

Question 1.

- Thickness of detector crystal: SNR increases as crystal thickness increases because the crystal detects more gamma rays. Spatial Resolution on the other hand decreases because the thicker crystal will detect gamma rays from a larger range of sources.
- Length of lead septa: Increasing the length of the septa decreases the SNR because less gamma rays will be able to go through the septa and reach the crystal. The spatial resolution in this case increases (distance between two resolvable features is less) because of the resulting geometry of the collimator.
- FWHM of energy window: For a poisson distribution like that of the radioactive decay, SNR is defined as N/σ where N is proportional to the number of gamma rays detected and σ is half the FWHM. Increasing the FWHM will decrease the SNR. The CNR, which is essentially equal to the SNR in nuclear imaging, will also decrease.

Question 2.

The gamma rays interacting with the K-shell electrons of lead in the collimator result in X-rays at 75 and 88 keV. Compton scattering of the gamma rays in the scintillation crystal results in the peak at 90 keV.

Question 3.

The closer the organ being imaged to the surface of the patient, the less the degree of gamma ray attenuation. The SNR is directly related to the gamma rays that reach the scintillation crystal. By taking the image from both sides of the patient, we could make up for the tissue attenuation by comparing the two images.

Question 5.

When mass is converted to energy, remember Einstein!

$$E = mc^2$$

$$E = (9.1 \times 10^{-31}) * (3 \times 10^8)^2 = 8.198 \times 10^{-14} \text{ J} = 511 \text{ keV}$$

Question 4.

[Use Matlab for 2D convolution]

```

A=1  1  1  1  1
1  2  2  2  1
1  2  3  2  1
1  2  2  2  1
1  1  1  1  1

```

```

Kernel1= 1  1  1
1  4  1
1  1  1

```

```

A1=A(v)Kernel1=1  2  3  3  3  2  1
2  8  11  12  11  8  2
3  11  20  22  20  11  3
3  12  22  28  22  12  3
3  11  20  22  20  11  3
2  8  11  12  11  8  2
1  2  3  3  3  2  1

```

This kernel represents a low-pass filter.

```

Kernel2=-1  -1  -1
-1  9  -1
-1  -1  -1

```

```

A2=A(v)Kernel2=-1  -2  -3  -3  -3  -2  -1
-2  5  2  1  2  5  -2
-3  2  6  4  6  2  -3
-3  1  4  11  4  1  -3
-3  2  6  4  6  2  -3
-2  5  2  1  2  5  -2
-1  -2  -3  -3  -3  -2  -1

```

This kernel represents a high-pass filter.

