ABR Radiologic Physics

Initial Certification Sample Questions

Computer-Based Examinations

PART 1: General

1. Kerma and absorbed dose are related quantities. Beyond the depth of maximum dose, the fall-off rate of these two quantities is best described as _____.

1. both dose and kerma fall off equally
2. kerma falls off faster than dose
3. dose falls off faster than kerma
4. dose falls while kerma rises
5. dose rises while kerma falls

2. At 75 degrees Fahrenheit, an ionization chamber exposed to the atmosphere should have its reading "temperature corrected" by multiplying the reading by _____.

1. 0.9936
2. 1.0032
3. 1.0064
4. 1.0859

3. The mass attenuation coefficient of bone with a density of 1.8 g/cm 3, is 0.2 cm 2/g for an 80-keV gamma ray. The percentage of 80-keV photons attenuated by a slab of bone 4 cm thick is _____%.

1. 36
2. 45
3. 55
4. 64
5. 76

4. The modulation transfer function (MTF) curve is a plot of _____.

1. image contrast versus resolution
2. subject contrast versus image contrast
3. detail detection versus viewing condition

4. system characteristics versus component characteristics
5. image contrast versus spatial frequency

5. The loss of contrast in a therapy verification image compared with a simulator radiographic image is mostly a result of _____.

1. an increased number of pair productions
2. an increased number of Compton interactions
3. an increased number of photoelectric interactions
4. a decreased number of photoelectric interactions
5. a decreased number of Compton interactions

6. 2-cc-volume ionization chamber is placed in a radiation field of 100 R/s. The current generated is how many amperes (ρ air = 0.0013 g/cm 3)?

1. 5.1 x 10 -11
2. 6.3 x 10 -10
3. 5.1 x 10 -9
4. 6.3 x 10 -8
5. 5.1 x 10 -7

7. At a radiologist's workstation, the instantaneous exposure rate through the wall from a chest cassette holder is 500 mR/h during exposures of 10 mAs at 100 kV and 100 mA. The maximum exposure at the workstation during 1 week for 200 exposures would be approximately _____ mR.

1. 0.28
2. 2.8
3. 28
4. 280
5. 2800

8. In pair production, _____.

1. the electrons and positrons are emitted at 180° to each other
2. positrons and antineutrinos are produced when the interactions occur
3. photons with energies greater than 2.04 MeV are necessary for the interactions to occur
4. the annihilation of the positron produces two photons that travel in approximately opposite directions
5. the total energy of the incident photon is evenly divided between the kinetic energy of the pair of particles

9. Ten 1024 x 1024 digital images with 64 shades of gray are to be transmitted at the rate of 1.049 x 10 5 bits/s. The images can be transmitted in approximately _____.

1. 10 s
2. 30 s
3. 1 min
4. 10 min
5. 1 h

10. A group of patients exhibit lifetimes that are normally distributed with a mean of 36 months and a standard deviation of 3.0 months. What percentage of these patients will survive at least 42 months?

1. 2.5%
2. 5.0%
3. 33.0%
4. 67.0%
5. 95.

Answers for this section:

1. A
2. C
3. E
4. E
5. D
6. D
7. B
8. D
9. D
10. A

PART 1: Clinical

1. There are _____ cervical vertebrae.

1. 12
2. 10
3. 7
4. 5
5. 4

2. A fetus receives a dose of 2 Gy during weeks 15 - 39 of pregnancy. There is an increased risk of _____.

1. Down syndrome
2. leukemia in the child
3. intrauterine death
4. macrocephaly in the infant
5. neonatal death

3. The most likely exam for a patient who is suspected of having kidney stones is a(n) _____.

1. abdominal CT
2. abdominal MRI
3. abdominal ultrasound
4. ERCP
5. hysterosalpingogram

4. Breast cancer occurs most often in the _____ .

1. chest wall
2. lower inner quadrant
3. lower outer quadrant
4. upper inner quadrant
5. upper outer quadrant

Answers for this section are not provided.

PART 2: Diagnostic Radiological Physics

SIMPLE QUESTIONS

1. Patient entrance skin exposure for a screen/film radiography system with film density being held constant will not depend on _____.

1. SID
2. kVp
3. grid ratio
4. beam area
5. focal spot size

2. For a CT image acquired with 200 mAs, a change of 10 HU between adjacent pixels equals a contrast of _____ %.

1. 0.02
2. 1
3. 2
4. 10
5. 14

3. As a potential contrast agent for ultrasound, which of the following materials would be expected to be the strongest reflector for a fixed concentration of small (<5 m m) particles?

1. A solid polymer
2. A solid phospholipid
3. Encapsulated air
4. Aluminum
5. Protein

4. In a spin echo MRI pulse sequence with TR = 2000 msec and TE = 100 msec, the anatomy having the highest signal intensity in the resulting brain image is _____.

1. gray matter
2. white matter
3. lens of the eye
4. CSF
5. intracranial fat

5. According to NCRP 116, the occupational equivalent dose annual limit for an extremity is _____ Sv.

1. 0.5
2. 1.5
3. 5
4. 15
5. 50

Answers for this section:

1. E
2. B
3. C

4. D
5. A

PART 2: Diagnostic Radiological Physics

COMPLEX QUESTIONS

1. Below is shown a series of repeat measurements of the output of an x-ray tube and generator for an 80-kVp beam, 10 mAs at 1 meter. The coefficient of variation of these measurements is _____.

1. 71.
2. 7.0
3. 0.7
4. 0.07
5. 0.007

Measurement #	Output (mR)
1	71.3
2	70.9
3	72.2
4	7108
5	71.5

2. A 5-MHz ultrasound beam is incident on a blood vessel at an angle of 45 degrees. If the blood is moving toward the transducer, and the mean velocity is 30 cm/s, the mean frequency shift of the back-reflected power spectrum is _____ kHz.

1. 0.7
2. 1.4
3. 2.8
4. 5.6
5. 11.2

3. A CT ionization chamber has an active length of 10 cm. Dose is measured with the body CTDI phantom positioned appropriately. A scan is performed at 130 kVp, 120 mAs and 5-mm slice thickness. The electrometer reading is 110 mR. (Assume an f-factor of 0.9 cGy/R.) The CTDI is _____ mGy.

1. 12
2. 20
3. 32

4. 40
5. 44

4. For a 30-cm FOV and a gradient strength of 2.1 mT/m, the change in frequency of the protons at a distance of 10 cm from the null of the phase encode gradient is _____ kHz.

1. 40.6
2. 26.8
3. 21.3
4. 8.9
5. 2.1

Answers for this section:

1. E
2. B
3. B
4. D

top

PART 2: Medical Nuclear Physics

SIMPLE QUESTIONS

1. The exposure gamma ray constant for I-131 is approximately _____ R-cm 2/mCi-hr.

1. 0.7
2. 1.2
3. 1.6
4. 2.2
5. 3.3

2. A SPECT study is performed using line sources of Tc-99m according to the NEMA protocol. If the FWHM is 10.5 mm in the center, the peripheral tangential spatial resolution at 10 cm from the center line will be approximately _____ mm.

1. 7.5
2. 9.5
3. 11.5

4. 13.5
5. 15.5

3. Which of the following is a false statement about imaging techniques?

1. Image quality is reduced when In-111 is used for imaging with a collimator designed for Tc-99m.
2. Tc-99m with a pinhole collimator can be used to image a 3-mm diameter lesion.
3. High energy collimators will provide good spatial resolution for F-18.
4. Tungsten would be a better collimator material than lead for imaging Tl-201.
5. The energy of Co-57 is so close to that of Tc-99m, that it can be used for high count flood correction in SPECT imaging.

4. If the minimum, mean, and maximum pixel counts in the CFOV of a smoothed intrinsic flood are 4500, 5200, and 5500, respectively, the integral uniformity will be _____ %.

1. 5
2. 6
3. 10
4. 14
5. 15

5. In a gate-synchronized ventricular function study, the color-coded phase image shows a group of pixels in the apex of the left ventricle displayed in the hue assigned to the atria. The most likely explanation is _____.

1. global left ventricular hypokinesis
2. valvular insufficiency
3. malfunctioning software
4. cardiac arrhythmia
5. apical dyskinesis

Answers for this section:

1. D
2. B
3. C
4. C
5. E

PART 2: Medical Nuclear Physics

COMPLEX QUESTIONS

1. A Tc-99m radioactive tracer is removed from the kidneys by three pathways: 1) absorption in the blood at 50 percent every 3 hours; 2) excretion to the bladder at 50 percent every 2 hours; and 3) physical decay. The effective half-time of the radioactive tracer in the kidney is _____ hours.

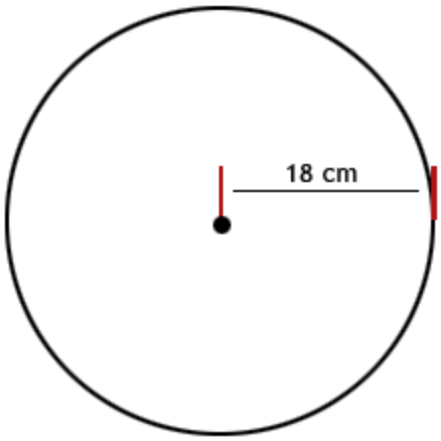
1. 1
2. 2
3. 4
4. 6
5. 11

2. A generator is eluted and yields 300 mCi of Tc-99m. What is the maximum acceptable number of microcuries of Mo-99 allowable at the time of elution in order for clinical studies to be done up to 6 hours after elution?

1. 5.6
2. 12
3. 24
4. 30
5. 45

3. If annihilation radiation originates in the center of the water-filled phantom diagrammed below, the PET attenuation correction factor will be _____. (μ = 0.096 cm -1)

1. 15.9
2. 24.1
3. 31.7
4. 40.3
5. 48.5



4. A c 2 test was performed with a sample size of 10 using a long-lived source. The following results were obtained:

s n-1 = 205.5
Mean = 3752.6

The c 2 value is _____.

1. 14.3
2. 101.3
3. 205.6
4. 3753
5. 42,256

5. The following intrinsic line spread function was recorded using a slit phantom.

Channel #	Cts	Channel #	Cts	Channel #	Cts
133	300	138	900	143	833
134	400	139	950	144	710
135	580	140	1000	145	560
136	675	141	970	146	480
137	780	142	911	147	345

The distance per channel is 0.4 mm. The intrinsic spatial resolution (FWHM) is _____ mm.

1. 3.48
2. 3.75

3. 4.28
4. 4.48
5. 6.50

Answers for this section:

1. A
2. C
3. C
4. B
5. D

top

PART 2: Therapeutic Radiologic Physics

SIMPLE QUESTIONS

1. High energy photon beams from an accelerator require flattening filters in order to _____.

1. increase low-energy photons
2. correct for the pulsing of radiation
3. increase fluence along the central axis of the beam
4. increase depth dose
5. make the beam flat across the full field

2. Highest neutron flux in a therapy treatment room is produced by _____.

1. a Cobalt-60 source
2. a 10-MeV electron beam
3. a 10-MV photon beam
4. a 20-MV photon beam
5. a 20-MeV electron beam

3. According to TG-59, an ionization chamber reading is corrected to compensate for the temperature and pressure dependence of the _____.

1. air volume in the ionization chamber
2. mass of air in the ionization chamber
3. mass stopping power ratio for electrons in the ionization chamber
4. mass stopping power ratio for electrons of the phantom material
5. density of air in the monitor chamber

4. The equivalent square of a 10 x 20-field is _____.

1. 12 x 12
2. 13 x 13
3. 15 x 15
4. 18 x 18
5. 20 x 20

5. In IMRT treatment planning, critical organs are _____.

1. shielded with superflab
2. delivered the same dose as GTV
3. prescribed 0.5 % of PTV
4. delivered organ tolerance dose
5. delivered skin tolerance dose

Answers for this section:

1. E
2. D
3. B
4. B
5. D

top

PART 2: Therapeutic Radiologic Physics

COMPLEX QUESTIONS

1. A 4-MV linac beam, 10 cm x 10 cm with a 45° wedge, is used to deliver 200 cGy to a tumor located at the isocenter (100 cm SAD) at 10-cm depth. Given the following:

1. output at 100 cm SSD at d max 1.2 cm is 1.04 cGy/MU
2. wedge factor 0.70
3. back-scatter-factor 1.03
4. percent depth dose 60%
5. tissue-air-ratio 0.75

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

1. 206

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

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

1. 245 cGy
2. 255 cGy
3. 261 cGy
4. 268 cGy
5. 281 cGy

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

3. A lesion at 1-cm depth in tissue is to be treated with 6-MeV electron beam with bolus. A dose of 1.5 Gy to 80% is prescribed. If output is 1cGy/MU, SSD is 104 cm and cone factor is 0.8, what should the thickness of the bolus be, and how many MU should be delivered?

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

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

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

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

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

Answers for this section:

1. D
2. C
3. C
4. C
5. B