Review Problem Set - MRI

1. Consider a 1.5T magnet with Gz=20 mT/m, the difference in larmor frequency between the magnet isocenter (z=0) and a position z=1 cm is equal to,
    a) 8.52 kHz
    b) 8.52 MHz
    c) 63.9 MHz
2. The axes in the rotating frame of reference differ from those in the laboratory frame of reference in that,
    a) Each of the transverse axes precess about their direction at the Larmor frequency
    b) The z-axis precesses at the Larmor frequency
    c) Both x and y axes rotate around the z-axis at the Larmor frequency

3. In order to change the flip angle of the RF pulse,
    a) Change the bandwidth of the RF pulse
    b) Change the amplitude of the RF pulse
    c) Change amplitude of the slice selection gradient

4. In order to change the slice profile,
    a) Change the envelope of the RF pulse at the same bandwidth
    b) Change the RF pulse amplitude
    c) Change the slice selection gradient

5. It is possible to reverse the action of magnetic field inhomogeneity dephasing in FID signals when using,
    a) Gradient echo sequence
    b) Spin-echo sequence
    c) Inversion recovery sequence

6. The signal after a perfect 180 degree RF pulse is expected to be,
    a) Zero
    b) T1-weighted
    c) T2* weighted

7. Comparing a gradient-echo and a spin-echo sequences with the same parameters (TR/TE, flip angle, etc.), the signal from gradient-echo is always,
    a) Smaller
    b) Larger
    c) Equal but opposite in phase

8. To measure T1, we usually use,
    a) Gradient echo pulse sequence
    b) Spin echo pulse sequence
    c) Inversion recovery pulse sequence

9. Magnetic resonance spectroscopy can be used for,
    a) Mapping concentration of different nuclei in the human body noninvasively
    b) Mapping concentration of different metabolites in the human body noninvasively
    c) Mapping magnetic field inhomogeneity in PPM scale inside the magnet

10. The T2-weighted MR image depends on,
    a) Only T2 values inside the body
    b) Only spin density inside the body
    c) Both spin density and T2 inside the body

11. A material that is chemically shifted from water by 1.7kHz has a different resonance frequency at 4T from that of water by approximately,
  a) 1 ppm.
  b) 10 ppm.
  c) 100 ppm.
12. To null a tissue with T1=300 ms using inversion recovery, we should use a TI equal to approximately,
  a) 200 ms
  b) 300 ms
  c) 400 ms
13. The net magnetization refers to
  a) The remaining magnetization after T2* decay.
  b) The difference between spins pointing with B0 and those pointing against B0
  c) The magnetization in the transverse plane at equilibrium.
14. As the static magnetic field becomes higher, the MR signal from is expected to,
  a) Increase quadratically
  b) Decrease linearly
  c) Increase linearly
15. The tipped magnetization vector under the laboratory frame of reference appears,
  a) Precessing around z-axis at the Larmor frequency
  b) Stationary
  c) Rotating at the Larmor frequency.
16. In order to change the slice position of the RF pulse,
  a) Change the pulse modulation frequency
  b) Change the slice selection gradient position
  c) Change the position of the patient
17. In order to change the slice thickness,
  a) Change the slice amplitude
  b) Change the envelope at the same bandwidth
  c) Change the slice selection gradient
18. The rate at which the measured signal in the transverse plan disappears is a function of,
  a) T1
  b) T2
  c) T2*
19. The rate at which the inverted magnetization in inversion recovery sequences relaxes depends on,
  a) T1
  b) T2
  c) T2*
20. The signal decays fast in free induction decay because of,
  a) Spin-spin relaxation
  b) Spin dephasing
  c) Spin lattice relaxation
21. The signal at time TE in a spin echo pulse sequence depends on,
  a) T1
  b) T2
  c) T2*
22. To measure T1, we usually use,
  a) Inversion recovery pulse sequence
  b) Gradient echo pulse sequence

c) Spin echo pulse sequence

23. Magnetic fields in the Tesla range are used for MRI because,
    a) they are easier to generate b) they allow a stronger signal to be obtained
    b) they provide better T1/T2 values d) the existing magnets happen to be in that range
    c) they provide lower noise
24. Rotating frame is preferred to lab frame because,
    a) Rotating frame makes it easier to follow the motion of net magnetization
    b) It provides a nicer polar representation instead of the usual Cartesian form
    c) It makes it easier to image claustrophobic patients
    d) It makes it faster to perform imaging
    e) It reduces motion artifacts
25. Net magnetization can be observed only when,
    a) it is in the rotating frame of reference b) it is in the lab frame
    b) it is in the equilibrium position d) it is in the transverse plane
    c) it is in the same direction as B0.
26. Equilibrium position of net magnetization can be reached after an RF pulse is followed by a delay that is equal to,
    a) 5 T2
    b) TR
    c) TE
    d) 5 T2*
    e) 5 T1
27. To control the slice thickness of an RF pulse, one can do the following:
    a) Change the modulation of the RF pulse
    b) Change the duration of the RF pulse
    c) Change the bandwidth of the RF pulse
    d) Change the amplitude of the RF pulse
    e) Change the direction of the X and Y RF coils
28. A T2*-weighted p ulse sequence can be,
    a) A spin-echo sequence with long TR and long TE
    b) A gradient echo sequence with short TR and short TE
    c) A spin-echo sequence with short TR and long TE
    d) A gradient sequence with long TR and long TE
    e) A spin-echo sequence with long TR and short TE
29. A slice selection gradient of 5 mT/m if combined with an RF pulse of bandwidth of 1kHz will select a slice of thickness:
    a) 1 cm
    b) 1 mm
    c) 2 mm
    d) 5 mm
    e) 8 mm
30. Aliasing artifact in the phase encoding direction results from:
    a) A number of phase encoding steps that is too small
    b) A number of phase encoding steps that is too large
    c) A phase encoding step that is too small
    d) A phase encoding step that is too large
    e) Under-sampling the received time-domain echoes

31. In designing an RF pulse to select a 5mm slice in a 1.5T magnet, if the slice selection gradient is set at 5mT/m and the desired flip angle is ?/6, a proper design for the duration of a rectangular RF pulse can be selected approximately as:
    a) 1 msec
    b) 2 msec
    c) 8 nsec
    d) 1 nsec
    e) Other: ……
32. To acquire an oblique slice that makes an angle of 45 degrees with x-, y- and z-axes, the slice selection design consists of:
    a) Three similar RF pulses in x-, y -, and z-directions with no gradients
    b) One RF pulse and no gradients
    c) Two RF pulses in x- and y-directions and a gradient in z-direction
    d) One RF pulse and equal gradients in x-, y-, and z-directions (*)
    e) Other: ……
33. To control the flip angle of an RF pulse, one can do the following:
    a) Change the modulation of the RF pulse b) Change the duration of the RF pulse
    b) Change the bandwidth of the RF pulse d) Change the amplitude of the RF pulse
    c) Change the direction of the X and Y RF coils
34. Fourier encoding means:
    a) Frequency encoding
    b) Phase encoding
    c) Slice selection
    d) Frequency or phase encoding
    e) Frequency encoding, phase encoding and slice selection
35. The Larmor frequency at 10 cm away from the iso-center of a 1.5 Tesla magnet is:
    a) 63.9 MHz
    b) 42.6 MHz
    c) 28.4 MHz
    d) 21.3 MHz
    e) 85.2 MHz
36. Frequency encoding can be applied for:
    a) Spatial encoding in one dimension
    b) Spatial encoding in two dimensions
    c) Spatial encoding in three dimensions
    d) Shimming the magnet
    e) Slice selection
37. In conventional gradient echo, a single row in the k-space is filled within each:
    a) Scan time
    b) TE period
    c) TR period
    d) RF Excitation
    e) TI period
38. The field of view is primarily determined by:
    a) The sampling bandwidth and read-out gradient
    b) SNR
    c) The number of acquired k-space samples
    d) The size of the reception coils

e) The image resolution.

39. Increasing the voxel size in the phase encoding direction at same coverage will:
    a) Increase the scan time
    b) Decrease the scan time
    c) Have no effect on the scan time
    d) Cause aliasing
    e) Cause motion artifacts
40. In Fourier imaging sequence, each TR enables the acquisition of:
    a) One point in the image
    b) One line in the image
    c) One point in the k-space of the image
    d) One line in the k-space of the image
    e) A collection of random points in the image
41. The cause of aliasing artifact is:
    a) The absence of sampling in RO direction
    b) The absence of sampling in PE direction
    c) The under-sampling in PE direction
    d) The over-sampling of the RO direction
    e) The over-sampling of both the PE and RO directions
42. Cross-talk is the result of:
    a) Interference in signal lines
    b) Interference between gradient coils
    c) Overlapping between adjacent slice profiles
    d) Overlapping of gradients
    e) Overlapping of RF pulses
43. A slice selection gradient of 5 mT/m if combined with an RF pulse of bandwidth of 1kHz will select a slice of thickness:
    a) 1 cm
    b) 1 mm
    c) 2 mm
    d) 5 mm
    e) 8 mm
44. The negative gradient lobe applied right before the RO gradient in the same direction is used to:
    a) Make phase encoding
    b) Make better slice selection
    c) Allow longer acquisition
    d) Make center of k-space in the center of acquisition window
    e) Center image
45. To increase the resolution in the frequency encoding direction for the same FOV,
    a) use higher sampling rate for same duration
    b) use same sampling rate for longer duration
    c) use higher sampling for longer duration
    d) apply additional phase encoding
    e) use a thinner slice selection
46. The key component for spatial encoding in MRI systems is,
    a) main magnet
    b) quadrature coils
    c) gradient coils

d) shim coils
e) gantry

47. In a multi-slice TOF MRA imaging sequence, the scan parameters were: TR/TE: 300/20 msec, FOV: 20cm x 20cm, Matrix 256x256, Number of slices: 128, slice thickness: 5mm, NEX: 2, flip angle: 30 degrees. The shortest total acquisition time for this sequence is approximately:
    a) 18 minutes
    b) 245 minutes
    c) 2 minutes
    d) 9 minutes
    e) Other: …….
48. Image resolution can be expressed in units of,
    a) bits
    b) lp/mm
    c) 1/sec
    d) mm/sec
    e) points
49. Inversion time for suppressing fat (T1=300 ms) in an image is approximately,
    a) 400 ms
    b) 800 ms
    c) 200 ms
    d) 1 sec
    e) other: -------
50. The resolution in the read-out direction depends on,
    a) Sampling duration (k-space coverage)
    b) Sampling bandwidth (k-space sampling rate)
    c) Sampling dynamic range (number of bits of sampling A/D)
51. The FOV in the phase encoding direction depends mainly on,
    a) Phase encoding step size only
    b) Number of phase encoding steps and step size
    c) Matrix size in the phase encoding direction only
52. To maintain the same resolution in the read-out direction at a larger FOV, one can,
    a) Increase the k-space sampling bandwidth only
    b) Increase the k-space coverage in the read-out direction only
    c) Increase both k-space sampling bandwidth and k-space coverage
53. The acquisition time for 30 128x128 slices when NEX=2, TE=50 ms, and TR=1 sec is approximately,
    a) 8.5 min
    b) 4.3 min
    c) 6.4 min
54. For a multi-slice imaging sequence with parameters given as: slice thickness: 5mm, flip angle: 60 degrees, matrix size: 128x192, FOV: 20cmx25cm, NEX: 1, and TR/TE: 600/20, the ratio of acquisition time to acquire 25 slices to that of acquiring 20 slices using this sequence is,
    a) 1
    b) 1.25
    c) 2
55. A material that is chemically shifted from water by 1.7k has a different resonance frequency at 4T from that of water by approximately,
    a) 10 ppm.
    b) 100 ppm.

c) 1 ppm.

56. The total acquisition time for a 3-D Fourier acquisition of a volume of matrix size 128? 128? 256 with TR/TE: 100/15ms is approximately,
    a) 14 minutes.
    b) 27 minutes.
    c) 54 minutes.
57. The k-space represents,
    a) The Fourier domain of the image
    b) The MR image space
    c) The space where k-space trajectories are designed.
58. The FOV in the read-out direction depends on,
    a) Sampling bandwidth
    b) Sampling duration
    c) Sampling dynamic range
59. The FOV in the phase encoding direction depends mainly on,
    a) Phase encoding step size
    b) Number of phase encoding steps
    c) Matrix size in the phase encoding direction
60. The implementation of FOV selection in MRI systems is done through,
    a) Proper selection of sampling steps in kx and ky directions.
    b) Proper selection of k-space coverage in in kx and ky directions.
    c) Proper positioning of the patient inside the magnet.
    d) Proper adjustment of the image reconstruction software.
    e) Proper selection of the Larmor frequencies inside the patient.
61. Given a 60 degrees RF pulse that is implemented using a Sinc time domain envelope using a slice selection gradient Gz=15mT/m at 1.5T to excite a 3mm slice centered at z=1cm, we can derive another RF pulse to excite a similar slice profile at z=2cm by modifying the current pulse as follows,
    a) Increase the modulation frequency by 6.4kHz.
    b) Shift the slice selection gradient by 1 cm.
    c) Double the time domain width of the RF pulse.
    d) Decrease the amplitude of the RF pulse by one half.
    e) Change the RF envelope function.
62. Draw a properly labeled T2-weighted magnetic resonance imaging sequence that can be used for imaging 3-D volume using 3 -D Fourier imaging. Draw a clear diagram of its k-space trajectory.
63. Draw a properly labeled T2* -weighted sequence that has the shown k-space trajectory: