1. The periodic table is organized into __________ and _________.
    a. groups, periods
    b. groups, types
    c. blocks, groups
    d. blocks, types

2. All elements in a period have __________
    a. different number of electron shells
    b. similar chemical and physical characteristics
    c. same number of electron shells
    d. different physical, but similar chemical characteristics.

3. The two axes of the Chart of the Nuclides represent the number of _______ and _______.
    a. neutrons, electrons
    b. neutrons, positrons
    c. protons, electrons
    d. protons, neutrons

4. The periodic table represents ________ whereas the Chart of the Nuclides represents ________.
    a. elements, groups
    b. elements, isotopes
    c. groups, periods
    d. groups, isotopes

5. On the Chart of the Nuclides, a solid gray square represents the isotope is ___________.
    a. naturally radioactive
    b. stable
    c. artificially radioactive
    d. fissionable

6. The elements that fall along the line of stability on the Chart of the Nuclides have an equal number of _______ and ________.
   a. protons, neutrons
   b. protons, electrons
   c. neutrons, electrons
   d. neutrons, positrons

7. Isotopes that reside on the upper end of the line of stability on the Chart of the Nuclides undergo radioactive decay by ________.
   a. electron capture
   b. spontaneous fission
   c. positron release
   d. alpha particle release

8. In _________, the nucleus splits into unequal parts with a large amount of energy.
   a. thermal fission
   b. spontaneous fission
   c. nuclear fission
   d. intermediate fission

9. When a nucleus undergoes ________, the fission fragments have excess neutrons and undergo beta decay.
   a. thermal fission
   b. spontaneous fission
   c. intermediate fission
   d. nuclear fission

10. The most important factor in a complexation reaction is the _________.
    a. valence state
    b. physical state
    c. radioactive half-life
    d. chemical form

11. _______ occurs when ions in an aqueous solution form an insoluble ionic solid.
    a. dissolution
    b. segregation
    c. polarization
    d. precipitation

12. The separation or partitioning of radioisotopes in liquid solutions is performed by _____________.
    a. evaporation
    b. precipitation
    c. solvent extraction
    d. complexation

13. _________ reactions are a function of a metal atom or ion's ability to join with compounds that have pairs of electrons to donate.
    a. complexation
    b. separation
    c. complexation
    d. precipitation

14. The attraction of a specific ion to a given ion exchange resin is known as __________.
    a. equilibrium
    b. selectivity
    c. preference
    d. attraction

15. To selectively remove an ion from ion exchange resin, it may be necessary to add _________ and adjust ________ to get the best result.
    a. carrier, flow
    b. acid, pH
    c. caustic, temperature
    d. carrier, pH

16. Carriers not only carry along small amounts of the radioisotope, but also help determine ________.
    a. isotopic yield
    b. chemical composition
    c. isotopic composition
    d. chemical yield

17. Carriers provide the ability to extract a desired radioisotope by adding a _________ similar stable isotope to the sample.
    a. biologically
    b. radioactively
    c. chemically
    d. isotopically

18. In selecting an isotopic carrier to a sample, care should be taken to ensure that the carrier has the same __________ and _________ as the nuclide to be analyzed.
    a. oxidation state, chemical form
    b. oxidation state, mass number
    c. chemical form, density
    d. chemical form, solubility

19. Tracers are used so that the __________ of the chemical separation can be monitored.
    a. activity
    b. yield
    c. purity
    d. solubility

20. One important issue that should be considered that should be considered when choosing a tracer is ____________.
    a. health hazards of the tracer
    b. cost of the tracer
    c. disposal costs
    d. time necessary for preparation

21. Limiting factors such as the chemical form at the tracer level and _______ make the selection of an ideal carrier difficult.
    a. chemical properties
    b. cost
    c. chemical impurities
    d. availability

22. Gas proportional counters operate on the principle of the ________ of gas molecules by decay particles to generate a pulse.
    a. destruction
    b. combination
    c. acceleration
    d. ionization

23. The two factors that contribute to ion pair production in gas proportional counters are _________ and ________.
    a. charge potential, high electron charge
    b. charge potential, high electron density
    c. low electron density, low charge density
    d. low electron density, high charge density

24. Gas proportional counters may be used to count and analyze _________ and __________ radiation.
    a. alpha, gamma
    b. beta, gamma
    c. gamma, x-ray
    d. alpha, beta

25. The primary disadvantage of gas proportional counting systems is _____________.
    a. sample preparation
    b. sample size
    c. sample activity
    d. sample density

26. The primary advantage of gas proportional counting system is its ________ in counting alpha and beta nuclides of various energies.
    a. versatility
    b. accuracy
    c. precision
    d. speed

27. __________ and ________ can aid in the elimination of errors in gas proportional counting data.
    a. Lower count rates, thicker detector windows
    b. Larger sample sizes, good techniques
    c. Pulse height discriminators, clean separations
    d. Higher activity samples, short counting times

28. When performing alpha analysis using gas proportional counting, source and samples must be ______ and _______for maximum detection capability.
    a. thick, moist
    b. thin, uniform
    c. thin, moist
    d. thick, uniform

29. The attenuation of alpha particles in a sample that is too dense or has an uneven surface is called _________.
    a. self-shielding
    b. self-annihilation
    c. self-assistance
    d. self-absorption

30. Alpha counting data errors commonly occur because of __________
    a. crossfire
    b. crossover
    c. crosstalk
    d. cross-intimidation

31. When reviewing a gas proportional spectrum containing both alpha and beta counts, the alpha counts should appear at the ____ of the spectrum
    a. lower end
    b. middle
    c. upper end
    d. none of the above

32. Liquid scintillation counters rely on the interaction of the __________ and the __________ producing light photons.
    a. beta particles, photocathode tube
    b. phosphor, photomultiplier tube
    c. beta particles, phosphor
    d. beta particles, photomultiplier tube

33. What color light is emitted in a scintillation counter?
    a. White
    b. Blue
    c. Red
    d. Green

34. Liquid scintillation counting is unique in that it ___________.
    a. samples must be dark adapted
    b. detector requires a high voltage
    c. moves particles using a carrier gas
    d. requires extensive sample preparation

35. Coincidence counting in liquid scintillation counters describes the ___________________.
    a. ability to sum all counts simultaneously
    b. ability to send multiple light signals to the multi-channel analyzer
    c. ability to count background samples at the same time
    d. ability to detect light in two photomultiplier tubes

36. The liquid scintillation counting system is primarily used to count ______ radiation; however, _________ radiation can be counted on a limited basis.
    a. beta, gamma
    b. alpha, gamma
    c. alpha, beta
    d. beta, alpha

37. The most common interference associated with liquid scintillation counting is _____________.
    a. absorption
    b. masking
    c. quench
    d. shielding

38. Liquid scintillation counting error can be caused by _________________.
    a. chemicals, color, and opacity
    b. chemicals, time, and opacity
    c. chemicals, color, and particulates
    d. color, particulates, and density

39. In a gamma spectroscopy system, the energy that is produced as a result of the number of __________ that are produced when the gamma ray strikes the detector.
    a. photons
    b. electrons
    c. protons
    d. neutrons

40. The transfer of energy to an inner shell electron during a gamma ray interaction occurs because of ____________.
    a. photoelectric effect
    b. pair production
    c. Compton scattering
    d. self-absorption

41. The interaction of a gamma ray with an inner shell electron, resulting in an electron along with a photon escaping is known as ____________.
    a. photoelectric effect
    b. recoil scattering
    c. pair production
    d. Compton scattering

42. The two most common types of gamma detectors are __________ and __________.
    a. Semi-conductor, proportional
    b. scintillation, Geiger-Mueller
    c. scintillation, semi-conductor
    d. semi-conductor, ionization

43. The most common material used for gamma ray scintillation detectors is ___________.
    a. potassium chloride
    b. sodium iodide
    c. sodium chloride
    d. germanium

44. Germanium is used in gamma counting systems because it ____________.
    a. has better peak resolution
    b. is very mobile
    c. has a long half-life
    d. has a higher efficiency factor.

45. Lowering the temperature of a germanium detector increases ___________.
    a. reaction time
    b. geometry
    c. stopping power
    d. cost

46. Liquid nitrogen cooled gamma counting systems that are not cooled adequately are susceptible to:
    a. vibration
    b. condensation
    c. static electricity
    d. electronic noise

47. One advantage of scintillation gamma detectors over other types is ___________.
    a. Power considerations
    b. mobility
    c. range of isotope identification
    d. cross-talk

48. Errors in gamma spectroscopy systems can be attributed to either __________ or ___________.
    a. system performance, interpretation of data
    b. system performance, inadequate count time
    c. lack of vendor support, sample preparation
    d. environmental factors, operator error

49. A key consideration when preparing samples for gamma counting is ________.
    a. density
    b. color
    c. geometry
    d. sample source

50. The gamma counting efficiency of a liquid sample can be increased by ___________.
    a. reducing the count time
    b. shielding the sample
    c. reducing the overall geometry size
    d. increasing the cooling of the detector

51. Gamma spectroscopy peaks should be __________.
    a. Wide to contain more counts
    b. Narrow to isolate different energies
    c. Combined with other isotope energies to ensure adequate counting
    d. Different each time a same is counted due to decay

52. Alpha spectroscopy counting takes place in _______________.
    a. a nitrogen filled detector
    b. a helium gas chamber
    c. in a clean-room environment
    d. in a vacuum chamber

53. Due to a __________, alpha spectrometers must possess adequate resolution to readily identify individual isotopes.
    a. small range of energies
    b. large range of energies
    c. large number of isotopes
    d. small number of isotopes

54. Alpha spectroscopy is subject to cross-talk from ___________.
    a. low-energy beta emitters
    b. high-energy beta emitters
    c. gamma radiation
    d. radiofrequency interference

55. The most common type of isotope separation is __________.
    a. fluoride precipitation
    b. electro-plating
    c. sample evaporation
    d. alpha energy isolation

56. The primary disadvantage of alpha spectroscopy is _____________.
    a. high cost of operation
    b. low detector efficiency
    c. extensive sample preparation
    d. long counting times

57. Alpha particles have ________ travel distances compared to other radioactive particles.
    a. short
    b. long
    c. unpredictable
    d. mid-range

58. One cause of alpha detector contamination is __________.
    a. beta energy in the detector
    b. Loose sample material
    c. Loss of nitrogen cooling
    d. low sample counts

59. In alpha spectroscopy, what is a region of interest (ROI)?
    a. An area of the detector that has a higher efficiency.
    b. The average of an isotope’s energy profile.
    c. A range of channels where a specific isotope is found.
    d. The common energy of the most likely isotope.

60. The mean rate at which a nuclide decays is called it's ________.
    a. carrier ratio
    b. efficiency
    c. recovery
    d. activity

61. ____________ is the ratio of the amount of analyte present in a spiked sample to the amount of analyte added, expressed as a percentage.
    a. Activity
    b. Recovery
    c. Efficiency
    d. Attenuation factor

62. The decay constant can be used in radiochemistry activity calculations to ______________.
    a. determine sample activity at a given point in time
    b. correct for background errors
    c. calculate the amount of radiation received during decay
    d. determine whole-body dose rates for sample analysts

63. __________ is a source of counting error.
    a. Geometry
    b. Continuous discharge
    c. Self-absorption
    d. Random disintegration

64. The term ___________ _____ refers to the time interval which must elapse after a pulse is counted before another pulse can be detected.
    a. resolving time
    b. rest time
    c. down time
    d. recovery time

65. A laboratory technician is subject to error in radiochemistry processes because of _________.
    a. self-absorption
    b. sample geometry
    c. reagent purity
    d. inattention to detail

66. A radiochemistry analysis error related to human performance is _________.
    a. equipment failure
    b. cross-contamination
    c. high counting background
    d. instrument efficiency

67. The first legislation dealing with nuclear waste was called the ____________.
    a. Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA)
    b. Atomic Energy Act
    c. Nuclear Waste Policy Act
    d. Radioactive Waste Disposal Act

68. The regulation regarding radioactive waste currently guiding cleanup in the United States is enforced by the ______________.
    a. Environmental Protection Agency
    b. Department of Energy
    c. Department of Homeland Security
    d. Nuclear Regulatory Commission

69. 40 CFR – Part 191 was specifically written for wastes created __________.
    a. during laboratory operations
    b. from nuclear bomb testing
    c. during production of nuclear weapons
    d. from disposal of nuclear reactor fuel

70. Transuranic wastes contain elements with atomic numbers greater than ________.
    a. 100
    b. 78
    c. 118
    d. 92