Image characteristics

Exercise 1

A and B are two ideal images characterized respectively by a spatial frequency spectrum with of k_{xAmax}= k_{yAmax} 5 lp/mm and k_{xBmax} = k_{yBmax}=10 lp/mm (lp=line pair).

1) What does this mean in terms of image resolution? (1 point)
2) Let's suppose we use a digital detector with 40x40 cm FOV and 2048x2048 pixel grid. How is the final image resolution affected? (3 points)
3) What does it change when we use an 20x20 cm FOV? (2 points)

Exercise 2

Given the following image where the gray box represents the imaged object and the white area the background (no interactions). Compute

1) Contrast (1 points)
2) SNR (2 points)
3) CNR (2 points)

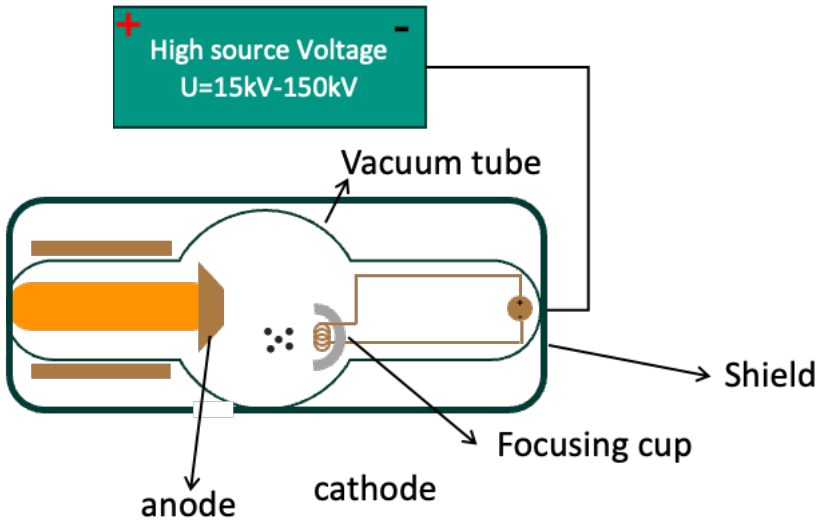
1	**0**	**3**	**2**
1	**42**	**43**	**1**
2	**41**	**40**	**1**
0	**4**	**2**	**2**

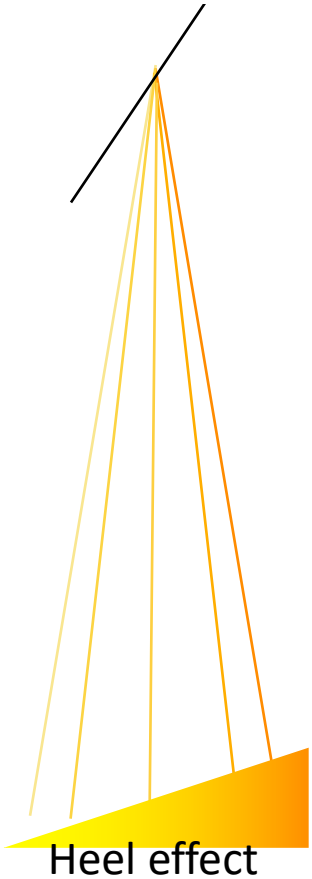
X-ray production

Exercise 3

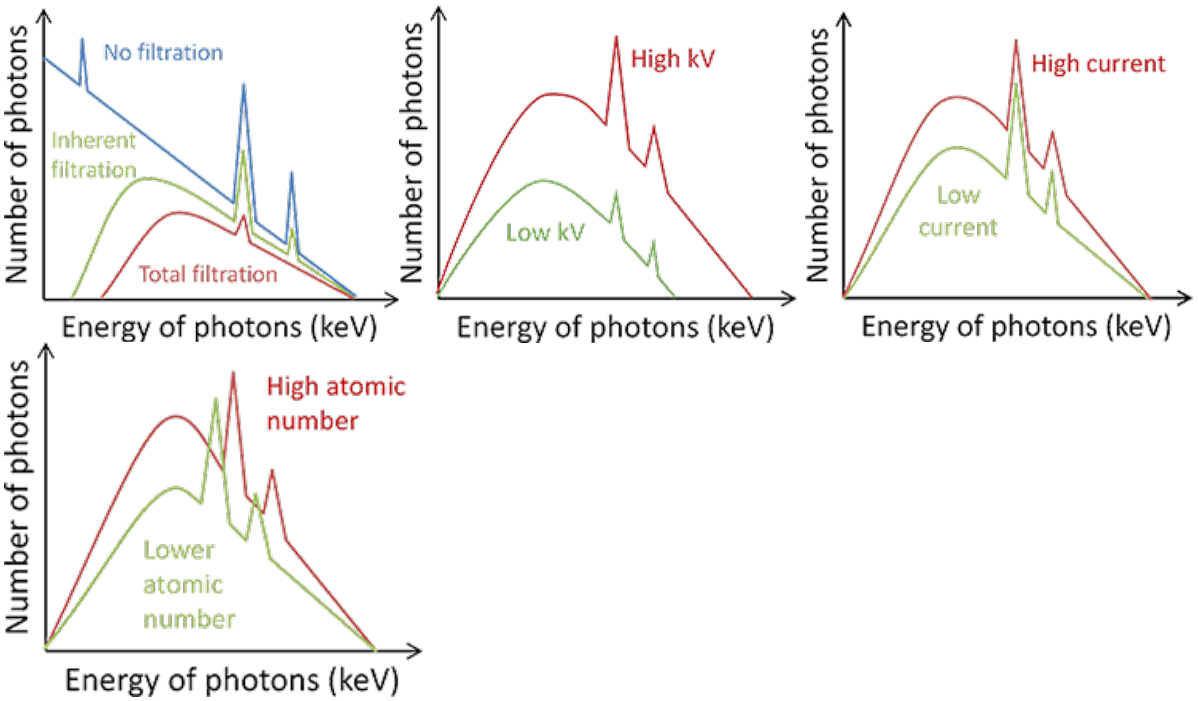
1) Sketch and label the most important components of the X-ray tube and describe each component (5 points)

2) What do we mean with “anode angle”? How does it affect the X-ray beam production and image quality? (4 points)
3) How can the X-ray intensity spectrum can be modified? (4 points)





Heel effect



Exercise 4

Sketch and explain the X-ray tube energy spectrum,
1) at the exit of the X-ray tube before any filtering takes place (2 points)
2) after the filter but before the X-rays have reached the patient (2 points)
3) Explain what the maximum energy value represents, and which energy is assumed to be the beam energy (2 points)

Exercise 5

2.1 Figure 2.43 shows the intensity of X-rays produced from a source as a function of their energy. With respect to the reference graph shown on the left, one plot corresponds to a decrease in tube current, and the other to a decrease in the accelerating voltage (kVp). Explain which plot corresponds to a decrease in which parameter.

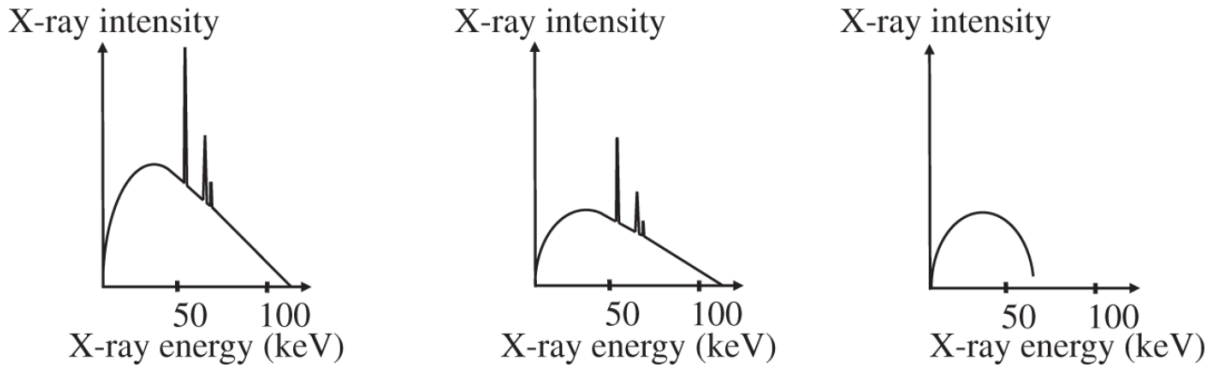


Figure 2.43 Illustration for Exercise 2.1.

Exercise 6

What is the effect of the kV and mA s of an X-ray tube on

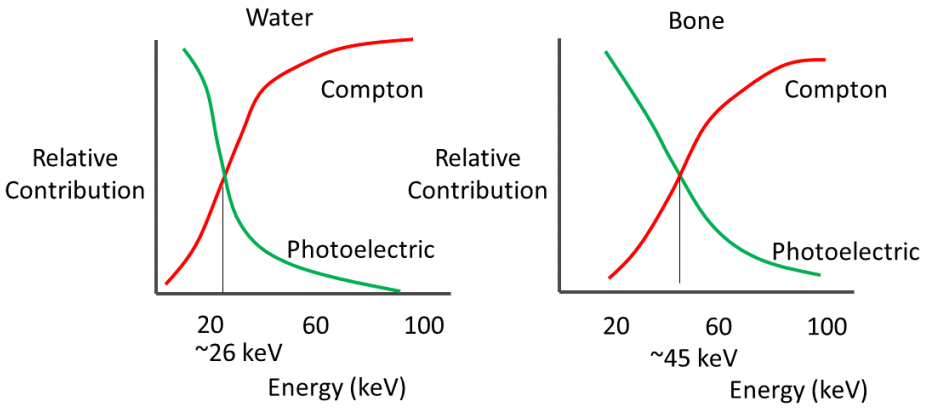
(a) the patient dose (2 points)
(b) the image quality? (4 points)

X-ray tissue interactions

Exercise 7

1) Explain which X-ray tissue interactions could occur at imaging energy range level (4 points)
2) Sketch the dependance of tissue interactions from energy (3 points)

X-ray Attenuation (Energy Dependence)



Computed tomography

We want to perform CT of the thorax covering a scan length 38.4 cm in the cranio-caudal direction with a beam collimation to the detector array of 0.60 mm (slice thickness).
The 360◦ rotation time is 0.33 s. Calculate the scan time with the following settings (5 points).

1) single raw detector with pitch=1
2) single raw detector with pitch=1.5
3) 64-raw scanner with pitch=1

4) 32-raw detector with pitch=1.5
5) What does it change, in terms of scan time if we choose 180° z-reconstruction instead of 360° z-reconstruction