

Exam 19.02.2024

Note: 20 closed-ended questions from the self assessment quizzes on tuwel (but 3 questions are new and not from there) and 3 open questions from the teaching points. Time Limit: 30 min. The answers are correct (BUT NOT QUESTION 10.). Some questions are not answered because I don't know the solution.

1.

Match the K edge energies with the elements used in x-ray detectors

Barium	37.4 keV
Iodine	33.2
Cesium	36.0 keV
Selenium	12.7 keV
Gadolinium	50.2 keV

2.

Today, most x-ray image detectors work in

Select one:

- a. photon counting mode
- b. energy integration mode

3.

In keV photon dosimetry the measurement concept using "exposure" given in C/kg has been replaced by the concept based on Kerma measured in Gy.

4.

MTF(0)=?

Select one:

- a. 0
- b. 1 (100%)
- c. between 30% and >60%, depending on detector technology
- d. between 30% and >60%, depending on x-ray photon spectrum used, and detector technology

5.

Which of the following can be regarded as part of the **long-ranged** secondary radiation field in x-ray interaction with matter?

Select one or more:

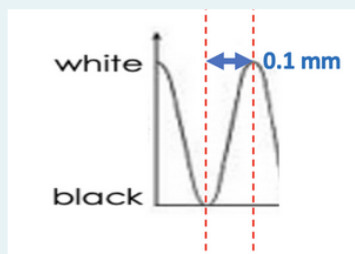
- a. annihilation photons (in case of MeV primary radiation)
- b. scatter photons
- c. Auger electrons
- d. secondary electrons

6. open question

Which simple and very general considerations will define the energy range (kVp and appropriate filtration, or keV) to be used in medical imaging with x-ray photons in human patients?

7.

A line pattern with a periodic light-dark modulation with a distance of 0.1 mm between the center of the white and the black line:



corresponds to which spatial frequency (in mm^{-1})?

8.

If both conditions on radiation hardness to be used,

- hard enough to achieve an appropriate detector dose at an acceptable dose burden to the patient, and
- soft enough to result in usable contrast

cannot be met at the same time,

Select one or more:

- a. MRI or ultrasound might be more useful than x-ray
- b. other contrast mechanisms than differences in x-ray attenuation need to be used
- c. a low dose x-ray image shall be performed
- d. higher prefiltration has to be used

9. open question

Why do we need to consider narrow beam and broad beam geometry in attenuation calculations or simulations? In which of the two is the attenuation measured larger, and why?

10. THIS ANSWER IS WRONG!!!

In nuclear medicine the pharmacokinetics of the tracer is very important because it

allows the use of very short lived radioisotopes .

(note: choose *the most important one* for clinical imaging!)

11.

An anti-scatter grid will have a higher selectivity, i.e., better scatter removal properties, if

Select one or more:

- a. if the grid ratio is larger
- b. if the radiation is harder
- c. the grid lines are denser (= more lines per cm)
- d. the grid lamellae are higher

12.

The image shown corresponds to a common examination. It shows a



Select one:

- a. CT Scan
- b. Color coded CR image
- c. Positron Emission Tomography fused with an MRI scan
- d. Digital image acquired with a flat panel detector

13.

The detection statistics and the resulting image noise is governed by

Select one:

- a. Gaussian statistics
- b. the t-distribution
- c. Poisson statistics
- d. Maxwell-Boltzmann statistics

14.

Technically, we get rid of photons with too low x-ray photon energies to be useful for imaging by using

appropriate .

15.

CBCT describes a modality where acquires a 3 dimensional image volume.

Select one:

- a. Gamma camera system with either a single or dual head detector system
- b. a flat panel detector, usually from a fluoroscopy system
- c. an ultrasound probe
- d. CT scanner with a limited rotation angle

16.

In unsharp masking the frequency characteristics of the enhancement is controlled by

Select one:

- a. the latitude selected
- b. the kernel size
- c. the bit depth
- d. the weighting factor used in the weighted sum of original and high pass filtered image

17.

If the DQE is specified just as "DQE" without an argument, it refers to

Select one:

- a. DQE at the Nyquist frequency
- b. the QDE
- c. $DQE(\infty)$
- d. DQE of infinitely large structures
- e. $DQE(1)$

18.

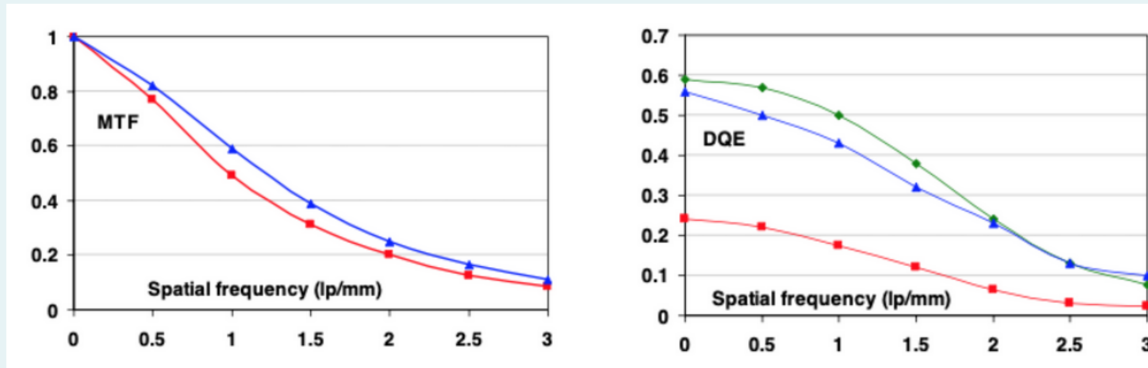
In order for the kerma to be a good estimator of absorbed dose, which of the following conditions needs to be satisfied (besides negligible fluorescence losses)?

Select one:

- a. low effective atomic number of absorber
- b. secondary electron equilibrium
- c. directly ionizing radiation being the predominant contributor to absorbed dose
- d. high photon energies

19. open question

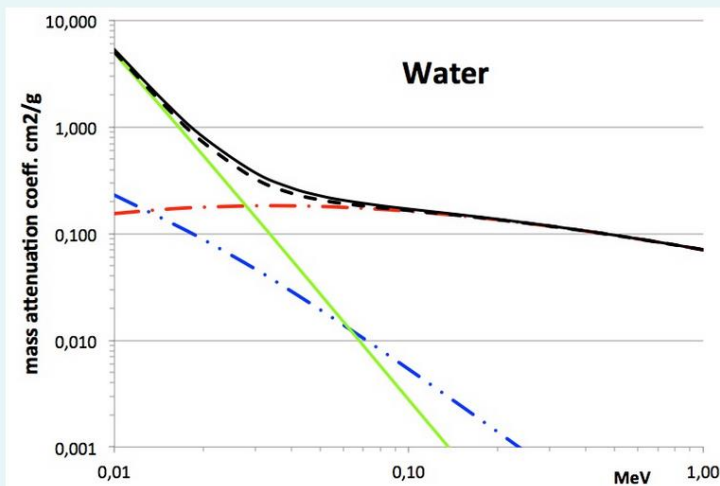
Associate MTF and DQE figures with the corresponding detector technologies!



Which curves describe which detector technology (green is missing in the MTF figure, but it would also be quite close to blue as in the DQE figure).

Note that there are three different technologies, based on the previous comment on MTF of the "green" system. What is the reason that the curves on the figure on left hand side look so similar? What is the implication on the corresponding DQEs in the right figure?

20.



In the figure mass attenuation coefficients are shown for the various attenuation effects of photons up to 1 MeV energy. Inelastic scatter (often treated in the Compton approximation) corresponds to the

Select one:

- a. solid black line
- b. green line (solid)
- c. dashed black line (_ _ _)
- d. red line (. _ . _)
- e. blue line (. . _ . . _)

21.

Automatic signal normalization aims at

Select one:

- a. normalizing pixel (or voxel) values to the same AOC (area under curve) in different images
- b. presenting images taken with different dose levels with identical grey values
- c. optimizing image histograms for best visual image perception by a human reader
- d. presenting images taken with different kVp with identical grey level histograms

22.

For large λ the Poisson distribution approaches a Gaussian (Normal) distribution with variance

Select one:

- a. 0
- b. $\lambda/2$
- c. λ
- d. 1
- e. ∞

23.

The Bucky factor is named after Gustav Peter Bucky, who

Select one:

- a. invented the use of positive contrast media based on high Z materials, as mercury. However, since mercury was too toxic, his idea has been forgot for approximately a decade
- b. invented the automatic exposure control
- c. developed the anti scatter grid and had the idea of integrating it into the patient couch
- d. built the first fluoroscopy system based on needle shaped CsI crystals