General

- 5 rem is equivalent to - mSv.
- A. 0.05
- B. 0.5
- C. 5
- D. 50
- E. 500

General

- 5 rem is equivalent to - mSv.
- A. 0.05
- B. 0.5
- C. 5
- D. 50
  - 1 rem = 1cSv = 10 mSv
- E. 500

General

- In order to convert exposure (R) to absorbed dose (mGy), the factor for diagnostic x-rays and muscle tissue by which exposure is multiplied is closest to - .
- A. 0.1
- B. 5
- C. 9
- D. 20
- E. 90

General

- In order to convert exposure (R) to absorbed dose (mGy), the factor for diagnostic x-rays and muscle tissue by which exposure is multiplied is closest to - .
- A. 0.1
- B. 5
- C. 9
  - The f factor (roentgen-to-rad conversion factor) for muscle tissue ranges from 0.921 at 10 keV to 0.960 at 150 keV.
  - 1 rad is equal to 10 mGy.
- D. 20
- E. 90

General

- Exposure is - :
- A. The energy absorbed in a given mass of a medium.
- B. The air kerma of a photon beam.
- C. Measured in Sv.
- D. The ionization in a given mass of air.

General

- Exposure is - :
- A. The energy absorbed in a given mass of a medium.
- B. The air kerma of a photon beam.
- C. Measured in Sv.
- D. The ionization in a given mass of air.
  - Exposure is equal to the total charge of ions of one sign produced in a unit mass of air. Units were formerly roentgen R, and are now C/kg in the SI system.

General Mismatch

- A. Bq
- B. Sv
- C. C/kg
- D. Gy
- E. J

- Absorbed dose
- Activity
- Exposure
- Dose equivalent

General

- Absorbed Dose= Gy = J/kg
- Activity= 1 Bq = 1 disintregration / sec
- Exposure = C/kg is the SI unit. 1R = 2.58 x 10^{-4} C/kg in air.
- Dose equivalent = 1 Sv = 1 Gy x Q, where Q is a quality factor which depends on the type of energy of the radiation, and its RBE.

General

- The energy equivalent of an electron at rest is - .
- A. 0.51 keV
- B. 930 keV
- C. 0.51 MeV
- D. 1.02 MeV
- E. 930 MeV

General

- The energy equivalent of an electron at rest is - .
- A. 0.51 keV
- B. 930 keV
- C. 0.51 MeV
  - This can be found from Einstein's equation. $E=mc^2$
- D. 1.02 MeV
- E. 930 MeV

General Mismatch

1. Emitted by the cathode of an x-ray tube.
2. The particle responsible for MR Imaging.
3. Assuming A-E have the same energy, the - has the shortest path length in water.
4. Is indirectly ionizing.

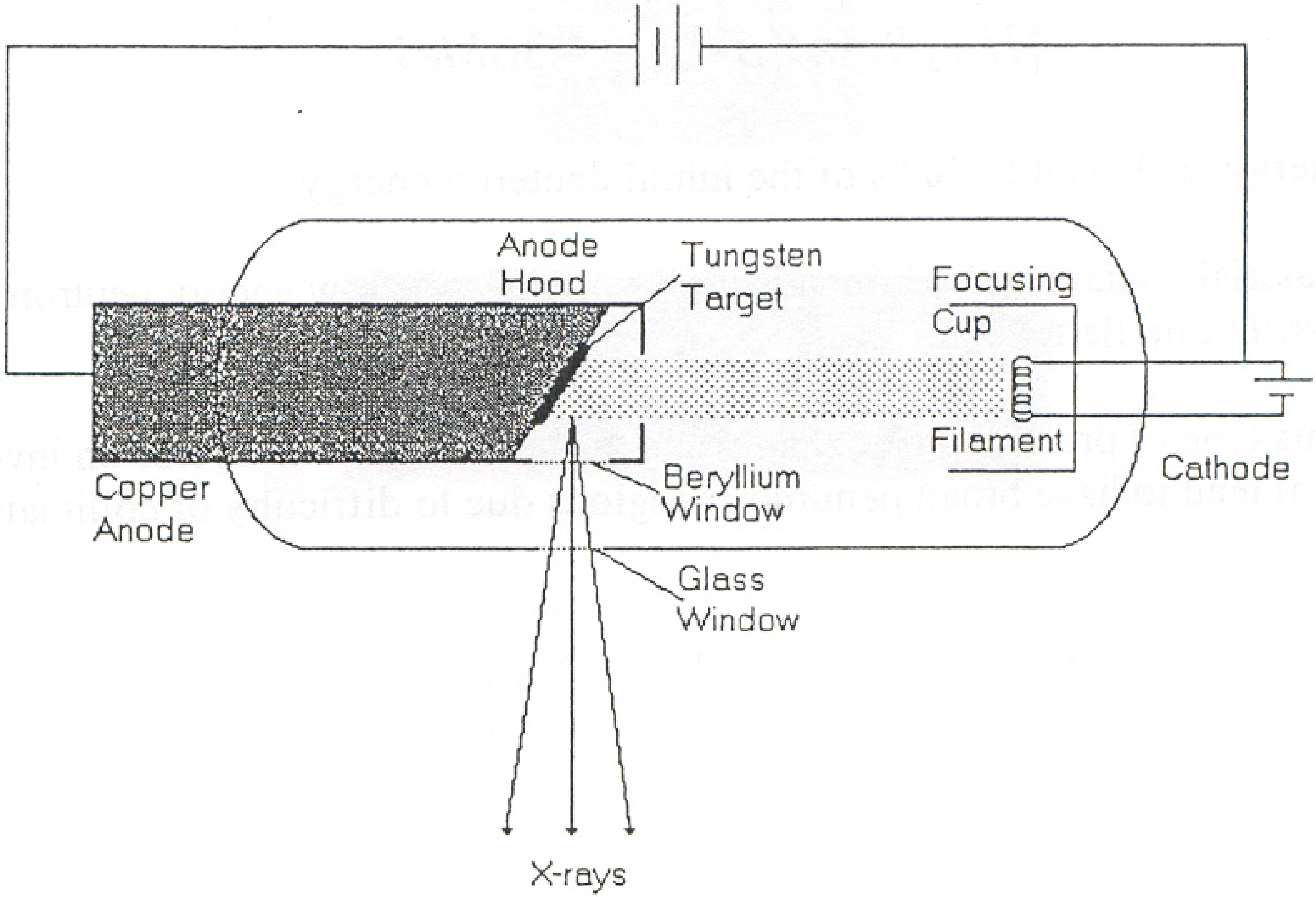
- A. Electron
- B. Positron
- C. Neutron
- D. Alpha particle
- E. Proton

General

1-A, 2-E, 3-D, 4-C

1. Emitted by the cathode of an x-ray tube.
2. The particle responsible for MR Imaging.
3. Assuming A-E have the same energy, the - has the shortest path length in water.
4. Is indirectly ionizing.

- A. Electron
- B. Positron
- C. Neutron
- D. Alpha particle
- E. Proton

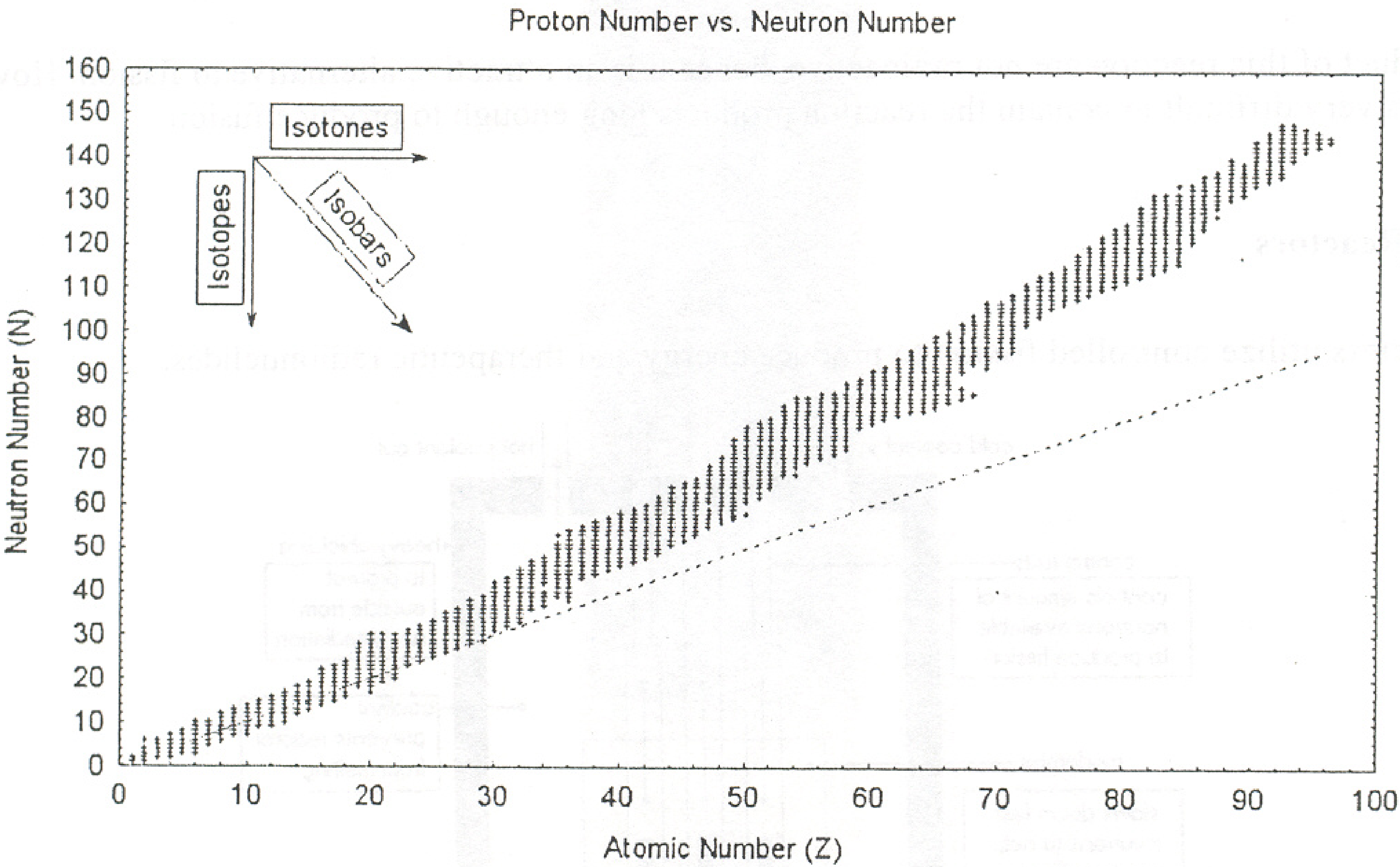

Anode
Hood
Tungsten
Target
Focusing
Cup
Filament
Cathode
Copper
Anode
Beryllium
Window
Glass
Window
X-rays

General

- 131Iodine and 125Iodine have:
- A. Have different chemical properties.
- B. Have different Z values.
- C. Occupy different columns on the periodic table.
- D. Have the same number of neutrons.
- E. None of the above.

General

- 131Iodine and 125Iodine have:
- A. Have different chemical properties.
- B. Have different Z values.
- C. Occupy different columns on the periodic table.
- D. Have the same number of neutrons.
- E. None of the above.
  - Isotopes of an element have the same Z (number of protons or electrons) but different numbers of neutrons and electrons and hence, different mass(mass number). Chemically, all isotopes of the same element are identical.


Proton Number vs. Neutron Number
Isotones
Isotopes
Isobars
Neutron Number (N)
Atomic Number (Z)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

Helpful Memory Aids for Remembering Isotopes/Isotones/Isobars

Memory Aid	Same
Isotopes	proton number
Isobars	mass number
Isotones	neutron number

general

- All of the following are true except: Tritium 3H --- hydrogen 1 H.
- A. is an isotope of
- B. has more neutrons than
- C. has more electrons than
- D. is chemically identical to

general

- All of the following are true except: Tritium 3H --- hydrogen 1 H.
- A. is an isotope of
- B. has more neutrons than
- C. has more electrons than
  - Tritium has one proton, two neutrons, and one electron.
  - Hydrogen has one proton and one electron.
  - Isotopes of an element have different numbers of neutrons, but the same numbers of protons and electrons, and hence are chemically identical.
- D. is chemically identical to

General

- 59/27Co has --- neutrons and mass number --- .
- A. 59 27
- B. 59 32
- C. 32 27
- D. 27 59
- E. 32 59

General

- 59/27Co has --- neutrons and mass number --- .
- A. 59 27
- B. 59 32
- C. 32 27
- D. 27 59
- E. 32 59
  - 59, the atomic mass number (A), is the number of protons(Z) plus the number of neutrons(N).

$$^{A}_{Z}X$$

General

- When an electron is removed from an atom, the atom is said to be:
- A. Radioactive.
- B. Ionized.
- C. Inert.
- D. Metastable.

General

- When an electron is removed from an atom, the atom is said to be:
- A. Radioactive.
- B. Ionized.
  - An atom is said to be ionized when an orbital electron is removed, leaving a net positive charge.
- C. Inert.
- D. Metastable.

General

- In an atomic nucleus, the binding energy per nucleon:
- A. Is not affected by the process of radioactive decay.
- B. Is independent of Z.
- C. Is maximum for low and high values of Z.
- D. Increases after decay to the ground state.

General

- In an atomic nucleus, the binding energy per nucleon:
- A. Is not affected by the process of radioactive decay.
- B. Is independent of Z.
- C. Is maximum for low and high values of Z.
- D. Increases after decay to the ground state.
  - Radioactive decay to the ground state results in a more stable ion, and hence the binding energy per nucleon increases.

General

- Compared with an atom of argon (2=18), potassium (2=19) is:
- A. Much more reactive.
- B. Slightly less reactive.
- C. Much less reactive.
- D. About equally reactive.

General

- Compared with an atom of argon (2=18), potassium (2=19) is:
- A. Much more reactive.
- B. Slightly less reactive.
- C. Much less reactive.
- D. About equally reactive.

General

- After 10 half-lives, the fraction of activity remaining is - .
- A. $1-(1/2)^{10}$
- B. $1-e^{-0.693 \times 10}$
- C. $(1/2)^{10}$
- D. $e^{-0.693 \times 10}$
- E. C and D

General

- After 10 half-lives, the fraction of activity remaining is - .
- A. $1-(1/2)^{10}$
- B. $1-e^{-0.693 \times 10}$
- C. $(1/2)^{10}$
- D. $e^{-0.693 \times 10}$
- E. C and D
  - After N half-lives, the fraction of initial activity remaining is $(1/2)^n$. It can also be expressed as $e^{-\lambda t}$, where $\lambda = 0.693/T_{1/2}$. Substituting n x $T_{1/2}$ for T gives $e^{-0.693n}$

General

- A radioactive source of strength 47.0 $mGy.m^2.h^{-1}$ and half-life of 74 days will decay to _____ $mGy.m^2.h^{-1}$ after 222 days.
- A. 23.5
- B. 11.8
- C. 5.9
- D. 2.9
- E. 1.5

General

- A radioactive source of strength 47.0 $mGy.m^2.h^{-1}$ and half-life of 74 days will decay to _____ $mGy.m^2.h^{-1}$ after 222 days.
- A. 23.5
- B. 11.8
- C. 5.9
- D. 2.9
- E. 1.5

General

- A batch of ^{125}I seeds for a prostate implant is required to have an activity of 0.50 mCi/seed at the time of the implant. If the seeds arrive 5 days early, their activity will be ___ mCi/seed on arrival. (Half-life = 60 days.)
- A. 0.47
- B. 0.53
- C. 0.59
- D. 0.62
- E. 0.77

General

- A batch of ^{125}I seeds for a prostate implant is required to have an activity of 0.50 mCi/seed at the time of the implant. If the seeds arrive 5 days early, their activity will be ___ mCi/seed on arrival. (Half-life = 60 days.)
- A. 0.47
- B. 0.53
  - At=Ao exp (0.693 x t/60), where t=5.
- C. 0.59
- D. 0.62
- E. 0.77

General

- If the biological and physical half-lives of a radiotracer are both 2 hours, the effective half-life is ___ hours.
- A. 0.25
- B. 0.5
- C. 1.0
- D. 2.0
- E. 4.0

General

- If the biological and physical half-lives of a radiotracer are both 2 hours, the effective half-life is ___ hours.
- A. 0.25
- B. 0.5
- C. 1.0
  - Note: 1/Teff = [1/Tp + 1/Tb]
- D. 2.0
- E. 4.0

General

- During nuclear decay, energetic particles are emitted. The maximum energy of these particles is a function of the:
- A. Mass defect.
- B. Neutron capture cross section.
- C. Spin orientation of the particles.
- D. Decay constant.

General

- During nuclear decay, energetic particles are emitted. The maximum energy of these particles is a function of the:
- A. Mass defect.
  - The energy available for particles emitted from an unstable nucleus is the difference between the masses of the initial nucleus and the daughter nucleus plus any emitted particles. This mass can be converted into units of energy using E=mc2.
  - The mass of a nucleus is less than the sum of its protons and neutrons by an amount called the mass defect, which is greatest for the most stable nuclei.
- B. Neutron capture cross section.
- C. Spin orientation of the particles.
- D. Decay constant.

General

- Which of the following is/are true regarding positron emission?
- 1. It is accompanied by neutrino emission.
- 2. It cannot occur unless the energy levels of the parent and daughter differ by 0.51 Mev.
- 3. It is followed by annihilation and emission of two 0.51 MeV photons.
- 4. It consists of monoenergetic positrons.

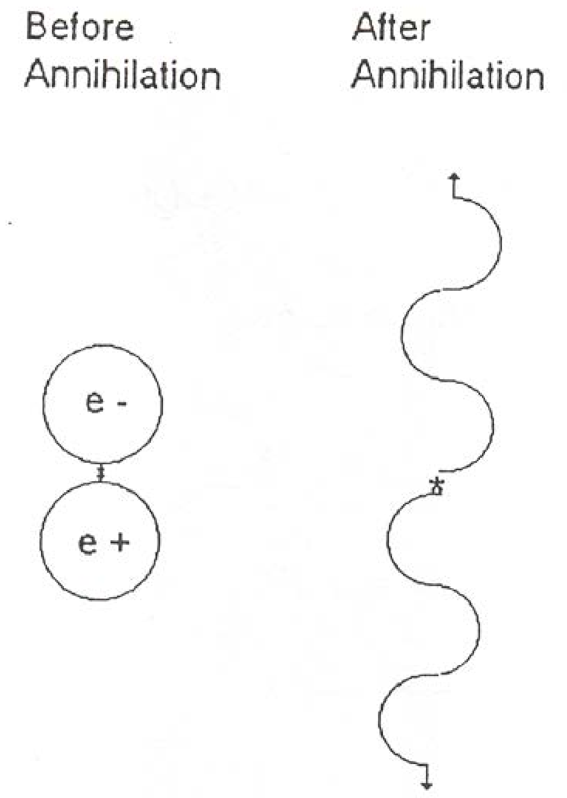
- A. 1,3
- B. 2,4
- C. 4 only
- D. 1,2,3,4
- E. None of the above

General

- Which of the following is/are true regarding positron emission?
- 1. It is accompanied by neutrino emission.
- 2. It cannot occur unless the energy levels of the parent and daughter differ by 0.51 Mev.
- 3. It is followed by annihilation and emission of two 0.51 MeV photons.
- 4. It consists of monoenergetic positrons.

- A. 1,3
  - Positrons, like betas, have a spectrum of energies. Two 511 keV annihilations photons are emitted when the positron looses its kinetic energy and combines with an electron.

- In positron emission, a proton is converted into a neutron, positron and neutrino.
- Threshold is 1.02 Mev
- Result is two 0.511 MeV annihilation photons in opposite directions.



General

- Which of the following is/are true regarding electron capture?
- 1. It can compete with positron emission in isotopes with an excess of protons.
- 2. It can result in characteristic x-ray emission.
- 3. It can result in Auger electron emission.
- 4. It can result in the emission of a neutrino

- A. 1,3
- B. 2,4
- C. 4 only
- D. 1,2,3,4

General

- Which of the following is/are true regarding electron capture?
- 1. It can compete with positron emission in isotopes with an excess of protons.
- 2. It can result in characteristic x-ray emission.
- 3. It can result in Auger electron emission.
- 4. It can result in the emission of a neutrino

- D. 1,2,3,4
  - Positron emission and electron capture often compete as a decay process in the same radionuclide with an excess of protons. In electron capture, an electron, usually from the K shell, combines with the proton to form a neutron and emitted neutrino. The K shell vacancy causes characteristic x-rays and auger electrons to be emitted.

General

- How do you increase Z to Z+1 but leave A contstant
- A. Beta plus decay.
- B. Beta minus decay.
- C. Alpha decay.
- D. Isomeric transition.

General

- How do you increase Z to Z+1 but leave A contstant
- A. Beta plus decay.
  - In Beta minus decay, Z increase by 1, but A remains constant.
- B. Beta minus decay.
- C. Alpha decay.
- D. Isomeric transition.

General

- Heavy radioactive nuclei (mass number A > 200) decay most frequently with the emission of a(n) ___.
- A. Beta particle
- B. Gamma ray
- C. Auger electron
- D. Alpha particle

General

- Heavy radioactive nuclei (mass number A > 200) decay most frequently with the emission of a(n) ____.
- A. Beta particle
- B. Gamma ray
- C. Auger electron
- D. Alpha particle
  - Example is $^{226}Ra \rightarrow {}^{222}Rn$

General

- Characteristic x-rays may be emitted following:
- 1. Internal conversion
- 2. Beta minus decay
- 3. Electron capture
- 4. Alpha decay

- A. 1,3
- B. 2,4
- C. 4 only
- D. 1,2,3,4
- E. None of the above

General

- Characteristic x-rays may be emitted following:
- 1. Internal conversion
- 2. Beta minus decay
- 3. Electron capture
- 4. Alpha decay

- A. 1,3
  - Only processes listed that create a vacancy in an electron shell.
- B. 2,4
- C. 4 only
- D. 1,2,3,4
- E. None of the above

General

- During an isomeric transition, all of the following may be emitted, except:
- A. Auger electron.
- B. Beta particle.
- C. Characteristic x-rays.
- D. Internal conversion electrons.
- E. Gamma rays.

General

- During an isomeric transition, all of the following may be emitted, except:
- A. Auger electron.
- B. Beta particle.
  - The nucleus emits a gamma ray which can sometimes interact with the orbital electrons and emit an internal conversion electron. If this occurs, it can be followed by a characteristic x-ray, or an Auger electron.
- C. Characteristic x-rays.
- D. Internal conversion electrons.
- E. Gamma rays.

General

- Positron emission occurs in radionuclides which have an excess of:
- A. Electrons.
- B. Positrons.
- C. Neutrons.
- D. Protons.
- E. Mesons.

General

- Positron emission occurs in radionuclides which have an excess of:
- A. Electrons.
- B. Positrons.
- C. Neutrons.
- D. Protons.
  - Nuclei with excess protons decay by positron emission, whereas nuclei with an excess of neutrons decay by beta minus emission.
  - Proton → $n + B^{+} + v$
- E. Mesons.

General

- Which of the following is produced in a cyclotron?
- A. 137Cs
- B. 18F
- C. 192Ir
- D. 40K

General

- Which of the following is produced in a cyclotron?
- A. 137Cs
- B. 18F
  - 18F is a positron emitter used in PET.
  - 137 Cs is a reactor fuel by-product, created by fission.
  - 192 Ir is created by bombarding 191 Ir with neutrons in a reactor.
  - 40 K is a naturally occuring isotope of potassium, present in the human body.
- C. 192Ir
- D. 40K

General

- The minimum photon energy in an x-ray spectrum is determined by the:
- A. Inherent and added filtration.
- B. Target material.
- C. kVp.
- D. Maximum mA.
- E. None of the above.

General

- The minimum photon energy in an x-ray spectrum is determined by the:
- A. Inherent and added filtration.
  - Minimum photon energy depends on filtration.
- B. Target material.
- C. kVp.
- D. Maximum mA.
- E. None of the above.

General

- In a typical x-ray beam, the 2nd HVL ____ the 1st HVL.
- A. is always greater than
- B. is always less than
- C. is the same as
- D. could be greater than or less than

General

- In a typical x-ray beam, the 2nd HVL ____ the 1st HVL.
- A. is always greater than
  - This is due to beam hardening as the beam passes through the 1st HVL.
- B. is always less than
- C. is the same as
- D. could be greater than or less than

General

- For a typical diagnostic x-ray beam, the HVL is measured in ___ .
- A. mm Pb
- B. cm W
- C. mm Al
- D. cm Cu

General

- For a typical diagnostic x-ray beam, the HVL is measured in ____ .
- A. mm Pb
- B. cm W
- C. mm Al
- D. cm Cu

General

- The effective photon energy of an x-ray beam can be increased by:
- A. Increasing the tube current.
- B. Decreasing the filtration.
- C. Increasing the mAs.
- D. Increasing the tube voltage.
- E. None of the above.

General

- The effective photon energy of an x-ray beam can be increased by:
- A. Increasing the tube current.
- B. Decreasing the filtration.
- C. Increasing the mAs.
- D. Increasing the tube voltage.
  - Decreasing filtration lets through more low energy photons, and decreases the effective energy of the beam. The mA and mAs have no effect on beam energy.
- E. None of the above.

General Mismatch

1. Has the longest wavelength.
2. Has the shortest wavelength.
3. Has the 2nd highest energy.

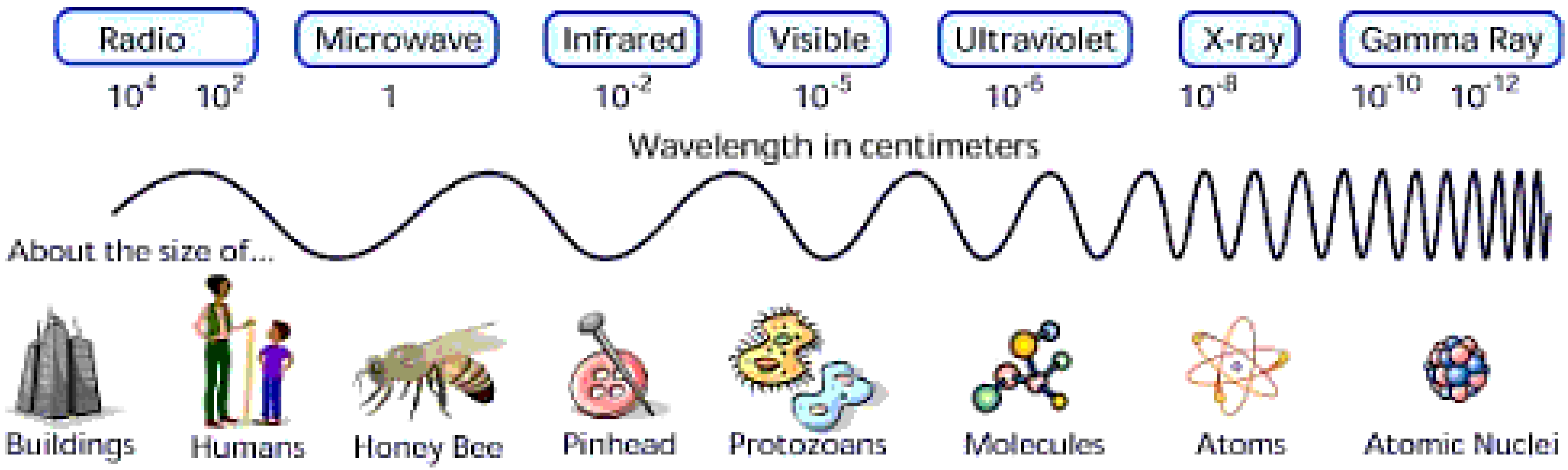
- A. Gamma rays
- B. Ultraviolet
- C. Infrared
- D. Radiowaves
- E. Visible light

General

1-D, 2-A, 3-B

1. Has the longest wavelength.
2. Has the shortest wavelength.
3. Has the 2nd highest energy.

- A. Gamma rays
- B. Ultraviolet
- C. Infrared
- D. Radiowaves
- E. Visible light


Radio
Microwave
Infrared
Visible
Ultraviolet
X-ray
Gamma Ray
10^4 10^2
1
10^{-2}
10^{-5}
10^{-6}
10^{-8}
10^{-10} 10^{-12}
Wavelength in centimeters
About the size of...
Buildings
Humans
Honey Bee
Pinhead
Protozoans
Molecules
Atoms
Atomic Nuclei

General

- The frequency of a photon of wavelength 10-5cm is ___ Hz. (Velocity of light c = 3 X 108 m/s)
- A. 30
- B. 3000
- C. 3 X 10^5
- D. 3 X 10^{15}
- E. 3 X 10^{25}

General

- The frequency of a photon of wavelength 10-5cm is ____ Hz. (Velocity of light c = 3 X 108 m/s)
- A. 30
- B. 3000
- C. 3×10^{5}
- D. 3×10^{15}
  - $c=\lambda\upsilon$. Thus $\upsilon = c/\lambda = 2x10^{8}m/s/10^{-7}m$
- E. 3×10^{25}

General

- The energy of a photon of wavelength 10-scm is - e V (Planck's constant = 4.14 x 10-15 eVs; c = 3 X 108 m/s)
- A. 1.8 x 10^{-3}
- B. 12.4
- C. 8.1 x 10^{2}
- D. 1.24 X 10^{8}
- E. 3.6 X 10^{4}

General

- The energy of a photon of wavelength 10^{-7}cm is ____ e V (Planck's constant = 4.14×10^{-15} eVs; c = 3×10^{8} m/s)
- A. 1.8 x 10-3
- B. 12.4
  - C= hυ = hc/υ, where h = Planck's constant.
  - Thus E = (4.14 x 10-15 eVs) x (3×10^{8} m/s)/10^{-7} cm =12.4 eV
- C. 8.1 x 102
- D. 1.24 X 108
- E. 3.6 X 104

General

- An exposure rate of 50 mR/hr is measured at a distance of 1 m from a source of radiation. The exposure rate will be 2 mR/hr at ____ m.
- A. 25
- B. 20
- C. 15
- D. 5
- E. 2

General

- An exposure rate of 50 mR/hr is measured at a distance of 1 m from a source of radiation. The exposure rate will be 2 mR/hr at ____ m.
- A. 25
- B. 20
- C. 15
- D. 5
  - By inverse square law, $I_1/I_2 = (d_1/d_2)^2$
- E. 2

General

- The relationship between HVL and linear attenuation coefficient μ is ___ .
- A. HVL = 0.5 μ
- B. HVL = $e{-}\mu$
- C. HVL = $e^{0.693 x \mu}$
- D. 0.693 = μ x HVL

General

- The relationship between HVL and linear attenuation coefficient μ is ____ .
- A. HVL = 0.5 μ
- B. HVL = e–μ
- C. HVL = $e^{0.693 x \mu}$
- D. 0.693 = μ x HVL

General

- A monoenergetic photon beam has a linear attenuation coefficient of 0.1 cm^{-1} in tissue.
- After traveling through 5 cm of tissue, the fraction of the initial intensity remaining is ___ .
- A. 0.61
- B. 0.50
- C. 0.43
- D. 0.38
- E. 0.05

General

- A monoenergetic photon beam has a linear attenuation coefficient of 0.1 cm^{-1} in tissue.
- After traveling through 5 cm of tissue, the fraction of the initial intensity remaining is ____ .
- A. 0.61
  - $I_x = I_o\ e^{-\mu x}$; ,μ=0.1cm^{-1}; x=5.0cm
  - $I_x = e^{-0.5} = 0.61$
- B. 0.50
- C. 0.43
- D. 0.38
- E. 0.05

General

- Houndsfield numbers in a CT image are linearly related to the:
- A. Mass attenuation coefficient.
- B. Linear attenuation coefficient.
- C. Electron density of the patient.
- D. Number of photoelectric interactions per cm.

General

- Houndsfield numbers in a CT image are linearly related to the:
- A. Mass attenuation coefficient.
- B. Linear attenuation coefficient.
  - CT number = 1000 x $[(\mu_{material} - \mu_{water}) / \mu_{water}]$ where μ is the linear attenuation coeff.
- C. Electron density of the patient.
- D. Number of photoelectric interactions per cm.

General

- The reason for the differential contrast between bone and soft tissue in a diagnostic radiograph is due primarily to:
- A. Compton interactions.
- B. Pair production.
- C. Photoelectric effect.
- D. Coherent scatter.

General

- The reason for the differential contrast between bone and soft tissue in a diagnostic radiograph is due primarily to:
- A. Compton interactions.
- B. Pair production.
- C. Photoelectric effect.
  - The Z^3 dependence of the photoelectric effect is responsible for the bone-tissue contrast in a diagnostic radiograph, along with the difference in density between tissue and bone.
- D. Coherent scatter.

General

- Carbon (Z=6, A=12) is about ____ times as likely as hydrogen (Z=1, A=1), per unit mass, to undergo a photoelectric interaction.
- A. 216
- B. 144
- C. 36
- D. 1/6
- E. 1/36

General

- Carbon (Z=6, A=12) is about ____ times as likely as hydrogen (Z=1, A=1), per unit mass, to undergo a photoelectric interaction.
- A. 216—Remember Z^3
- B. 144
- C. 36
- D. 1/6
- E. 1/36

General

- A photoelectric interaction occurs between an 9.0 keV photon and a K shell electron. A 4.0 ke V photoelectron is emitted. The binding energy of the K shell is ___ keV.
- A. 4.0
- B. 5.0
- C. 9.0
- D. 13.0
- E. Cannot tell from information given.

General

- A photoelectric interaction occurs between an 9.0 keV photon and a K shell electron. A 4.0 ke V photoelectron is emitted. The binding energy of the K shell is ____ keV.
- A. 4.0
- B. 5.0
  - The energy of a photon is totally absorbed by the electron, which uses 5.0 keV to overcome its binding energy, leaving 4.0 keV as the energy of the emitted photoelectron.
- C. 9.0
- D. 13.0
- E. Cannot tell from information given.

General

- Following a photon interaction with matter, a photon is detected. It could be any of the following **except**:
- A. Characteristic x-ray following photoelectric interaction.
- B. Scattered photon following Compton interaction.
- C. Annihilation photon following pair production.
- D. Scattered photon following photoelectric interaction.

General

- Following a photon interaction with matter, a photon is detected. It could be any of the following **except**:
- A. Characteristic x-ray following photoelectric interaction.
- B. Scattered photon following Compton interaction.
- C. Annihilation photon following pair production.
- D. Scattered photon following photoelectric interaction.
  - In a photoelectric interaction, the incident photon is completely absorbed. A photoelectron is emitted, but the vacancy it leaves gives rise to a characteristic x-ray.

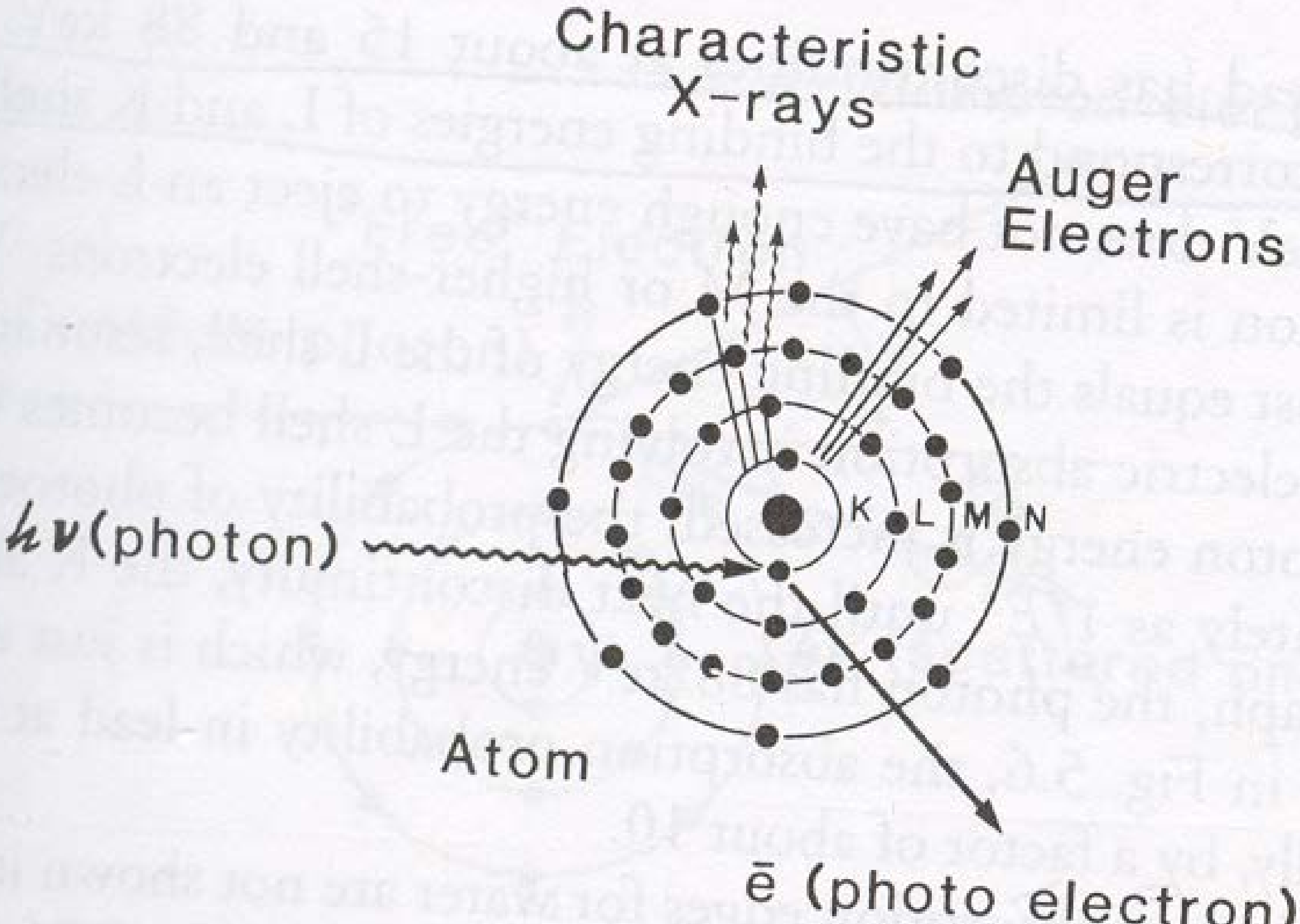


FIG. 5.5. Illustration of the photoelectric effect.

General

- The type of interaction in which a 100 ke V photon is scattered with half its initial energy, and an electron is emitted with the remaining energy would be:
- A. Classical scatter.
- B. Photoelectric.
- C. Pair production.
- D. Compton.

General

- The type of interaction in which a 100 ke V photon is scattered with half its initial energy, and an electron is emitted with the remaining energy would be:
- A. Classical scatter.
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- C. Pair production.
- D. Compton.

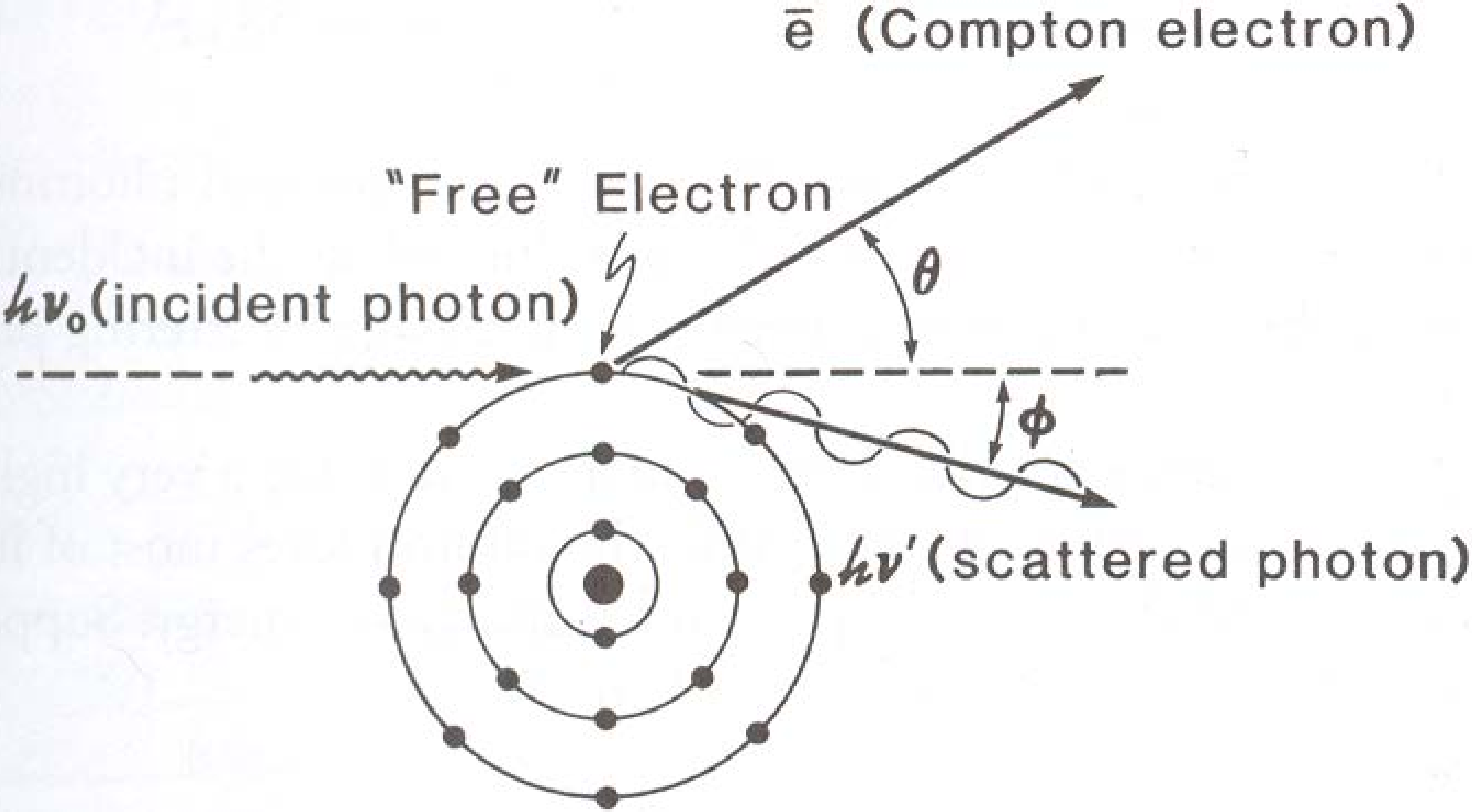

FIG. 5.7. Diagram illustrating the Compton effect.

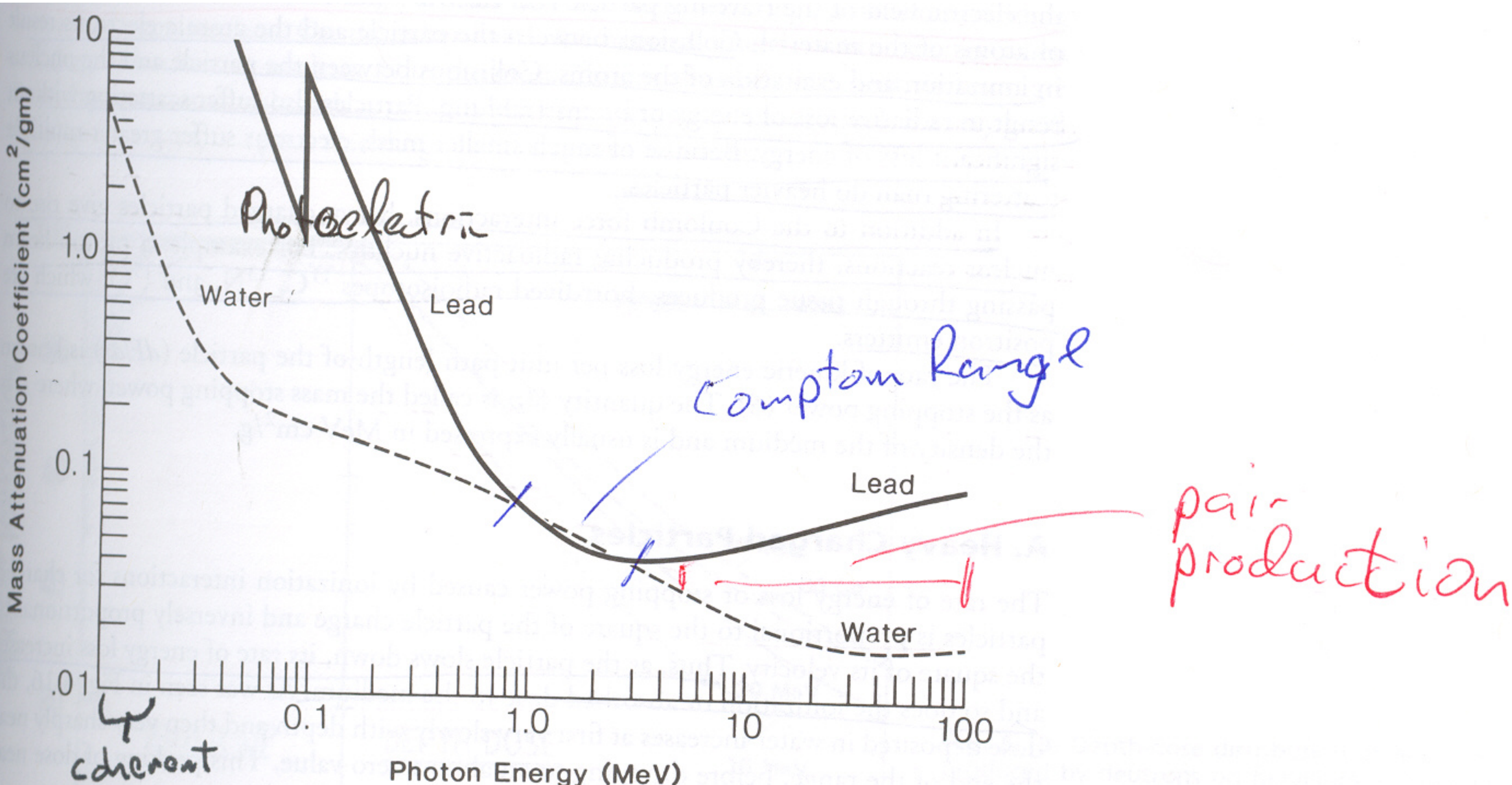

FIG. 5.12. Plot of total mass attenuation coefficient (μ/ρ) as a function of photon energy for lead and water. (Reprinted with permission from Johns HE, Cunningham JR. *The physics of radiology,* 3rd ed. Springfield, IL: Charles C Thomas, 1969.)

General

- Two materials with Z values of 7 and 14 are irradiated by a photon beam. The ratio of Compton interactions per unit mass is approximately:
- A. 1:4.
- B. 1:2.
- C. 1:1.
- D. 2:1.
- E. Dependent on the photon energy.

General

- Two materials with Z values of 7 and 14 are irradiated by a photon beam. The ratio of Compton interactions per unit mass is approximately:
- A. 1:4.
- B. 1:2.
- C. 1:1.
  - The probability of a Compton interaction per unit mass is independent of Z, since it depends on the electron density, which is fairly constant for all materials except hydrogen.
- D. 2:1.
- E. Dependent on the photon energy.

General

- Compton scatter:
- A. Takes place with inner shell, bound electrons.
- B. Is an interaction with the nucleus.
- C. Is more likely at energies just below the Kedge.
- D. Decreases in probability as photon energy increases.
- E. Is responsible for the efficiency of lead as a diagnostic room shielding material.

General

- Compton scatter:
- A. Takes place with inner shell, bound electrons.
- B. Is an interaction with the nucleus.
- C. Is more likely at energies just below the Kedge.
- D. Decreases in probability as photon energy increases.
  - The probability of Compton interaction decreases with increasing photon energy.
- E. Is responsible for the efficiency of lead as a diagnostic room shielding material.

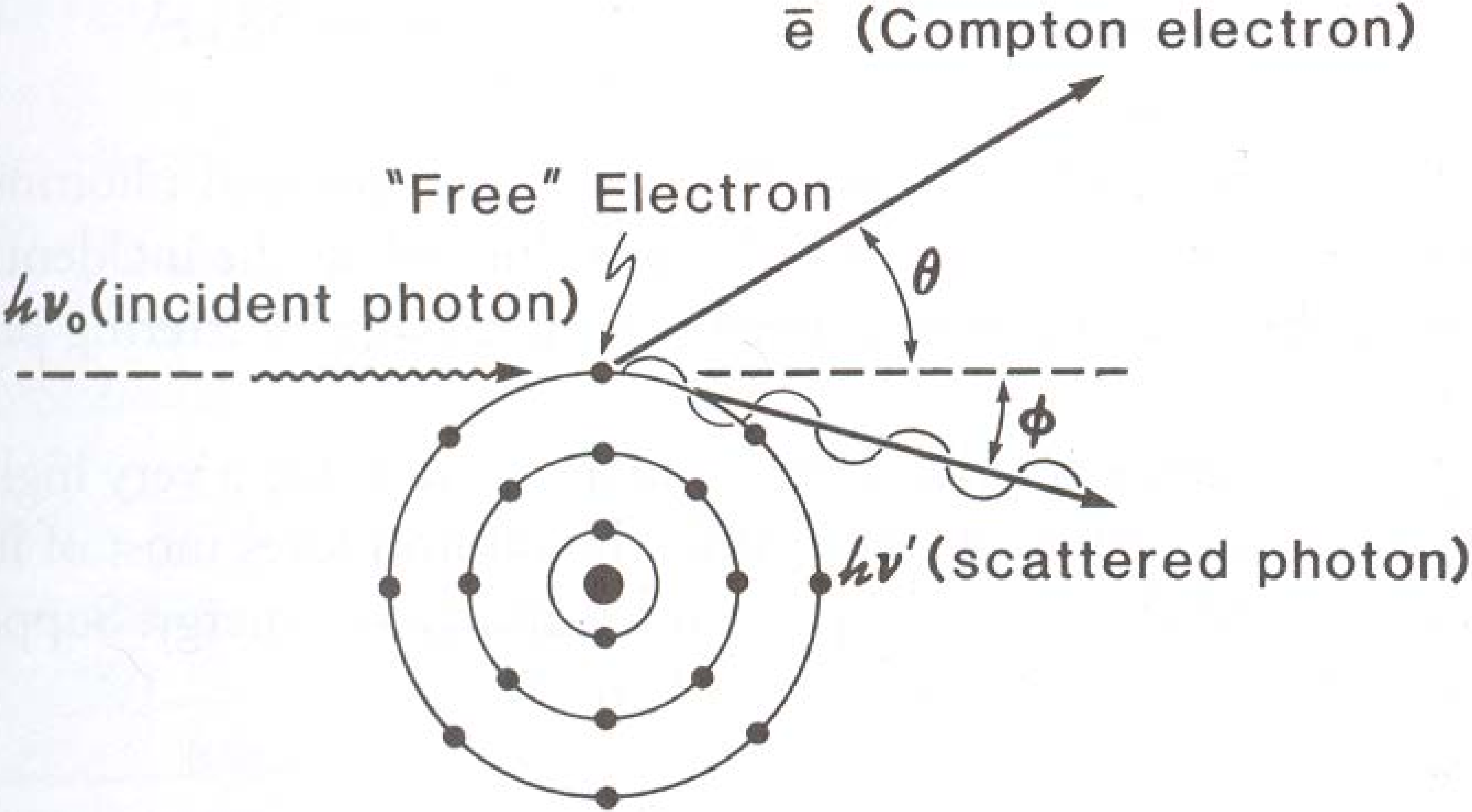

FIG. 5.7. Diagram illustrating the Compton effect.

General

- Compton scattered electrons can be emitted at:
- A. Any angle.
- B. 0°-90° with the incident photon.
- C. 30°-120° with the incident photon.
- D. 90°-180° with the incident photon.

General

- Compton scattered electrons can be emitted at:
- A. Any angle.
- B. 0°-90° with the incident photon.
  - The Compton photon can be scattered at any angle, but the emitted electron is limited to 0º-90º with the direction of the incidental photon.
- C. 30°-120° with the incident photon.
- D. 90°-180° with the incident photon.

General Mismatch

- Pair production can occur for which of the following photon energies?
- 1. 1.02 keV
- 2. 0.51 MeV
- 3. 1.02 MeV
- 4. 2.51 MeV

- A. 1,2,3,4
- B. 2, 3, 4
- C. 3,4
- D. 4 only

General Mismatch

- Pair production can occur for which of the following photon energies?
- 1. 1.02 keV
- 2. 0.51 MeV
- 3. 1.02 MeV
- 4. 2.51 MeV

- A. 1,2,3,4
- B. 2, 3, 4
- C. 3,4
  - The threshold for pair production, as the name suggests, is the energy required to create two electons at rest, i.e. 2 x 0.51 MeV.
- D. 4 only

General

- If a 6 Me V photon undergoes pair production, which of the following is true?
- A. Two 0.51 MeV photons will be emitted.
- B. A 4.98 MeV photon is scattered.
- C. 6 Me V is shared as kinetic energy between a positron and an electron.
- D. Two positrons are emitted at 180° to each other.

General

- If a 6 Me V photon undergoes pair production, which of the following is true?
- A. Two 0.51 MeV photons will be emitted.
  - From the initial 6 MeV, 1.02 MeV is used to create a positron and an electron, and the remaining 4.98 MeV is dived between the particles as kinetic energy. After losing its kinetic energy, the positron will annihilate with an electron at rest, emitting two annihilation photons each of energy of 0.51 MeV.
- B. A 4.98 MeV photon is scattered.
- C. 6 Me V is shared as kinetic energy between a positron and an electron.
- D. Two positrons are emitted at 180° to each other.

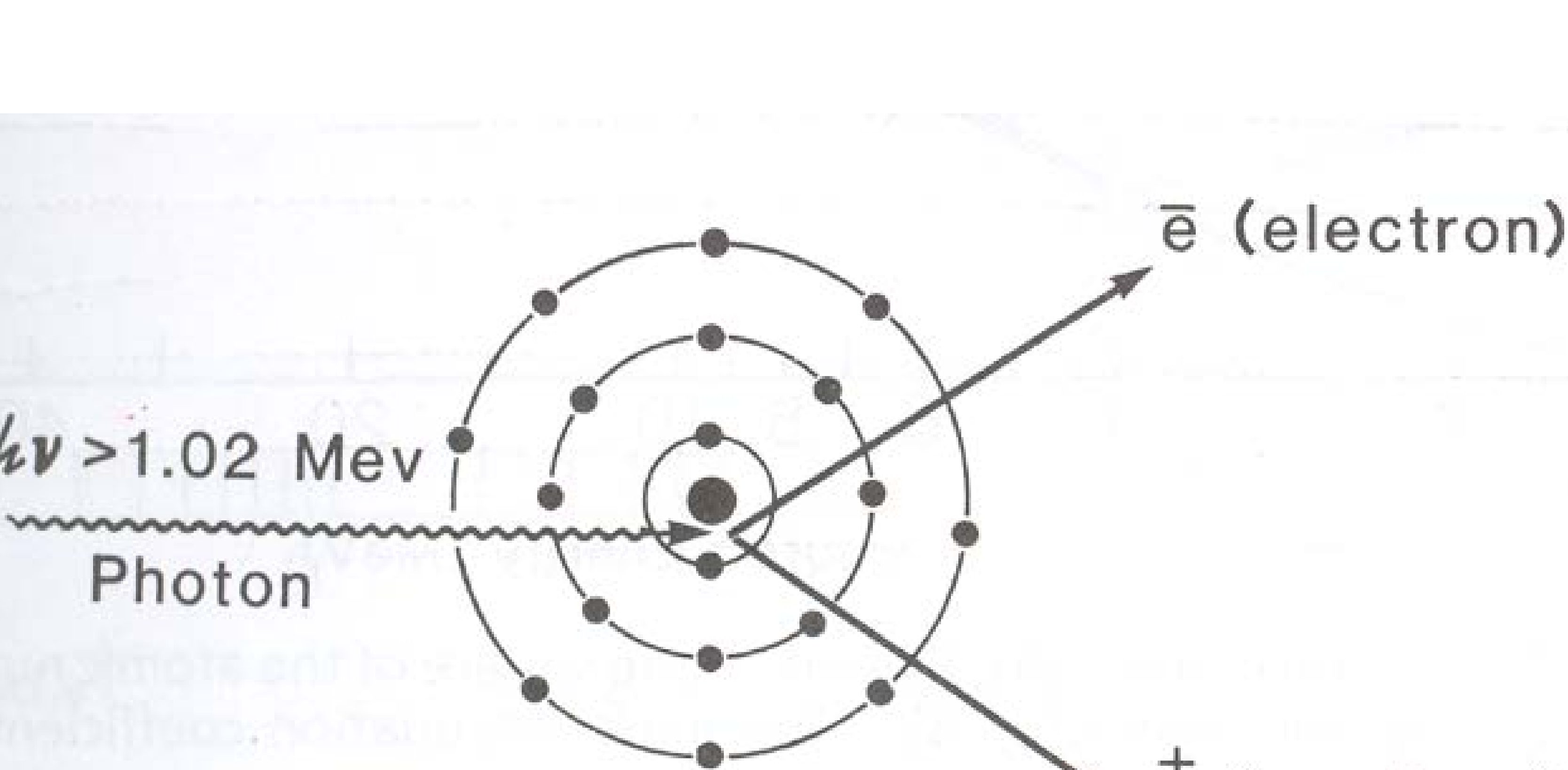

FIG. 5.9. Diagram illustrating the pair production process.

General

- Match the most appropriate interaction to the description. (answers can be used more than once.).
- A. Coherent scatter
- B. Photoelectric
- C. Compton
- D. Pair production

General

- 1. Chiefly responsible for loss of contrast in a diagnostic radiograph.
- 2. No energy is transferred or locally absorbed.
- 3. Probability of interaction, per unit mass, depends on Z3.
- 4. Probability of interaction increases as energy increases.

- Match the most appropriate interaction to the description. (answers can be used more than once.).
- A. Coherent scatter
- B. Photoelectric
- C. Compton
- D. Pair production

General

1-C, 2-A, 3-B, 4-D

- 1. Chiefly responsible for loss of contrast in a diagnostic radiograph.
- 2. No energy is transferred or locally absorbed.
- 3. Probability of interaction, per unit mass, depends on Z^3.
- 4. Probability of interaction increases as energy increases.

- Match the most appropriate interaction to the description. (answers can be used more than once.).
- A. Coherent scatter
- B. Photoelectric
- C. Compton
- D. Pair production

General

- Which of the following is **true**?
- A. At any given photon energy, only one type of interaction is possible.
- B. Compton, photoelectric, and pair production all decrease in probability with energy.
- C. The most likely interaction in soft tissue at 100 ke V is photoelectric.
- D. The most likely interaction in soft tissue at 1.5 MeV is Compton.

General

- Which of the following is **true**?
- A. At any given photon energy, only one type of interaction is possible.
- B. Compton, photoelectric, and pair production all decrease in probability with energy.
- C. The most likely interaction in soft tissue at 100 ke V is photoelectric.
- D. The most likely interaction in soft tissue at 1.5 MeV is Compton.
  - Comptom is most probable between 25KeV and 25Mev.

General

- The 2.2 MeV betas from 90Sr will travel about ___ in tissue and ___ in air. (ρ_{air} = 0.0013 g/cm3).
- A. 1 cm 8 m
- B. 2 cm 4 m
- C. 1 cm 80 m
- D. 2 cm 220 m
- E. 4.4 cm 34 m

General

- The 2.2 MeV betas from 90Sr will travel about ____ in tissue and ____ in air. (ρ_{air} = 0.0013 g/cm3).
- A. 1 cm 8 m
  - Betas travel about 0.5 cm per MeV in unit density material. In air, they will travel about 1/0.0013 or 800 times as far.
- B. 2 cm 4 m
- C. 1 cm 80 m
- D. 2 cm 220 m
- E. 4.4 cm 34 m

General

- In PET imaging, the image is created from:
- A. Positrons emitted from the patient which strike the detectors.
- B. Annihilation photons.
- C. Protons.
- D. Photoelectrons emitted when the positrons interact with tissue.

General

- In PET imaging, the image is created from:
- A. Positrons emitted from the patient which strike the detectors.
- B. Annihilation photons.
  - PET relies on coincidence counting of the annihilation photons that are emitted in opposite directions from the point where a positron and electron annihilate. The positron emitter is labeled to a substance that is taken up by, or metabolized by, the tissue to be imaged. 18F can be tagged to materials that are metabolized by the body.
- C. Protons.
- D. Photoelectrons emitted when the positrons interact with tissue.

General

- The rate of energy loss of a particle depends on which of the following?
- 1. Energy
- 2. Mass
- 3. Velocity
- 4. Charge

- A. 1,3
- B. 2,4
- C. 1 only
- D. 4 only
- E. 1,2,3,4

General

- The rate of energy loss of a particle depends on which of the following?
- 1. Energy
- 2. Mass
- 3. Velocity
- 4. Charge

- A. 1,3
- B. 2,4
- C. 1 only
- D. 4 only
- E. 1,2,3,4
  - Increased mass and charge, and slower velocity all contribute to a greater rate of energy loss.

General

- Electrons lose energy when passing through matter by:
- 1. Production of Bremsstrahlung.
- 2. Photoelectric interactions.
- 3. Collisions with other electrons.
- 4. Production of delta rays.

- A. 1,2
- B. 3,4
- C. 1,3,4
- D. 1,2,3
- E. 1,2,3,4

General

- Electrons lose energy when passing through matter by:
- 1. Production of Bremsstrahlung.
- 2. Photoelectric interactions.
- 3. Collisions with other electrons.
- 4. Production of delta rays.

- A. 1,2
- B. 3,4
- C. 1,3,4
  - The photoelectric interaction is a photon interaction with mater.
  - No energy loss.
- D. 1,2,3
- E. 1,2,3,4

General

- All of the following are directly ionizing radiation except:
- A. Protons.
- B. Alpha particles.
- C. Beta particles.
- D. Neutrons.
- E. Positrons.

General

- All of the following are directly ionizing radiation except:
- A. Protons.
- B. Alpha particles.
- C. Beta particles.
- D. Neutrons.
  - Neutrons are indirectly ionizing: their energy is given to charged particles, such as protons, which then directly ionize the atoms along their path.
- E. Positrons.

General

- Two x-ray films, each with optical density of 1.0, are placed on top of one another. The fraction of incident light transmitted through the "sandwich" is:
- A. 0.2
- B. 0.02
- C. 0.01
- D. 0.001

General

- Two x-ray films, each with optical density of 1.0, are placed on top of one another. The fraction of incident light transmitted through the "sandwich" is:
- A. 0.2
- B. 0.02
- C. 0.01
  - Optical density is the logarithm of the incident intensitydivide by the transmitted intensity. Optical density is therefore additive. Thus, 1.0 + 1.0 = 2.0 is the optical density of the sandwich, and $1/10^2$ or 0.01 of the incident light is transmitted.
- D. 0.001

General

- Grids are used in diagnostic radiology to
- A. Reduce patient dose.
- B. Allow a lower kVp to be used.
- C. Reduce scatter to the film.
- D. Reduce scatter dose to the patient.

General

- Grids are used in diagnostic radiology to
- A. Reduce patient dose.
- B. Allow a lower kVp to be used.
- C. Reduce scatter to the film.
  - Grids tend to increase patient dose (for the same optical density on the film), but they intercept scatter generated by interactions in the patient, which would reduce contrast.
- D. Reduce scatter dose to the patient.

General

- Which of the following is true regarding MRl?
- A. The MRl signal differentiates between tissues on the basis of their Z values.
- B. MRI can image metabolic activity.
- C. MRI scans have better resolution than plane radiographs.
- D. Patients with tungsten prostheses cannot undergo MRI scans.

General

- Which of the following is true regarding MRI?
- A. The MRI signal differentiates between tissues on the basis of their Z values.
- B. MRI can image metabolic activity.
  - Only ferromagnetic metals cause problems in high magnetic field of MR scanner. Differences in hydrogen content, not Z, are imaged by MRI. Plane film has a much better resolution than CT or MRI.
- C. MRI scans have better resolution than plane radiographs.
- D. Patients with tungsten prostheses cannot undergo MRI scans.

General

- A paper states that a certain result (95% survival at 5 years) has a p value of 0.01. This means that:
- A. The result is true 0.01 % of the time.
- B. There is a probability of 1 in 100 that this result was obtained by chance.
- C. The result is true for 99% of the population.
- D. There is a 1% probability that the result is typical of the population.

General

- A paper states that a certain result (95% survival at 5 years) has a p value of 0.01. This means that:
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- C. The result is true for 99% of the population.
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General

- A radioactive sample is counted, yielding a value of 900 counts. If this were repeated, the value would fall between ___ and ___ 95% of the time.
- A. 870 930
- B. 840 960
- C. 850 950
- D. 895 905
- E. 612 1188

General

- A radioactive sample is counted, yielding a value of 900 counts. If this were repeated, the value would fall between ___ and ___ 95% of the time.
- A. 870 930
- B. 840 960
  - The standard deviation $\sigma = N^{1/2} = 900^{1/2} = 30$
  - 68% of the measurements fall within $\pm\sigma$ of the mean, and 95% fall within $\pm 2\sigma$ of the mean.
- C. 850 950
- D. 895 905
- E. 612 1188

General

- A CT image consists of 200 slices, each 512 x 512 pixels, each pixel having a 16-bit pixel depth. The size of the file is ___ .
- A. 500 kB
- B. 5MB
- C. 10 MB
- D. 50 MB
- E. 100 MB

General

- A CT image consists of 200 slices, each 512 x 512 pixels, each pixel having a 16-bit pixel depth. The size of the file is ____ .
- A. 500 kB
- B. 5MB
- C. 10 MB
- D. 50 MB
- E. 100 MB
  - 16 bits equal 2 bytes. 2 x 512 x 512 x 200 = 104857600 bytes = 100 MB

General

- 1. Average dose to a member of the population from radon.
- 2. Maximum recommended dose to a radiation worker.
- 3. Average dose to a member of the population from medical uses of radiation.
- 4. Maximum recommended dose to a member of the public *(infrequent* exposure).

- Match the following annual radiation levels with the sources listed. (answers may be used more than once.).
- A. 50 mSv
- B. 10 mSv
- C. 2 mSv
- D. 1 mSv
- E. 0.5 mSv

General

1-C, 2-A, 3-E, 4-D

- 1. Average dose to a member of the population from radon.
- 2. Maximum recommended dose to a radiation worker.
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- C. 2 mSv
- D. 1 mSv
- E. 0.5 mSv

Annual Effective Dose Equivalents		
Type	Dose Equivalent (rem)	Dose Equivalent (mSv)
Radiation Workers	5	50
General Public - Infrequent	0.5	5
General Public - Continuous	0.1	1
Students under age 18	0.1	1
Embryo-fetus	0.5	5
Embryo-fetus after declared pregnancy	0.05 Monthly	0.5 Monthly
Lens of eye	15	150
Other organs	50	500
NCRP #91		

General

- The *average* total annual dose to a member of the public from background and man-made radiation is ___ mSv.
- A. 5.0
- B. 3.5
- C. 1.5
- D. 0.4
- E. 0.2

General

- The *average* total annual dose to a member of the public from background and man-made radiation is ____ mSv.
- A. 5.0
- B. 3.5
- C. 1.5
- D. 0.4
- E. 0.2

General

- The average annual doses are as follows (in mSv/yr)
  - Radon 2.0
  - Diagnostic 0.39
  - Nuclear Med 0.14
  - Natural background other than radon 1.0
    - Cosmic, internal, fallout

General

- 1. Induction of cancer from exposure to radiation.
- 2. Skin burns from prolonged fluoroscopic exams.

- The following effects are:
- A. Stochastic
- B. Deterministic
- C. Both
- D. Neither

General
1-A, 2-B

- 1. Induction of cancer from exposure to radiation.
  - Cancer induction is probabilitic, i.e. there is a certain probabilty of inducing cancer from a dose of radiation, but the severity of the effect if not dose related. → Stochastic
- 2. Skin burns from prolonged fluoroscopic exams.
  - Skin reactions to radiation are an example of deterministic: there is a threshold and severity is dose-related.

General

- According to BEIR V, the *additional* risk of cancer death from a 0.1 Sv (10 rem) exposure to a population of 100,000 people would be about ___%.
- A. 0.01
- B. 0.1
- C. 1.0
- D. 10.0

General

- According to BEIR V, the *additional* risk of cancer death from a 0.1 Sv (10 rem) exposure to a population of 100,000 people would be about ____%.
- A. 0.01
- B. 0.1
- C. 1.0
  - BEIR V (1990) states that the excess cancer deaths in a population of 100000 persons exposed to 0.1 Sv would be about 770 males or 810 females.
- D. 10.0

General

- If a physician receives an average whole body dose of 0.05 mSv from a procedure involving interventional fluoroscopy, ___ of these procedures can be performed each week.
- A. 5
- B. 10
- C. 20
- D. 40
- E. 80

General

- If a physician receives an average whole body dose of 0.05 mSv from a procedure involving interventional fluoroscopy, ____ of these procedures can be performed each week.
- A. 5
- B. 10
- C. 20
  - The recommended whole body dose limit for radiation workers is 50 mSv/yr, or 1.0 mSv/wk.
- D. 40
- E. 80

General

- All of the following are used in x-ray machine room shielding calculations in the United States, **except**:
- A. Occupancy factor and Use factor.
- B. Weekly dose limit to workers or public.
- C. Workload.
- D. Beam energy.
- E. Instantaneous dose rate.

General

- All of the following are used in x-ray machine room shielding calculations in the United States, **except**:
- A. Occupancy factor and Use factor.
- B. Weekly dose limit to workers or public.
- C. Workload.
- D. Beam energy.
- E. Instantaneous dose rate.
  - The instantaneous dose *rate* is not a factor in barrier thickness calculations. However, the total dose in a week must be kept below the recommended limit for workers or the general public, depending on who will occupy the area.

General

- Ion chamber readings are corrected for temperature and pressure because:
- A. The chamber's calibration factor is stated at 22°C and 760 mmHg.
- B. As temperature increases, the gas in the chamber expands, resulting in a higher collected charge.
- C. As pressure increases, the gas in the chamber is compressed, resulting in a lower collected charge.
- D. All of the above are true.

General

- Ion chamber readings are corrected for temperature and pressure because:
- A. The chamber's calibration factor is stated at 22°C and 760 mmHg.
  - B and C result in lower and high charge collection, respectively. The temperature-pressure correction gives the reading which would have been measured with the chamber at standard temperature and pressure.
- B. As temperature increases, the gas in the chamber expands, resulting in a higher collected charge.
- C. As pressure increases, the gas in the chamber is compressed, resulting in a lower collected charge.
- D. All of the above are true.

General

- Personnel monitors must have all of the following features, except:
- A. No energy dependence over the range of radiation encountered.
- B. Negligible loss of stored signal over 1 month of wear, and time taken to process detector.
- C. Must be unaffected by normal fluctuations in environment (temperature, pressure, humidity).
- D. Ability to differentiate between different energies and types of radiation.

General

- Personnel monitors must have all of the following features, except:
- A. No energy dependence over the range of radiation encountered.
  - Although LiF TLD have little energy dependence, film (which is widely used in personnel monitoring) has a greater response to low energy because of the high Z components in the emulision.
  - By using various filters over portions of the film, and comparing the developed film densities in each area, and estimate of doses in different energy ranges can be obtained.
- B. Negligible loss of stored signal over 1 month of wear, and time taken to process detector.
- C. Must be unaffected by normal fluctuations in environment (temperature, pressure, humidity).
- D. Ability to differentiate between different energies and types of radiation.

General

- A unit dose radioisotope is delivered to a hospital. The vendor supplies a calibration of its activity. Regulations require the hospital to do all of the following, **except**:
- A. Wipe test the package before opening it.
- B. Treat the packaging material as low-level radioactive waste.
- C. Quantify any residual activity left following use of the radioisotope.
- D. Keep logs of receipt, use, and disposal (or storage) of all radioisotopes.

General

- A unit dose radioisotope is delivered to a hospital. The vendor supplies a calibration of its activity. Regulations require the hospital to do all of the following, **except**:
- A. Wipe test the package before opening it.
- B. Treat the packaging material as low-level radioactive waste.
  - If the packaging material reads background, it can be disposed of as regular trash, provided all radioactive warning labels have been removed or obliterated.
- C. Quantify any residual activity left following use of the radioisotope.
- D. Keep logs of receipt, use, and disposal (or storage) of all radioisotopes.

Diagnostic

- In diagnostic x-ray equipment, tube A has a 12° anode angle and tube B has a 7° anode angle. Relative to tube B, tube A:
- A. Limits the size of the usable x-ray field due to cutoff of the beam.
- B. Provides a smaller effective focal spot size for the same filament size.
- C. Is desired for cineangiographic and neuroangiographic equipment.
- D. Provides better spatial resolution.
- E. Is desirable for large field-of-view coverage.

Diagnostic

- In diagnostic x-ray equipment, tube A has a 12° anode angle and tube B has a 7° anode angle. Relative to tube B, tube A:
- A. Limits the size of the usable x-ray field due to cutoff of the beam.
- B. Provides a smaller effective focal spot size for the same filament size.
- C. Is desired for cineangiographic and neuroangiographic equipment.
- D. Provides better spatial resolution.
- E. Is desirable for large field-of-view coverage.

Diagnostic

- A large anode angle (12-15 degrees) with a large filament results in large field coverage, but increased geometric blur, hence spatial resolution degradation. A small anode angle (7-9 degrees) is desirable for small field of view image receptors, such as cineangiographic and neuroangiographic equipment, where field coverage is limited by the image intensifier diameter.

Diagnostic

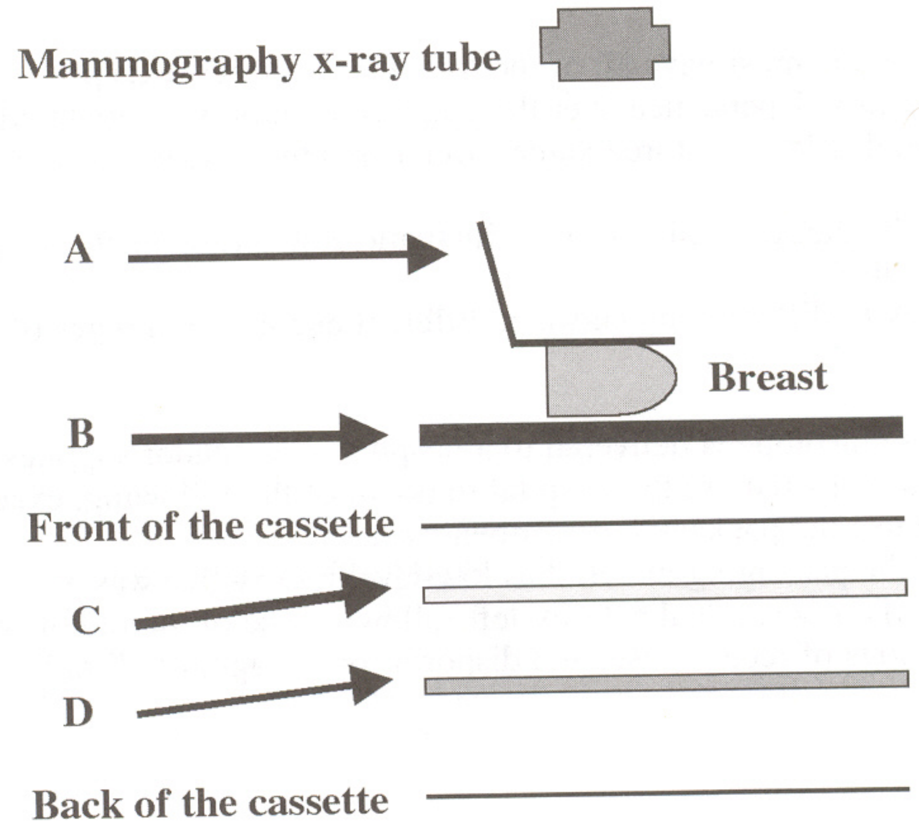
- Concerning radiographic equipment, variation of the effective focal spot size in the image receptor field:
- A. Occurs along the anode-cathode direction.
- B. Occurs perpendicular to the anode-cathode dimension.
- C. Is the highest at the center of the image receptor.
- D. Shows shortening of the projected focal spot size toward the cathode side of the field.
- E. Causes less blur for structures placed under the cathode side of the field.

Diagnostic

- Concerning radiographic equipment, variation of the effective focal spot size in the image receptor field:
- A. Occurs along the anode-cathode direction.
  - The length of the effective focal spot varies with the position in the image plane in the anode-cathode direction.
  - It shortens because of the line-focus principle toward the anode side of the field while it lengthens towards the cathode side.
  - Less geometric blur will be seen for objects positioned towards the anode side of the field.
  - The effective focal spot size does not change appeciably with position in the width dimension of the field (perpendicular to the anode-cathode).
- B. Occurs perpendicular to the anode-cathode dimension.
- C. Is the highest at the center of the image receptor.
- D. Shows shortening of the projected focal spot size toward the cathode side of the field.
- E. Causes less blur for structures placed under the cathode side of the field.

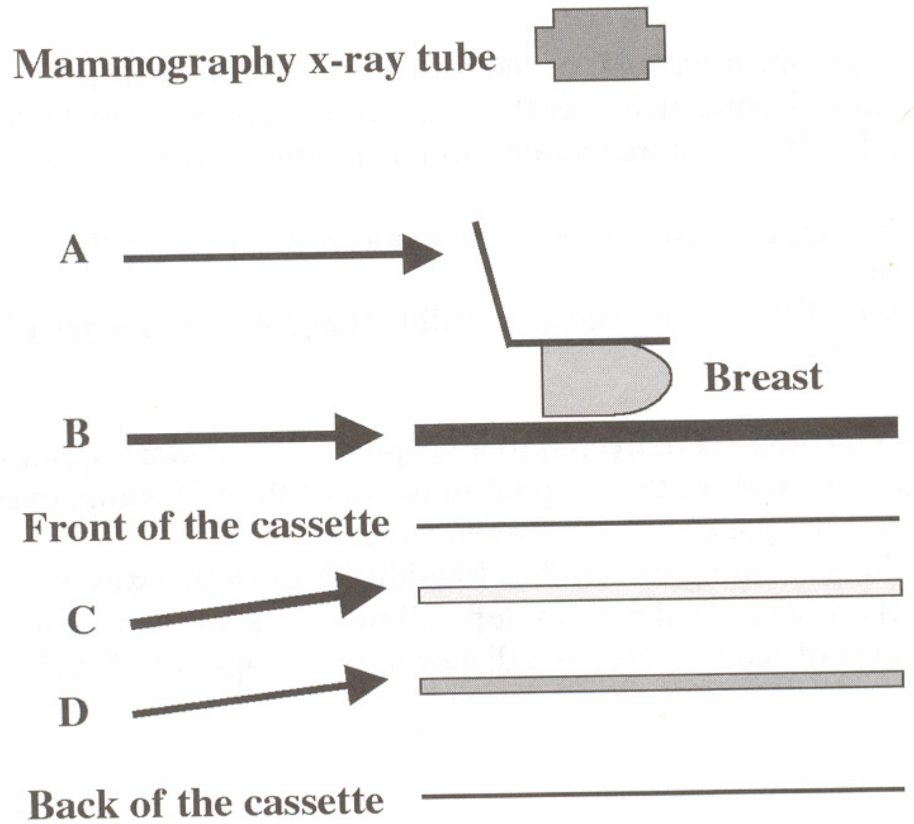
Diagnostic

- Match the following components of a mammography screen-film system in the above figure
- D3. Film
- D4. Anti-scatter grid
- D5. Screen



Diagnostic
1-C, 2-B, 3-D

- Match the following components of a mammography screen-film system in the above figure
- 1. Film
- 2. Anti-scatter grid
- 3. Screen



mammography

- In mammography, the screen is position in back of the cassette so that x-rays travel through the casette and film before interacting with the phosphor.
- X-rays are more likely to interact near the phosphor surface closest to the film emulsion. This reduces the distance traveled by the light, minimizing its spread and thereby preserving spatial resolution. The grid is placed before the cassette to reduce scatter radiation reaching the film.

Diagnostic

- Concerning diagnostic x-ray equipment, leakage radiation is:
- A. Radiation that escapes the tube housing when the unit is off.
- B. Radiation that escapes the tube housing during the exposure.
- C. Radiation that leaks from the power cables.
- D. Radiation that is transmitted through the cassette.

Diagnostic

- Concerning diagnostic x-ray equipment, leakage radiation is:
- A. Radiation that escapes the tube housing when the unit is off.
- B. Radiation that escapes the tube housing during the exposure.
- C. Radiation that leaks from the power cables.
- D. Radiation that is transmitted through the cassette.

Diagnostic

- Off-focus radiation in x-ray tubes:
- A. Results from a small fraction of electrons scattering from the target and striking the filament cup.
- B. Is a high-intensity x-ray source over the face of the cathode
- C. Can be reduced by placing a grid between the collimator and the filter
- D. Increases geometric blurring and image background fog

Diagnostic

- Off-focus radiation in x-ray tubes:
- A. Results from a small fraction of electrons scattering from the target and striking the filament cup.
- B. Is a high-intensity x-ray source over the face of the cathode
- C. Can be reduced by placing a grid between the collimator and the filter
- D. Increases geometric blurring and image background fog
  - Results from electrons in the x-ray tube that strike the anode outside the focal spot area. These electrons create low-intensity x-ray source over the face of the anode.

Diagnostic

- The difference between kVp and keV is the difference between:
- A. Exposure and dose.
- B. Monoenergetic and heterogeneous photon beams.
- C. Potential difference and energy.
- D. Gamma-rays and x-rays.
- E. Ionizing and non-ionizing radiation.

Diagnostic

- The difference between kVp and keV is the difference between:
- A. Exposure and dose.
- B. Monoenergetic and heterogeneous photon beams.
- C. Potential difference and energy.
  - kVp is the kilovolt peak, a potential difference.
  - keV is kilo electron volts, a unit of energy.
- D. Gamma-rays and x-rays.
- E. Ionizing and non-ionizing radiation.

Diagnostic

- The energy of *characteristic radiation* emanating from a tube operating at 100 kVp is determined by:
- A. The elemental composition of the target.
- B. Whether a single phase or three phase, or high- frequency generator is used.
- C. Rectification of the secondary potential.
- D. The tube current.
- E. The space charge compensation circuit.

Diagnostic

- The energy of *characteristic radiation* emanating from a tube operating at 100 kVp is determined by:
- A. The elemental composition of the target.
  - The characteristic radiation is solely determined by the target material. If the energy of the electrons does not exceed the binding energy of the target electrons, characteristic radiation will not be produced.
- B. Whether a single phase or three phase, or high-frequency generator is used.
- C. Rectification of the secondary potential.
- D. The tube current.
- E. The space charge compensation circuit.

Diagnostic

- A typical *filament* current for an extremity x-ray examination is ___ mA
- A. 5
- B. 50
- C. 250
- D. 500
- E. 5000

Diagnostic

- A typical ***filament*** current for an extremity x-ray examination is ___ mA
- A. 5
- B. 50
- C. 250
- D. 500
- E. 5000
  - Around 2 to 10 Amps or 2000 to 10000 mA.
  - However, the tube current is 1 to 5 mA for fluro
  - 200-1000 mA for radiography using short pulses.

Questions T4-–T9 refer to the following data tables for 6 MV photons. (PDD are for 100 cm SSD.)

		Field Size				
	Depth (cm)	5 × 5	10 × 10	15 × 15	20 × 20	25 × 25
PDD	3	95.3	95.8	95.4	95.6	95.6
	8	72.0	75.0	76.3	77.3	77.9
	10	64.2	67.6	69.2	70.3	71.1
	15	47.7	51.6	53.7	55.4	56.4
	20	36.7	39.2	41.5	43.4	44.5
TMR	3	0.978	0.984	0.981	0.982	0.982
	8	0.809	0.842	0.857	0.869	0.877
	10	0.745	0.784	0.804	0.818	0.828
	15	0.602	0.647	0.675	0.697	0.713
	20	0.487	0.530	0.560	0.586	0.605
Output (cGy/MU) at depth = 1.6 cm, SSD = 100 cm		0.950	1.000	1.038	1.055	1.069
Output (cGy/MU) at depth = 1.6 cm, SAD = 100 cm		0.980	1.032	1.071	1.089	1.103

Therapy

- To deliver 200 cGy to a depth of 3.0 cm in a 14 x 8 cm supraclavicular field set up at 100 cm SSD, with a small corner block (tray factor = 0.96), the MU setting is ____
- A. 235
- B. 230
- C. 224
- D. 217
- E. 210

Therapy

- To deliver 200 cGy to a depth of 3.0 cm in a 14 x 8 cm supraclavicular field set up at 100 cm SSD, with a small corner block (tray factor TF = 0.96), the MU setting is ___
- A. 235
- B. 230
- C. 224
- D. 217
  - Convert rectable to square to get PDD
  - MU= [dose/fx] / [(cGy/MU at SSD) x TF x (PDD/100)]
- E. 210

6. Equivalent Squares

It was found that for a given rectangular field, a square field could be found that was equivalent with respect to PDD (i.e. they had equal PDD). Such a square is called an equivalent square field.

Tables have been tabulated for equivalent squares. This table is called Day's table.

Table of Equivalent Squares For Rectangular Fields						
	4	10	14	20	24	30
4	4.0					
10	5.8	10.0				
14	6.3	11.6	14.0			
20	6.7	13.0	16.3	20.0		
24	6.8	13.5	17.2	21.7	24.0	
30	6.9	13.9	18.0	23.3	26.4	30.0

The equivalent square can also be approximated by the formula:

$$s = \frac{4A}{P}$$

where:

s is the side of equivalent square.

A is the area of the rectangular field (for a rectangle of sides a and b = ab).

P is the perimeter of the rectangle (for rectangle = 2(a+b)).

Therapy

- If the field in question above were set up at 100 cm SAD, with the isocenter at d=3.0 cm, the MU setting would be ___ .
- A. 230
- B. 225
- C. 212
- D. 205
- E. 202

Therapy

- If the field in question above were set up at 100 cm SAD, with the isocenter at d=3.0 cm, the MU setting would be ___ .
- A. 230
- B. 225
- C. 212
- D. 205
  - MU = dose/ [(SAD output) x TF x TMR]
- E. 202

therapy

- The maximum tissue dose in question above is ____ cGy.
- A. 200
- B. 205
- C. 209
- D. 217
- E. 225

therapy

- The maximum tissue dose in question above is ____ cGy.
- A. 200
- B. 205
- C. 209
  - Dose at 3cm
  - Dose at dmax = 200 x (100/95.8)=209 cGy
- D. 217
- E. 225

therapy

- With the isocenter at d=3 cm, as in question T5 above (isocenter set up), the dose at d=10 cm is ____ cGy.
- A. 123
- B. 139
- C. 159
- D. 182
- E. 195

therapy

- With the isocenter at d=3 cm, as in question T5 above (isocenter set up), the dose at d=10 cm is ____ cGy.
- A. 123
- B. 139
- C. 159
- D. 182
- E. 195

THerapy

- Parallel opposed lung fields, 13.0 x 17.5 cm, are treated at 100 cm SAD, d=10 cm, to a total dose of 180 cGy/fraction. The MU setting per field is ___ .
- A. 105
- B. 100
- C. 98
- D. 95
- E. 93

THerapy

- Parallel opposed lung fields, 13.0 x 17.5 cm, are treated at 100 cm SAD, d=10 cm, to a total dose of 180 cGy/fraction. The MU setting per field is ____ .
- A. 105
- B. 100
- C. 98
- D. 95
- E. 93

Therapy

- In question T8 above, if the beam energy is 6 MV, the maximum tissue dose in the treated volume will be about ___ % greater than the prescribed dose at the isocenter.
- A. 0
- B. 2
- C. 6
- D. 12
- E. 18

Therapy

- In question T8 above, if the beam energy is 6 MV, the maximum tissue dose in the treated volume will be about ___ % greater than the prescribed dose at the isocenter.
- A. 0
- B. 2
- C. 6
- D. 12
- E. 18

Therapy

- A patient is treated to the thigh with isocentric AP/PA fields using 6 MV photons. If the machine is broken and the patient has to be switched to another linac with 4 MV photons, all of the following would be expected **except**:
- A. Slightly increased skin dose.
- B. Increased dose homogeneity.
- C. Decreased depth of dmax.
- D. Increased MU

Therapy

- A patient is treated to the thigh with isocentric AP/PA fields using 6 MV photons. If the machine is broken and the patient has to be switched to another linac with 4 MV photons, all of the following would be expected **except**:
- A. Slightly increased skin dose.
- B. Increased dose homogeneity.
  - With lower energy, the dose at Dmax will increase.
- C. Decreased depth of dmax.
- D. Increased MU

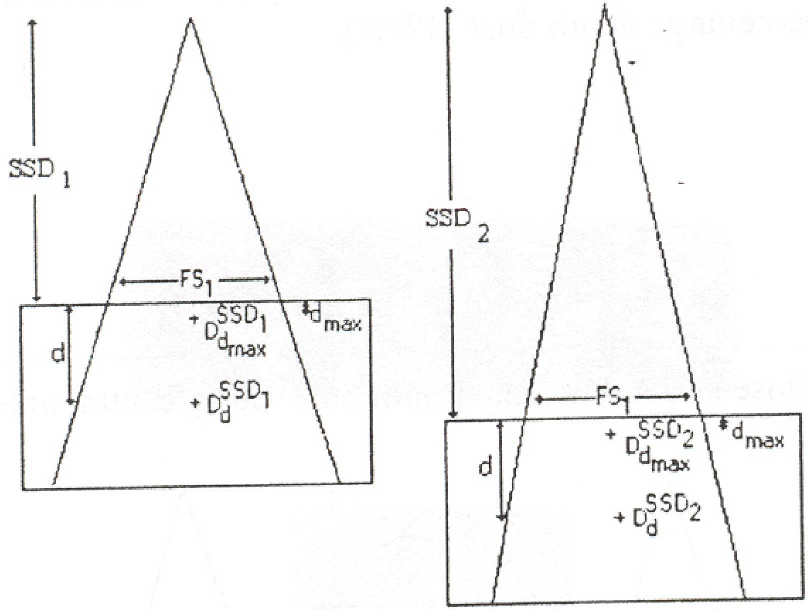
Therapy

- The factor that most influences the change in PDD with SSD is the change in:
- A. Beam energy as distance increases.
- B. Scatter in tissue.
- C. Attenuation in the patient.
- D. Inverse square.
- E. Scatter in air.

Therapy

- The factor that most influences the change in PDD with SSD is the change in:
- A. Beam energy as distance increases.
- B. Scatter in tissue.
- C. Attenuation in the patient.
- D. Inverse square.
- E. Scatter in air.

The reason for the apparent increase in PDD with increasing SSD can be seen from the following derivation: Consider the scenario where we have a water phantom positioned at SSD_1. We measure the doses at depths d and d_{max}. After these measurements, we then increase the distance from the source to the surface of the phantom to SSD_2.



Therapy

- Given a square field and an elongated rectangular field of the same *area,* which would you expect to have the greater percent depth dose for 4 MV photons?
- A. The square.
- B. The rectangle.
- C. They have the same depth dose.

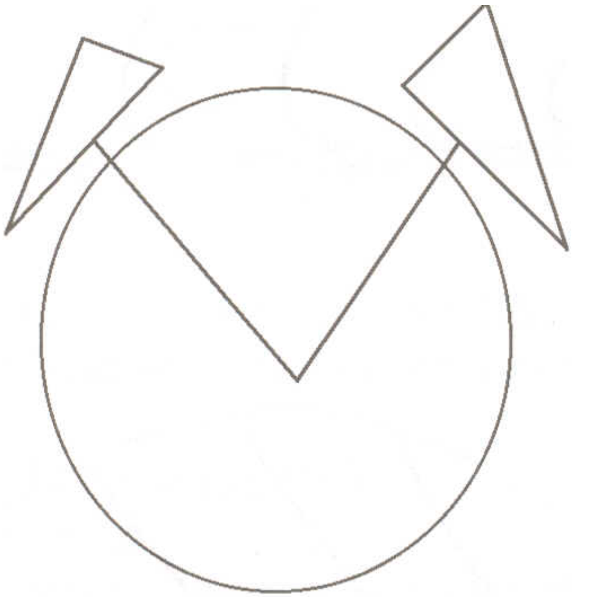
Therapy

- Given a square field and an elongated rectangular field of the same *area,* which would you expect to have the greater percent depth dose for 4 MV photons?
- A. The square.
  - While as area increaes the PDD increase.
  - But with rectangle, the corners will have to travel further to contribute to the center. Therefore Square wins.
- B. The rectangle.
- C. They have the same depth dose.

Therapy

- According to the "rule of thumb" for wedge angle vs. hinge angle, the wedge that would give the most homogeneous dose distribution in the diagram below is ___ degrees.
  - 15
  - 30
  - 45
  - 60

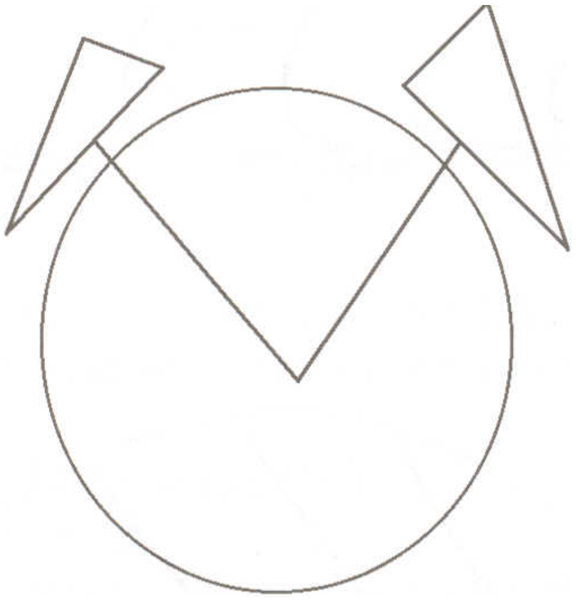
Hinge Angle = 60°



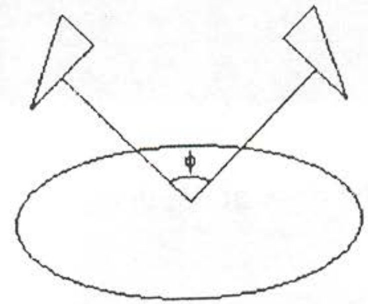
Therapy

- According to the "rule of thumb" for wedge angle vs. hinge angle, the wedge that would give the most homogeneous dose distribution in the diagram below is ___ degrees.
  - 15
  - 30
  - 45
  - 60

Hinge Angle = 60°



For a two-field technique the term hinge angle (ϕ) is used to describe the angle between two wedges.



It has been found that the optimal wedge angle (θ) can be calculated for a given hinge angle from:

$$\theta = 90^\circ - \frac{\phi}{2}$$

Thus the following hinge angles are found:

Wedge Angle θ	Hinge Angle ϕ
15°	150°
30°	120°
45°	90°
60°	60°

Note that these hinge angles assume that the wedge pair is incident on a flat phantom.

Therapy

- All of the following are advantages of a dynamic wedge over a physical wedge, **except:**
- A. Same depth dose as the open beam.
- B. Field height is not limited.
- C. Therapists do not have to lift a heavy wedge.
- D. Less dose outside the field (e.g., to contralateral breast).
- E. Wedge transmission factor is independent of field width.

Therapy

- All of the following are advantages of a dynamic wedge over a physical wedge, **except:**
- A. Same depth dose as the open beam.
- B. Field height is not limited.
- C. Therapists do not have to lift a heavy wedge.
- D. Less dose outside the field (e.g., to contralateral breast).
- E. Wedge transmission factor is independent of field width.
  - With a dynamic wedge, the wedge factor(measured on the beam axis) is a function of both the starting and ending jaw position, i.e, both field width and offset.

Therapy

- A wedge transmission factor is 0.75. The monitor unit setting is ____ times that calculated for the open beam.
- A. 0.25
- B. 0.75
- C. 1.33
- D. 1.75
- E. 2.33

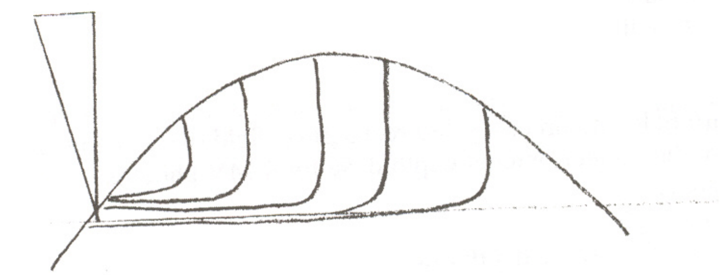
Therapy

- A wedge transmission factor is 0.75. The monitor unit setting is ____ times that calculated for the open beam.
- A. 0.25
- B. 0.75
- C. 1.33
  - MU with wedge = (MU Open)/(Transmission factor)
- D. 1.75
- E. 2.33

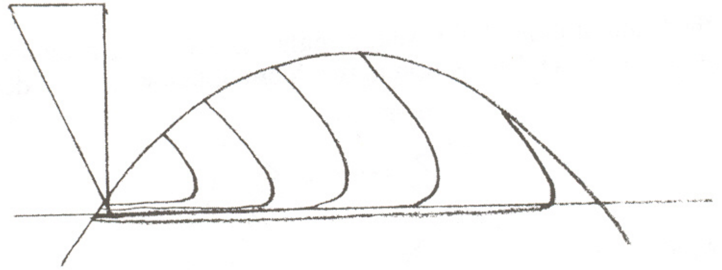
Therapy

- Which one of the wedged isodose curves shown, when combined with a similar opposed wedged field, would deliver the most homogeneous dose to the breast volume?

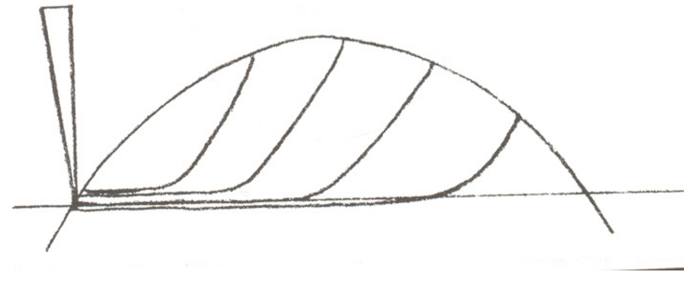
A.



B.

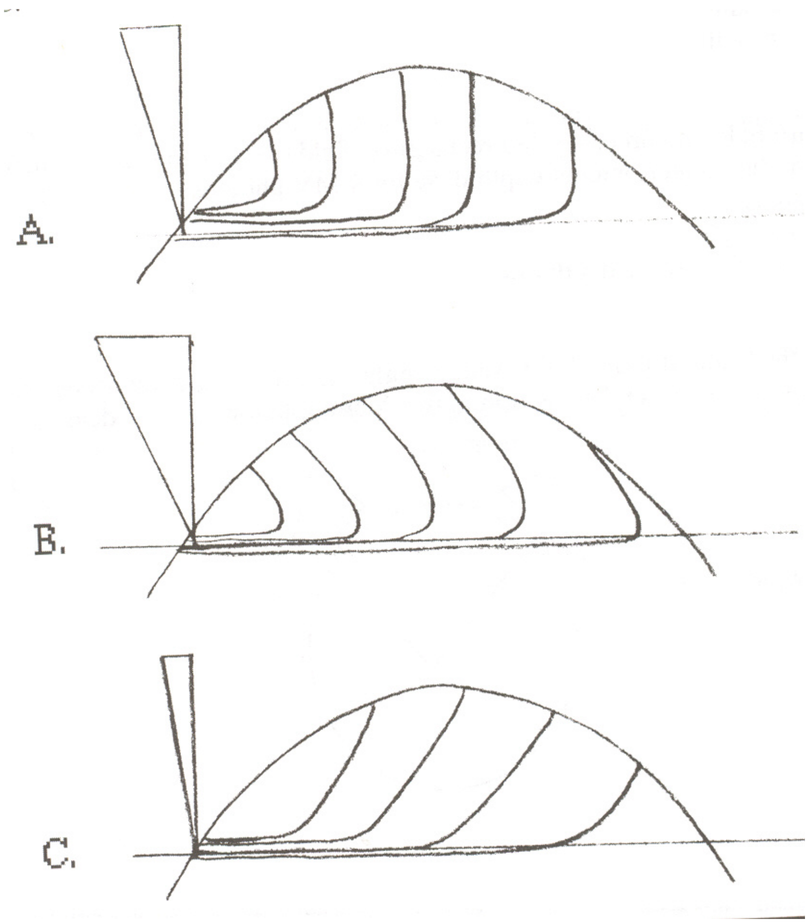


C.



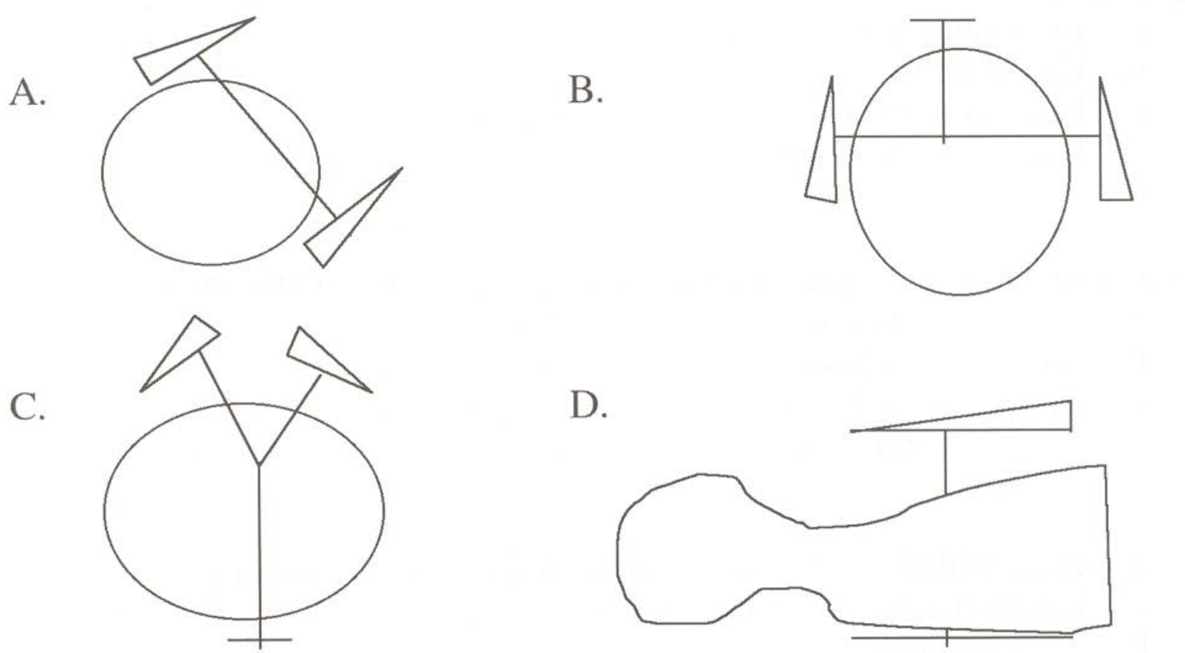
Therapy

- A: the wedges are used as missing tissue compensators.
- When parrell-opposed fields, the optimal plan is where the isodose lines become perpindicular to central axis.



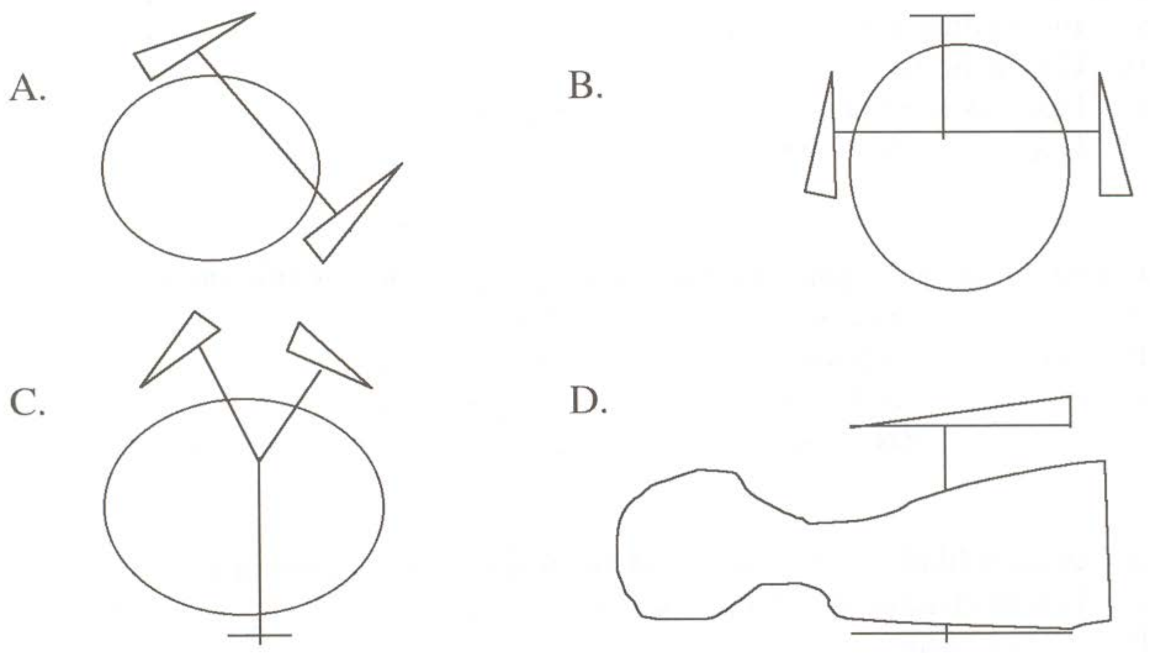
Therapy

- Which one of the following plans has the wedges in the correct orientation?



Therapy

- Which one of the following plans has the wedges in the correct orientation?
  - C: all others are reverese.



THerapy

- The purpose of a "beam spoiler" in a photon beam is to:
- A. Increase dose in the build build-up region.
- B. Reduce the PDD at 5 cm depth.
- C. Filter out scattered electrons, to reduce the skin dose.
- D. Reduce the energy of a photon beam.
- E. Increase the TMR beyond dmax.

THerapy

- The purpose of a "beam spoiler" in a photon beam is to:
- A. Increase dose in the build build-up region.
  - i.e. bring up the skin dose.
- B. Reduce the PDD at 5 cm depth.
- C. Filter out scattered electrons, to reduce the skin dose.
- D. Reduce the energy of a photon beam.
- E. Increase the TMR beyond dmax.

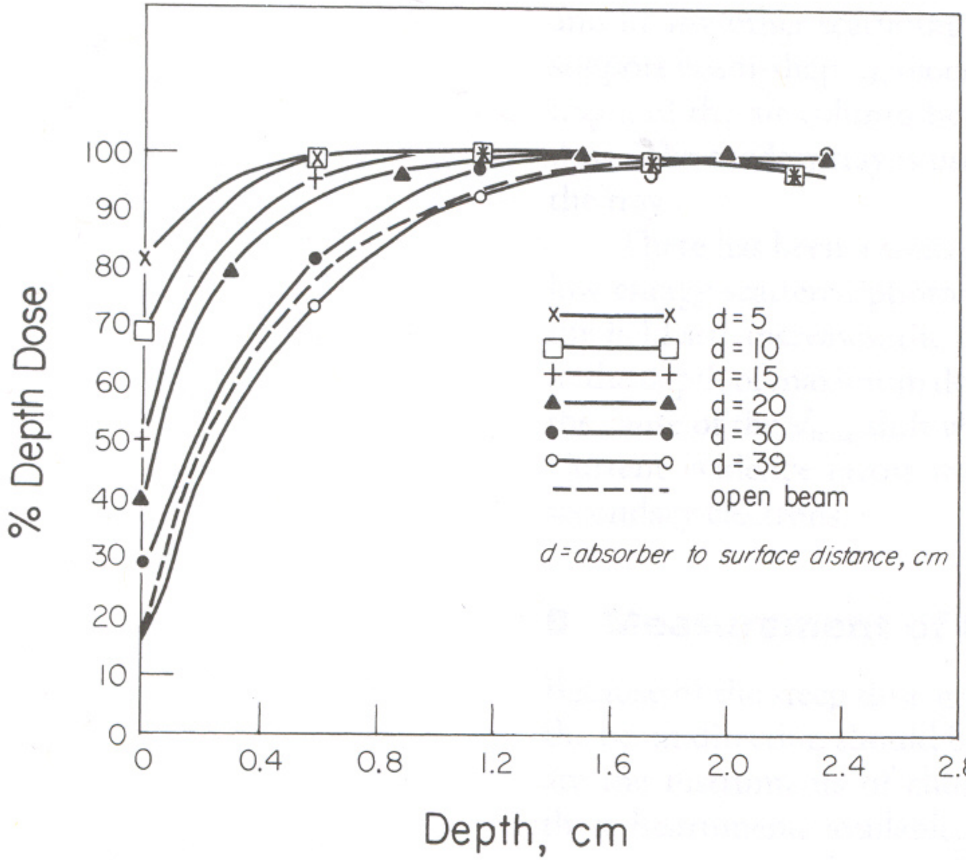
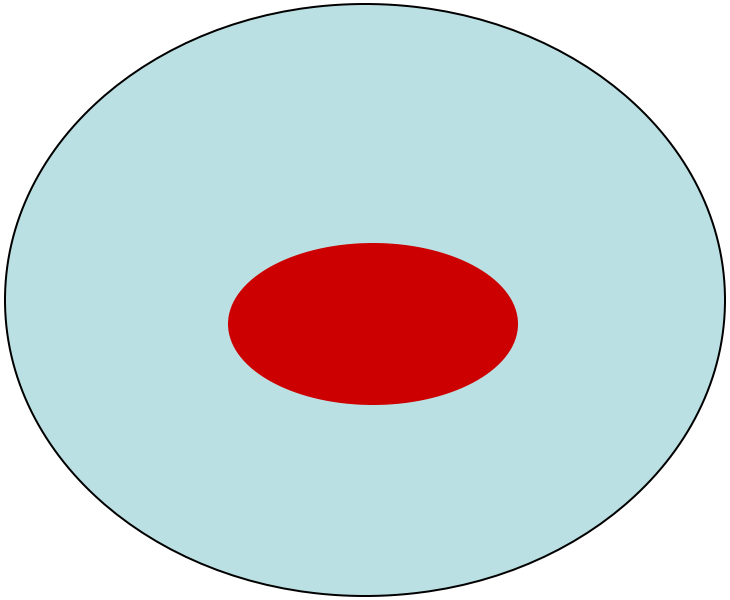


FIG. 13.6. Effect of Lucite shadow tray on dose buildup for 10-MV x-rays. Percent depth dose distribution is plotted for various tray-to-surface distances *(d)*. 10-MX x-rays, tray thickness = 1.5 g/cm^2, field size = 15 × 15 cm, SSD = 100 cm, and SDD = 50 cm. (From Khan FM, Moore VC, Levitt SH. Effect of various atomic number absorbers on skin dose for 10-MeV x-rays. *Radiology* 1973;109:209, with permission.)

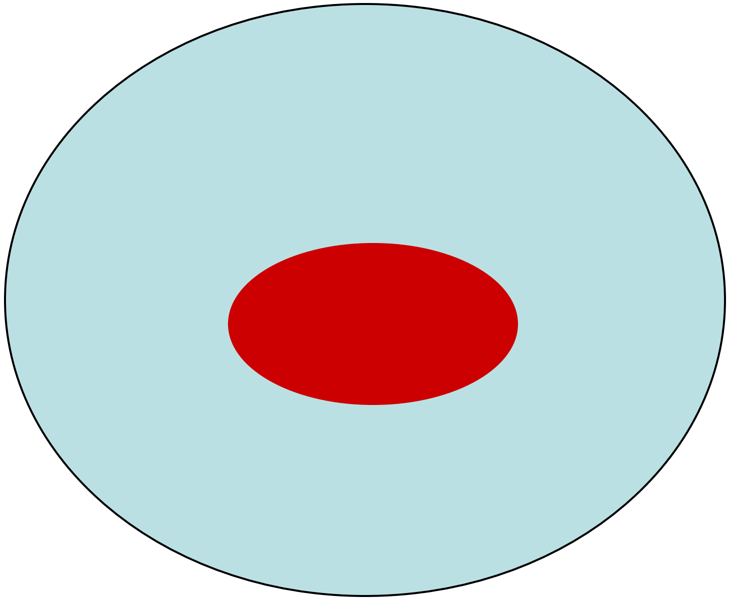
THerapy

- The PTV shown can be treated with 4-fields (AP/PA and Lats) or conventional 360 rotation. Assuming no field shaping is used, compared with the 4-field plan the rotation plan:
- A. Conforms better to the shape of the PTV.
- B. Requires fewer monitor units.
- C. Delivers a much more homogeneous dose to the PTV.
- D. Treats a larger volume of normal tissue.



THerapy

- The PTV shown can be treated with 4-fields (AP/PA and Lats) or conventional 360 rotation. Assuming no field shaping is used, compared with the 4-field plan the rotation plan:
- A. Conforms better to the shape of the PTV.
- B. Requires fewer monitor units.
- C. Delivers a much more homogeneous dose to the PTV.
- D. Treats a larger volume of normal tissue.
  - Full rotation will treat an oval-shaped volume, both one that is longer in the AP. Therefore not good here. Two lateral arcs would be better then 360 degrees



Therapy

- In a photon beam, skin dose, as a percent (%) of dose at dmax, *increases* with all of the following except:
- A. Increasing obliquity.
- B. Use of bolus.
- C. Decreased SSD.
- D. Decreasing field size

Therapy

- In a photon beam, skin dose, as a percent (%) of dose at dmax, *increases* with all of the following except:
- A. Increasing obliquity.
- B. Use of bolus.
- C. Decreased SSD.
- D. Decreasing field size
  - As field size increase, skin does increases.

Therapy

- As photon energy *increases:* surface dose ___ and depth of dmax ___
- A. increases, increases
- B. decreases, increases
- C. increases, decreases
- D. decreases, decreases

Therapy

- As photon energy *increases:* surface dose ____ and depth of dmax ____
- A. increases, increases
- B. decreases, increases
- C. increases, decreases
- D. decreases, decreases

Therapy

- Surface dose is likely to increase with all of the following except:
- A. Lower electron beam energy.
- B. Use of bolus.
- C. Use of a spoiler.
- D. Obliquity.

Therapy

- Surface dose is likely to increase with all of the following except:
- A. Lower electron beam energy.
  - Opposite of electrons
- B. Use of bolus.
- C. Use of a spoiler.
- D. Obliquity.

Therapy

- In a *single isocenter* 4-field breast plan (i.e., using half-blocked fields for the tangents, supraclav, post axilla) the tangents are given a collimator rotation of 10° degrees to align with the chest wall. In order to match the supraclav field to the tangents, without creating a cold area at the match, the supraclav field requires a_.
- A. a couch rotation of 90° and a gantry rotation of 10°.
- B. a gantry rotation of 10° only.
- C. a gantry rotation of 350° only.
- D. a gantry angle of 0°, with light field edges matched on the skin.
- E. a collimator rotation of 10 and a gantry angle of 0°.

Therapy

- In a *single isocenter* 4-field breast plan (i.e., using half-blocked fields for the tangents, supraclav, post axilla) the tangents are given a collimator rotation of 10° degrees to align with the chest wall. In order to match the supraclav field to the tangents, without creating a cold area at the match, the supraclav field requires a___.
- A. a couch rotation of 90° and a gantry rotation of 10°.
  - ? If gantry rotation is to come off the throat?
- B. a gantry rotation of 10° only.
- C. a gantry rotation of 350° only.
- D. a gantry angle of 0°, with light field edges matched on the skin.
  - Will result in a cold triangle at depth.
- E. a collimator rotation of 10 and a gantry angle of 0°.

Therapy

- Adjacent single direct fields of heights 25 cm and 28 cm are matched at 6.0 cm depth. The gap to be left on the skin between the light field edges is - cm.
- A. 0.8
- B. 1.0
- C. 1.6
  - But ?
- D. 2.4
- E. 3.2

Therapy

- Adjacent single direct fields of heights 25 cm and 28 cm are matched at 6.0 cm depth. The gap to be left on the skin between the light field edges is __ cm.
- A. 0.8
- B. 1.0
- C. 1.6
- D. 2.4
- E. 3.2

Therapy

- The collimator rotation required to align 25 x 25 cm cranial fields with a direct spinal axis field of height 36 cm is ___ degrees.
- A. 3.5
- B. 5
- C. 7
- D. 10
  - Theta of coll = arctan(0.5 x L1 x 1/SSD); SSD = 100
- E. 17

Therapy

- A possible *disadvantage* of using parallel parallel-opposed 18 MV photons for treating a volume which includes superficial nodes is:
- A. Increased skin dose.
- B. Higher total dose at <1max.
- C. Insufficient dose in the build-up region.
- D. Higher dose rate.

Therapy

- A possible *disadvantage* of using parallel parallel-opposed 18 MV photons for treating a volume which includes superficial nodes is:
- A. Increased skin dose.
- B. Higher total dose at <1max.
- C. Insufficient dose in the build-up region.
- D. Higher dose rate.

Therapy

- All of the following are true regarding 10MV photons except:
- A. Penumbra is sharper than for 4 MV beam.
- B. The depth of dmax is approx. 2.0 cm.
- e. Attenuation is approx. 2.5% per cm.
- D. The PDD for a 10 x 10 cm beam at 10 cm depth is 74%.

Therapy

- All of the following are true regarding 10MV photons except:
- A. Penumbra is sharper than for 4 MV beam.
  - Pneumbra is sharper for lower engergy photon, i.e. why use for radiosurg?
- B. The depth of dmax is approx. 2.0 cm.
  - Thought 3cm, but I guess close enough
- e. Attenuation is approx. 2.5% per cm.
- D. The PDD for a 10 x 10 cm beam at 10 cm depth is 74%.

THerapy

- A patient's whole brain is treated isocentrically to 3000 cGy using 6 MV photons. If the calculation was done using 8.5 cm depth, but the patient's separation was in fact 15.0 cm, the dose received was about ___ cGy.
- A. 2700 B. 2970 C. 3030 D. 3090 E. 3300

THerapy

- A patient's whole brain is treated isocentrically to 3000 cGy using 6 MV photons. If the calculation was done using 8.5 cm depth, but the patient's separation was in fact 15.0 cm, the dose received was about ____ cGy.
- A. 2700 B. 2970 C. 3030 D. 3090 E. 3300
- Over by 1.5cm

Therapy

- Flattening filters in photon beams are designed to optimally flatten the beam at ____ cm depth.
- A. <dmax
- B. 5
- C. 10
- D. 20

Therapy

- Flattening filters in photon beams are designed to optimally flatten the beam at ____ cm depth.
- A. <dmax
- B. 5
- C. 10
- D. 20
  - Flattening filters cannot flatten the beam equally at all depths and tend to over flatten at dmax, and underflatten a d20.

Therapy

- The depth of dmax for an 18 MV photon beam is 3.5 cm. For parallel parallel-opposed
- 15 x 15 cm fields, with a separation of 20 cm, the *minimum* depth at which 95 % of the midplane dose occurs is ___ cm.
- A. 3.4 B. 3.0 C. 1.5 D. 0.5 E. 0.2

Therapy

- The depth of dmax for an 18 MV photon beam is 3.5 cm. For parallel parallel-opposed
- 15 x 15 cm fields, with a separation of 20 cm, the *minimum* depth at which 95 % of the mid-plane dose occurs is ___ cm.
- A. 3.4 B. 3.0 C. 1.5 D. 0.5 E. 0.2
  - The depth which 95% of the midplane occurs for parallel-opposed high engery beams is actually much less then dmax.

Therapy

- A photon field is calculated for treatment at 100 cm SSD. Due to an error in the ODI (optical distance indicator) the treatment is delivered at 98.8 cm SSD. The dose received by the patient at dmax is ___ .
- A. 3.6% low
- B. 2.4% low
- C. 1.2% low
- D. 1.2% high
- E. 2.4% high.
  - Due to inverse square law, (100/98.8)^2

Therapy

- For superficial x-ray units, increasing all of the following will increase the PDD except:
  A. Additional filtration.
- B. Field size.
- C. SSD.
- D. kVp.
- E. mA.

Therapy

- For superficial x-ray units, increasing all of the following will increase the PDD except:
  A. Additional filtration.
- B. Field size.
- C. SSD.
- D. kVp.
- E. mA.
  - Affect dose rate, not affect on energy or PDD.

Therapy

- Superficial x-rays, compared with 6 MeV electrons, ___.
- A. Have a lower skin dose.
- B. Deliver less dose to underlying tissues.
- C. Require thicker shielding.
- D. Have a sharper penumbra.

Therapy

- Superficial x-rays, compared with 6 MeV electrons, ____.
- A. Have a lower skin dose.
- B. Deliver less dose to underlying tissues.
- C. Require thicker shielding.
- D. Have a sharper penumbra.

Therapy

- Which of the following is **not true** for CT images of the torso used directly for computerized treatment planning?
- A. The patient must be scanned in the treatment position.
- B. A flat insert is required for the CT table.
- C. The CT image is a gray scale representation of the relative linear attenuation coefficient of each pixel.
- D. CT numbers must be converted into electron densities before pixel-by-pixel inhomogeneity corrections can be made.
- E. Triangulation points or surface marks are unnecessary since the isocenter can be related to internal organs.

Therapy

- Which of the following is **not true** for CT images of the torso used directly for computerized treatment planning?
- A. The patient must be scanned in the treatment position.
- B. A flat insert is required for the CT table.
- C. The CT image is a gray scale representation of the relative linear attenuation coefficient of each pixel.
- D. CT numbers must be converted into electron densities before pixel-by-pixel inhomogeneity corrections can be made.
- E. Triangulation points or surface marks are unnecessary since the isocenter can be related to internal organs.
  - Cyberknife?

Therapy

- Which of the following lists tissues in order of increasing Hounsfield (CT) number?
- A. Bone, muscle, fat, lung.
- B. Lung, fat, muscle, bone.
- C. Lung, muscle, fat, bone.
- D. Fat, lung, muscle, bone.
- E. Bone, fat, muscle, lung.

Therapy

- Which of the following lists tissues in order of increasing Hounsfield (CT) number?
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- D. Fat, lung, muscle, bone.
- E. Bone, fat, muscle, lung.

THerapy

- Triangulation points tattooed on the skin are used to reproduce a patient's position daily. These tattoos are likely to be *most* reliable for treating ___ .
- A. Glioma
- B. Prostate
- C. Breast
- D. Lung

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- Triangulation points tattooed on the skin are used to reproduce a patient's position daily. These tattoos are likely to be *most* reliable for treating ___ .
- A. Glioma
- B. Prostate
- C. Breast
- D. Lung

THerapy

- Heterogeneity corrections are greatest for ___ .
- A. 10 cm lung, and 6 MV photons
- B. 10 cm lung, and 18 MV photons
- C. 3 Cm bone, and 6 MV photons
- 0. 3 Cm bone and 10 MV photons

THerapy

- Heterogeneity corrections are greatest for ___ .
- A. 10 cm lung, and 6 MV photons
  - In lower energy beam, the attenuation per cm is greater, so the difference between soft tissue and lung will be greatest.
  - Lung vs. bone, lung has greater impact, secondary to path.
- B. 10 cm lung, and 18 MV photons
- C. 3 Cm bone, and 6 MV photons
- 0. 3 Cm bone and 10 MV photons

Therapy

- The dose under a 1.5 cm width cord block (5 HVL thickness) in a 6 MV photon beam at 5 cm depth is approximately ___ % of the dose in the open beam.
- A. 3
- B. 7
- C. 15
- D. 25
- E. 50

Therapy

- The dose under a 1.5 cm width cord block (5 HVL thickness) in a 6 MV photon beam at 5 cm depth is approximately ____ % of the dose in the open beam.
- A. 3
  - 5 HVL is equal to 3% transmission
- B. 7
- C. 15
- D. 25
- E. 50

Therapy

- In an irregular field calculation, the increase in MU setting to account for blocking will be greatest for:
- A. 10 MV photons, at a depth of dmax
- B. 4 MV photons, at a depth of dmax.
- C. 10 MV photons, at a depth of 10 cm.
- D. 4 MV photons, at a depth of 10 cm.
- E. 4 MV photons, at a depth of 5 cm.

Therapy

- In an irregular field calculation, the increase in MU setting to account for blocking will be greatest for:
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- B. 4 MV photons, at a depth of dmax.
- C. 10 MV photons, at a depth of 10 cm.
- D. 4 MV photons, at a depth of 10 cm.
- E. 4 MV photons, at a depth of 5 cm.

Therapy

- A film with a magnification of 1.4 has a block drawn on it that measures 3.5 cm on the film. The actual size of this block on a tray at 65 cm, and the projected size on the patient's skin at 100 cm SSD are ___ cm and ___ cm, respectively.
- A. 0.75, 0.85
- B. 1.1, 2.5
- C. 1.3, 1.8
- D. 1.6, 2.5
- E. 2.5, 3.1

Therapy

- A film with a magnification of 1.4 has a block drawn on it that measures 3.5 cm on the film. The actual size of this block on a tray at 65 cm, and the projected size on the patient's skin at 100 cm SSD are ___ cm and ___ cm, respectively.
- A. 0.75, 0.85
- B. 1.1, 2.5
- C. 1.3, 1.8
- D. 1.6, 2.5
  - Use similar triangle geometry
- E. 2.5, 3.1

Therapy

- At what SSD will the maximum field size of 40 cm diverge to 56 cm?
- A. 196 cm
- B. 156 cm
- C. 140 cm
- D. 128 cm
- E. 116 cm.

Therapy

- At what SSD will the maximum field size of 40 cm diverge to 56 cm?
- A. 196 cm
- B. 156 cm
- C. 140 cm
- D. 128 cm
- E. 116 cm.

Therapy

- On an 80 cm SAD 60 CO unit, a 15 x 15 cm isocentric field set up at 10 cm depth measures __ cm on the skin.
- A. 13.1
- B. 13.5
- C. 14.1
- D. 14.6

Therapy

- On an 80 cm SAD 60 CO unit, a 15 x 15 cm isocentric field set up at 10 cm depth measures __ cm on the skin.
- A. 13.1
  - By similar triagles
- B. 13.5
- C. 14.1
- D. 14.6

Therapy

- The *approximate* maximum dose to a patient's contralateral breast from tangential breast fields delivering a total dose of 5000 cGy is of the order of:
- A. 2500 cGy.
- B. 250 cGy.
- C. 25 cGy.
- D. 5 cGy.
- E. Negligible.

Therapy

- The *approximate* maximum dose to a patient's contralateral breast from tangential breast fields delivering a total dose of 5000 cGy is of the order of:
- A. 2500 cGy.
- B. 250 cGy.
  - Each field contributes about 2.5% of dose
    - Lateral field contributes internal scatter
    - The medial field contributes dose from the wedge.
    - IF a dynamic wedge is used, this will reduce the dose to the contralateral breast by almost one half.
- C. 25 cGy.
- D. 5 cGy.
- E. Negligible.

Therapy

- The component of dose to the fetus of a pregnant patient undergoing radiotherapy that *cannot* be modified by additional custom shielding is ___:
- A. Head leakage.
- B. Collimator scatter.
- C. Internal scatter.
- D. Scatter from blocks and blocking tray

Therapy

- The component of dose to the fetus of a pregnant patient undergoing radiotherapy that *cannot* be modified by additional custom shielding is ___:
- A. Head leakage.
- B. Collimator scatter.
- C. Internal scatter.
  - The other dose contributions vary with distance from the field edge and somewhat with field size, energy, and depth.
  - Photons below 10 MeV should be used to minimize Neutrons.
- D. Scatter from blocks and blocking tray

Therapy

- A TBI patient is treated at 400 cm SSD. If the linac is calibrated to deliver 1.0 cGy/MU at dmax, 100 cm SSD, approximately how many MU are required to deliver 100 cGy from one field at dmax to the TBI patient?
- A. 4000
- B. 1600
- C. 800
- D. 400
- E. 200

Therapy

- A TBI patient is treated at 400 cm SSD. If the linac is calibrated to deliver 1.0 cGy/MU at dmax, 100 cm SSD, approximately how many MU are required to deliver 100 cGy from one field at dmax to the TBI patient?
- A. 4000
- B. 1600
  - Using the inverse square law, the MU will be : 100 x (400/100)^2 = 1600 MU
- C. 800
- D. 400
- E. 200

Therapy

- All of the following will improve dose homogeneity for TBI except:
- A. Using the highest photon beam energy available together with a beam spoiler.
- B. Using AP and PA beams instead of opposed laterals.
- C. Using tissue compensators for the extremities.
- D. Using the shortest SAD consistent with adequate field size at the patient.
- E. Adding compensating material over the lung area.

Therapy

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- C. Using tissue compensators for the extremities.
- D. Using the shortest SAD consistent with adequate field size at the patient.
  - As SAD increases, the PDD increase, thus increasing the dose homogeneity for parallel-opposed fields.
- E. Adding compensating material over the lung area.

Therapy

- For stereotactic radiosurgery, accuracy and reproducibility should generally be on the order of __ mm.
- A. 7
- B. 5
- C. 2
- D. 0.5

Therapy

- For stereotactic radiosurgery, accuracy and reproducibility should generally be on the order of __ mm.
- A. 7
- B. 5
- C. 2
- D. 0.5

Therapy

- The gamma knife could be incorporated into the treatment of all of the following sites except:
- A. Certain patients with two brain mets, each measuring 2.0 cm in diameter.
- B. A 1.5 cm intra-auricular accoustic neuroma.
- C. A newly diagnosed GBM measuring 5 cm.
- D. A 1.0 cm surgically inaccessible arteriovenous malformation.

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Therapy

- Advantages of a multi-leaf collimator over cerrobend blocks for field shaping include all of the following, except:
- A. Decreased time to generate field shaping.
- B. Adjustments to field shaping are faster.
- C. Faster set-up (no tray to attach to head of machine).
- D. More conformal.

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Therapy

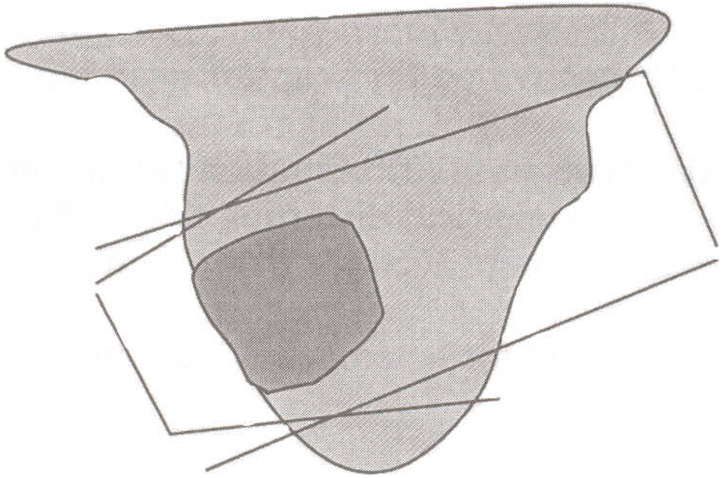
- Which one of the following is *required* for generating a conformal treatment plan?
- A. GTV
- B. CTV
- C. PTV
- D. Internal margin
- E. Set-up error.

Therapy

- Which one of the following is *required* for generating a conformal treatment plan?
- A. GTV
- B. CTV
- C. PTV
  - What is used for the plan
- D. Internal margin
- E. Set-up error.

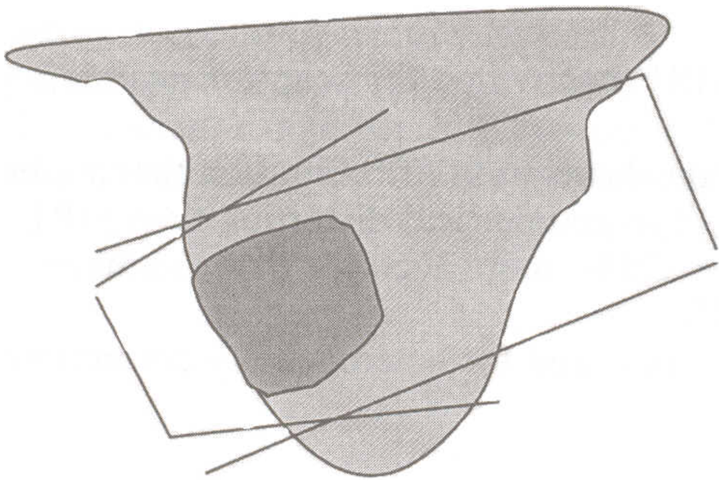
Therapy

- A lumpectomy site in the breast is treated with parallel parallel-opposed 6 MV photon fields, as shown to the right . On the DVH, 10% of the PTV receives less than 90% of the prescribed dose. The most probable reason for this is:
- A. The field arrangement and choice of angles could be improved.
- B. The fields are not wide enough to cover the PTV
- C. The beam energy is too low.
- D. The PTV is drawn up to the skin, and includes the build-up region.



Therapy

- A lumpectomy site in the breast is treated with parallel parallel-opposed 6 MV photon fields, as shown to the right . On the DVH, 10% of the PTV receives less than 90% of the prescribed dose. The most probable reason for this is:
- D. The PTV is drawn up to the skin, and includes the build-up region.
  - If the PTV really extends to the skin, a lower energy, and possibly bolus, would be needed to give adequate coverage.
  - For a DVH to be meaningful, the PTV needs to be carefully drawn to include only the tissue that needs to be treated to full dose.
  - A PTV drawn up to the skin will always include a lower dose region of build-up, the size of which will increase with increasing photon energy.



Therapy

- A radiotherapy department has a choice of 6, 10, and 18 MV photons. For IMRT prostate plans, __ MV photons are chosen, because:
- A. 6, this delivers the most homogeneous dose to the PTV.
- B. 10, this delivers a lower neutron dose than 18 MV, but acceptable dose to normal tissues.
- C. 18, this delivers the lowest neutron dose and the lowest normal tissue dose outside the PTV.
- D. 10, although this delivers the highest neutron dose, it gives the best dose distribution, and the neutron dose is clinically acceptable.

Therapy

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- A. 6, this delivers the most homogeneous dose to the PTV.
- B. 10, this delivers a lower neutron dose than 18 MV, but acceptable dose to normal tissues.
  - IMRT plans can require 3-5 times the MU for a conventional plan, so the neutron leakage is a consideration.
    - At 18 MV, the neutron leakage is 0.15%,vs. 0.04% for 10 MV.
    - However, higher photon energy will deliver less dose to normal tissue outside of the PTV.
  - Therefore 10 MV is a good compromise of a good dose distribution and a low neutron dose.
- C. 18, this delivers the lowest neutron dose and the lowest normal tissue dose outside the PTV.
- D. 10, although this delivers the highest neutron dose, it gives the best dose distribution, and the neutron dose is clinically acceptable.

Therapy

- Potential advantages of IMRT include all of the following except:
- A. Dose conformity for irregularly shaped volumes.
- B. The possibility of dose escalation.
- C. Reduced normal tissue morbidity at conventional doses.
- D. Ability to treat a volume with a concave surface, conformally.
- E. Simpler verification of dose calculation and delivery.

Therapy

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Therapy

- In IMRT inverse planning for treatment with the "step and shoot" technique, all of the following are specified by the human planner (i.e., not by the computer), except:
- A. Beam angles.
- B. Number of beams.
- C. Beam weights.
- D. Dose constraints for contoured volumes.
- E. PTV contour on CT images.

Therapy

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Therapy

- Reasons for fusing an MRI scan with a CT scan for treatment planning brain tumors include all of the following except:
- A. Some brain lesions have areas of infiltration that are better visualized on MRI .
- B. CT is less subject to geometrical distortion than MRI.
- C. Image fusion should be more accurate than estimating contours on CT using a hard copy of the MRI.
- D. The CT image is required for heterogeneity corrections.

Therapy

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- C. Image fusion should be more accurate than estimating contours on CT using a hard copy of the MRI.
- D. The CT image is required for heterogeneity corrections.
  - But not an issue in partial brain plans since the thickness of the skull does not make that much difference.
    - But I thought flickenger said it did.

Therapy

- All of the following are true regarding PET used in treatment planning, except:
- A. PET/CT can aid in treatment target definition.
- B. PET images can show areas of metabolic activity.
- C. ^{18}F, a cyclotron produced positron emitter, is used in most PET studies.
- D. Registration of PET and CT images can be a problem, which the combined PET/CT unit is designed to solve.
- E. An advantage of the combined PET ICT unit is that it makes gating unnecessary.

Therapy

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Therapy

- Orthogonal films of a gynecological applicator are required for dosimetry planning. AP and lateral films are taken, but the lateral film has very poor contrast. All of the following solutions may provide films with acceptable contrast except:
- A. Retake lateral, reducing the collimator setting to the minimum area possible.
- B. Retake lateral using a higher ratio grid.
- C. Retake lateral with increased mAs.
- D. Take orthogonals at 45° and 315° instead of 0° and 90°.

Therapy

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- A. Retake lateral, reducing the collimator setting to the minimum area possible.
- B. Retake lateral using a higher ratio grid.
- C. Retake lateral with increased mAs
  - Has no effect on contrast.
  - Contrast is improved by reducing scatter.
- D. Take orthogonals at 45° and 315° instead of 0° and 90°.

Therapy

- Proton beam therapy has a potential advantage over photon beam therapy because:
- A. Monoenergetic protons have an ideal depth dose distribution for treating deep-seated tumors such as the prostate.
- B. Protons have an exponential depth dose similar to that of neutrons.
- C. Protons have a lower RBE, and hence are less damaging to normal tissue.
- D. Protons exhibit a sharp fall-off in dose beyond the PTV, which spares normal tissue.

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Therapy

- A 10 x 10 cm 9 Me V electron field has the 90% depth dose at approximately __ cm depth.
- A. 2.1
- B. 2.7
- C. 3.6
- D. 4.5
- E. 9.0

Therapy

- A 10 x 10 cm 9 Me V electron field has the 90% depth dose at approximately __ cm depth.
- A. 2.1
- B. 2.7
  - E/3 cm
- C. 3.6
- D. 4.5
- E. 9.0

Therapy

- To ensure adequate coverage of the treatment volume with an electron beam, it is important to remember that:
- A. All isodose curves decrease in width with depth.
- B. All isodose curves increase in width with depth.
- C. The 90% isodose increases and the 20% isodose decreases in width with depth.
- D. The 90% isodose decreases and the 20% isodose increases in width with depth.

Therapy

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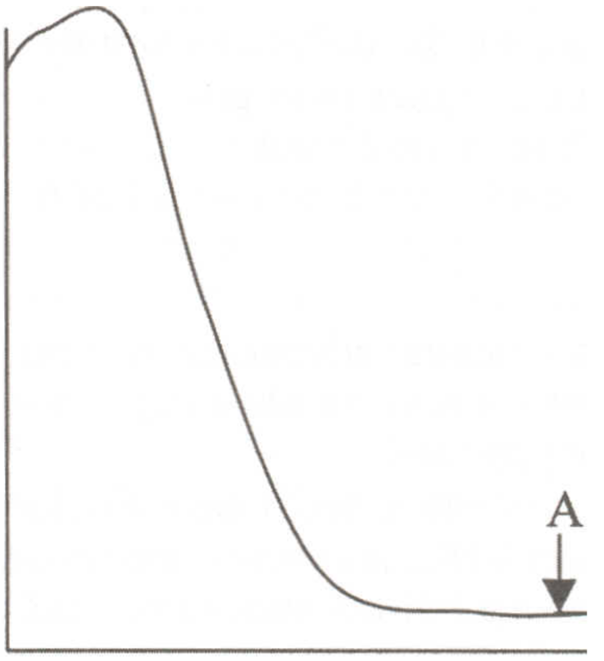
- D. The 90% isodose decreases and the 20% isodose increases in width with depth.

Therapy

- The part of the electron depth dose curve labeled A on the diagram is mainly due to:
- A. Electrons with the highest energy which have the greatest range.
- B. Bremsstrahlung x-rays created by electron interactions with tissue.
- C. Characteristic x-rays generated by electrons striking the collimators.
- D. Bremsstrahlung x-rays created by electron interactions with high Z components in the head.



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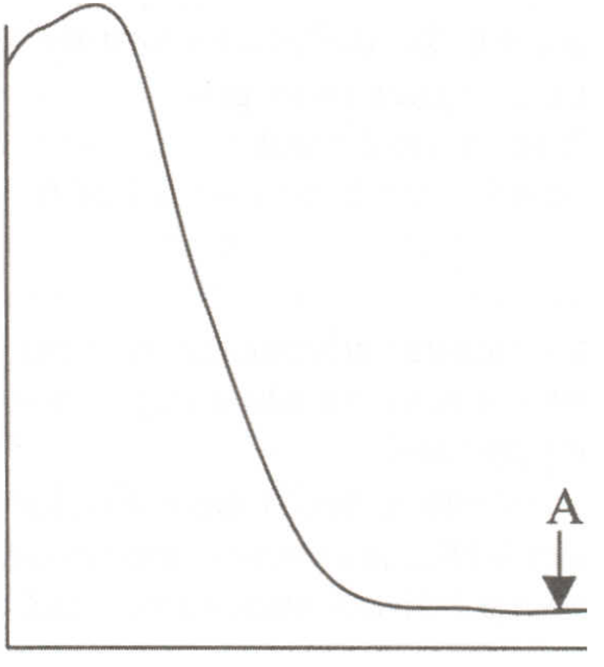
- C. Characteristic x-rays generated by electrons striking the collimators.
- D. Bremsstrahlung x-rays created by electron interactions with high Z components in the head.
  - The tail increases with increasing energy, but is usually between 2% and 5%.
  - From interaction with the high Z compents of the head of the linac.



Therapy

- A cervical neck node is to receive a boost with 16 MeV electrons using a 3.0 cm circular cut-out in a 6 x 6 cm cone. This field must be treated at 115 cm SSD to avoid the shoulder. All of the following are true, except:
- A. The electron output (cGy/MU) is reduced compared to an open 6 x 6 cm cone.
- B. The penumbra width will increase, compared to that at 100 cm SSD.
- C. The depth of the 90% isodose will be less than that of the open 6 x 6 cm cone.
- D. The output at 115 cm SSD will be (100/115)2 times that at 100 cm SSD.

Therapy

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- C. The depth of the 90% isodose will be less than that of the open 6 x 6 cm cone.
- D. The output at 115 cm SSD will be (100/115)2 times that at 100 cm SSD.
  - For electrons, output can be corrected by the inverse square law only when the virtual SSD is not used in the equation.
  - For very small inserts, it is best to measure the output for the actual cut-out and SSD to be used.

Therapy

- The output for an electron cone is 1.02 cGy/MU The MU required to deliver 200 cGy to the 95% isodose level is - MU
- A. 196
- B. 206
- C. 218
- D. 222
- E. 235

Therapy

- The output for an electron cone is 1.02 cGy/MU The MU required to deliver 200 cGy to the 95% isodose level is - MU
- A. 196
- B. 206
  - MU = dose per fraction / [output x (PDD/100)]
    - = 200/[1.02 x 0.95]=206
- C. 218
- D. 222
- E. 235

Therapy

Depth (cm)	0	0.5	1.2	1.5	1.7	2.0	2.3	4.0
PDD	77	95	100	97	90	70	50	3

- A chest wall of thickness 1.2 cm overlies lung of density 0.33 g cm-3. If 0.5 cm of bolus is placed on the skin, use the 6 MeV electron depth dose table below to estimate the *approximate depth in lung* of the 50% isodose.
- A. 0.3
- B. 0.6
- C. 0.9
- D. 1.8
- E. 2.9

Therapy

Depth (cm)	0	0.5	1.2	1.5	1.7	2.0	2.3	4.0
PDD	77	95	100	97	90	70	50	3

- A chest wall of thickness 1.2 cm overlies lung of density 0.33 g cm-3. If 0.5 cm of bolus is placed on the skin, use the 6 MeV electron depth dose table below to estimate the *approximate depth in lung* of the 50% isodose.
- A. 0.3
- B. 0.6
- C. 0.9
- D. 1.8
  - The chest wall is a a depth of 1.7 cm (1.2 + 0.5 cm). If the lung were unit density, the 50% line would be at a total depth of 2.3 cm or 0.6 cm in the lung.
  - However, the lung has a density of 0.33 times that of soft tissue, so the isodoses beyond the CW are at an increased depth.
  - A good approximation is to scale the depth of the isodose in lung by 1/(electon density), in this case 0.6/0.33 =1.8 cm.
- E. 2.9

Therapy

- A batch of 125-I seeds is ordered for a prostate implant. On arrival, the activity is 0.455 mCi/seed. The activity will be 0.420 mCi/seed after __ days.
- A. 14
- B. 10
- C. 7
- D. 5
- E. 2

Therapy

- A batch of 125-I seeds is ordered for a prostate implant. On arrival, the activity is 0.455 mCi/seed. The activity will be 0.420 mCi/seed after __ days.
- A. 14
- B. 10
- C. 7
  - A_t/A_o = 0.420/0.455=exp[-(0.693 x t / 60).
- D. 5
- E. 2

Therapy

- The dose rate in cGy/hr in air at 1 m from a radioactive source is closest numerically to the source strength expressed in units of:
- A. mCi.
- B. Ci.
- C. GBq.
- D. Air Kerma Strength.
- E. mg Ra equivalent

Therapy

- The dose rate in cGy/hr in air at 1 m from a radioactive source is closest numerically to the source strength expressed in units of:
- A. mCi.
  - Related to the number of disintrigrations/second of the source.
- B. Ci.
  - Related to the number of disintrigrations/second of the source.
- C. GBq.
  - Related to the number of disintrigrations/second of the source.
- D. Air Kerma Strength.
  - Has the units of dose rate or μGym^2h^{-1} or Gym^2h^{-1} or cGy/hr at 1 m.
- E. mg Ra equivalent

Therapy

- The exposure rate constant is:
- A. 0.957 for all photon-emitting radionuclides.
- B. The dose rate in tissue at 1 m from a point source.
- C. 8.25 R-cm2/mCi-hr for 1 mg Ra equivalent of any radionuclide.
- D. The value that must be entered under "Transport Index" for mailed packages.

Therapy

- The exposure rate constant is:
- A. 0.957 for all photon-emitting radionuclides.
- B. The dose rate in tissue at 1 m from a point source.
- C. 8.25 R-cm2/mCi-hr for 1 mg Ra equivalent of any radionuclide.
  - The exposure rate constant is different for each radionuclide, and is the exposure rate for a given activity at a given distance, usually per mCi at 1 cm, or per Ci at 1 m.
  - One “mg Ra equivalent” is the quantity of a radionuclide which has the same exposure at 1 cm as 1 mg radium.
- D. The value that must be entered under "Transport Index" for mailed packages.

Therapy

- For a Fletcher applicator with loading of 15-10-10 mg-Ra equ in the tandem and 15 mg-Ra equ in each ovoid, a lateral displacement of 0.2 cm in the location of point A would cause about a ___% change in the dose rate at that point.
- A. 0.1
- B. 1
- C. 2
- D. 10
- E. 30

Therapy

- For a Fletcher applicator with loading of 15-10-10 mg-Ra equ in the tandem and 15 mg-Ra equ in each ovoid, a lateral displacement of 0.2 cm in the location of point A would cause about a ___% change in the dose rate at that point.
- A. 0.1
- B. 1
- C. 2
- D. 10
  - Calculate using inverse square law.
  - (2/2.2)^2=0.83 or 17%.
  - This would be correct if all sources were 2.0 cm from point A. However since most sources are more then 2 cm away, the answer is less.
- E. 30

Therapy

- A patient has a temporary implant containing 20 mCi of 192-Ir. (Γ = 4.6 R-cm2/mCi-hr). The exposure rate at 2.5m from the sources is ___ mR/hr.
- A. 5.5
- B. 3.2
- C. 1.5
- D. 0.5
- E. 0.05

Therapy

- A patient has a temporary implant containing 20 mCi of 192-Ir. (Γ = 4.6 R-cm2/mCi-hr). The exposure rate at 2.5m from the sources is ___ mR/hr.
- A. 5.5
- B. 3.2
- C. 1.5
  - Exposure rate = Γ x A/r^2 = 4.6 x 20 / $(250)^2$ = 0.00147 R/hr
- D. 0.5
- E. 0.05

Therapy

- A permanent implant has a half-life of 17 days. After 51 days, ___ times the initial activity remains, and ___ % of the total dose has been delivered.
- A. 0.125, 87.5
- B. 0.25, 75.0
- C. 0.125, 12.5
- D. 0.875, 87.5
- E. 0.25, 25.0

Therapy

- A permanent implant has a half-life of 17 days. After 51 days, ___ times the initial activity remains, and ___ % of the total dose has been delivered.
- A. 0.125, 87.5
- B. 0.25, 75.0
- C. 0.125, 12.5
- D. 0.875, 87.5
- E. 0.25, 25.0

Therapy

- When reconstructing the 3-D positions of a tandem and ovoid from orthogonal films, it is often difficult to identify the R and L ovoids on the lateral film. All of the following can be helpful, except:
- A. Using different dummy markers in each ovoid.
- B. Rotating the orthogonal films a few degrees (e.g., gantry angles of 10° and 100° until the ovoids are separated on the lateral view).
- C. Taking films at gantry angles of 45° and 315°.
- D. The ovoid with the larger diameter is the one closest to the film cassette.

Therapy

- When reconstructing the 3-D positions of a tandem and ovoid from orthogonal films, it is often difficult to identify the R and L ovoids on the lateral film. All of the following can be helpful, except:
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- B. Rotating the orthogonal films a few degrees (e.g., gantry angles of 10° and 100° until the ovoids are separated on the lateral view).
- C. Taking films at gantry angles of 45° and 315°.
- D. The ovoid with the larger diameter is the one closest to the film cassette.
  - The ovoid closest to the x-ray tube will project larger on the film, however this is a very small effect.

Therapy

- The Patterson-Parker system cannot be used for a single plane breast implant, using equal strength 192 Ir seeds placed on a 1 cm grid, because:
- A. The system requires unequal strength sources at the periphery and in the center.
- B. Patterson-Parker only applies to radium and cesium sources.
- C. The ends cannot be "crossed.".
- D. The system applies only to permanent, not temporary, seed implants.

Therapy

- The Patterson-Parker system cannot be used for a single plane breast implant, using equal strength 192 Ir seeds placed on a 1 cm grid, because:
- A. The system requires unequal strength sources at the periphery and in the center.
  - The paterson-parker system is a set of rules which, if followed, delivers an even dose (within prescribed limits) to a plane at a given “treating distance” from the implant.
  - It requires a higher activity (mCi/cm) at the periphery than in the center, to counteract the inverse square effect.
    - For implants with equal activity per seed, the rules do not apply.
- B. Patterson-Parker only applies to radium and cesium sources.
- C. The ends cannot be "crossed.".
- D. The system applies only to permanent, not temporary, seed implants.

Therapy

- When 192 Ir sources are sent from the manufacturer to a hospital, all of the following are true, except:
- A. The container must be D.O.T approved.
- B. The "Transport Index" must be measured, and written on the label.
- C. A radioactive source warning label must be attached to the container.
- D. The maximum dose rate on the surface of the container must be stated on the label.
- E. The activity and radionuclide must be stated on the label.

Therapy

- When 192 Ir sources are sent from the manufacturer to a hospital, all of the following are true, except:
- A. The container must be D.O.T approved.
- B. The "Transport Index" must be measured, and written on the label.
  - The transport index (TI), which is the maximum dose rate at 1 m, must be stated on the label, along with the radionuclide and its activity;
- C. A radioactive source warning label must be attached to the container.
- D. The maximum dose rate on the surface of the container must be stated on the label.
  - the surface dose rate is not required on the label
- E. The activity and radionuclide must be stated on the label.

Therapy

- According to NRC regulations, sealed radioactive sources must be leak tested except when:
- A. The activity is below 5.0 mCi.
- B. They are "in storage" (i.e., not in use).
- C. They emit photons only.
- D. They have been shown not to leak for the previous 2 years.

Therapy

- According to NRC regulations, sealed radioactive sources must be leak tested except when:
- A. The activity is below 5.0 mCi.
- B. They are "in storage" (i.e., not in use).
- C. They emit photons only.
- D. They have been shown not to leak for the previous 2 years.

Therapy

- A lead apron would be effective shielding for a brachytherapy procedure with which of the following radionuclides?
- A. 137 Cs
- B. 125 I
- C. 192 Ir
- D. A and B
- E. All of the above.

Therapy

- A lead apron would be effective shielding for a brachytherapy procedure with which of the following radionuclides?
- A. 137 Cs
  - 660 keV avg and Need 5.5 mm
- B. 125 I
  - 28 kev ang and need 0.025 mm
  - Standard lead aprons contain about 0.5mm lead.
    - Good for diagnostic x-rays, but not photons.
- C. 192 Ir
  - 380 Kev avg and Need 2.5 mm
- D. A and B
- E. All of the above.

Therapy

- All of the following are true of 192 Ir except:
- A. It can be used in the form of strands of seeds for temporary implants.
- B. It is the radionuclide most often used in High Dose Rate Afterloaders.
- C. It is created by neutron activation in a reactor.
- D. Mean energy is about 350 keV.
- E. Half-life = 60 days.

Therapy

- All of the following are true of 192 Ir except:
- A. It can be used in the form of strands of seeds for temporary implants.
- B. It is the radionuclide most often used in High Dose Rate Afterloaders.
- C. It is created by neutron activation in a reactor.
- D. Mean energy is about 350 keY.
- E. Half-life = 60 days.
  - 74 days.

TABLE 15.1. PHYSICAL CHARACTERISTICS OF RADIONUCLIDES USED IN BRACHYTHERAPY

Radionuclide	Half-Life	Photon Energy (MeV)	Half-Value Layer (mm lead)	Exposure Rate Constant (Rcm^2/mCi-h)
^{226}Ra	1,600 yr	0.047–2.45 (0.83 avg)	12.0	8.25[a b] (Rcm^2/mg-h)
^{222}Rn	3.83 days	0.047–2.45 (0.83 avg)	12.0	10.15[a c]
^{60}Co	5.26 yr	1.17, 1.33	11.0	13.07[c]
^{137}Cs	30.0 yr	0.662	5.5	3.26[c]
^{192}Ir	73.8 days	0.136–1.06 (0.38 avg)	2.5	4.69[c]
^{198}Au	2.7 days	0.412	2.5	2.38[c]
^{125}I	59.4 days	0.028 avg	0.025	1.46[c]
^{103}Pd	17.0 days	0.021 avg	0.008	1.48[c]

[a]In equilibrium with daughter products.
[b]Filtered by 0.5 mm Pt.
[c]Unfiltered.

Therapy

- A radionuclide which emits photons of average energy 21 keV and has a 17-day half-life is:
- A. 125 I.
- B. 103 Pd.
- C. l37 Cs.
- D. 198 Au.
- E. 192 Ir.

Therapy

- A radionuclide which emits photons of average energy 21 keV and has a 17-day half-life is:
- A. 125 I.
- B. 103 Pd.
- C. l37 Cs.
- D. 198 Au.
- E. 192 Ir.

Therapy

- The dose in tissue at 1.0 cm depth from the surface of a vaginal cylinder, expresed as a percent of the surface dose, is:
- A. Greatest for the largest diameter cylinder.
- B. Greatest for the smallest diameter cylinder.
- C. Independent of cylinder diameter.

Therapy

- The dose in tissue at 1.0 cm depth from the surface of a vaginal cylinder, expresed as a percent of the surface dose, is:
- A. Greatest for the largest diameter cylinder.
  - Secondary to inverse square law.
  - For this reason, and also to deliver an even dose to the mucosal surface, the largest diameter appropriate for the patients is generally used.
- B. Greatest for the smallest diameter cylinder.
- C. Independent of cylinder diameter.

Therapy

- The ICRU rectal point in a gynecological insertion using tandem and ovoids is defined as:
- A. The point on the rectal marker closest to the tandem at its superior end.
- B. The most posterior and superior point on the radio-opaque packing.
- C. A point 0.5 cm posterior to the radio-opaque packing, centered at the ovoids.
- D. A point 2 cm posterior and 2 cm superior to the external os, as visualized on the lateral film.
- E. A point 1 cm posterior and 1 cm inferior to the external os, as visualized on the lateral film.

Therapy

- The ICRU rectal point in a gynecological insertion using tandem and ovoids is defined as:
- A. The point on the rectal marker closest to the tandem at its superior end.
- B. The most posterior and superior point on the radio-opaque packing.
- C. A point 0.5 cm posterior to the radio-opaque packing, centered at the ovoids.
  - Rectal markers can sometimes give a lower dose if they are not positioned at the anterior rectal wall.
  - The ICRU point is assumed to be the highest dose to the rectum.
- D. A point 2 cm posterior and 2 cm superior to the external os, as visualized on the lateral film.
- E. A point 1 cm posterior and 1 cm inferior to the external os, as visualized on the lateral film.

Therapy

- An HDR treatment has a total treatment time of 282 seconds on May 1st. Assuming the 192Ir source has not been changed, the treatment will take ___ seconds on May 15th.
- A. 322
- B. 302
- C. 296
- D. 264
- E. 247

Therapy

- An HDR treatment has a total treatment time of 282 seconds on May 1st. Assuming the 192Ir source has not been changed, the treatment will take ___ seconds on May 15th.
- A. 322
  – The treatment time increases by the inverse of the source decay.
  – Decay time = 14 days; Half-life = 72 days.
  – Time = 282 x exp (0.693 x 14/74) = 322.
- B. 302
- C. 296
- D. 264
- E. 247

Therapy

- An HDR treatment planning system uses optimization to deliver an even dose at a radius of 1 cm from a bronchial applicator. The dwell times will be:
- A. Higher at the ends than in the center.
- B. Alternately high and low.
- C. All approximately equal.
- D. Higher in the center than at the ends

Therapy

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- B. Alternately high and low.
- C. All approximately equal.
- D. Higher in the center than at the ends

Therapy

- The long-term success of intravascular brachytherapy (IVBT) depends on all of the following except:
- A. The relative doses delivered to the innermost lumen wall and the adventitia.
- B. Not exceeding a maximum dose to the innermost lumen wall.
- e. Achieving an axially symmetric dose relative to the vessel adventitia.
- D. The rate of dose delivery during the procedure.
- E. Treating the full dose to a distance proximal and distal to the balloon-injured area.

Therapy

- The long-term success of intravascular brachytherapy (IVBT) depends on all of the following except:
- A. The relative doses delivered to the innermost lumen wall and the adventitia.
- B. Not exceeding a maximum dose to the innermost lumen wall.
  - A clinically acceptable dose to the adventitia cannot be associated with a damaging dose to the innermost lumen.
- e. Achieving an axially symmetric dose relative to the vessel adventitia.
- D. The rate of dose delivery during the procedure.
  - The dose gradient across a vessel is important. A clinically acceptable dose to the adventitia cannot be associated with a damaging dose to the innermost lumen.
- E. Treating the full dose to a distance proximal and distal to the balloon-injured area.
  - Avoid the candy-wrapper affect.

Therapy

- Which of the following is the most important advantage of brachytherapy over teletherapy? A. There is no repair of sublethal injury.
- B. A more homogeneous dose is delivered.
- C. The oxygen enhancement ratio is reduced.
- D. The volume of normal tissue treated is minimized.
- E. Radiation exposure to personnel is less.

Therapy

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- D. The volume of normal tissue treated is minimized.
- E. Radiation exposure to personnel is less.

Therapy

- When a linear accelerator is used in the *electron* mode, the electron beam passes through each of the following components except:
- A. Accelerator tube.
- B. Bending magnet.
- C. Target.
- D. Primary collimator.
- E. Monitor chamber.

Therapy

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- A. Accelerator tube.
- B. Bending magnet.
- C. Target.
- D. Primary collimator.
- E. Monitor chamber.

Therapy

- "On a linac with a nominal dose rate of 300 MU/min, a treatment requires a monitor unit setting of 150 MU This means that:
- A. The timer will terminate the beam after exactly 30 seconds.
- B. The timer constantly monitors the true dose rate, and terminates the beam after the time calculated to deliver 150 MU
- C. The monitor chamber collects charge as the beam passes through it, and terminates the beam after a charge equivalent to 150 monitor units has been collected.
- D. The beam is terminated after 150 R has been collected in the chamber.

Therapy

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- A. The timer will terminate the beam after exactly 30 seconds.
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- C. The monitor chamber collects charge as the beam passes through it, and terminates the beam after a charge equivalent to 150 monitor units has been collected.
- D. The beam is terminated after 150 R has been collected in the chamber.

Therapy

- Bending magnets are needed in linear accelerators:
- A. To rotate the electron beam so that it points towards the isocenter.
- B. Only in the photon mode.
- C. Only for linacs with the waveguide mounted perpendicular to the gantry rotation axis.
- D. Only in the electron mode.
- E. With dual energy photons only.

Therapy

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- C. Only for linacs with the waveguide mounted perpendicular to the gantry rotation axis.
- D. Only in the electron mode.
- E. With dual energy photons only.

Therapy

- Regarding neutrons, which of the following is false?
- A. Neutrons are produced in therapy linacs operating at nominal energies of 10 MeV and above.
- B. Additional shielding for neutrons is required for linacs operating at nominal energies of 15 MeV and above.
- C. High-Z materials are the most effective neutron moderators.
- D. Neutrons have a high RBE because they give rise to secondary protons.
- E. Neutrons are more readily attenuated by concrete than by an equal mass of lead.

Therapy

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- A. Neutrons are produced in therapy linacs operating at nominal energies of 10 MeV and above.
- B. Additional shielding for neutrons is required for linacs operating at nominal energies of 15 MeV and above.
- C. High-Z materials are the most effective neutron moderators.
  - Hydrogenous materials (concrete, polyethylene) and boron are more effective neutron moderators.
- D. Neutrons have a high RBE because they give rise to secondary protons.
- E. Neutrons are more readily attenuated by concrete than by an equal mass of lead.

Therapy

- Most of the neutrons produced by a high-energy linac are produced:
- A. In the patient.
- B. In the floor and walls of the room.
- C. In the electron mode rather than the photon mode.
- D. In the head of the linac.

Therapy

- Most of the neutrons produced by a high-energy linac are produced:
- A. In the patient.
- B. In the floor and walls of the room.
- C. In the electron mode rather than the photon mode.
- D. In the head of the linac.
  - Most neutrons are generated by interactions between high-energy photons and high Z components in the head of the linac.

Therapy

- A superficial x-ray unit has an HVL of 2 mm Al. Which of the following will cause the greatest increase in dose rate at the patient's surface?
- A. Increasing the filtration by 1 mm.
- B. Increasing the beam current from 8 to 12 mA.
- C. Changing the kVp from 100 to 80.
- D. Increasing the SSD from 15 to 18 cm.

Therapy

- A superficial x-ray unit has an HVL of 2 mm Al. Which of the following will cause the greatest increase in dose rate at the patient's surface?
- A. Increasing the filtration by 1 mm.
- B. Increasing the beam current from 8 to 12 mA.
  - Dose rates increase proportionally with mA.
  - All other factors reduce the dose rate.
- C. Changing the kVp from 100 to 80.
- D. Increasing the SSD from 15 to 18 cm.

Therapy

- The AAPM's TG-40 report on Quality quality Assurance assurance requires all of the following Q/ A measures, **except**:
- A. Verification by spot check of the activity of seeds used for permanent implants.
- B. Daily output checks of all photon and electron beams on a linac.
- C. Annual verification of depth dose data and profiles for all photon and electron beams on a linac.
- D. Monthly verification of photon beam symmetry.

Therapy

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- A. Verification by spot check of the activity of seeds used for permanent implants.
- B. Daily output checks of all photon and electron beams on a linac.
  - Photons should be checked daily and electrons are least twice a week.
- C. Annual verification of depth dose data and profiles for all photon and electron beams on a linac.
- D. Monthly verification of photon beam symmetry.

Therapy

- The protocol currently recommended by the AAPM for calibrating megavoltage therapy units is:
- A. SCRAD.
- B. The Nordic protocol.
- C. TG-51.
- D. ICRU Report 21.

Therapy

- The protocol currently recommended by the AAPM for calibrating megavoltage therapy units is:
- A. SCRAD.
- B. The Nordic protocol.
- C. TG-51.
- D. ICRU Report 21.

Therapy

- Calculation of the *primary barrier* thickness for a linac in a radiotherapy department requires all of the following factors except:
- A. Workload.
- B. Photon energy.
- C. Wall material.
- D. Recommended dose limit for staff on other side of wall.
- E. Head leakage.

Therapy

- Calculation of the *primary barrier* thickness for a linac in a radiotherapy department requires all of the following factors except:
- A. Workload.
- B. Photon energy.
- C. Wall material.
- D. Recommended dose limit for staff on other side of wall.
- E. Head leakage.
  - If the barrier is thick enough for the primary beam, it is more than adequate to attenuate head leakage when the beam is pointing away from the barrier, since head leakage is less than 0.1% of the usefull beam.

Therapy

- Which of the following provides the greatest amount of shielding?
- A. 7 half-value layers of concrete.
- B. 6.0 cm lead for a beam with HVL 12 mm.
- C. 2 tenth tenth-value layers of lead.
- D. 1 TVL of lead and 1 TVL of concrete.

Therapy

- Which of the following provides the greatest amount of shielding?
- A. 7 half-value layers of concrete.
- B. 6.0 cm lead for a beam with HVL 12 mm.
- C. 2 tenth tenth-value layers of lead.
- D. 1 TVL of lead and 1 TVL of concrete.

Therapy

- A 60CO source is stuck in the "on" position, delivering 100 cGy/min at the isocenter. The therapist enters the room to rescue the patient, and spends 1 minute at a distance of 1 meter from the isocenter (with the beam pointing towards the floor). The dose received by the therapist is approximately ___ times the recommended weekly dose limit.
- A. 0.1
- B. 1.0
- C. 10
- D. 100
- E. 1000

Therapy

- A 60CO source is stuck in the "on" position, delivering 100 cGy/min at the isocenter. The therapist enters the room to rescue the patient, and spends 1 minute at a distance of 1 meter from the isocenter (with the beam pointing towards the floor). The dose received by the therapist is approximately ___ times the recommended weekly dose limit.
- A. 0.1
- B. 1.0
  - The dose rate at a distance of 1 m lateral to the beam direction, scattered from the patient, is about 1/1000th (inverse square)of the dose rate at the isocenter, or about 100 mrem/min.
  - The recoomended whole body dose limit is
    - 5 rem/yr (50 mSv/yr)
    - Or 100 mrem/wk (1 mSv/wk)
- C. 10
- D. 100
- E. 1000

Therapy

- TLD ring badges are worn in addition to a whole-body film badge for brachytherapy procedures because:
- A. The film badge cannot discriminate between different types and energies of radiation.
- B. The recommended dose limit for the hands is higher than for the whole body, and requires a separate measurement.
- C. The ring badge acts as a backup for the film badge in case the film badge is damaged during processing.
- D. TLD is uniquely sensitive to the particles emitted from brachytherapy sources.
- E. The skin of the hands has a lower recommended dose limit than the whole body.

Therapy

- TLD ring badges are worn in addition to a whole-body film badge for brachytherapy procedures because:
- A. The film badge cannot discriminate between different types and energies of radiation.
- B. The recommended dose limit for the hands is higher than for the whole body, and requires a separate measurement.
  - The dose to the hands is 500 mSv per year or 10x the whole body limit.
- C. The ring badge acts as a backup for the film badge in case the film badge is damaged during processing.
- D. TLD is uniquely sensitive to the particles emitted from brachytherapy sources.
- E. The skin of the hands has a lower recommended dose limit than the whole body.

Therapy

- The radiation detector used to monitor a patient after removal of an 192Ir seed implant must be
- 1. Calibrated annually
- 2. Able to integrate dose
- 3. Capable of detecting background levels of radiation
- 4. A solid rather than a gas-filled detector

- A. 1,3
- B. 2,4
- C. 1,2,3,4
- D. 4 only

Therapy

- The radiation detector used to monitor a patient after removal of an 192Ir seed implant must be
- 1. Calibrated annually
- 2. Able to integrate dose
- 3. Capable of detecting background levels of radiation
- 4. A solid rather than a gas-filled detector

- A. 1,3
  - The detector will measure background if all sources have been removed.
- B. 2,4
- C. 1,2,3,4
- D. 4 only

Therapy

- Which of the following is/are *always* required to have a state license in order to work in a radiotherapy department?
- 1. Attending physician
- 2. RSO
- 3. Therapist
- 4. Physicist
- A. 1,2
- B. 1,3
- C. 1,2,3
- D. 1,2,3,4
- E. 1 only

Therapy

- Which of the following is/are *always* required to have a state license in order to work in a radiotherapy department?
- 1. Attending physician
- 2. RSO
- 3. Therapist
- 4. Physicist
- A. 1,2
- B. 1,3
- C. 1,2,3
- D. 1,2,3,4
- E. 1 only
  - But varies state to state.