Name Solutions

1. (Multiple Choice) A medical image that appears smoothed, with heavily blurred edges and no visible noise, can be described as:
    a. having little to no low frequency content.
    b. having little to no high frequency content.
    c. having been through a high pass frequency operation.
    d. having been oversampled (too many samples per square centimeter) when the image was digitized.
    e. having been discretized with a sampling rate greater than the Nyquist sampling rate.

2. (Multiple Choice) A computer graphics display presents the color "orange" to the observer. This color is formed from:
    a. The additive blending of millions of colors each of which are stored in the pixels of image.
    b. The subtraction of varying amounts of cyan, magenta, and blue each of which are stored in the pixels of the image.
    c. The additive combination of cyan, magenta, and blue that are part of the display colormap.
    d. The colormap describing how orange (formed from the subtractive scheme) represents a certain pixel intensity.
    e. The additive blending of 3 primary colors that are mapped to unique intensity levels found in the pixels of the image.

3. (Brief answers) Detectors
    a. What types of detectors are used for X-ray imaging?

For planar imaging: screen-film, image intensifiers, storage phosphors, solid-state detectors

For computed tomography: scintillators and solid-state detectors

    b. What types of detectors are used in nuclear imaging?

Scintillators, some solid-state detectors

4. (Brief answers) Imaging Radiation Sources
    a. What are the two sources or process of generation of imaging photons in nuclear imaging?

Nuclear decay and positron annihilation

    b. What is the source or process of generation of photons used in x-ray imaging?

Bremsstrahlung

    c. What is the half-life of Tc99m and what is the energy of the photons generated?

6 hours, 140 keV

    d. What is the half-life of F-18 and what is the energy of the photons generated?

2 hours (109 min), 511 keV

    e. Is there a half-life in the process of generation of photons for x-ray imaging?

No

    f. What is the energy of photons generated for x-ray imaging?

A range from roughly 30 keV to the kV potential or kVp typically 120 keV

5. (Brief answers) Medical imaging with photons in the 30 to 700 keV energy range
    a. What are the two major methods of photon interaction in this energy range?

Photo-electric absorption and Compton scattering

    b. What is the general term for reduction in the number of photons?

Attenuation

    c. What are the three types of photons in this energy range?

Nuclear, annihilation, and bremsstrahlung, or gamma-ray, annihilation, and x-ray

6. (Multiple Choice)
    a. For imaging properties, how much attenuation of photons is desired in x-ray imaging?
        i. none
        ii. some
        iii. complete

b. For imaging properties, how much attenuation of photons is desired in nuclear imaging?
   i. **none**
   ii. some
   iii. complete

7. For each of the following images, briefly answer the following (as best you can with a maximum of one sentence for each point for each image. One or two words should suffice in most cases):
   a. Identify the modality (e.g. x-ray, nuclear) of the following images.
   b. Identify whether the images are formed using tomographic or projection imaging
   c. Identify whether the images are formed using transmission or emission
   d. Identify whether the images imaging anatomy or function
   e. Identify the physical value(s) represented by the image. That is, if each pixel represents a number, what does that number represent?

1

a. Modality?
Nuclear

b. tomographic or projection?
Projection

c. transmission or emission?
emission

d. anatomy or function?
Both, but more function

e. physical value?
radioactivity (number of photons) along line of sight)

2

a. Modality?
Nuclear

b. tomographic or projection?
Projection

c. transmission or emission?
Transmission (unusual)

d. anatomy or function?
anatomy

e. physical value?
Bone attenuation at imaging energy (unknown)

3

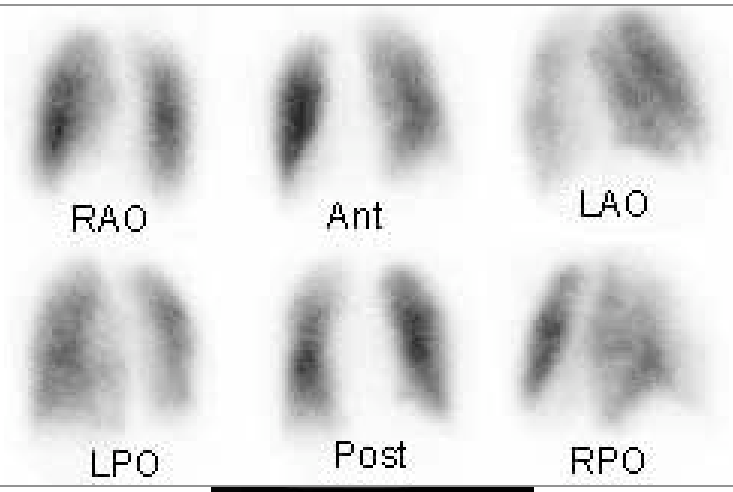
a. Modality?
Nuclear

b. tomographic or projection?
projection

c. transmission or emission?
emission

d. anatomy or function?
function

e. physical value?
radioactivity (number of photons) along line of sight)



4

a. Modality?
X-ray

b. tomographic or projection?
projection

c. transmission or emission?
transmission

d. anatomy or function?
anatomy

e. physical value?
Complex weighted of attenuation for different energies along line of sight

5

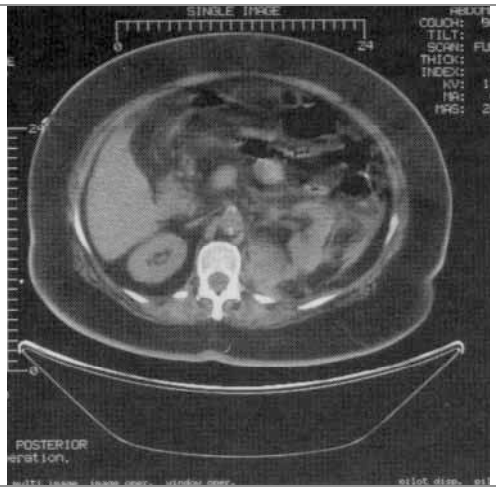
a. Modality?
CT

b. tomographic or projection?
tomographic

c. transmission or emission?
transmission

d. anatomy or function?
anatomy

e. physical value?
Complex weighted of attenuation for different energies for each voxel



6

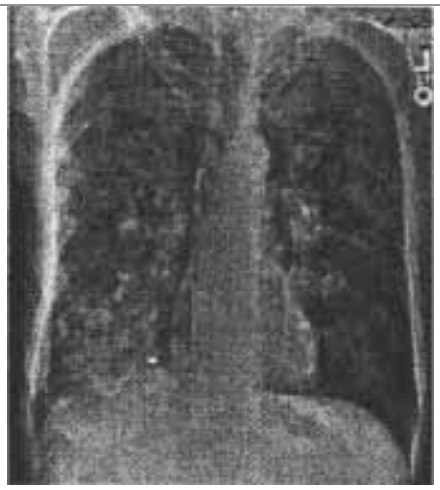
a. Modality?
X-ray

b. tomographic or projection?
projection

c. transmission or emission?
transmission

d. anatomy or function?
anatomy

e. physical value?
Complex weighted of attenuation for different energies along line of sight



7

a. Modality?
Nuclear

b. tomographic or projection?
projection

c. transmission or emission?
emission

d. anatomy or function?
function

e. physical value?
radioactivity (number of photons) along line of sight)

8

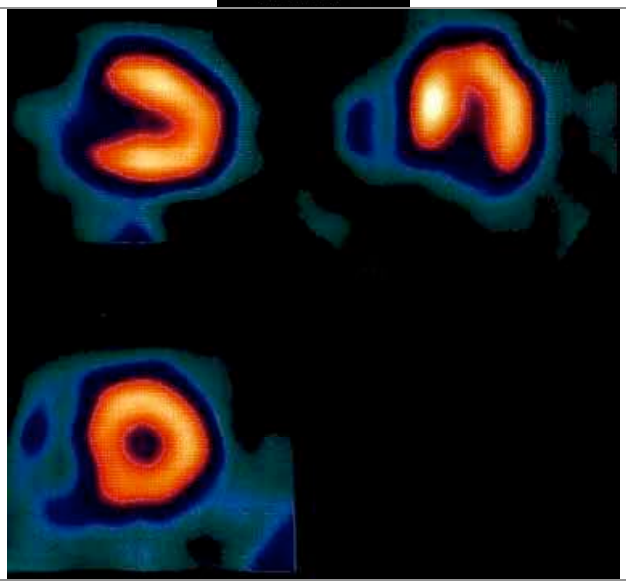
a. Modality?
SPECT or PET

b. tomographic or projection?
tomographic

c. transmission or emission?
emission

d. anatomy or function?
function

e. physical value?
Concentration of radiotracer in each voxel



9

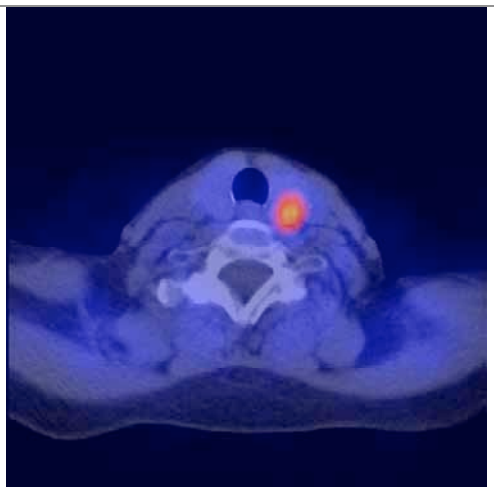
a. Modality?
CT with PET (or SPECT)

b. tomographic or projection?
tomographic

c. transmission or emission?
both

d. anatomy or function?
both

e. physical value?
Each voxel is a split of (1) Complex weighted of attenuation for different energies (CT) and (2) Concentration of radiotracer (PET)



10

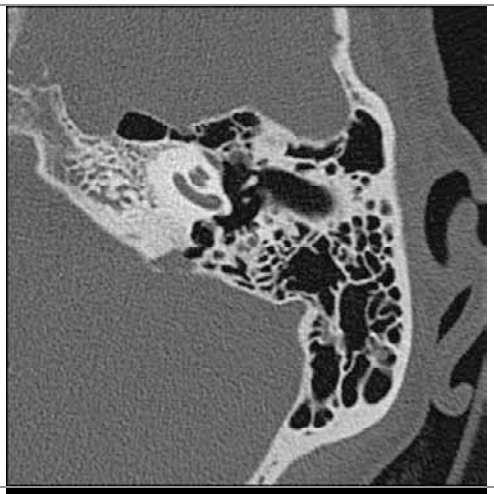
a. Modality?
CT

b. tomographic or projection?
tomographic

c. transmission or emission?
transmission

d. anatomy or function?
anatomy

e. physical value?
Complex weighted of attenuation for different energies for each voxel



11

a. Modality?
CT

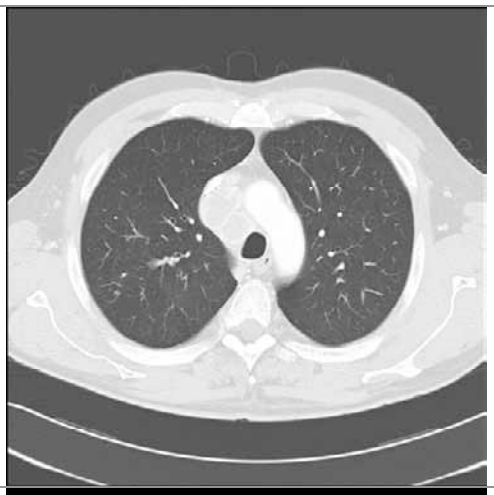
b. tomographic or projection?
tomographic

c. transmission or emission?
transmission

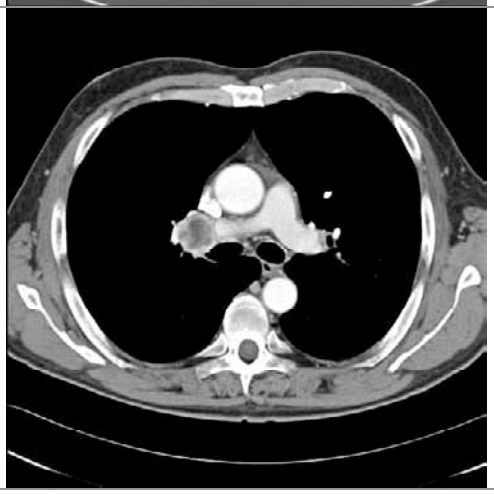
d. anatomy or function?
anatomy

e. physical value?
Complex weighted of attenuation for different energies for each voxel

12 a. Modality?
CT
b. tomographic or projection?
tomographic
c. transmission or emission?
transmission
d. anatomy or function?
anatomy
e. physical value?
Complex weighted of attenuation for different energies for each voxel



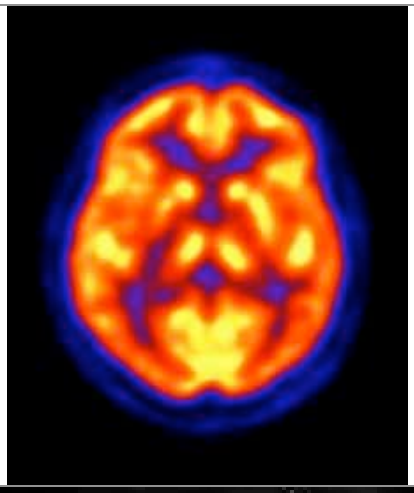
13 a. Modality?
CT
b. tomographic or projection?
tomographic
c. transmission or emission?
transmission
d. anatomy or function?
Anatomy
e. physical value?
Complex weighted of attenuation for different energies for each voxel



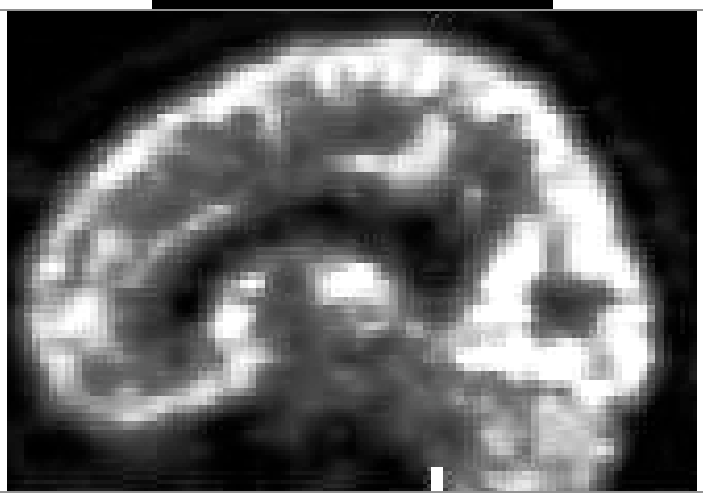
14 a. Modality?
X-ray
b. tomographic or projection?
projection
c. transmission or emission?
transmission
d. anatomy or function?
anatomy
e. physical value?
Complex weighted of attenuation for different energies along line of sight

15 a. Modality?
X-ray
b. tomographic or projection?
projection
c. transmission or emission?
transmission
d. anatomy or function?
anatomy
e. physical value?
Complex weighted of attenuation for different energies along line of sight

16 a. Modality?
PET
b. tomographic or projection?
tomographic
c. transmission or emission?
emission
d. anatomy or function?
function
e. physical value?
Concentration of radiotracer in each voxel



17 a. Modality?
PET
b. tomographic or projection?
tomographic
c. transmission or emission?
emission
d. anatomy or function?
function
e. physical value?
Concentration of radiotracer in each voxel



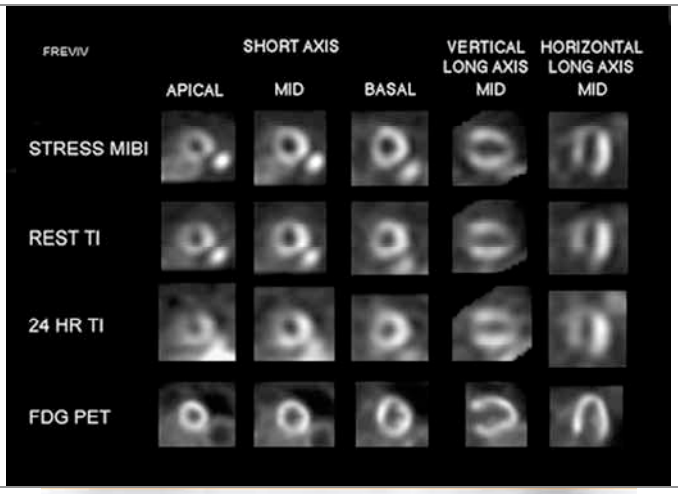
18 a. Modality?
SPECT

b. tomographic or projection?
tomographic

c. transmission or emission?
emission

d. anatomy or function?
function

e. physical value?
Concentration of radiotracer in each voxel



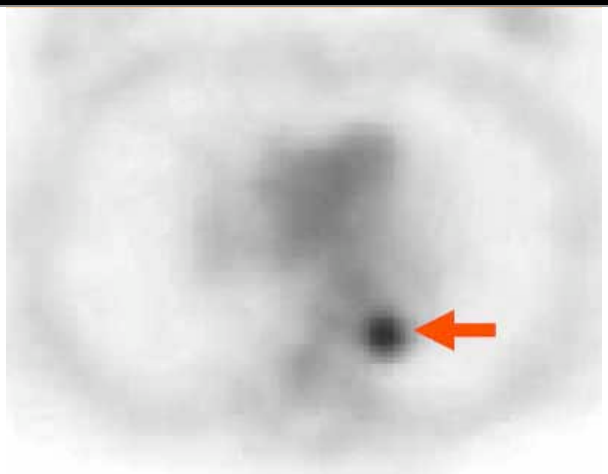
19 a. Modality?
PET

b. tomographic or projection?
tomographic

c. transmission or emission?
emission

d. anatomy or function?
function

e. physical value?
Concentration of radiotracer in each voxel



20 a. Modality?
PET and CT

b. tomographic or projection?
tomographic

c. transmission or emission?
both

d. anatomy or function?
both

e. physical value?
Each voxel is a split of (1) Complex weighted of attenuation for different energies (CT) and (2) Concentration of radiotracer (PET)

8. For the images discussed above, identify which images are essentially the same type based on the above categories (even though they may look different and/or show different features). Identify common types using categories a-d above. Use one or at most two line(s) per group

(1) Nuclear projection emission function: Images 1, (2), 3, 7

(2) X-ray projection transmission anatomy: Images 4, 6, 14, 15

(3) Nuclear (PET or SPECT) tomographic emission function: Images 8, (9), 16, 17, 19, (20)

(4) X-ray (CT) tomographic transmission anatomy: Images 5, (9), 10, 11, 12, 13, (20)

(5) Dual modality (3) and (4): Images 9, 20