceptable high isocenter (D. Greene, linear accelerators for radiation therapy, KW) After waveguide and upstream relative to the target

BM changes the direction of the accelerated beam from horizontal to vertical and is located between accelerator structure and the target (SC)

Agree. KMW

Probably also select energy band (different energy has different bending angle, a slit can select a narrow band energy and block other others.

Agree. JPS

87. Where are the electrons generated in a linac?

gun/filament AA

Agree. KMW

Agree. JPS

88. What does Gamma measure?

Both dose difference and distance to agreement.

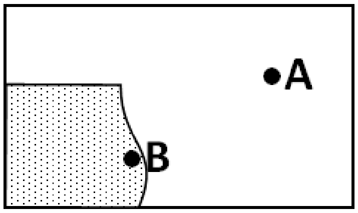
Agree. JPS

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. Theta(coll)= $\tan^{-1}$(1/2*17*1/ssd) the ssd value is missing.

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

PTV outside CTV (KW)

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



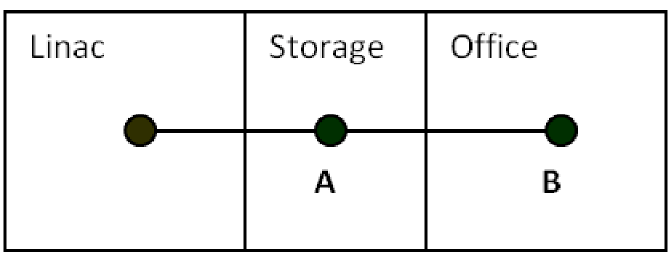
92. When to check the wedge interlock
Monthly (TG40)
Agree. KMW
Agree. JPS

93. IMRT Head and Neck treatment. What are the dose constraints for critical organs.
cord<45Gy, mean parotid<26Gy, mandible<66Gy, pituitary<40Gy, etc (SC)

94. What is the tolerance dose for the kidney3000 to ⅔ kidney 20Gy? (SC)

95. What is the reference depth used in photon beam calibrations (per TG-51)
d = 10 cm. (KW)
Agree. KMW
Agree. JPS

96. Distances given: Linac to A=6m, Linac to B=12m. Survey meter measures 0.6 mrem/hr at point A. 200 cGy delivered at each treatment is also given. How many patients can be treated to limit the exposure at point B to below 2 mRem/wk



97. 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 (ans: 0.1%, 0.5%, 1%, 3%, 10%)
IMRT QA usually employs 3% 3 mm criteria. The measured error should be less than 3 %. Anyone ? (KW)
Yes. (gamma)Van Dyke criteria.
so the answer to this problem is resolution 1mm?
In our clinic, we allow 1% measurement error on CAX diode (KW)

98. 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 (from 2006 recall, photon side hot spot:electron side cold spot, photon side cold spot:electron side hot spot, both sides hot spots, both sides cold spots or no hot spots)
.Hot spot on the photon side. **Agree. KMW**
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
Agree. JPS
Doses at 5cm are:16 MeV , ~85% @ 5cm, 10MV , dmax ~2.5cm, ⇒94% @5cm.
99. Describe the Morning (daily) QA for a HDR brachytherapy treatment source per TG-40
source position check with the ruler, door interlk, emergency stops, visual(cameras) and audio functions, compare activity

printout with calculated/treatment planning.
source position check with film, dwell time check with timer.the ruler has a gaf film insert.
Check portable survey meter
Agree. JPS

100. What are the Daily output tolerance for X-ray and electrons
X-ray 3% **constancy**
electron 3 % **constancy** (TG40 table 2, KW)
Agree. JPS

101. Ep = E0 (1-d/Rp) given that at depth d1, the energy is E1 and at depth d2 the energy is E2, at depth d3 what is the energy
two equations, two unknown.What information is given?
Agree. JPS

102. Question on backscattering using block for electron beams. How does it change with energy E and Z.
my try: low energy, high Z → more scatter... Agree? KMW
Yes Kahn (Fig. 14.37 &14.38, KW)
Agree. JPS

103. 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.
Ratios of TVLs?
104. Neutron dose equivalent (mSv) outside field per photon Gy at isocenter for 20MV beam.
Measurements have shown that in the 16 to 25 MV x-ray therapy mode the neutron dose equivalent along central axis is approximately 0.5% of the x-ray dose and falls off to about 0.1 % outside the field.
Agree. For further details see McGinley. JPS
So, 0.1 % x 1 Gy = 1 mSv as the neutron dose equivalent (KW)

105. Scatter and leakage shielding thickness calculations are equal. The shielding that should then be used is? TVL+HVL
If the thicknesses of the two barriers differ by at least threeHVLs, the thicker of the two will be adequate. If the difference is less than three HVLs, one HVLshould be added to the larger one to obtain the required secondary barrier. Khan P363

106. Parts definitely not included in EPID.
For Varian, an array of image detector is based on a-Si, and within this units a scintillator converts the radiation beam into visible photons. The light is detected by the photodiode array implanted on the a-Si panel. (Kahn, sec. 12.3.B, KW) Do I miss other important part?

107. S/rho and rho given for lead. Calc thickness of lead used to shield 20MeV beam.
S/rho * rho → X Mev/mm → 20/X → thickness
Agree. JPS

108. How many TVL's in a linac head?
3 TVL, dont know reference... anyone?
<0.1% head leakage requirement means 1/1000 attenuation so ⇒ 3TVL AA
Agreed. This is mentioned in a few references including McGinley. JPS

109. The PDD for wedge increases over open field due to what property of the wedge Beam hardening AA

110. Define the purpose of the guard ring in a plane parallel chamber.
(Sue) http://www.hps.org/publicinformation/ate/q8149.html The guard rings play a major role in reducing the leakage of extraneous charge to the collecting electrode.
(KW) Additional info from Frank Attix (Intro. to radiological phys....) p312. The guard electrode is primarily to provide a

uniform electric field, thus allowing the radius of the collecting vol to be well defined. In some parallel plate chamber, the guard rings also stops the leakage current from HV electrode.
Two functions: reducing leakage and define active volume boundary of the chamber.
Agree. JPS

111. Electrons at extended SSD, know the properties of the distribution and dose?
my guess: output decrease, surface dose decrease...???
output decrease, penumbra widening, dose uniformity degradation (TG70,sec IIIF, kw)

112. Why does the equivalent square technique work?
my try: It gives the same PDD...
The equivalent square gives the same PDD and output because it emulates the same scattering property of the true field (Metcalf, p391, KW)
Agree. JPS

113. TG51: what's upper limit for Pion? 1.05 AA 5%
Reference: TG51 P8
Agree. JPS

114. TG51: where is cylindrical chamber's center placed for photon beam calibration?
depth 10 cm (TG51, KW)
Is this an effective point of measurement question?. JPS

115. TG51: to cross calibrate parallel-plate chamber for electron dosimetry, what should use? High Energy Electrons AA
Could you please tell me the reference? I would have guessed Co60... TG51 (KW) **Worksheet C**
Agree. JPS

116. TG51: k_Q depends on what properties?
Quote TG51 p1849, k is a function of beam quality Q [specified by $\%dd(10)_x$ or R_{50}] and chamber type (KW)
Agree. JPS

117. TG51: What's energy specification for electron beams? R50 AA
Agree. JPS

118. TG51: total consecutive measurements were done with 20% difference, the reason for this could be?
The reference photon dosimetry is supposed to be done with SAD setup but performed on SSD setup, or vice versa. The inverse square law shows (110)^2/100^2 = 1.21 ~ 20% off, anyone? (KW)
agree. InvSq seems to be only option for such an big effect (AA)
Seems reasonable. JPS
chamber breaks, electrometer breaks KMW

119. TG51: where is the effective point of measurement of parallel-plate chamber?
The center of the front (upstream) face of the chamber air cavity (KW)
Agree. JPS

120. TG51:How do you convert ionization curve to %dd curve?
If we use cylindrical chamber
Photon we don't need to convert when the depth is beyond
Electron: We will need to use stopping power ratio as specified in Eqs. (6) and (8) in TG70, (KW)
If this is TG51 question, no other corrections expect for shifts based on chamber radius are needed for both photon and electron .
TG51, after shifting it's still ionization curve, but not % depth-dose curve, figure 1 in TG51.

The reference depth for electron-beam dosimetry is at dref = $0.6R_{50}$-0.1cm, which is essentially the depth of

maximum dose for beams =10MeV, but is deeper for higher energy beams. By going to this depth, the protocol (TG-51) makes use of* stopping power ratios *which account for the realistic nature of electron beams. **TG-51**

Basically I_{50} is used to determine R_{50} (the depth (cm) where the dose falls to ½ its maximum value) via
$R_{50} = 1.029(I_{50})-0.06$ (cm) ($2 <= I_{50} <= 10$cm)
$R_{50} = 1.059(I_{50})-0.37$ (cm) ($I_{50} > 10$cm)
JPS

121. Question about the best radioactive material used in PET to help in radiation oncology treatment planning. Agent used in PET? F18/FDG AA
Agree. JPS

122. 9MeV electron beam. At 4 cm depth, how much lead should be used to shield deeper structure? No other information.
9MeV - 4cm*2Mev/cm = 1MeV
1MeV / 2MeV/mm (for Pb) = 0.5 mm AA
This would be my answer as well, just wondering do we need to add the extra 1mm here?
Look like, Kahn suggested add 1 mm extra (sec. 14.6.B, KW)
Agree with 0.5mm+1mm added as safety margin (Khan). JPS

123. Difference between physical wedge and dynamic wedge is?
dynamic wedge has less beam hardening and less scatter...
Agree. JPS

124. IMRT: Difference between simulated annealing and gradient reduction in IMRT?
My guess: annealing is stochastic; gradient reduction is deterministic...
Gradient method works to decrease the cost function in the direction of the steepest descending gradident in the cost function space; the cost fun may be trapped in the local minimum
Simulated annealing use stochastic strategy (randomly varying current solution) to find optimal solution which is better finding the global minimum and avoiding solutions trapped in local minimum (2011 AAPM review course, KW)
Exactly. JPS

125. Shown an IMRT fluence map for a 5 fields prostate IMRT, identify the various fields.
Find this link, it's not fluence but dose distribution. For AP field, it faces bladder, so the central dose is low. Because the dose constraint for rectum is more stringent than bladder, so we can see the RAO and RPO field show higher dose on the bladder side, same thing for LAO & LPO. (KW)
http://www.wienkav.at/kav/kfj/91033454/physik/aS500/aS500_imrt.htm
126. What is the Klystron's function. RF power amplifier AA

127. Which part of the linac will give rise to a low gas pressure fault?
waveguide...
The more detail answer is the transition section between the magnetron\klystron and the tranmission waveguide. (p52, Green, linear accelerator for radiation therapy, KW)
Agree. JPS

128. If a Linac's outputs are off the same way for all the beams, what could be the problem? **Monitor Ion chamber**

129. What's the definition of a PTV?**Planning target volume**
Includes gross target volume (visible disease), clinical target volume (microscopic disease) & margin for setup uncertainty KMW

130. Which organ shows partial volume effect?**kidney, lung, liver** add more (bladder, rectum, parotid, heart, esophagus) (KW)/generally dose not have a max dose limit

131. Photon field abuts electron field, where is the location of the hot spot and why?photon(scatter from electron)

Agree. JPS

132. Define the The Transport Index represents the exposure rate
the measurement is done 1meter from the surface of the container.
Transport index of 1 is Exposure of 1mR/hr @ 1 meter from the surface of the package. JPS

133. What parameters affect the Mayneord's F Factor and when is it most accurate?
the Mayneord F factor is not considering scattering, so it's more accurate for the beam that has less scatter. So, smaller field size will be more accurate to use the Mayneord's factor (Kahn sec. 9.3.c, KW)
Agree. JPS

134. What "stereotactic" means in stereotactic radiosurgery3D AA

135. TG43: what is Lambda? Dose Rate Constant AA

136. Tolerance for simulator laser vs. gantry center **2mm (TG40)**

137. Amount of X-ray contamination of 18 MeV electron beam? ~ 2%anyone?
2% - 5% Khan P281
2-5% Agree. JPS

138. IMRT shielding: how much more shielding needed in addition to a regular linac shielding
The workload is about 5 times more... anyone?
The workload may remain the same but the MU is increased around 2 - 10 fold higher. Therefore, in NCRP151, a F factor is introduced in IMRT leakage calculation which can be adopted as 5. Leakage will mostly affect the 2nd barrier than the primary barrier. If the leakage is increased by factor 5, we will need additional 2.3 HVL = 0.5^(2.3) = ⅕ to bring the leakage down to the original dose limit (KW)
Agree. JPS

139. 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?
interpolation of the calibrations of Cs-137 and 250KeV x-ray
Do you have a reference for this? E_{avg} Ir-192 is ~ 380 KeV JPS
a paper written by Steven J. Goetsch 1990 "calibration of Ir HDR afterloading systems"

140. Given a 45Gy photon treatment to neck. Choose electron energy for boost to treat nodes at 3cm depth and spare cord at 5cm depth. 9Mev(80% is at 3cm and zero at 5cm) any comments!!!
I agree with 9MeV, or 12 MeV with 1cm bolus?
My opinion: The most useful treatment depth (Kahn, sec 14.4.A) is R90 which is 2.8 cm for 9MeV, and 9MeV will have better skin-sparing compared to 12 MeV, since we only want to treat the node at 3 cm depth (KW)
Agree. JPS

141. Treat 4.3 cm depth with 12 MeV and 200 cGy, what is the dose at dmax.
12/4.3=2.79~2.8 ⇒ So Rx is to 80%. (Remember the rule of thumb E/2.8 ⇒ 80%)
200/0.8=250cGy at dmax AA

142. Shielding: What's peak energy of photons near door? **511KeV**
Agree. JPS

143. 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?
simple average? anyone? The workload is the sum of the 4 electron energies since the information is limited, I used 200 Gy/4 x (0.035 + 0.02 + 0.015 + 0.01) = 5Gy (KW)

I think it's 4 Gy, unless I'm doing the math wrong.
Thx! should be 4Gy

144. What is the decay rate of 192Ir per day. ~1% AA

145. Weekly dose limit for unrestricted area. **0.02mSv/wk**

146. What are the properties of a GM counter.
GM is much more sensitive than ion chamber, which can detect individual photon. However, this detector is not a dose-measuring device but rather than a preliminary surveys to detect the presence of radiation. It can significantly underestimate dose. The voltage applied to GM is much higher than the ion chamber. (Kahn sec.16.8.A.2), anyother comment? (KW)
Agree. JPS

147. 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?
theta= tan-1(5.25/100)=3 deg.
RPO =180+45-2*3=219 deg.
Agree. JPS

148. What is the difference between Acceptance Testing and Commissionning of Linac.
Acceptance test: Verification process of the machine based on manufacture's guidelines for a small subset of beam data.
Commissioning: A process where a full set of data is acquired that will be used for patient treatment. (TG106, KW)
Agree. JPS

149. Tolerance for deviation in a light field for a CT sim **2mm**

150. How much total dose is given by an I-125 seed **1.44*T1/2*D0**

151What is the dose rate at 1m from a patient receiving external beam treatment?
0.001, the scatter dose, shouldn't it be 0.1% = 0.001? if we consider 90 degree scatter 1 m away from patient (Kahn sec 16.6B, KW)
the rule of thumb is that the dose scattered laterally from a megavoltage beam has a max photon energy of about 500 keV and the dose at 1 m is about 1/1000th of the dose at the isocenter.
Agree. JPS

152. If the high voltage power source is pushing too much, what is the most likely observed result on the accelerator.
From AAPM review course 2011, it mentioned that if we increase magnetic field too much for magnetron, it will leads sudden drop of electron current in the magnetron. Therefore, it will be no output. Any better answer?(KW)
This is sort of a vague question. If the high voltage power source is powering the direct current perpendicular magnetic field then I agree with the previous statement. A higher magnetic field will cause the trajectories of electrons to bend more and they will therefore pass further away from the cavities decreasing the overall microwave power. However, if the high voltage power source is powering the electric field between the anode and cathode, that will increase the overall kinetic energy of the electrons therefore increasing the overall microwave power induced in the cavities.

More generally (for machines with a klystron) an instability in the high voltage power supply will lead to energy instabilities as well as output instabilities because it will affect the gun filament as well. JPS
JPS, thank you for such detail comment I agree with you. One more thing, I wonder why gun filament will be affected by the klystron output ? any reference I can look at it, thx! (KW)

153. Which modality (photons or electrons) and energy is used to cross calibrate a parallel-plate chamber with a cylindrical chamber. **High energy electron or Co60...?** High energy electron TG51

Agree. JPS

154. What is the Electron beam quality specified by?R50 (TG51, KW)
Agree. JPS

155. Given a table of PDD's 4 MV and 18 MV what is the ratio of max dose 4MV/18MV.
Must have some other conditions...

156. What is the effect on point outside treatment field when using dynamic wedge versus hard wedge.**Less scatter**
Agree. JPS

157. 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. What is the ratio of dwell times 1 to 2 to make dose A equal dose B? **inverse square law**
I calculate as 20:17 (KW)
Agree. JPS

158. 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?
My try: Assume total fraction number is 30; X+Y=30; 62*30+1.5X+1.5*0.18*Y=4000 → Y=19.18, so need at least 20 fractions with cord block.

159. 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.
0.32*X/(0.17^2)*(0.5)^(20/5.5)=50 → X = 56.4mCi, we need to consider the 2cm from the pig, the source is inside the pig. I would think the distance be 15cm instead of 17cm ⇒ radius of drum is 15. Am I wrong?? I used 15 cm as well and I got 43 mCi (KW)
I get 43.9mCi as well. JPS
Thanks
160. TBI, diode reading 450cGy on surface, prescribed midline 600cGy POP laterals, 30cm separation. TMRs were given with 350cmSSD. What is error in midline dose?
The answer will depend on whether the diode reading is an entrance dose. Assuming that's the case, it's just the Ddmax reading from one beam: and also the exit dose from the other beam?

I originally thought that but I think when the term entrance dose is used for diode measurements, it implies one beam at a time so it's just the contribution from that one beam.

Ddiode = Ddmax
$D_{mp\ from\ diode} = 2*D_{dmax}*TMR(15cm)*(350/365)^2$
$= 2*D_{mp\ from\ diode}*TMR(15cm)*(350/365)^2$
$\%\ diff = (D_{mp\ from\ diode} - D_{RX\ midplane})/D_{RX\ midplane}$

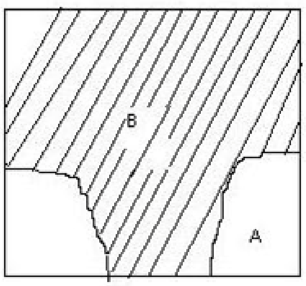
161. Three isocentric beams 120 deg apart, AP and post obliques. Each goes through 15 cm depth to isocenter. 180Gy at isocenter weighted equally for three beams. Post beams transfer 9cm lung (electron density= 0.33), TMRs given at 3,6,9,12,15 cm. Calculate MU(post obliques)/MU(AP).
My try: For the two post obliques: 9cm lung = 3cm tissue → 6*3.5% = 21% less attenuation; MU(oblique): MU(AP) = 79:100... anyone?I am not following :(equivalent depths for the obls. 9cm, ap=15cm, find TMRs at 9cm =>MU=cGy/TMRs*Factors)
Here is my formula; MU(oblique)/MU(AP) = TMR(15)/TMR(radiological depth) = TMR(15)/TMR(9/3+6) = TMR(15)/TMR(9), (TG114, KW) **(the way to go :))**
Exactly. JPS

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

163. Given Kersey's formula and the distances and ratio of maze areas, neutron dose at isocenter (m Sv) 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.
Hn = H0*(S0/S1)^2*(1/d1)^2*10^(-d2/5meter), in this question, it says neutron dose at iso, that's why I used 1 instead of 1.41...not sure about the square of area...
In Kersey's formula, d0 is actually 1.41 m from target (NCRP151, p44 eq.2-18, KW), ^2 for the ratio of area maybe a typo?

164. 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.
With Taylor expansion, for simplicity: 3.75*420 = 9.43*T2 → T2=167s, agree with ken, forgot the attenuation after source change. Your time is on Aug 16th!!==>175sec
I calculate as 3.75*420 = 9.43*0.5^(5/74)*T2, T2 = 175s (KW)correct
Exactly KW. JPS

165. 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.



Need help with this one, do we need SAR here?
Here is my thought, following Kahn sec 10.3 example 8: Assume depth at point A, and B = d_A, and d_B, respectively. The field size for the whole field as S, and for B block field as S_B, and A field as S_A;
The MU can be obtained from field A; MU = 200/(%DD(d_A,S_A)*Sp(S_A)*Sc(S)*OAR(pointA)), if no OAR was given in the question, we can just assume it's CAX for point A.

For point B, 90 = MU*%DD(d_B,S_B)*Sp(S_B)*Sc(S)*0.5^(n), we can solve this equation to get block thickness n. (KW)
Could also be a similar problem as example 8 on Page 173

166. 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?
TVL of lead x, TVL of concrete y,
x + y = 6
2x+18y = 36, so x = 4.5 , 4.5 x 2 = 9 in of lead (KW)
YES!! JPS

167. Sim film taken at 102cm SSD, SFD 140cm. Want to treat at 120cm SSD. What distance to film should be used when cutting blocks.**102/140 = 120/X → X=164.7**
Agreed. JPS

168. 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.)?
40/56=100/X → X=140 → 167-140=27cm, patient thickness is 27cm
Yes. JPS

169. Given diagram of one dimension blocked field with distance from CAX and table of SARs (0cm 6cm 9cm 10cm etc),

calculate SAR.
CLARKSON's method, simple subtraction?
Agree (Kahn sec. 9.5.A KW)
Yes. I think Bentel has a detailed example of this calculation. JPS

170. 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?
150*f^2 = 52.3*(f+10)^2 → f = 14.39cm
That's how I solved it. JPS

171. Dose to cord from AP/PA 100 SAD setup. Given 22cm separation, cord 4cm deep, and 200cGy to isocenter.

172. Film exposed for dosimetry. Given transmitted light is 200 times smaller than original, what is the dose? OD vs dose table is iven.
OD = -log(I/I0) → OD = 2.3 → dose based on OD vs DOSE table.
Yes. JPS

173. 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.

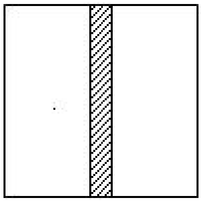
174. 15 x 20 POP, calculate MU for dose required. No Output factor vs. field size or calibration condition provided.

175. 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?
200cGy / 238% = 84cGy???
This is what I got. 3 equally weighted beams giving 200cGy to the 238% isodose line will each contribute 84 cGy. JPS

176. 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).
in Khan, he mentioned that output factor could be relative to a reference depth. He gave an example of Dmax but it doesnt have to be Dmax i guess... please correct me if i'm wrong.
It may calculate in this way; Dose1(reading1) = MU/(TMR(d=10,FZ = 10)*Scp(10)), where Scp(10) = 1, I assumed d = 10 cm is the reference depth, and Dose2(reading2) = MU/(TMR(d=10,FZ = 20)*Scp(20)), so Scp(20) = (D1*TMR(10,10))/(D2*TMR(10,20)) (KW)
That seems like a very reasonable solution. JPS.

177. 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)	



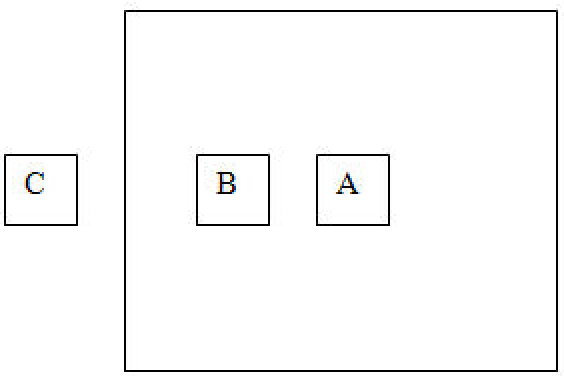
my try:
Assume point A is under one of the open portions of the field. Assuming no scatter from the other open field.
for the open field, it's 6x15 → Feq = 8.57; the block 3x15;   Feq = 5
MU = Dose at A / (OF(8.57)*OCR*TMR(8.57)) → for the same MU, dose at CAX will be:
Dose at CAX = MU*OF(15) - MU*OF(5)*95%

Not sure if this question gives correct information, output factor is Sc, but we will need Sp as well, so
MU = Dose at A/(Sc(15)*Sp(8.57)*OCR*TMR(7, 8.57))
Dose at CAX = MU(Sc(15)*Sp(15)*TMR(7,15) - Sc(15)*Sp(5)*TMR(7,5)*95%) (KW)

KW's solution makes sense JPS

check out: example 8 on Page 173

178. 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.



5^2/12^2 = 0.07 → 2 TVL I was wrong, thx, agree with ken
Can someone explain how they came to this answer? I don't understand why 12 is used (I'm assuming you're adding the 7m and 5 m) but that doesn't make sense to me. The source is moving from 7m to a closer distance of 5m. An how are you getting 0.07?

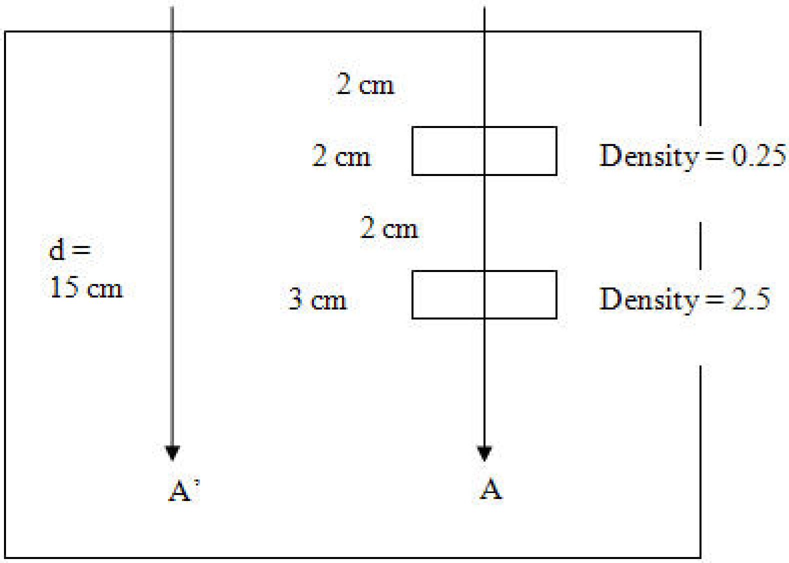
I use 7^2/5^2 x 10^(-n) = 1, and n = 0.29 TVL (KW) I am still hung up on this one: I also got TVL = 0.3, by doing it long-hand, assuming a W=450Gy/wk, but the answer choices do not give this as an option. If you see below in the 2010 recalls, this same Q is asked and the A choices were A) 4.7 TVLs (B) 3.7 TVLs (C) 2.7TVLs (D) 1.7 TVLs

The distance for primary beam should be "target" to the point of measurement from NCRP151, so in this case it should be more accurately using 8^2/6^2 x 10 ^ (-n) and n = 0.25 TVL (KW), To LSK107 comment, we have 5 choices, so (E) may be our answer. (KW) Where are the 8 and 6 coming from? target to the calculation point

KW's answer makes sense. JPS

179. From source to point A, there are: 100 cm SSD to surface, then 3 cm tissue, 2 cm inhomogeneity (re=0.25), 3 cm tissue, another 3 cm inhomogeneity (re=2.5), finally 4 cm tissue. So depth is 15 cm. 4MV beam delivers 200 cGy to point

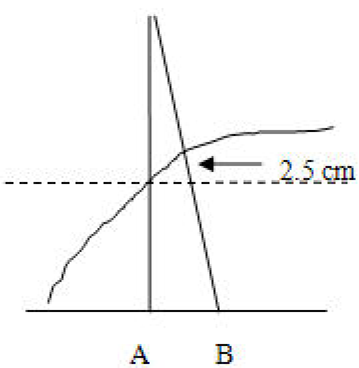
A with inhomogeneities. What's the dose to point A without the inhomogeneities? TMRs were given.
3+2*0.25+3+3*2.5 +4= 18cm → use TMR it is 2+2*.25+2+3*2.5+6=18cm



-
Dose to point A' without inhomogeneity = (200/(TMR(depth = 18))*TMR(depth = 15) (KW)
YES. JPS
180. Given primary workload, distance to office, and TVL, calculate shielding thickness to achieve 1/10 of MPD. U, T, MPD were not given.
U = ¼; T=1; MPD = 0.02mSv/wk, I read it somewhere, kinda remember this 1/10 MPD somewhere
W x U x T x 10^(-n/TVL) x (1/d^2) = 1/10 x MPD (just feel weird the design goal even 1/10 for uncontrolled area) (NCRP151, KW)

Agree with KW. I think 1/10 of MPD is a safe and conservative design goal. JPS

181. 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 along CAX.



Dmax with SSD = 100 is: 200/0.65 = 307.7cGy → Dmax with SSD = 97.5 is: 307.7*100^2/97.5^2 = 323.7cGy
Assume 6MV: %DD(12.5) with SSD = 97.5 is: 0.56*((97.5+1.6)/(100+1.6))^2*((100+12.5)/(97.5+12.5))^2 = 0.557
Dose at B: 323.7*0.557 = 180.3cGy
Observe here that the PDD(12.5) does NOT change (0.56 ⇒ 0.557) with the Mayneard Factor. In fact in Khan's discussion, the PDD correction factor by Mayneard Factor is not considered at all with the assumption that it does not change much. AA
Good point, thank you.Knowing that %DD does not change, one can calculate Dose @B=323.7*0.56=181cGy directly. Right??

182. 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?
Equivalent depth problem

183. Orthovoltage shielding calculation given the workload.

184. 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)
change to 18MeV The question is dealing with D80% 9MeV, Bolus is more relevent to the question. We are not comparing two energies.
Agreed. JPS

185. 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, ans: 20fxs 24fxs 26fxs 28fsx
Calculate cord dose from AP and PA beam for each fraction by using TMR, then divide 4500 with this fraction dose...

186. What is the dose for irreparable damage to the kidney?
Emami dose tolerance: TD5/5 for whole kidney is 2300cGy

Here is the recall from 2008: What is the dose for irreparable damage to the kidney?
1000cGy, 2000cGy, 3000cGy, 4000cGy
2000 cGy (KW)
Are we supposed to pick the value that's higher than the limit? so 3000cGy?
I would also choose 2000 cGy based on the phrasing of the question and the Emami constraints. JPS

187. 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
Yes. JPS

188. Given a diagram of a DVH that shows critical organs, PTV and GTV curves. Choose which curve represents the GTV

189. 13.05 nC exposure, W/e = 33.3J/c 2.58 x 10^-4 C/kg What is the volume of gas in the chamber?

190. TG51 calculation. You have to calculate Ppol, Pion and Ptp (in kPA). Mraw high and low given,.
$P_{ion}(V_H) = (1 - V_H/V_L)/(M_H/M_L - V_H/V_L)$ for pulse beam regular linac
$P_{pol} = |(M_+ - M_-)/2M_{+\ or\ -}|$
$P_{tp} = (273.2 + T)/(273.2+22) \times 101.33/p$, (KW)
Yes. JPS

191. What is the range of a Y 80 beta 2.2Mev in air? **11meter**
Yes. JPS

192.Effective energy of an electron Ez 4 Mev, depth is 1.7cm and an Eo is7.1 Mev.
$E_z = E_0(1-z/R_p) \rightarrow R_p = 3.89$cm
Yes. JPS

193. 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.
Khan P63: bone: multiply 1.65; lung: multiply 0.33

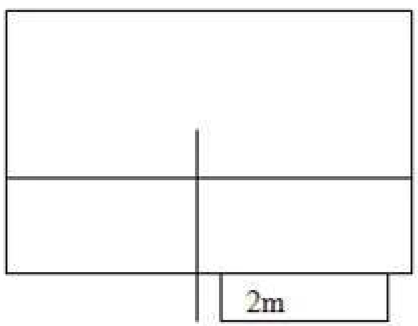
194. A universal wedge has a 0.65 wedge factor. A 60 degree wedge is needed. 100 Mu are given for open and 200 Mu given for the wedge field. What is the average WF?
Tan(THETAeffective)/Tan(60) = 200*0.65 / (200*0.65+100) → THETAeffective = 44.38
This question asks average WF than the effective wedge angle; my approach is (chamber reading of wedged field/ chamber reading of open field) = (100 + 200x0.65)/300 = 0.77 (KW) **thanks**
Yes. JPS

195. If the collimator rotation is off 1.2mm, the couch rotation is off 1.4mm and the gantry rotation is off 1.5mm, according to AAPM what is the overall uncertainty?sqrt(1.2^2 + 1.4^2 + 1.5^2) = 2.37 mm, (KW)
Yes. JPS

196. 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 (SC)

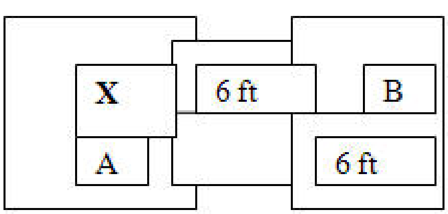
197. Calculate the steradian of a 50cm diameter area on a standard linear accelerator.
Omega = 2*pi*(1-cos(theta)) → theta=arc(tan(0.5/2)) → Omega = 0.19 … is this right? **Yes, it is 0.187**where did you get (0.5/2)??? KW has the correct calcs.
In shielding calculation 'skyshine', the solid angle is simply calculated as theta = tan(SAD/half field size), McGinley book "shielding techniques" Ch7. P104 example, so theta = arc(tan(0.25/1)), and get omega = 0.187 (KW)**correct**
Agree with KW. JPS

198. 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).
0.1*10^-3 * 4 / 5*10 = 8*10^-6 → 6 TVL, I use



For a Workload of 10 patients for week we get : 5000 cGy/wk or 50,000mGy/wk, Weekly limit P = 0.02 mSv/wk, d=2meters B = Pd²/WUT = 0.02*(4)/50,000 => 5.79 TVLs

199. 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?



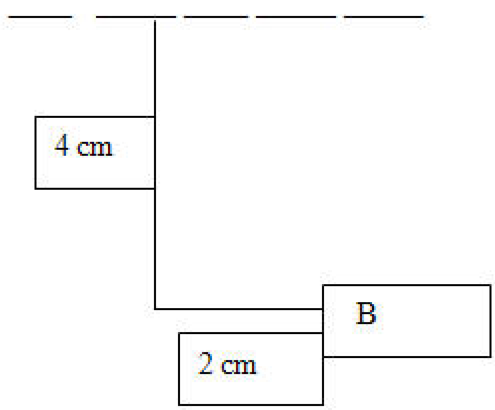
I think the real problem should be much clearer than this...

200. Shielding question that gives a thickness of concrete and the room is shielded for 6X. How much more shielding is required for 18X?

10cm more of concrete

201.Why do the doctors leave a strip around each side of the treated area on a sarcoma? **To avoid Lymphedema**

202. What is the dose to point B?



203. Universal Wedge, WF = 0.2, what % MU needed for 30 degree effective wedge

0.2*X / (0.2*X + Y) = ⅓ → X:Y = 5:2

tan(30)/tan(60) = p x 0.2 / (p x 0.2 + (1 - p)), where p is the %MU for wedge field, so p = 71% of MU delivered for wedge field (KW)

204. What does a fMRI measure

the most popular fMRI sequence is Blood oxygen level dependent (BOLD) MRI, so my guess would be blood oxygen level.

205. 1 R delivered, 3x10-10 C measured, what's the size of the chamber?

1R = 2.58*10^-4 C/kg → 1.16*10^-6 kg → get volume with air density

The air density is about 1/1000 of tissue so chamber size is around 1.16 cm^3 (KW)

VOL = Q/(RHOair)*(X) = 0.98cc [use air density of 1.293kg/m^3]==>x=q/m ==>I get 0.899cc

206. 30 cm2 field directed at roof, what is sold angle subtended at a point on the ground?

It maybe a skyshine problem (NCRP151); theta = arc(tan(0.15/1)) = 8.53 degree, solid angle = 2x pi x (1 – cos(8.53)) = 0.07 (KW)Agree

207. 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?

Say dose from each source at 1cm is X:

200 = X(1/16+2/17+2/20) → X = 714; Dose at B = X(1/16+1/17+1/20+1/25+1/32) = 173.18cGy

I take point B is 2 cm away from point A so it's 6 cm from midline source.

200 = X(1/16+2/17+2/20) → X = 714; Dose at B = X(1/36+2/37+2/40) = 94.25 cGy (KW)

yea, you are right, lateral here means along the midline. thanks

208. Increasing the current to the magnetron does what?

Inc E

209. Retrofit a linac to perform IMRT… how much shielding do you need to add?

Leakage will be the concern due to 2 - 10 fold higher MU from IMRT compared to conventional linac (NCRP 151), 5 fold higher MU can be an appropriate number to consider IMRT leakage (KW)

210. What is the source of electrons in an electron treatment?
Electron gun

211. Given density of lead and mass atten coef for a random energy… what is TVL?
mu/rho * rho = mu; TVL = ln10/mu

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

213. SRS treatment, 4mm cone… what is max dose? Answers
Should be 4cm?? At MSKCC, we prescribe 15Gy to 80% IDL for tumor larger than 3cm.

(from yahoogroup) 1; We treated a trigeminal with 8000cGy to 100% line, single fraction , 5mm cone (radionics).
2; For trigeminals at our clinic we routinely prescribe 80Gy to the 90%IDL(88Gy) with a 4mm cone in 1 fraction.
3; In SRS the only site that needs 4-5mm cone alone is Trigeminal and the typical prescription is 80 Gy to Max.
So max dose for 4mm cone is 80 Gy.
From Handbook of evidence-based radiation oncology 2nd, p67 "SRS is used with 80Gy at 100% IDL" (KW)

214. 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?
Guess output and TMR will be given and it's a MU calc problem?
Assuming the WF is given, the correct MU/field = 160/WF, so (160/WF - 160) = the missing MU/field, so the MU/field from 11 to 30 fx should be ((160/WF - 160)x10/20 + 160/WF)/field (KW)

215. Electron Eo = 7.1 Mev, mean E at 2 cm = 4 Mev. what is range?
Ez = E0(1-z/Rp) → Rp = 4.58cm

216. According to TG51 you need to adjust you %DD by what?
Is this question asking about the shift of depth-ionization curve?
Or it could be another effective point of measurement question. JPS

217. What happens to surface dose and %DD by adding a physical wedge?
My Guess: surface dose will decrease (scattered e- from head got stopped) and %DD will increase (beam hardening)
I vote surface dose will decrease due to beam hardening so it will be large penetration and %DD will increase (Kahn Fig. 11.6, KW)

218. Three layer material. First layer is 3 cm thick, HU = 0. Second layer is 4 cm thick, HU = -800. Third layer is 2 cm thick, HU = -100. What is effective depth?
(from Yahoo group) Assume a linear relationship between electron density and HU, HU=0 is water with density =1; HU=-1000 is air with density close to 0 → HU = -800 with a density = 0.2; HU = -100 with a density = 0.9 → 3+4*0.2+2*0.9 = 5.6cm

219. Why can't MRI be used for hetero corrections?
MRI has no attenuation information

220. Why should you convince the doctor to not use a 25 cm x 3 cm electron cutout?
My guess: with such a small cutout, the output and PDD will be changed a lot, hard on MU calc... anyone?lack of lateral scatter??
The reason can be it's elongated cutout; because it's abnormal cutout, the field size equivalence can be difficult to be established. Therefore, it will be hard to characterize the output, PDD..etc (Kahn 3rd sec. 14.4.E, KW)
thanks, sounds right to me
Sounds good and the shorter dim might not exceed the LSE point Eo/2.5: 2.4cm for 6 Mev and 3.6cm for 9 MeV

JPS

221. You have a half beam 6 MV photon beam and a parallel 9 Mev electron that match on skin surface… where is hot spot?
on the photon beam side because of electron scatter

222. What is definition of EUD?
Equivalent uniform dose (EUD) – the idea behind EUD is to find the uniform dose that gives the same biological effect for a given non-uniform distribution. The dose level of that uniform dose is then the equivalent uniform dose of the non-uniform distribution. Used for optimization.

(Yahoo group) EUD: (equivalent uniform dose), a dose when distributed uniformly across the target volume, causes the survival of same number of clonogens as the true dose distribution. It can be calculated from DVH and radiobiological parameters. min tu dose<EUD<mean dose. from Ref. (IMRT summer school 2003) by Ellen Yorke

223. What is definition of integral effective dose?
Integral biological effective dose (IBED) ?
Integral dose is defined as the total energy imparted to the body outside the target volume (Hendee, p180). In SI units, it's unit is in J. So, I think integral effective dose is the similar stuff but just add the organ weighting factor for each organ, anyone? KW
Yes this is a correct definition and I think the question was referring to IBED. JPS

224. What part of curve is an ion chamber used for calibration operated in?
Ionization range
Yes, more specifically on the first plateau of the Ionization versus Bias Voltage curve. JPS

225. Why would a doctor use Pd103 instead of I125 for prostate implant?
dose would be delivered in a shorter time.
Yes. JPS

226. Which part of linac is not water cooled?
Water cooling for linac is either to maintain the frequency or remove excessive heat. It may be easier to list the component needing the water cooling rather than not water cooled; the components need water cooled are 1. Microwave valve, 2. Accerlerating waveguide. 3. Resonant cavities, 4. target 5. Focusing and steering coils 6. RF isolator, 7. Transformers, (Green p53, KW)
Is water cool the only cooling system in linac?
I believe the target may be oil cooled. JPS

227. According to TG40… how often do you check wedge interlocks? **monthly**

228. 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

229. HDR calculation using point source formalism from TG-43 (given dose rate constant, radial dose function)
TG43

230. Treating a stereotactic lesion in the head with a 4 mm diameter beam. What is the largest dose you can prescribe?
I think it's asking 4cm, 15Gy prescibe to 80% with linace non-coplanar beams (4mm, 12Gy @ 100%)Anyone?
This question may be a repeated question see Q.213 (KW)

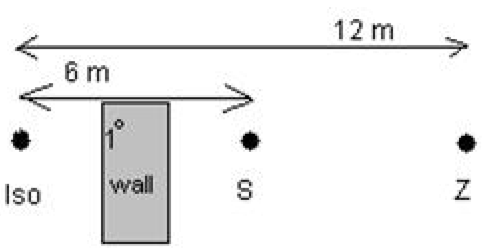
231. Standard Gap Calc between a treatment with an SSD setup and a treatment with an SAD setup.

232. Concrete is used for neutron sheilding for what reason?
slow down the neutron to thermal
The hydrogenous makeup of concrete causes it to have a much higher neutron cross section than say lead or steel. JPS

233. Using lead and concrete to shield Primary wall. From the inside, what is the order of the materials?
concrete then lead...
From NCRP151 or AAPM 2011 review course, it suggested lead and then concrete, because photoneutron can be produced in the lead itself, so concrete can then absorb neutron. (KW)
per McGinley: lead, then concrete
Pb then concrete JPS

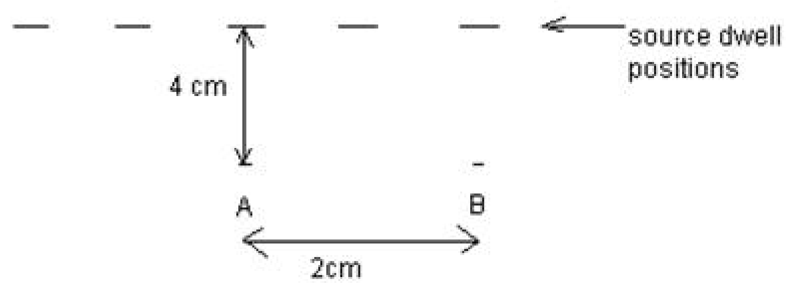
234. Given 125I half life of 59.4 days, given exposure rate constant in cGy/hr/U or cGy/U/hr. After 30 days what is the dose rate to the tumor in mSv/hr? **Dt = Do*exp(-0.693/59.4*30)**

235. 200 keV beam. The density of copper is given in g/cm3, and the μ/ρ for copper is given in cm2/g. If 3 mm of copper attenuates the beam to 63% of its original intensity, what is the TVL for copper?
density of copper = 8.92 g/*cm3*; μ/ρ = 0.1559cm2/g → mu = 1.39cm^-1 → HVL = 4.5mm
TVL = ln10/mu , so TVL = 1.65 cm (KW)
236. 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.



(6+1)^2/(12+1)^2 = 0.29; 0.2cGy/hr *0.29 = 0.058cGy/hr at Z; 0.08/0.058 = 1.38hr → 1.38*60/0.5 = 165 patients/wk → 33patients/day...
considering it's primary beam so the distance from target to s and to z are 7 and 13 m, following the inverse square law, the dose at point z is reduced from 0.2 cGy/hr to 0.2 x 49/169 = 0.058 cGy/hr
The maximum accumulated dose at point z is 0.08 cGy/wk, it means 0.08 cGy/0.058 = 1.38 rh/wk. The machine only can operate for 1.38 hr /wk, total patient amount is 1.38 x 60 /0.5 = 165 pt/wk so 165 pt/5 days = 33 pts/ day
Yes but embarrassingly tricky :) JPS

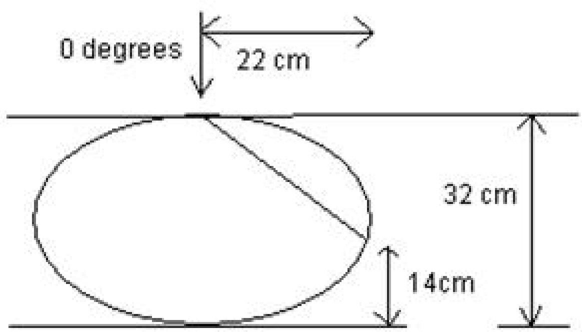
237. Given 5 HDR sources. 1 cm between each source dwell position. 4 cm between middle source and point A. The dose at point A is given. What is the dose at point B. Equal dwell times for all sources. (Also given source active length which is less than 2*distance)



Checked with a brachy guru at our center, it should be: source active length which is less than 0.5*distance. Then we can assume point source and simply use inverse square.

238. 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?
depth = 12cm; 20/25 = SAD2/100 → SAD2 = 80 → SSD2 = 80-12 = 68cm

239. Find the RPO angle given the following (diagram). The line represents the central ray of the beam through the patient.



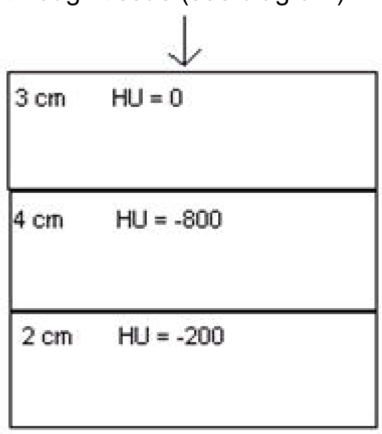
Assume they are using half field block, angle for RPO = 90 +arc(tan(18/22)) = 129.29

240. Parallel opposed fields with equal weighting. 60 Gy in 30 fractions is prescribed to the isocenter. The fields are equally weighted. (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.

242. 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/m3. 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?

243. For a photon skyshine calc, What is the solid angle of a circular beam with a 50 cm diameter?
arctan(25/100)=14 deg ⇒ solid angle = 2*pi*(1-cos(14))=1.87

244. A beam travels through tissue (see diagram). What is the radiographic depth?



245. 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?

Increased MU usage for IMRT will only affect the secondary shielding for leakage, but i'm not sure what factor we need to apply to the workload when doing calculation.

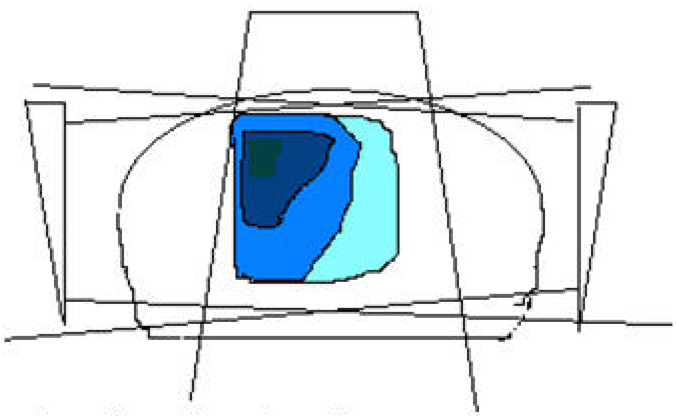
Assuming the original work load = W, and the IMRT factor = 5, so the total leakage workload WL= W/2 + W/2 X 5 = 3W which means the point behind the secondary barrier dose will receive 3 fold higher dose than without IMRT implemented. We need 3 X 10^(-n) = 1, TVL = 0.47 (KW)

246. A universal wedge with a wedge factor of 0.25 is used to deliver a beam with an effective wedge factor of 30 degrees. What is the fraction of MU's delivered by the wedged portion of the field.

MUw : MUo = 2:1

tan(30)/tan(60) = p x 0.25 / (p x 0.25 + (1 - p)), where p is the %MU for wedge field, so p = 67% of MU delivered for wedge field. For universal wedge, the equation is tan(theta')/tan(theta) = W2/(W2+W1) theta' is the effective wedge angle, and W2 and W1 are the beam weight related to "the dose portion" of the field for wedged and open field (linear accelerator for radiation therapy, Green, p 85-86)(KW)

247. 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 the wedge angle and increase the weight of LLat, lower the weight of AP as well? ...

i may increase the wedge and lower the weight of AP and R-Lat or just increase the weight of L-Lat(KW)

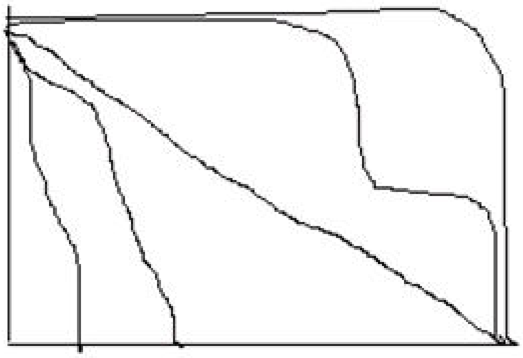
248. When the current in the magnetron increases what is the resulting change:

Help with the machine problem …

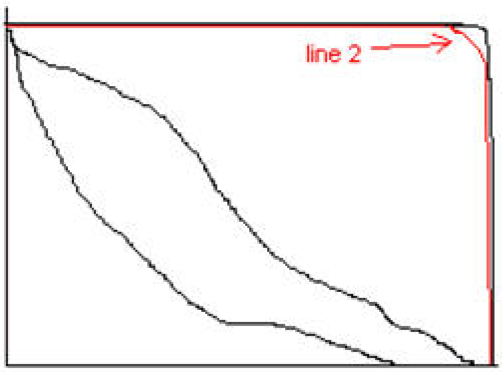
The magnetron provides high power microwave to waveguide, if changing the current in the magnetron, the output powerof the magnetron will be increased, and the energy of the electron traveling in the waveguide will be increased as well. Any other opinion? (KW)

Seems reasonable but pls see my previous soliloquy on magnetrons. JPS

249. Shown DVH and must choose the DVH line representing most heterogeneous dose distribution **the diagonal line**



250. Which structure does line 2 represent on this DVH for an IMRT plan? **PTV**



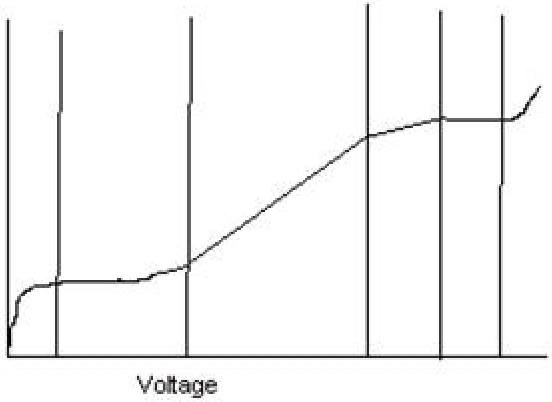
251. When treating a lung tumor, what is the dose associated with radiation pneumonitis (V20=30%, V50=10% etc)?
I guess we will answer this with emami dose tolerance as i think different center use different constrains... for pneumonitis, is it TD5/5 for ⅓ of the volume?
FYI, Penn use mean lung < 20 Gy, V20< 35%, and sometimes, we will look at V5<60% (KW)

252. Neutron dose from 15 MV photons
Measurements have shown that in the 16 to 25 MV x-ray therapy mode the neutron dose equivalent along central axis is approximately 0.5% of the x-ray dose and falls off to about 0.1 % outside the field.

253. When an electron beam has an oblique incidence on the surface, what happens?
surface dose will increase
1) incr side scatter @ dmax
2) shift dmax toward surface
3) decr depth of penetration

254. According to Bragg-gray cavity theory, the diameter of the air cavity should be what?
the cavity is sufficiently small so that its introduction into the medium does not alter the number or distribution of the electrons that would exist in the medium without the cavity. Khan P101

255. In which region would a cylindrical ion chamber be operated on a voltage versus ion pairs collected graph?
the second section from left



Yes. JPS

256. In Monte Carlo Treatment Planning Algorighms, 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.
10 kev
100 kev
200 kev
500 kev
1 Mev

(from yahoogroup) 10 kev is the cut-off energy for neglecting the contribution of these low energy particles to dose while 200 KeV is a cutoff energy when we do not trace particles as discrete entities but boundles all of them into one continuous distribution in the dose calculation, ie these low energy particles are still having contribution to the dose. cut-off energy for Monte Carlo calculations is usually a user defined variable. It could be 100, 300, 500 KeV, for instance. Ref: Int. J. Radiation Oncology Biol. Phys., Vol. 72, No. 1, pp. 220-227, 2008

257. How much do shift your ionizationcurve to get a PDD curve?
0.6Rcav for photon; 0.5Rcav for electron

258. 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: image intensifier, automatic brightness control, scatter grid, another choice I don't remember...

259. 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?
Calculate the dose first and then calculate the MU? Or there are better ways by converting %DD to TMR?
Here is my calculation, assuming machine is calibrated 1 cGy/MU at dmax, SSD = 100 for 6x, field size S, and Sc and Sp measured at dmax; MU_ssd = D/(1cGy/MU x %DD(10) x Scp(S)). Scp(S) = D(10)/(%DD(10) x MU_ssd)-(1)
Changing to SAD setup; 1 cGy/MU x (100+1.5/100)^2 = 1.03 cGy/MU at dmax with SAD setup.
MU_SAD = D/(1.03 cGy/MU x TMR(10) x Scp(S)) - (2)
We put eq. (1) into (2), we can get the MU_SAD = 0.97x(%DD(10)/TMR(10)) x MU_ssd (KW)
I think the key to this problem is the conversion between output with SSD setup to output with SAD setup by using inverse square law, am i right?
Agreed. JPS

260. 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?

Assume the wedge was used for both beams. 1/0.8 = 1.25 → 200*1.25*10 = 2500cGy; 200*30 - 2500 = 3500cGy → 3500/20 = 175 → 175/200*147 = 129MU

I think the wedge was in the treatment but it wasn't taken into account in the MU calclation; so (147/0.8 - 147) x 10 /20 + 147/0.8 = 202 MU /per field for 11 - 30 fx, (KW) **agree**

I actually interpreted the question the same as YY and got the same answer but if the question was actually asking what KW thought, then I also agree with his solution. JPS

==================================2004 ABR Part II – Therapy Physics Type

2. TG51 question Given Ppol, Pelec, T (deg C), P (mmHg), Vhigh = +300V, Vlow = +150V, 100mu Reading for Vh = 1.71 …., 100mu reading for Vl = 1.70…., given 60CoNdw Gy/C for chamber, given pdd photon, given kQ (not asked to do energy determination to find kQ) calc cGy/mu at dmax for photon beam. Answers approx 0.6% apart. (Also given plenty of irrelevant information such as TG51 electron beam parameters)

1. corrected M = Pion*P_{TP}*Pele*Ppol*Mraw; 2. Dose at 10cm D10= M*kQ*N_{Dw}^{Co} ; 3. Dmax = D10 / PDD10

3. Simulator shielding question, NCRP 116 level to worker with office above simulator room. Occupation mentioned – I don't recall but was an allied health profession not related to radiation oncology/ radiology. Floor to floor = 12 ft, iso = 48" above floor, SAD = 100cm, given U=1/4. W=800mA.min/wk. Asked to work out the thickness of concrete shielding required. Answers about 4mm apart. Provided with a graph of R/(mA.min) at iso on vertical axis (log scale) vs concrete shielding thickness (cm) on horizontal scale – with the log scale, the plot was reasonably linear. Basically I think what you had to do was find allowed R/mA.min at point where person is sitting, then project back to iso to give your number for the Y axis then read across to get concrete thickness.

my try: 12*12*2.54cm -48*2.54cm = 2.4m → 800*1/4=200mA*min/wk; MPD = 0.02mSv/wk relative to 2mR/wk → 2*$(2.4)^2$ = 11.52mR→ at iso 2/11.52 = 0.1736mR/mA*min → check out the plot Agree?

McGinley, p126, Ch8 gave a good example, we simply follow the B = Pd^2/(WUT) to get the B transmission in R/(mA x min) at 1 m, and then find the required concrete shielding thickness. There is no need to project the R/mA.min at iso, coz B is already defined as 1 m.

The distance from target to the people sitting position is (12 – 4) ft x 0.3 + 0.3 + 1 m = 3.7 m

B = 2 mR/wk x 3.7^2 / (800 mAmin/wk) x ¼ = 0.14 mR/(mAmin) = 1.4 x 10^(-4) R/(mA.min) then find the concrete thickness based on B (KW)

5. Counts given (cpm) for reference source with known activity (mCi). How many counts allowed to stay below wipe test leakage limit – limit not given (5nCi?).

Just confirmed about 5nCi, so this is a simple algebra?

5Ci x 10^-9 x (3.7 x 10^10)dps/s x 60 = 1.11 x 10^4 cpm (KW)

6. 2cm diameter lead pig inside polyurethane foam inside 30cm diameter shipping drum. HVL Pb given. Exposure rate constant of 192 Ir given (but not the one I know!). Calc max activity to keep below 50mR/hr on surface. Another variant of this question used 137Cs (again I didn't recognize the exposure rate constant provided), activity provided and asked to calc thickness of lead to reduce exposure rate to certain level (TVL given).

Since diameter of the drum is given, so i guess we dont need to count the 2cm lead into distance, therefore D=15cm; then do the standard ISL calc.

14. Neutron dose equivalent ratio 18MV vs 15 MV. Answers were fairly widely separated ie 1, 2, 5, 10, 100.

According to NCRP151, for varian machine 15MV H0 = 0.79-1.3mSv/Gy; for 18MV H0 = 1.02-1.6mSv/Gy, so it could be 1or 2, anyone?

From AAPM review course, Peter Biggs shielding handout, page 24 " At 10 MV, the production of neutrons is quite low, and by 15 MV, neutron production increaes by a factor 10, and by 18 MV, a further factor of 2. Therefore, I will vote for 2. (KW)

15. Given distance iso to maze and maze length, neutron dose at iso (mSv) per photon cGy at iso, what is neutron dose (mSv) at door per photon cGy at iso. Told TVL of neutrons is 5m, but not where it applies. I applied kersey formula ie ISL iso to maze, then 5m TVL down maze to door.

Hn = H0*(S0/S1)*$(d0/d1)^2$*exp(-d2/5); d0 = 1 here for H0 at iso

17. Dual scattering foil in linac, when change to electron mode (from photon) what happens. A. gun current reduces substantially, B. Both scattering foils are in place C.

other options that were way off.
My guess: Gun current increase? both scattering foils in place...

This recall can be wrong, because both answers are correct. When changing from photon to electron mode, the gun current can change from 600 mA for 6x to 150 mA for 18 MeV due to large electron current required to generate Bremsstrahlung photon. The double scattering foil are mounted together, so they are in the place when changing photon to electron mode. (MetCalf p22, 26 p31, KW)

18. g(r) for 125I vs 103Pd. A. same at all depths, B. Pd exceeds I beyond 1cm, C Pd exceeds I beyond 4cm, **D. I exceeds Pd beyond 1cm**, E. Same at all depths.
Pd exceeds I below 1cm

24. TG40 how often do you check well chamber leakage.A. 2 years, **B. Every use**, C.…

30. 10MV through 6cm lung, dose actual vs dose without inhomogeneity.
2.5%*6cm = 15% dose difference.
31. A question involving 10mg Ra – simple application of ΓxA/d2 – but needed to know (ie not given) exposure rate const. = 8.25 Rcm2/mg.hr

35. In IMRT the physicist does not define: **A. Beam Weights** B. Field Sizes C. Gantry Angles

36. Field size required at midplane is 25cm, maximum can open is 20cm. What is SSD? (separation = 22cm)
20/25 = 100/STD → STD = 125 → SSD = 125-12 = 113
41. No diagram with this one making it tough. Patient on simulator couch with isocenter 5cm right of midline. Wire placed on midline (didn't say A or P). R Lat film taken. Measured cord depth of 6.7cm, but therapist forgot to reset isocenter to midline. What is the true cord depth. If you think this is confusing, then I agree. Basically I think the depth was measured assuming isocenter at midline, then question was asking what is the true depth.
I think we need source to film distance for this problem. Anyone has an idea?
Assuming the cord depth (pt in supine, from posterior) was already taken into account the source to film depth, meaning the therapist thought the cord was at midline at isocenter. However, it was on105 cm from source.
film cord depth fx, source to film distance SFD, so
fx/ SFD = 6.7/100 - (1)
fx/SFD = true depth/105 -(2)
Therefore, the true cord depth can be **6.7/100*105 = 7.035**

43. Beam steering vs gantry angle in a linac. Signals to steer originate from ….. ion chamber …. various other options.
what does 'beam steering' refer to?
Using Varian machine as an example, steering magnetic coils are placed at the gun end, and at the end of the waveguide, used to correct the geometric misalignments in the e gun, and guide the beam accurately onto the x-ray target (or electron window). The beam incident position and angle uncertainty onto the ion chamber are monitored by the 2 ion chambers placed after the target. The 2 ion chambers send the signal back to the coils to adjust the beam alignment (or steering the beam) (KW)

44. Considering a dual ion chamber scanning water tank, an error in the PDD (a shift up or down – I don't recall which) 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.

46. Electron cutout changed from 6x6 to 4x4. What doesn't change, A. Bremstrahlung B. Output Factor, **C. Depth of 80%**, D. Surface Dose.
For this problem, i have some uncertainty, for higher electron energy, C will change as well. So i'm thinking about A, but A will change with collimator setting as well...
It depends on the energy, TG70 Fig. 15 shows the Depth of 80% changing for high energy. Fig. 14 shows the bremstrahlung is relative stable for 15 MeV, I would choose A (kw)
I think the choices may also include Rp, then I will probably choose Rp

47. I50 ionization depth of an electron beam is 5.1 cm. The energy of the beam is …..
R50 = 1.029*5.1-0.06 = 5.19; ave(E0) = 2.33*R50 = 12MeV.
Question: when we are talking about 12MeV, we are referring to average E0, or $(Ep)_0$
Observation: R50 is not that much different than I50, I will just use I50 x 2.3 = 11.7~12 MeV which is E0 (KW)
48. Saturation in an ionization chamber refers to ….A. voltage high enough to prevent recombination ….other options that were not correct.

49. A survey points a linac beam at a primary wall and measures 2mR/hr. Is this OK?
There were various options in the answers, but this was the point of the question.
this is equivalent to 0.02mSv/hr, so it's ok. We may also need to consider weekly dose limit (KW)

50. An ion chamber is used to perform a survey. You also need all of the following **except**: A. Dose rate of linac **B. Sufficient buildup around the survey meter** C… other options that looked to me like they were required. Area survey requires the highest dose rate and the largest field size, so A is correct. (NCRP 151, p100, KW) **they are asking about EXCEPT**

56. A question where you were given air kerma and had to calculate roentgens from this.
I think you just divide by 0.876 rad/R – this gave one of the answers.

58. Most radiation sensitive part of the eye is ….. lens

59. TVL is related to HVL by **A: TVL = ln10/ln2 HVL**, B… other impressive but erroneous relationships.

62. What happens when you change from 15cm field size to 20cm field size for electrons. No energy given. Various combinations of change in surface dose (increase / decrease) and change in dmax (increase/decrease). Only one option had no change in surface dose (which I chose)
15cm is already larger than half of the range of most electron beam, so depth dose doesn't change anymore.

67. Four field prostate treatment to 200cGy. What is the dose to anterior rectum. No other information was given, anterior was in bold. I answered **200cGy**.

68. What should you check with each use of an ionization chamber / electrometer.
(TG40) leakage, collection potential, redundancy check; the redundancy check is only for local standard table IV (kw)

70. A 60Co single field calc 100SSD, cGy/min at dmax given. PDD table given, BSF table given, TAR table given. Prescribed dose was 300cGy to 10cm deep. Had to use 4A/P to convert to square field (had to use 4A/P on numerous rectangular field questions.
TMR = TAR/BSF; i assume the output for Co is also measure in water...?
71. Had to do single field 125 cm SSD calculation. 300cGy to 10cm deep. Given output factor as a function of field size graph (no Sc or Sp which in my opinion makes it impossible to do this question accurately), given PDD table, TMR table, given output at dmax for a 10x10 at 100cm SSD. Answers all very close ie approx 1% apart.
inverse square to convert output 100SSD to 125SSD → MU calc with PDD table

73. Monte Carlo calculations require a random number generator and ….**A. probability distributions**, B,C,D,E other options that didn't look right.

74. Dose 10cm deep 5cm outside field is A. 1% B. 2% C. 3% D. 4% E. 5%
from yahoogroup:
For 6 MV photons 2cm outside of a 10x10 field 7% the CAX dose at 10cm
For 6 MV photons 5cm outside of a 10x10 field 3% the CAX dose at 10cm

For 18 MV photons 2cm outside of a 10x10 field 5% the CAX dose at 10cm
For 18 MV photons 5cm outside of a 10x10 field 2% the CAX dose at 10cm

76. Pacemaker dose limit.**200cGy**

77. Apparent mCi is **less** / more / same as mCi

==================================2005 ABR Part II – Therapy Physics Type

41.- A tumor is reduced because of its higher mitotic activity , was my answer.

42.- PET cant bring information about (metabolism, metastasis, pathology, TX follow up, tumor)
I would guess metabolism, anyone?

53.- Detector resolution required for SRS field profile is (less than 1mm, 2mm, 3mm, etc)
TG101 < 1 mm
TG42 < 2 mm (KW)
So I guess we're going with 1mm on this one? JPS i will vote for 1mm (KW)

56.- A set of CT numbers was given -1000, -100, 0, 100, 1000. Select proper order of tissues that correspond with the order of these CT numbers. Air, lung, water, soft tissue, bone were in all possible answer in different orders.
-1000: Air, -100: adipose(lung), 0:Water, 100:Soft tissue, 1000:Bone (KW)

==================================2006 ABR Part II – Therapy Physics Type

4. What measurement device is best for a simulation room survey? ion chamber, ion chamber w/ electrometer, GM, scintillation counter? ion chamber Kahn 3rd p415 (KW)
7. Given lots of TG-51 parameters, calculate cGy/MU for photons.
8. Given lots of TG-51 parameters, calculate cGy/MU for electrons.
17. What method cannot be used to verify an IMRT plan? Film, point hand calc? **single ion chamber**
22. Question on changing Brachytherapy sources from 192Ir to 125I (or vice versa) and calculating activity/dose rate
24. Daily output tolerance for X-ray and electrons (3%:5%, 3%:3%, 2%:3%, 5%:5% etc) TG40 Table 2 (KW)
25. One beam profile diagram was provided with profile line variation at the surface. The reason for that.....Ans was---Water fluctuation.

==================================2007 ABR Part II – Therapy Physics Type

2. Scatter and leakage shielding thickness calculations are equal. The shielding that should then be used is: A TL + 1HVL, B other options including Ts + TL, Ts + 1TVL
1 HVL is added to the larger of the 2 barrier thickness (NCRP 151 p34 KW)

3. Parts definitely not included in EPID – options were ion chamber, CCD camera, mirror, silicon screen, some other dose detection device. (Is that correct? KW)
video based EPID will have video camera, not sure if it's CCD camera Khan P214

4. TBI – what is not true – A. Dose Uniformity < 15%, B. Tissue Equivalent,
Compensators are used, C. High SSD, D. AP preferred over lateral, E. Lower dose conformity with increased energy.
Higher energy giving better dose uniformity (rather than conformity), KW TG17
Yes. JPS

8. Purpose of the guard ring in a plane parallel chamber is to? A. "Define the collection volume" appeared to me to be the only reasonable answer.

9. 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 …
Extended SSD changes output significantly following effective SSD or virtual source method, and penumbra increase due to larger electron scattering in air (TG25,p98-99,& Fig 25 KW)

10. Why does the equivalent square technique work? A. **Because scatter doses are equal between square and rectangular fields**. Other options involved statement about collimators and scatter that sounded wrong **Khan P145**

13. TG51: to cross calibrate parallel-plate chamber, what should use?
Co60, high energy photon, high energy electron, low energy electron.

14. TG51: KQ depends on what? (choices included beam energy, ion chamber, both)

22. IMRT: Difference between simulated annealing and gradient reduction in IMRT? Faster, more accurate in dose calculation in build up, better with step-and-shoot than with sliding window, achieve global minimum instead of local, etc.

25. Gas pressure low fault is related to which part in Linac? Gun, Waveguide, Magnetron, Accelerating tube, etc.

28. Which organ shows partial volume effect? Brachial Plexus, Kidney, Optic nerve, etc.

29. To compare light field vs. radiation field, film is used. Ask distances for SSD and film SAD. SSD=100, SAD=100; SSD=100-dmax, SAD=100; etc.

31. The Transport Index represents the exposure rate…. (choices included “on the surface” and “at one meter”)
At one meter from surface. (reference: http://www.nrc.gov/reading-rm/basic-ref/teachers/unit5.html)
32. Mayneord’s Factor is more accurate for: 6MV, 6x6, 110 SSD; 6MV, 30x30, 150 SSD; 15MV, 6x6, 110 SSD; 15MV, 6x6, 150 SSD; etc.
Mayneord doesn’t count for scatter, so whichever has the lowest scatter.
36. Amount of X-ray contamination of 18 MeV electron beam? 1%, 4%, 10%, etc.

37. IMRT shielding: how much more shielding needed? All wall + TVL; Primary + TVL; Secondary + HVL; Secondary + TVL; etc. Leakage: Secondary + HVL or TVL depending on the % of the leakage workload changing (KW)

41. Multi detector CT, when cone beam increases size, what’s true: Collimator decreases, scatter photon increases, etc. (not quite sure about the answers) **agree with you about scatter**

42. Shielding: What’s peak energy of photons near door? 200 keV, 500 keV, etc. (Kahn, 3rd p412, KW)

===============2008_Therapy_Part II_Type===================================

· Which scenario would you most likely talk to the Dr.?
A. if he had a small cut-out to place on the skin and he ordered 12 Mev electrons? (This scnerio seems OK not necssary to talk to the physician, anyone? KW)

· Which curve represents 18 Mev , 6x6 FS,
Equivalent radius for 18 MeV = Req = 0.88 x sqrt(18) = 3.7 cm which is equal to 6.5 x 6.5 cm FS. After 6 x 6 cm, we should see %DD not change much along with the increase of field size (Kahn 3rd p314-315 KW)

· Overall uncertainty according to TG40? 6%, 5%, 4%, 3% (KW)

1. You calibrate a machine with the outside temp and press…. But this is the inside temp and press… how far off is your output? Use TG51 eq Ptp = 273.2 + T/(273.2 + 22) x 101.33/p to calculate the difference outside and inside temp and pressure (KW)
2. You use a 3x3 electron cutout… what doesn’t happen? Dmax decreases, output decreases, flatness decreases, range decreases

1. giving a dose rate constant of I125 (Ir192?) measured experimental 0.7, two numbers calculated by Monte Carlo method (0.64, 0.67), something like that, ask according to TG-43, which one to use in planning system, 0.64,0.67,0.7,0.65 (the experiment one, one of the Monte Carlo one, or the average of the two Monte Carlo)
0.67, the average of the two monte carlo, then average with experimental. TG43P640

3. An office will be add next to the storage room, distance to the point in storage room from the source is 6meters, to the point in office is 12meters, the reading in the point at storage room is 0.6mSv/hour, how many patient can they treat per week to get less 2mSv/week in that point in the office, the barrier between storage room and office has no attenuation,

beam shoot on the barriers only 30s per patient, clinic is running 5 days per week. **33 patient, repeat problem**

1. Standard Gap Calc between a treatment with an SSD setup and a treatment with an SAD setup. Answer was 1.95 cm gap on skin. Options included 1.9 cm and 2 cm. I chose 2.

2. Electrons are produced in a linac by (thermionic emission from anode, thyratron anode, heating a filament, etc)

3. definition of QA All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality (TG40 appendix B, KW)

4. when treating an extremity, why do we block out a sliver of skin? (spare lympatic system, aid in skin healing after radiation, other choices)
6. All of the following change when an electron beam is made significantly smaller by adding a cutout EXEPT: Rp, dmax dose, etc.
7. What is the purpose of the bending magnet. Options included: to accommodate a horizontal waveguide, and to focus the electron beam on the target.

-----2009 Recall--

2009 ABR_Physics_Part II_Type

1. What is the energy of 12 MeV electron beam at depth of 0.5 cm of a thick lead slab?
   2MeV/mm → 10MeV decrease after 5mm of lead → 12-10 = 2MeV
2. A treatment room is designed for 6 MV photons and the primary thickness wall is given. Then it was decided that 18 MV to be upgraded. What would be the required thickness of the 18 MV? (both TVLS for 6 and 18 MV are given) **TVL 6MV → B the attenuation → with TVL 18MV & B → thickness**
3. Using wedge, the wedge factor is given, and both the dose and the dose rate are given. Calculate the MUs.
   I think we dont need the dose rate here right? The dose rate here may mean the calibration factor such 1cGy/MU at dmax (KW)
   Yes. JPS

4. A plot for DVH is given, what the dose is given to 90% of the organ.
5. What is the tolerance dose for 1/3 of the kidney?
   ⅓ vol of kidney < 20 Gy (handbook of evidence-based radiation oncology 2nd, p369, KW)
6. Which of the following element has equal effect from both Compton & Photoelectric effect: I, Ir, Co, Cs.
   Ir and Au (Khan P329) I think it is iodine at 25 kev,
   Same question For which isotope do Monte Carlo calculations account that photoelectric interaction and Compton scatter cancel out so that only primaries are considered?
   Ir and Au (Khan P329)
   The crossover energy for the compton and PE cross sections occurs around the average energy of the I-125 gamma. JPS

7. Using HDR Brachtherapy, Which is better to employ Ultrasound or CT scans or both of them. **CT**
8. A question about scout images and DRRs.
   DRR is a map of average attenuation coefficients computed along each of large number of rays drawn from the source of radiation to the location of virtual film. The result is animage comparable to a simulator film. (Hendee p253, kw)
   Scout image: A scout view is a preliminary image obtained prior to performing the major portion of a particular study. There may be one or more reasons to get a scout view: to make sure the region of interest is included in the field of view, to check the exposure technique, or as a baseline prior to administration of contrast material. Anymore detail?

9. Procedures for commissioning 3 D treatment planning.MU calc, isodose distribution of fs, planning consistancy, isodose comparison, etc
10. Stereotactic Question: what would be the dose to the surrounding healthy tissue to achieve a uniform dose to the target of 20 Gy. **something close to 20Gy?**
11. Question about TG-51, about the right procedure to perform electron calibration. Given the following options: field 10 x 10 cm
    R50 is 8.5 cm
    d(ref) = 0.6 r(cav)-0.1
1. Question on Kernel and Heterogeneity.Kahn p477-479 3rd edition

2. Question on dose homogeneity using TBI. compensators required to achieve homogeneity of +/-10% Kahn p412
3. Determine the linear attenuation coefficient for a material, where both of d and d(eff) are given, and also HVL is given. mu=ln2/HVL
4. Question on 3 D cone beam artifact. What is reason of the noise?combination of beam hardening effect and x-ray scatter causing increase of CT# reducing contrast
5. Question on Gating
6. Question on MonteCarlo
7. Question on the effect of IMRT on a treatment planning: low gradient & low dose, low gradient& high dose, high gradient & low dose, high gradient & high dose. **high gradient & high dose**
8. On TSEI, to increase 5% homogeneity which is better to extend the distance or to reduce the energy used or what other method? other methods can be using multiple fields or continuous arc, how about using spoiler? (From Kahn sec 14.8 B.1, low energy electron scattered more while passing through air, combination of multiple low energy field can give adequate uniformity over pt's width. Therefore, I will choose extend distance, decrease energy, multiple fields, scattering plate placed in front of pt., multiple arc, KW) **Agree with Ken, we use 9MeV here, and after the spoiler, about 6MeV reach patient.**

9. Suppose we have a malfunction in the bending beam magnet system, What would you expect to realize a change in: **flatness and output will be off …** (the profile (symmetry) will be off which is more obvious than flatness and output, needs to adjust the steering coil, KW)
I agree. Symmetry is a much better answer. JPS

10. To increase the energy in the accelerator, what you do? Increase the current in the magnetron, or **Increase the voltage in the magnetron**, Increase the current in the Thyratron, or, increase the current to the Gun
(Green:Linear accelerator for radiation therapy:p32, increase the voltage kw)

11. Question on Radiobiology. The given dose is 54 Gy through 30 fxs. The doctor wants to do accelerated fractions to 20 fxs so that patient will get the same radiobiology effect. The therapeutic ratio is 10. What is the new dose?
d1 = 180cGy; 5400*(1+180/10) = 20*d2*(1+d2/10) → d2 = 2.54Gy
YES! JPS

12. What is the highest dose to Public?
annual: 1mSv for frequent; 5mSv for infrequent
13. Question on convolution to correct the heterogeneity, what kind of Algorithm is used.convolusion superposition
14. Question on the definition of KERMA.(there were: four almost very similar definitions, and I barley was able to get the right one)KERMA is the sum of the initial kinetic energies of all the charged ionizing particles(electrons and positrons) liberated by uncharged particle(photons) in a material
15. Question on definition of ITV. It is: ITV= CTV + IM
16. Question on the disadvantages of Diodes.
Over response to soft photon especially for deeper depth and large field size (TG106 Fig 1.c, KW)
Dependence on temperature, angle, dose rate and energy; need electric connection (AAPM summer school 2011)
YES! JPS
17. Question on the electron density disadvantages of using MRI for treatment planning.
image doesn't have any electron density information
18. if a photon beam penetrating 3 cm of healthy tissue then 9 cm in the lung then 1 cm of healthy tissue to reach the point x, where the prescribed dose at x is 250 cGy, what is the dose at x because of the lung?
Assume 6MV was used, if the inhomogeneity correction was not on, 9cm lung is equivalent to 3m tissue.
for 6MV, the attenuation in tissue is about 4%/cm → 4% * 6 = 24% → 250*0.24 = 60cGy overdose
According to TG65 table 8, for 4-6MV, the dose will increase 3%/cm lung, so 250 x 0.27 = 67.5 overdose (KW)
19. Similar to last question, what the MU would be because of the lung/ **MU would be 24% lower,** 27% lower (KW)
20. The strength of a radioactive source is given and has a unit of U.cGy/hr, both distance and anisotropy function are given, what is the strength at a distance of 2 cm? **TG43 formula**
21. Question on TG-51 for photon calibration, what is the difference between 10 AND 10(X). **electron contamination**
22. What we do to cancel the e contamination effect at energy higher than 10 MV
1mm lead foil to be placed about 50cm from the phantom surface
23. Determine the angle of the collimator of craiospinal treatment (both SSD, and spinal cord length are given).tan theta=0.5L/SSD
24. A treatment room has no office on the tope of it. The dose rate is 40 msv/week. If an office to be established over that room and the dose rate to be 2 msv/week. What is the thickness of the steel layer that is should be added to the concrete ceiling? Both TVLs for concrete and steel are given.2=40B, B=0.05, n= -log(B) n=1.3 TVL

25. Which will give the highest portion of the photon dose at the door of the maze: is it from the head, or from wall between the door and the accelerator or **from the scattering wall facing both the accelerator and the door**?
26. A point C is outside a treatment room; if the dose at c is the same for 6 or 18 mv. Both TVLs are given at 6 and 18 MV. What is the increment in the wall thickness if the dose rate increases to a given value?
27. A radioactive source is sent from a vendor with a given strength. The physicist performed a well calibration on it and found that the current is 60 nA. What is the percent difference between his vale and the vendor value?
28. Question on TG-51. Determine K(Q). All other factors are given.
29. Question on TG-51. Determine Ke(cal). All other factors are given.
30. What would be the dose at point 2 if the dose1 at point1 is given and also all of the following are given: d1, d2, TMR1, TMR2.
31. 9 MeV electron beam, we want to treat at the line 80%, what you do?

9/2.8 = 3.2cm

32. Choose the right graph from 4 options that shows the relation between the e density and the CT number.

close to linear...?

Yes. JPS

33. In 4 D CT Helical, what is the pitch?

pitch is the ratio of table increment over slice thickness. For multi–detector row CT, pitch is generally defined as the table travel per rotation divided by the collimation of the x-ray beam.

34. If the patient thickness is 22 cm, SAD=100 cm, source to film distance is 130 cm, d=11 cm if technique is changed from SAD to SSD, What is the new source to film distance.

100/130 = 111/X → X = 144.3

Yes. I got 145cm. JPS

35. Question on stem effect on the diode.
36. Easy Question on for 2 opposed beams, calculate the dose at the midplane. All parameters are given.
37. What would be the effect of adding a wedge through a photon beam: **beam hardening and scatter**
38. Using photon mode in the linear accelerator , which one from the following materials have the highest cross section for neutron production: **high photon energy, does it related to high Z material as well?** Besides being produced in the linac head, photoneutrons are also produced in the patient and in the bunker walls, floor and ceiling. The production in the linac head is particularly important because of the presence of a large amount of high-Z materials and their large photo-neutron production cross sections. Furthermore, these high-Z materials have low neutron capture cross sections and the generated photoneutrons will escape from the linac head.

Since this question asks the material, I therefore put possible choice as reference :

1. Tungsten W, 74, 2. Lead Pb 82, 3. Copper, Cu 29, 4. Aluminium, Al 13 (KW)

I think they were looking for any of the tungsten components in the LINAC head. See McGinley. JPS

39. A 5.4cc target in SRS has a conformity index of 2.3. How much normal tissue received the prescribed dose? **5.4*2.3 = 12.42,** following ICRU62, CI = treated vol / PTV , so 5.4 x 2.3 - 5.4 = 7.02 cc (KW)

Yes. JPS

40. What is the duty cycle in respiratory gating? **the beam on fraction of the whole respiratory cycle …**

Yes. It's the fraction of the total respiratory cycle the beam is on. JPS

41. Cross calibrate a parallel plane chamber with a farmer. Calculate correction factor with TG-51 type data given for the farmer.
42. Where is the effect point of measurement for a parallel plane chamber? Half way between capacitor plates, 2/3 between, 1/3 between, just inside the thin window. **just inside the thin window**
43. Best survey meter for lost I-125 seed? Cutie pie, GM tube, Thin window GM tube, Scintillation detector. According to P. Dendy Physics of Diagnostic Radiology the thin window GM tube is for beta emitters. I chose thin window for I-125 because of its low average photon energy of 28keV.

Any other comments? GM tube or thin window GM tube?

From TG64, it suggested GM counter and scintillation detector

TG56 (page2061), it specifically mentioned scintillation detector

2 websites say GM counter won't be able to detect I125 < 0.05 uCi http://web.princeton.edu/sites/ehs/radmanual/radman_app_b.htm#i125 (KW)

http://researchcompliance.uc.edu/radsafety/isotope/isds-i125.html

talked with our safety person, we usually use scintilation detection to detect contamination, then can use GM counter to locate the contamination.

When we have a lost seed, we use a scintillation detector to find it. JPS

44. Given film densities and some other data you had to construct the OD vs dose curve and determine some parameter.
45. Calculate skin gap in CSI spine treatment one field at SSD 100 and the other with SAD treatment (SSD=90cm).
46. Given PD-103 total dose calculate dose rate after 30days.

T1/2 = 17d & Total dose = 1.44*T1/2*D0 → D0 → Dt = D0*exp(-0.693/17*30)

47. Total treatment time of 420s with A=3.34Ci. Source change 5days later and patient starts treatment 3 days after the source exchange. What is the new treatment time?

approximation: A1*T1 = A2*T2

48. What is the accepted leakage in amps for a chamber/electrometer setup?

0.1% (TG40)

61. 60 degree universal wedge with a transmission factor of 0.5. What is the ratio of MU to get a 30 degree effective wedge? **MUw : MUo = 1:1**

This should be 1:2 JPS

62. Time in seconds to get 340cGy 1cm beyond mammosite balloon surface (balloon has 4 cm diameter).
Given air kerma strength

Assume air-kerma strength as X in cGy cm^2/h, 340 cGy / (X/9 cGy/h) = (340*9/X)*3600 in s (KW)

69. 3 layers of tissue. layer 1 = 3cm, HU = 1; layer 2=4cm, HU = -800; layer 3=3cm, HU = -100.....effective depth question

Assume linear relationship: 3cm + 0.2*2 + 3*0.9 = 6.1cm

70. Given a drawing of an axial cut of the chest with lung in the field. CAX of beam goes through chest wall (2cm)-->lung(11cm)-->cord(1cm) to give 200 cGy to pt A. If the TPS did not do heterogeneity corrections to calculate MU, what would be the actual dose delivered to Pt A. **11-11/3 = 7.3cm → 7.3*4% = 29.3% → 200*1.293 = 258.6cGy**

3% x 11 = 33% overdose, 200 x 1.33 = 266 cGy (TG65 table 8)

71. Given 7mSv/hr at 1m from source. Wall thickness to get less than 0.02mSv/hr at 1m beyond wall?
73. BED if physician normally prescribes 1.8Gy/day in 30 fx, but wants to reduce the fx # to 20 fx, what's the new daily dose when according to the linear quadratic model alpha/beta = 10?

74. Cord sits 5cm posterior to midplane of a 24 cm thick patient treated 180cGy/day AP/PA to 12cm. How many fractions can be treated to keep the cord below the 45Gy tolerance. TMR's for d=5, d=12, and d=19 given. ---> needed to use ratio of TMR's to solve. **calcuate the cord dose from AP and PA beams for each fx. I think the question is cord at 5cm depth from pa <u>NOT</u> posterior to midplane**

PA to cord = 90/TMR(12cm) x TMR(5cm) x (100/93)^2- (1)
AP to cord = 90/TMR(12cm) x TMR(19cm) x (100/107)^2 - (2)
fx = 4500 / (eq(1) + eq(2)) (KW)

Shouldn't there be an inverse sq factor here too since the cord is at extended distance to the isocenter? JPS

thank you for catching this!

75. Given a picture with 4 different tissue densities with their corresponding electron densities. Figure out dose using hetero corrections vs. without using hetero corrections.

equivalent depth calculated by taking average weighted by electron density?

76. Given 5mSv/hr, 300cGy/patient..3 patients that can be treated to keep the office (12 m away) to 0.02.

77. 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.

W_L = 4*0.65 + 0.35 = 2.95; so the workload for secondary leakage shielding was increased by a factor of 2.95

(leakage workload increase but not the regular workload on the iso, NCRP 151, KW)

78. Dose rate at 30 days from a 0.46mCi Pd source (given t 1/2 = 17days) if the total dose delivered is 120Gy?

D0 = 4.9Gy/day → Dt = 1.44Gy/day

I didn't ignore the exp term so 120 = D0 x 1.44 x 17 (1 - exp(-ln2/17 x 30)) => D0 = 6.9 Gy/day, and 6.9 Gy x 0.5 ^(30/17) = 2 Gy/day at 30 days. (KW)

Yes. JPS

79. PA Spine field L=35 abuts a cranial field Ant/Post length = 24, sup/inf length = 18. What is the couch rotation needed to match the divergence? Needed to use the rotation = arc tan(1/2 * Length/SSD)

arc(tan(9/100)) = 5.14

Yes. JPS

80. Collimator rotation needed to match the divergence on a craniospinal treatment. $\tan^{-1}(L_{1/2} / ssd)$see above

81. According to TG-66....something about distance in mm an iso can be off in a simulator **2mm or 1%** (only 2 mm in TG66)

82. Total error if gantry is off 1.2mm, couch is off 1.4mm... total=sqrt(1.2^2+1.4^2)=1.84

83. If you order seeds for an I-125 prostate seed implant, according to AAPM recommendations, what percentage off can your in-house measured activity be from the manufacturer's activity?

5% for individual seed, 3% for the average error (TG40 P600 Table1x)

85. The seminal vesicles are located _____ and _____ to the prostate **superior and posterior**

86. 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/hr, how many patient can treat everyday. Beam on time for each patient on this direction is 30 sec. No other data (like TVL, Occupation,etc.)was given.

0.06 * (6+1)^2/(12+1)^2 = 0.017

88. Sim film setup, SSD is 80cm with 167cm SFD(source to film distance), patient 22cm thick. If SSD change to 100cm, what's new SFD?

(80+11)/167 = 111/x --> x=203.7

Why use pt sep - SSD changes (not SAD) - shouldn't it be: (80/167) = 100x = 208.75cm ?

89. For a 4 slice CT scanner with a slice thickness of 1mm a pitch 1.5 and a gantry rotation of 0.5 sec, how long will it take to scan 100mm?

(100 / 1.5 *4)* 0.5 = 8.3 s

Pitch is defined as table travel per rotation divided by the collimation of x-ray beam. However, more intuitive way to define pitch is table travel per rotation divided by the effective detector raw thickness. (Radiology, 233, 323-327 (2004))

Table speed = beam collimation (effective detector raw thickness) x pitch x gantry rotation per sec

= 4 x 1 mm x 1.5 x (1/0.5) = 12

100/12 = 8.3 s (KW)

<u>QUESTION:</u> IF THIS QUESTION WAS INCORRECTLY WORDED AND DID NOT SAY "4 SLICE CT", BUT INSTEAD 4D CT, WOULD YOU STILL MULTIPLY IT BY 4? I'M THINKING NO BECAUSE 4D CT DOES NOT REPRESENT THE # OF SLICES PER SCAN - CORRECT?

90. For regular fractionated IMRT, what is the TD5/5 for the parotid gland? 25Gy, 32Gy, 50Gy, 60Gy?

32Gy

91. What is the dose rate constant for a 2mCi Ir-192 source?

4.7 R*cm^2/mCi-hr --> 4.7*0.876 = 4.12 cGy*cm^2/mCi-hr

92. A universal wedge (60 degrees) with a 0.5WF. A 30 degree angle is desired. What is the ratio of wedged MUs to open MU?

1:1HOW?

mSv/hr, how this will be changed by changing energy from 6MV to 18MV???

87. If doctor want to change 30 fractions for 60Gy total priscription to 20 fractions, alpha/beta=10, old MU=200, what is the new MU?

BED calc

94. How are inhomogeneity corrections handled in the superposition convolution algorithm?

by appropriately adjust kernel ??

96. Which has a larger value for the radial function beyond 1cm I125 or Pd103?

I125

98. Find the MU's to deliver 90cGy (isocentric) with a wedge (WF=0.77) and open field size of 17x17 and blocked field of 11x11. Machine calibrated at SSD, dmax=3.3cm, 1cGy/MU. Current SSD=88cm (so treating 12 cm depth), Sc, Sp, and TMR tables given for all field sizes and all depths.

inverse square: 1cGy/MU * 1.033^2 / 1^2--> 1.07cGy/MU for SAD setup --> SAD MU calc (please correct me if I'm wrong)

Assuming the machine was calibrated at SSD = 100, and dmax = 3.3 cm at 1cGy/MU, we will need to correct the output using the inverse square law

MU = 90cGy/(TMR(12,11) x Sc(17) x Sp(11) x 0.77 x 1 cGy/MU x (103.3/100)^2) (KW)

99. Manufacturer calibration given as 6.3*10^5 Gy/hr. Two weeks later a reading of 71 nA is given, the calibration factor is

X (Gy/C). How far off is the source from the manufacturer's stated calibration?
71*10^-9 C/s * X *3600= Y Gy/hr;

-----2010 Recall---

Easy Questions

1. What is the TD5/5 for Optical Chiasm? (A) 4000 (B) 4500 (C) 5000 (D) 5500
TD5/5 3/3 : 5000 cGy by Emami

Tolerant Doses of Radiation
TD 5/5- The minimum tolerance dose
TD 50/5- The maximum tolerance dose
They refer to severe complication rate of 5 & 50% within 5 years of radiotherapy completion.

The values below are approximate & for learning purposes only!
Breast:TD50/5 3/3 ,Rectum:TD50/5 3/3 8000,Liver:TD50/5 3/3 4000 ,Testicles:TD50/5 3/3 2000 ,Colon:TD50/5 3/3 5500
Kidney: TD50/5 3/3 2800 ,Bladder: TD50/5 3/3 8000 ,Brain: TD50/5 3/3 6000 ,Lung: TD50/5 3/3 2450
During the exam, should we just follow Emami? As it's quite different from the constrain we use in our center...

2. Due to XXXXX, who should show up during a HDR procedure? (A) Certified physicist, user or console operator (B) Certified physicist, user (C) User and console user (D) Certified physicist, console user
TG59, p392: "USNRC requires that both an authorized user ~a radiation oncologist authorized to prescribe brachytherapy! and medical physicist ~or radiation safety officer! be physically prese, tnt at all HDR treatments"
⇒ I would go with (B), Certified physicist, user . (AA)
In our center, we have oncologist, physicist and therapist show up, B it is...

3. For IMRT plan verification, which of the following has the best spatial resolution (A) Diode array (B) Laser (C) Film
Film. AA

4. Treat 4.3 cm depth with 12 MeV electron, and Rx dose is 200 cGy, what is the dose at dmax? (A) 225cGy (B) 250cGy (C) 275cGy (D) 300cGy
12/4.3 = 2.8 ⇒ Rx to 80%.
⇒ 200/0.8 = 250 cGy AA

5. Pitch = 0.5. For 10 gantry rotation the slice of 5mm, what distance does collimator move? (A) 2.5cm (B) 5cm (C) 10cm (D) 20cm
I would assume it's asking couch move.. It will be 10*5*0.5=2.5cm (YY)
Pitch: table travel per rotation/total collimated slice width

6. According to NRC-151, what is the most important factor for shielding of pregnant women to be treated for breast cancer? (A) Block (B) Distance (C) Dose prescribed (D) Fetus period
Distance AA

7. What is the Stem Effect for cylindrical chamber from? (A) Leakage from chamber ionization (B) Air outside the chamber stem. stem effect is caused by measure of ionization in the body of stem and ionization of air between end of chamber and metal cap Kahn p86

8. In a PTV point of IMRT plan the prescription dose is 240cGy, the most nearby point of closest dose is 232cGy in 2.3mm away, for a 3% dose limit, what is the Gamma factor? (A) 0.92 (B) 0.98 (C) 1.12 (D) 1.15
Assume 3%, 3mm, (240-232)/240=3.33%, gamma=sqrt((3.33% / 3%)^2+(2.3/3)^2)=1.35, please correct me if I'm wrong (YY)

<u>Complicated Questions</u>

1. To compensate 5cm breast tissue, how much thickness of Al should be used based on the information given below. (Density for Al and tissue, electron density for Al and tissue, atomic numbers for both are given). (A) 1.85cm (B) 2.15cm (C) 2.55cm (D) 3.25cm)

T_c = TD*(tau/rho_c); density of Al=2.7g/cm^3; T_c=5*(0.7/2.7)=1.3cm; am I using the wrong density or sth? (YY)
should we use[(mu/rho)AL/(mu/rho)tissues]*5cm???

2. Patient is treated to 10cm depth of chest wall with SAD of 100cm. There is 6cm lung within the central axis of beam. How much more dose will be delivered without heterogeneous correction? TMR for different depth are given.
TMR_6 / TMR_10

3. TBI treatment, SAD = 478.5cm, the patient thickness is 39cm, the dose rate at 10cm is 0.0385cGy/MU, to avoid the dose rate at midline exceed 10cGy/min, what is the delivery rate of linear accelerator should be chosen? (Nothing else is given). (A) 200MU/min (B) 300MU/min (C) 400MU/min (D) 600MU/min

my guess: at midplane, the dose rate will be lower than 0.0385cGy/MU, therefore delivery rate is higher than 10/0.0385=260, and I think the difference wouldn't be as high as 50%, so I will guess B. So the SAD is redundant? (YY)

10 cm depth is 0.0385cGy/MU -> using ISL(large distance), in the midline, dose rate=0.0385 cGy/MU*[(478.5-9.5)/478.5]^2 = 0.03698 cGy/MU, where 9.5=478.5-39/2+10; if dose rate is x mu/min, then 0.03695 cGy/MU* x MU/min<10cGy/min => x<270 MU/min, I would pick up A, which we used in our clinic.

I agree - did same thing & would choose a

yes, i think it should be 200MU/min.

Actually, for large SSD, and a small change of distance of depth, inverse square law will not change things much. 10/0.0385 = 260 cGy/MU, and we need dose rate < 10 cGy/MU. 200 MU/min is the only choice. (KW)

I agree. JPS

4. TBI, diode reading 450cGy on surface, prescribed midline 600cGy POP laterals, 30cm separation. TMRs were given with 350cmSSD for depth 5, 10, 15, 20cm. What is error in midline dose? (A) Lower than 2.6% (B) higher than 2.6% (C) lower than 3.5% (D) higher than 3.5%

I choose D, it's gotta be A or D; since we dont have TMR for surface, so we only know Dmax > 450cGy (can I claim this?);

For 6x, the diode measurement in our department is placed with 1.5 cm bolus build-up on the top of it for surface measurement; which assumes the measurement is at the dmax.

The midline dose can be calculated by using TMR(15) and corrected by inverse square law;

D_midline = 450 cGy x TMR(15) x (350 + 1.5)^2/(350 + 15)^2 = 417 TMR(15)

The uncertainty will be 417TMR(15)/300 (KW)

Right. I saw a variation on this problem stating that diode measurement is the entrance dose which implies that it is measuring the dmax dose from 1 beam. JPS

So here we are ignoring the exit dose from the other beam? it is middle line and the % error

5. TG-51 photon calibration. Serial measurements are listed with all the P. What is the calibration factor at dmax? (A) 0.98 cGy/MU (B)1.00 cGy/MU (C) 1.02cGy/MU (D) 1.04cGy/MU

6. Two candidates position A, B for the ISO of linear accelerator. Point C is the point to be protected behind a wall. The limit of protection is 0.02mSv/week. Workload is not given. The distance of A to C is 7m, and B to C is 5m. If move the ISO from point A to B, how much more shielding is needed? (A) 4.7 TVLs (B) 3.7 TVLs (C) 2.7TVLs (D) 1.7 TVLs

49/25=1.96 --> 1 HVL should be added if the original shield was enough. what's wrong with my calc...? (YY)

7. Two 2x20 conjuncted retangles, 10% high in the conjuction area. 3mm penumbra for each ratangle. ask what is the position error.

my try: penumbra is defined width between 20% to 80% dose, 3mm --> 0.25mm for every 5% dose --> 0.25mm position error (YY)

3/60% x 5 % = 0.25 mm off for each rectangle (KW)

9. MLC sliding window, ask what is the dose ratio for two positions. Given a table of the MU delivered for each segment.

13. Calibrated in SSD100+dmax, TPS set SAD, depth 10cm, what is the dose/MU shoule be?

need help confirm my solution: convert calibration at 100SSD Dmax: 100 SAD Dmax by inverse square law as: (100+dmax)^2 / 100^2 --> calc D10cm by TMR (YY)

This question may ask calibrating machine at SSD = 100, dmax (6x 1.5 cm) with 1 cGy/MU and what's the dose/MU at SAD 100 d = 10 cm; the output will be changed from 1 cGy/MU x (101.5/100)^2 = 1.03 cGy/MU and then 1.03 cGy x TMR(10) to get the Dose/MU at depth 10 cm

14. Arc plans, given the prescription dose, the arc angle, the MU limit for each angle, and each arc, the output for each MU, ask how many arcs to get the dose.

can someone make a guess, expend this question a little bit?

This one also confused the crap outta me. JPS look at number 3 on the last page

16. Gamma Index calculation. **both distance to agreement and dose difference**

18. Give you dose and charge, ask you to calculate the chamber volume

dose (J/kg) → by devide 0.00876 Gy/R to get exposure R1; R = 2.58*10^-4 C/kg; also need calibration factor → (charge / R1)/1.29kg/m^3 --> volume

f factor for air is 0.876 cGy/R, and air density at 20 degree is 1.2 kg/m^3 at 0 degree is 1.29 kg/m^3 (KW)

22. Given the air kerma strength, ask when the strength was a higher value. **what...?**

23. Given the dose, seed number, air kerma strength and the dose rate for iodine, ask what is the air kerma strength by Pd with the same seed number, another prescription and the dose rate constant.

D1 and D2 are dose rate for I125 and Pd103

D1(r0,theta_0) = Sk_I125 x A_I125 (dose rate costant) –(1)

D2(r0,theta_0) = Sk_Pd103x A_Pd103 (dose rate costant) –(2)

Solve (1) and (2) get Sk_Pd103, D2 may not be given directly (KW)

25. Give a tangential plan, with open and wedge combination, and wedge factor, if the MU for open was delivered to wedge,
and vice versa, what is the real dose.

MU1 is open beam, and MU2 is the wedge beam

Prescribed Dose (T) = MU1 + MU2 x WF

Real Dose (R) = MU1 X WF + MU2

R = ((MU1 x WF + MU2) /(MU1+MU2xWF)) x T (KW)

27. For a 10MV plan, what the actual dose would be if the plan did not apply heterogeneity correction?

%2.5 increase for lung, %1.5 decrease for bone

29. Give a dose limit at Im, and the secretary office distance, ask the shielding calculation by ALARA principle.

ALARA principle implies reaching 1/10 of MPD? Office area U = 1, uncontrolled area 0.02 mSv/wk, hourly limit 0.02 mSv/hr (KW)

30. Given the formulae between dose limit for releasing patient and half life,initial activity of I131, ask the initial activity. Need to know the half life and dose limit.

I-131, half life 8days; releasing limit:

The release criteria is based on USNRC regulatory guide 8.39 (http://www.nucmed.com/nucmed/ref/8_39.pdf) and its errata http://pbadupws.nrc.gov/docs/ML0037/ML003739562.pdf.

The release criteria can be (1). The dose at 1 m away from pt. < 5 mSv. Therefore, the initial activity needs to be less a certain value or (2). If the initial activity is > a criteria, measured dose rate needs to be less a certain value.

For conservative choice, USNRC pick physical half life and 1 R = 10 mGy, and take the (1 – exp) term as 1. For the occupancy factor, it uses 0.25 for physical half life > 1 days, and 0.75 to 1 for physical half life < 1 days. Therefore,

According to the release criteria 1, (5 mSv at 1 m away)

Initial Activity (A) x 24 h x 8 days x 1.44 x 2.2 (R cm^2/mCi h) x 10 mSv/R x 0.25 /10000 = 5 mSv

A = 33 mCi (consistent with the Table 1 first criteria, in USNRC regulatory guide 8.39)

According to the release criteria 2,

If we have activity 33 mCi of I131, the dose rate at 1 m away is

33 x 2.2 R cm^2/(mCi h) x 10 mSv/R x 1/10000 = 0.07 (mSv/h) (consistent with the Table 1 2nd criteria, in USNRC regulatory guide 8.39) (KW)

32. An electron plan with the pdd, ask the depth of lung for a given dose

Khan P286, deff = d-z(1-CET), for lung CET is about 0.2-0.25, for bone, it's about 1.65. So basically it's the same way we calculate effective depth for photon, am I right? Yes (KW)

34. A treatment change SSD, what is the new dose? **inverse square, correct PDD, Maymeford factor.**

35. How many seconds to deliver a mammosite plan?

If no information provided, it should depends on source strength

Mammosite treatment is usually prescribed 340cGy, 10fx (340 ? AA, thx KW) cGy at 1 cm from the balloon surface, and the source is Ir-192 with 10 Ci initial activity. We know the exposure rate for Ir-192 is 4.6 R cm^2/mCi h
Therefore, the time can be calculated as 10 Ci x 4.6 R cm^2/mCi h x 0.97 cGy/R x Time x 1/9 = 340 cGy
Time = 0.06 h = 4.08 mins (The typical mammosite treatment is around 5 - 8 mins depending on the activity) (KW)

-----Additional Recall--

1. The linac is only capable of producing 20 MeV, 15 MeV, 10 MeV and 6 MeV electrons, no photon beams are available for this linac. The patient load is 20 per day… What is the workload that should be used in shielding calculations for such a vault.

The question is most likely about the "intraoperative electron beam therapy (IORT)". Good references are Int. J. Radiat. Oncol. Biol. Phys. 33, 725 (1995) and 18, 1215 (1990)
The pt. for IORT is usually treated with 1 fx (20 Gy). The patient load is normal 20 pt/month rather than per day (pls see the 2nd reference). The e beam exiting from the treatment cones is completed absorbed within patient so the x-ray contamination is the primary safety shielding concern. The neutron is also the concern but it is generated by the x-ray and 2 order of magnitude lower than the conventional linac due to lower electron beam current. For the board exam, I will just consider x-ray contamination for the highest electron energy

Workload / wk = 20 pts/4 wk x 20 Gy x 5%(x-ray contamination) = 500 cGy, the 100 Gy electron workload is consistent with the 2nd reference. (KW)

2. 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, treatment depth is 0.5cm.
(Khan P335) based on the table, for 10cm^2, 0.5cm depth → 235mg-h/900cGy; 235*5000/900 = 1305.56mg-hr → 1305.56mg-hr * 8.25Rcm^2/mg-hr = 10770.87Rcm^2; for Au-198, the exposure rate 2.38Rcm^2/mCi-hr → 10770.78/2.38=4525.58mCi-hr; Au-198 has a HL = 2.7days → Tavg = 1.44*2.7*24 = 93.31hr → 4525.58/93.31 = 48.5mCi

3. 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?
total dose ratio = 90/145 → 87*0.5*0.7*1.44*59.4*24 : 87*0.7*Sk*1.44*17*24 = 145:90 → 0.5*59.4 : 17*Sk = 145:90 → Sk = 1.08U

4. 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)
If give each of the 12 arcs 999MU → 999/120 = 8.325 <19.9 within per degree constrain, but: 12*999*0.75*0.82 = 73.72Gy < 90Gy → each arc needs to pass 2 times during the Tx.

5. 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/hr, 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%

For this question, I assumed the thickness of the wall is given, because in practical situation, we should know the thickness of the wall. Let's assume the thickness is 5 TVL for the wall. Therefore, the wall thickness is 5 x 13.7 in = 68.5 in.

Now, we want to add 18x, and the beam usage is 6x: 18x = 0.7: 0.3, so the workload for 6x and 15x are 0.7W and 0.3W. The wall penetration for 18x becomes 10^(-68.5/17.8) = 10^(-3.84), and we can calculate the dose at the storage room 6 m away as:
[0.7 + 0.3 /10^(-5) x 10^(-3.84)] x 0.06 = 0.37 mSv/h → at 12 m away using inverse square law 0.37 x [(6+1)/(12+1)]^2 = 0.11 mSv/h

0.02/0.11 = 0.18 h, 0.18x3600/30 = 21 pts; I suspect the question giving the dose limit is weekly 0.02 mSv/wk (from other recalls). Nevertheless, shielding needs to satisfy the hourly and weekly dose limit. In this question, weekly dose limit is more stringent than the hourly limit. 1 wk we can treat 21 pts, so 4 pts per day (this number is related to the assumption of wall thickness) (KW)

6. Spatial resolution of MOSFET detectors, possible answers were in units of **micrometer**
7. what will cause a significant change in dose rate of a linac?
8. Factor of degradation of incident photon energy to scattered
9. In a mantle field, what would receive the highest dose. (celiac, axilla etc...)
10. Ratio of photon to electron current on linac. **i only know that for electron, the current will be lower, but by how much? about 4 times?**
11. Given MHz, calculate the size of each microwave cavity
12. 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)

My guess: ISL to convert dose in air from 40" to 2cm → D1 → D1*BSF

13. When should HDR room shielding be reconsidered, recalculated?
14. which survey meter is best for simulation room survey? (GM counter? Scintillation survey meter? or else)

I will guess ion chamber

15. Penumbra calculation from LINAC given target surface distance (SSD = 100cm), target block distance (d1=30cm), depth in patient (d=10cm) and target dimensions 3 mm (r).

Penumbra = 3/30 x (100+10 - 30) = 8 mm (KW)

I think the target dimension should be 0.3cm but I agree with the final result :) (JPS)