1. As much as ———— atoms lined up together are narrower than a human hair.
   A 150,000  B 220,000  C 340,000  D half a million

2. The isotope of the hydrogen nucleus called ———— is the MR active nucleus used in clinical MRI.
   A protium  B platinum  C palladium  D promethium

3. The unit of precessional frequency is megahertz (MHz). 1 MHz is ———— cycles or rotations per second.
   A 100  B 1,000  C 100,00  D one million

4. The application of an RF pulse that causes resonance to occur is termed:
   A resonance  B the Larmor effect  C excitation  D phasing

5. ———— is the position of each magnetic moment on the precessional path around $B_0$ ($B_0$ is the magnetic field strength of the magnet).
   A Spin  B Phase  C NMV  D Frequency

6. The ———— time (TE) is the time from the application of the RF pulse to the peak of the signal induced in the coil - measured in ms.
   A edge  B echo  C encoding  D electron

7. ———— contrast parameters are those that cannot be changed because they are inherent to the body’s tissues.
   A Extrinsic  B TR  C TE  D Intrinsic

8. Fat molecules consist of large molecules called ———— that are closely packed together.
   A histidine  B lipids  C isoleucine  D glycine

9. Proton density contrast is always present and differs in each patient. It is the basic MRI contrast and is called proton density:
   A weighting  B scale  C differential  D value assignment

10. ———— weighted images are characterized by bright fat and dark water.
    A T2  B T1  C Proton density  D Nuclear density

11. When the NMV (net magnetization vector) is pushed to a full ———— degrees, it is said to be fully saturated.
    A 45  B 90  C 135  D 180

12. The spin echo pulse sequence commonly uses 90 degrees excitation pulse to flip NMV into the ———— plane.
    A coronal  B sagittal  C transverse  D frontal

13. ———— is the time between each 90 degree excitation pulse for each slice.
    A TAU  B TR  C TE  D RF

14. Magnetic field gradients are generated by coils of wire situated ———— the magnet.
    A surrounding  B on opposite ends outside  C within the bore  D both inside and outside

15. Gradients that dephase are called:
    A degraders  B spoilers  C zero gradients  D obsolete factors

16. Gradients that rephase are called:
    A backward gradients  B rewinders  C backtrackers  D step backs

17. ———— is the time from the excitation pulse to the peak of gradient echo.
    A TE  B TAU  C RF  D TR

18. Nuclei that experience a lower magnetic field strength due to the gradient:
    A speed up slightly  B speed up by a factor of 4  C slow down  D maintain their speed

19. Spatially locating (encoding) signal along a short axis of the anatomy is called ———— encoding.
    A phase  B frequency  C slice  D gradient

20. In gradient echo pulse sequences, the slice select gradient is switched on during the excitation pulse only.
    A True  B False
21. The frequency encoding gradient is switched on when the signal is received and is often called the ——— gradient.
A FOV  B reading  C readout  D uneven

22. Regarding imaging of the head, the ——— gradient performs phase encoding.
A Y  B X  C K  D readout

23. The duration of the readout gradient is called the sampling time or ——— window.
A gathering  B accumulation  C set  D acquisition

24. The sampling ——— is the rate at which frequencies are sampled or digitized during the acquisition window per second.
A period  B duration  C acceleration  D frequency

25. In MRI the sampling frequency is determined by the ——— theorem.
A Netter  B Nacci  C Nyquist  D Nace

26. As data of each signal position is collected, the information is stored as data points in ——— space.
A K  B X  C Y  D T

27. To produce an image from the acquired data points we need to complete a mathematical process called Fast Fourier ——— (FFT).
A transition  B transient  C transform  D tertiary

28. Frequency data digitized from the echo are the same on one side as they are on the other. The result is called ——— symmetry.
A identical  B conjugate  C harmonious  D balanced

29. The phase ——— determines the number of lines that must be filled to complete the scan.
A cube  B matrix  C parameters  D encoding

30. As long as at least ——— of the lines of K space that have been selected are filled during acquisition, then an image may be produced.
A one third  B one fourth  C one fifth  D half

CHAPTER FOUR: PARAMETERS AND TRADE-OFFS

31. The brightness of the pixel represents the strength of the MRI signal generated by a unit volume of patient tissue, called a:
A cuboid  B voxel  C matrix  D slice

32. A ——— matrix is one with a low number of frequency encodings and/or phase encodings and results in a low pixel count in the FOV.
A coarse  B pixilated  C broad  D fine

33. A long TR ——— SNR (signal to noise ratio).
A increases  B slightly decreases  C has no effect on  D decreases (by a factor of 4)

34. A short TE ——— SNR.
A slightly decreases  B decreases (by a factor of 4)  C increases  D has no effect on

35. The ——— controls the amount of data stored in each line of K space.
A NMV  B NTC  C NEX  D SNR

36. To double the SNR we need to increase the NEX and the scan time by a factor of:
A three  B four  C two  D five

37. The CNR (——— to noise ratio) is probably the most critical factor affecting image quality.
A coil  B core  C console  D contrast

38. The use of MTC (magnetization transfer contrast) increases CNR between pathological and normal tissues and is useful in many areas.
A True  B False

39. In large voxels, individual signal intensities are averaged together and not represented as distinct within the voxel. This results in:
A partial voluming  B a black space  C a white space  D no image detail displayed

40. In obtaining good resolution, achieving thin slices requires the slice select gradient slope to be:
A horizontal  B gradual  C steep  D vertical
41. To obtain equal resolution in every plane and at every angle of obliquity, each voxel should be symmetrical (isotropic).
   A True               B False

42. Spin echo pulse sequences are rephrased by a _______ degree rephrasing pulse.
   A 45               B 90               C 135            D 180

43. Another name for turbo factor is echo _______ length.
   A line               B train            C replication        D value

44. Very steep phase encoding slopes _______ the amplitude of the resultant echo.
   A increase by a factor of 3       B reduce        C slightly increase        D has no effect on

45. Fat remains bright on T2 weighted images due to the multiple RF pulses, which reduce the effects of spin-spin interactions in fat – called:
   A J coupling       B J spacing        C Z coupling       D Z spacing

46. It is possible to acquire fast spin echo images in shorter scan times by using a technique known as _______ shot fast spin echo (SS-FSE).
   A super            B sign            C single           D slice

47. _______ recovery (IR) was developed in the early days of MRI to provide good T1 contrast on low field systems.
   A Interval       B Isotropic       C Inversion          D Image

48. Pathology _______ produces an image that is predominantly T1 weighted, but where pathological processes appear bright.
   A contrast        B density         C algorithms        D weighting

49. Regarding the STIR sequence, the T1 required to null the signal from a tissue is _______ times its T1 relaxation time.
   A 0.85            B 0.41          C 0.32            D 0.69

50. _______ is used to suppress the high CSF signal in T2 weighted images so that pathology adjacent to CSF is seen more clearly.
   A Tau             B STIR           C FLAIR            D IR

51. FLAIR is used in brain and spine imaging to see periventricular and cord lesions more clearly – as high signal from adjacent CSF is:
   A nulled       B halted          C increased        D not perceived

52. Gradient echo sequences allow for a reduction in the scan time as the TR:
   A is greatly reduced   B is increased       C is slightly reduced   D remains constant

53. In the _______ state, there is co-existence of both longitudinal and transverse magnetization.
   A constant       B steady          C holding          D frozen

54. Any two 90 degree RF pulses produce a _______ echo.
   A Hahn            B Harris          C Handel           D Herbert

55. Gradient spoiling is _______ rewinding.
   A almost the same as    B the same as          C the opposite of   D dependent on

56. Balanced gradient echo was developed initially for imaging the:
   A brain            B abdomen        C limbs            D heart and great vessels

57. Fast gradient systems permit multi-slice gradient echo sequences with TEs as short as _______ ms.
   A 0.2          B 1.3           C 2.1            D 0.7

58. K space segmentation by acquisition acquires a section of K space at a time so that there are _______ excitations and TR periods.
   A four            B three          C eight           D two

59. The motion of flowing nuclei causes mismapping of signals and results in artefacts known as phase:
   A disappearance      B ghosting       C apparitions        D shifting

60. Flowing nuclei present in the slice for the excitation may exit the slice before rephrasing. This is called _______ phenomenon.
   A time of flight    B unphased       C exit              D time of exit

61. Nuclei that receive repeated RF pulses during an acquisition with a short TR are said to be:
   A full            B partial         C saturated        D spent
62. When nuclei within the same voxel are out of phase with each other, it is called __________ dephasing.
A extra-voxel  B intra-voxel  C motion  D reversible

63. When gradient moment rephrasing assumes a constant velocity and direction across the gradient at all times, it is called first order:
A motion compensation  B kinetic compensation  C frozen compensation  D time compensation

64. The frequency difference between fat and water is called __________ shift.
A permeability  B gradient  C chemical  D magnetic

65. The interval between the pre-saturation pulses is called SAT TR and is equal to the scan TR __________ the number of slices.
A divided by  B times  C minus  D plus

66. Pre-saturation does not give flowing nuclei a signal void (spatial pre-saturation).
A True  B False

CHAPTER SEVEN: ARTEFACTS AND THEIR COMPENSATION

67. Swallowing and pulsatile motion of the carotids along the phase axis produces __________ over the spinal cord.
A chemical shift artifact  B Moire’ artifact  C ghosting  D cross-excitation

68. Placing pre-saturation volumes over the area producing artifact nullifies signal __________ the artifact.
A and slightly increases  B and increases by a factor of 2  C and reduces  D but has no effect on

69. Some systems use a method known as respiratory gating or __________ that times the excitation RF with a certain phase of respiration.
A popping  B blending  C navigating  D triggering

70. __________ gating uses a light sensor attached to the patient’s finger to detect the pulsation of blood cells through the capillaries.
A Limb  B Side  C ECG  D Peripheral

71. Aliasing along the frequency encoding axis is known as frequency:
A wrap  B encasement  C pulse alignment  D compensation

72. Aliasing along both the frequency and phase axis can totally degrade an image and should be compensated for.
A True  B False

73. Increasing the sampling rate so that all frequencies are digitized sufficiently would __________ aliasing in the frequency direction.
A enhance or sharpen the  B eliminate  C double the rate of  D triple the rate of

74. Chemical __________ artifact is caused by the different chemical environments of fat and water.
A dots  B movement  C shift  D gradient

75. __________ artifact produces distortion of the image together with large signal voids.
A Truncation  B Out of phase  C Magnetic susceptibility  D Cross-excitation

76. __________ artifact appears as a dense line on the image at a specific point.
A Moire’  B Shading  C Magic angle  D Zipper

CHAPTER EIGHT: VASCULAR AND CARDIAC IMAGING

77. Blood __________ flow(s) at a constant velocity.
A always  B usually  C never  D does not usually

78. Images in which the signal from blood has been largely eradicated is known as __________ imaging.
A black blood  B bright blood  C wipe-out  D deletion

79. A technique known as __________ applies a non slice selective 180 degree pulse followed by a slice selective 180 degree pulse.
A IR pairing  B double IR prep  C doppia IR  D IR redundant

80. Vascular structures can be visualized by making vessels appear hyper-intense rather than hypo-intense - producing __________ imaging.
A deletion  B black blood  C bright blood  D wipe-out

81. __________ is maximized by enhancing the signal from moving spins in flowing blood and/or suppressing the signal from stationary spins.
A Vascular scale  B Vascular contrast  C Vascular eradication  D Vascular subtraction
82. Digital subtraction MRA, also known as ——— imaging, is a technique that allows visualization of the vasculature over a wide FOV.
A minus B blood enhancement C fresh-blood D MOTSA

83. MOTSA essentially provides the high resolution of 3D inflow techniques coupled with the wider coverage of 2D inflow MRA.
A True B False

84. Suppression of in-plane vascular signal, especially in 3D acquisitions, can be overcome by the utilization of ——— RF pulses.
A projectile B slowed C ramped D more leveled

85. MRA can be obtained through several techniques, including maximum intensity projection (MIP) and ——— surface display (SSD).
A shaded B stationary C signal D slice

86. The strength and duration of the velocity encoding gradient pulse is selected based on the blood flow ——— that is to be imaged.
A acceleration B velocity C pressure D volume

87. ——— MRA sequences have the ability to evaluate vasculature with blood flow in multiple directions and with varying flow velocities.
A NEX B AVM C PC D 2D

88. Regarding the parameters and clinical suggestions for PC-MRA, the TR should be ——— ms.
A 30 B 20 C 10 D 40

89. CE-MRA images can be post-processed (like TOF-MRAs) with the MIP technique, but not the SSD technique.
A True B False

90. As cardiac imaging uses each R wave to trigger the pulse sequence, the TR depends on the time interval between each R wave — called:
A the R period B the Double R interval C the R to R interval D the R duration

CHAPTER NINE: INSTRUMENTATION AND EQUIPMENT

91. The ——— converts ‘signals’ into images.
A radio frequency source B computer system C field gradient system D image processor

92. ——— materials have paired electrons.
A Diamagnetic B Paramagnetic C Superparamagnetic D Ferromagnetic

93. In the equation, \( B_0 = H_0(1 + X) \), the apparent magnetization of an atom is shown. In the equation, \( H_0 \) refers to:
A magnetic field B magnetic intensity C magnetic deceleration D magnetic acceleration

94. The most common material used to produce a permanent magnet is an alloy of aluminum, nickel, and cobalt known as:
A pachinko B chromium C manganese D alnico

95. To create a strong magnet, one wire is wrapped around to form many loops (like a spring), which creates a(n) ——— electromagnet.
A rotating B solenoid C even echo D processional

96. An electromagnet at room temperature is subject to Ohm’s law and is said to be a ——— magnet.
A superconducting B natural C resistive D simple

97. The capacity of an MRI cryostat varies with machine design, but a volume of ——— liters would probably be a good average.
A 750 B 900 C 1200 D 1500

98. ——— shimming is performed by scanning a phantom and adjusting the position of the shim plates for optimum field homogeneity.
A Passive B Active C Determined D Placement

99. The ——— defines the time it takes for a given gradient to reach maximum amplitude and what the amplitude is.
A slew rate B duty cycle C gradient speed D gradient rise time

100. A(n) ——— is a cylindrical array of electrically conductive elements positioned around the inner circumference of the magnet bore.
A head coil B body coil C extremity coil D central coil

CHAPTER TEN: MRI SAFETY

101. Created by a panel assembled by the American College of Radiology, the White Paper on MRI Safety was published for the first time in:

102. The text defines MR ——— as ‘an item that is known to pose hazards in all MRI environments’.
A conditional 7 B unsafe C precautionary D conditional 3
103. In the USA, the SAR (specific absorption rate) limits for extremities is ——— W/kg – in 5 minutes – per gram of tissue.
A 9  B 14  C 12  D 8

104. There have been a number of burns and even fires associated with exposure to the RF fields in MRI.
A True  B False

105. Some reversible biological effects have been observed on human subjects exposed to ——— T and above.
A 2.5  B 4.0  C 2.0  D 3.5

106. In a scanner with a cryostat volume of 1,500 liters, a spontaneous helium boil-off would liberate over ——— liters of gas.
A 1,000  B 10,000  C 100,000  D 1,000,000

107. Ferromagnetic metal objects can become airborne as projectiles in the presence of a strong static magnetic field, known as the:
A dart phenomena  B target affect  C missile affect  D airborne phenomena

108. Regarding MRI facility zones, the ACR white paper would term an area that generally pertains to the patient waiting room as Zone:
A I  B II  C III  D IV

109. Regarding levels of personnel, the ACR white paper deems individuals who have very extensive training in MR safety issues as Level:
A 1  B 2  C 3  D 4

110. Gadolinium is highly toxic, but it can be made safe for use by binding or chelating the gadolinium to other molecules.
A True  B False

111. Unpaired electrons have a magnetic moment (μ) that is ——— times that of a hydrogen proton.
A 5,000  B 50,000  C 500,000  D 5,000,000

112. The recommended dosage of gadolinium is ——— millimoles per kilogram (mmol/kg) of body weight, (0.2 ml/kg).
A 0.001  B 0.05  C 0.01  D 0.1

113. Gadolinium is a rare earth metal (lanthanide) – more commonly known as a ——— metal.
A base  B noble  C precious  D heavy

114. Studies have shown that approximately 80% of gadolinium is excreted by the kidneys in ——— hours.
A 1  B 3  C 10  D 48

115. Perfusion imaging measures blood volume to tissues; however, fewer than ——— % of tissue protons are intravascular.
A 20  B 15  C 10  D 5

116. Regarding CE-MRA, within ——— minutes after injection lesions begin to enhance so that they are isointense with normal parenchyma.
A 1  B 4  C 2  D 5

117. ——— is a term used to describe the movement of molecules in the extra-cellular space due to random thermal motion.
A Diffusion  B Transference  C Osmosis  D Tensor motion

118. The anatomy of white matter tracts can be mapped using strong multidirectional gradients in diffusion ——— imaging (DTI).
A tensor  B tertiary  C transference  D trace

119. Blood oxygenation level ——— (BOLD) produces MR signal intensity changes between stimulus and rest.
A dependent  B dosage  C diffusion  D data

120. Magnetic resonance ——— (MRM) uses very fine resolution data to image structures with the same resolution as pathology sections.
A micro  B microscopy  C movement  D motion
Fill in each blank. There are two options to submit the post-test.

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