

SECTION I [APPLIED SCIENCES (PHYSICS)]

1. Which special function is often used to describe wave propagation in cylindrical coordinates?
 - A) Hermite function
 - B) Bessel function
 - C) Laguerre function
 - D) Legendre function
2. In complex analysis, what is the residue of a function at a pole?
 - A) The value of the function at that point
 - B) The derivative of the function at that point
 - C) The coefficient of the Laurent series at that point
 - D) The integral of the function over a closed curve
3. What is the eigenvalue equation for a matrix A and its corresponding eigenvector v ?
 - A) $A v = v$
 - B) $A v = \lambda v$
 - C) $A = v \lambda$
 - D) $v = A \lambda$
4. In linear algebra, the determinant of a matrix is equal to:
 - A) The sum of its eigenvalues
 - B) The product of its eigenvalues
 - C) The trace of the matrix
 - D) The sum of its elements
5. What is the Laplace transform of the Dirac delta function, $\delta(t)$?
 - A) 1
 - B) 0
 - C) ∞
 - D) It does not have a Laplace transform.
6. In vector calculus, what is the curl of a gradient of a scalar function?
 - A) Zero
 - B) The scalar function itself
 - C) A vector with nonzero magnitude
 - D) Undefined

7. In phase space dynamics, the phase space of a system is described by the combination of:
- A) Time and velocity
 - B) Position and time
 - C) Position and momentum
 - D) Momentum and time
8. In two-body collisions, the centre of mass frame is defined as the frame in which:
- A) The total momentum is zero
 - B) The two bodies are at rest
 - C) The total kinetic energy is maximum
 - D) The total angular momentum is conserved
9. In the Lagrangian formalism of classical mechanics, generalized coordinates are used to describe the system's configuration. How many generalized coordinates are typically required to describe a system with N particles?
- A) N
 - B) $2N$
 - C) $N - 1$
 - D) $N + 1$
10. Small oscillations around a stable equilibrium point can be described using:
- A) Newton's second law
 - B) Hooke's law
 - C) Kepler's laws
 - D) Ohm's law
11. According to special relativity, as an object with mass approaches the speed of light, its relativistic mass:
- A) Increases
 - B) Decreases
 - C) Remains constant
 - D) Becomes zero
12. What is the primary principle that underlies the theory of relativity, both special and general?
- A) The principle of symmetry
 - B) The principle of equivalence
 - C) The principle of conservation
 - D) The principle of causality

13. The Laplace equation $\nabla^2\phi = 0$ is associated with:
- A) Electrostatics
 - B) Magnetostatics
 - C) Electromagnetic induction
 - D) Electromagnetic waves
14. What are the boundary conditions that need to be satisfied for Laplace's equation to find a unique solution?
- A) The electric field must be continuous across the boundary.
 - B) The magnetic field must be continuous across the boundary.
 - C) The charge density must be continuous across the boundary.
 - D) The electric potential must be continuous across the boundary.
15. Dielectrics are materials that can be polarized by an electric field. When a dielectric is placed in an electric field, it:
- A) Reduces the electric field
 - B) Enhances the electric field
 - C) Has no effect on the electric field
 - D) Causes an electric discharge
16. Coherence in the context of electromagnetic waves refers to the property of waves having:
- A) Constant amplitude
 - B) Constant frequency
 - C) A fixed phase relationship
 - D) A constant wavelength
17. In a uniform magnetic field, a charged particle will follow a path that is:
- A) A straight line
 - B) A circle
 - C) A parabola
 - D) A hyperbola
18. In quantum mechanics, what is the significance of an eigenvalue problem for a physical observable?
- A) It represents a solution to the Schrödinger equation.
 - B) It corresponds to a possible measurement result of the observable.
 - C) It indicates a probability distribution of particle positions.
 - D) It represents the momentum of a particle.

19. The hydrogen atom is a fundamental system in quantum mechanics. What is the shape of the electron's orbit in a hydrogen atom?
- A) Circular
 - B) Elliptical
 - C) Parabolic
 - D) Spherical
20. In the context of electromagnetic theory, what does the "curl" of a vector field represent?
- A) The divergence of the field
 - B) The line integral of the field
 - C) The rotation or circulation of the field
 - D) The magnitude of the field
21. What is the purpose of time-independent perturbation theory in quantum mechanics?
- A) To study time-dependent quantum phenomena
 - B) To determine the position of a particle at a given time
 - C) To calculate corrections to the energy levels of a quantum system
 - D) To measure angular momentum
22. Time-dependent perturbation theory is used to describe quantum systems that are subjected to time-varying perturbations. What does Fermi's golden rule describe?
- A) The rate of radioactive decay
 - B) The probability of a transition between energy levels
 - C) The scattering of particles
 - D) The time evolution of quantum systems
23. What is the connection between the Pauli exclusion principle and the statistics of particles in quantum mechanics?
- A) The Pauli exclusion principle does not relate to statistics.
 - B) Particles obey Bose-Einstein statistics if they violate the Pauli exclusion principle.
 - C) Particles obey Maxwell-Boltzmann statistics if they obey the Pauli exclusion principle.
 - D) Particles obey Fermi-Dirac statistics if they obey the Pauli exclusion principle.
24. In thermodynamics, the chemical potential represents the change in which extensive thermodynamic property with respect to a change in the number of particles?
- A) Energy
 - B) Temperature
 - C) Entropy
 - D) Gibbs free energy

25. What does the micro-canonical ensemble describe in statistical physics?
- A) Systems at constant temperature and pressure
 - B) Systems at constant temperature and volume
 - C) Systems at constant energy and number of particles
 - D) Systems at constant energy and pressure
26. Classical statistics is used for systems that obey the classical limit of quantum mechanics. What distribution is associated with classical statistics?
- A) Maxwell-Boltzmann distribution
 - B) Fermi-Dirac distribution
 - C) Bose-Einstein distribution
 - D) Planck distribution
27. Which semiconductor device allows current to flow in one direction and acts as a one-way valve for electric current?
- A) Diode
 - B) Transistor
 - C) Solar cell
 - D) LED
28. In an operational amplifier (op-amp), the voltage at the inverting input terminal is compared to the voltage at the:
- A) Non-inverting input terminal
 - B) Ground terminal
 - C) Output terminal
 - D) Power supply terminal
29. In error analysis, the propagation of errors is concerned with how errors in the input quantities affect the:
- A) Precision of measurements
 - B) Accuracy of measurements
 - C) Calculated results or output quantities
 - D) Units of measurement
30. The method used for fitting a curve to data points by minimizing the sum of the squares of the differences between the data points and the fitted curve is known as:
- A) The regression method
 - B) The interpolation method
 - C) The least squares fitting method
 - D) The extrapolation method

31. Which of the following atoms typically exhibit hyperfine structure in their spectral lines due to nuclear effects?
- A) Helium
 - B) Hydrogen
 - C) Oxygen
 - D) Sodium
32. What is the term for the correction to the energy levels of a hydrogen atom that accounts for the finite mass of the nucleus and the relativistic effects?
- A) Fine structure
 - B) Hyperfine structure
 - C) Zeeman effect
 - D) Stark effect
33. Electron spin resonance is a technique used to study the behavior of electrons in:
- A) Magnetic fields
 - B) Electric fields
 - C) Radioactive materials
 - D) High-energy accelerators
34. The concept of the Frank-Condon principle is particularly relevant in the study of:
- A) Electron spin resonance
 - B) NMR spectroscopy
 - C) Vibrational spectra of molecules
 - D) Atomic transitions
35. Raman spectroscopy is a technique that involves the interaction of light with:
- A) Vibrational and rotational transitions in molecules
 - B) Atomic nuclei in a magnetic field
 - C) Free electrons in a conductor
 - D) Radioactive particles
36. Optical pumping is a technique used to achieve population inversion in the energy levels of a laser medium. What does population inversion refer to?
- A) More electrons in the ground state than in the excited state
 - B) More electrons in the excited state than in the ground state
 - C) An equal distribution of electrons between ground and excited states
 - D) No electrons in either the ground or excited states

37. In the context of lasers, what does the term "coherence length" refer to?
- A) The length of a laser cavity
 - B) The length of a laser beam
 - C) The spatial extent over which the laser beam exhibits coherent behaviour
 - D) The length of a laser medium
38. The reciprocal lattice is a mathematical construct used to describe the:
- A) Real space arrangement of atoms in a crystal
 - B) Diffraction pattern of a crystal
 - C) Symmetry of a crystal
 - D) Physical lattice of a crystal
39. What type of specific heat is described by the Debye model?
- A) Electronic specific heat
 - B) Lattice specific heat
 - C) Heat capacity at constant pressure
 - D) Heat capacity at constant volume
40. In the Drude model of electrical conductivity, what is the primary cause of electrical resistance in a conductor?
- A) Scattering of electrons by lattice vibrations
 - B) Collision of electrons with other electrons
 - C) Flow of ions in the lattice
 - D) Quantum tunnelling of electrons
41. The Hall effect is a phenomenon that results from the interaction of charged particles with a magnetic field and is used to measure:
- A) Temperature
 - B) Electrical resistance
 - C) Magnetic susceptibility
 - D) Charge carriers' sign and density
42. In the context of band theory of solids, what is the primary factor that distinguishes metals, insulators, and semiconductors?
- A) The density of atoms in the solid
 - B) The crystal structure of the solid
 - C) The presence or absence of energy bands
 - D) The type and size of the energy gap in the electronic band structure

43. Superfluidity is a unique property of certain fluids that occurs at:
- A) High temperatures
 - B) Low temperatures
 - C) Any temperature
 - D) High pressures
44. Quasicrystals are a type of ordered phase of matter that exhibit:
- A) Long-range translational order and short-range orientational order
 - B) Short-range translational order and long-range orientational order
 - C) Both short-range translational and orientational order
 - D) Neither translational nor orientational order
45. The semi-empirical mass formula is used to calculate the binding energy of a nucleus and is based on the number of:
- A) Protons and neutrons
 - B) Electrons and positrons
 - C) Photons and neutrinos
 - D) Quarks and gluons
46. What is the primary constituent of protons and neutrons in the nucleus according to the quark model?
- A) Up quark and down quark
 - B) Electron and neutrino
 - C) Positron and antineutrino
 - D) Photon and gluon
47. Parity non-conservation in weak interactions was first observed in experiments involving the decay of:
- A) Electrons
 - B) Muons
 - C) Neutrinos
 - D) Pions
48. The Gell-Mann-Nishijima formula, also known as the Eightfold Way, relates what quantum numbers of hadrons?
- A) Charge and spin
 - B) Isospin and strangeness
 - C) Parity and angular momentum
 - D) Mass and energy

49. The Hall effect and thermoelectric power are phenomena related to the behaviour of charge carriers in solids. What do they provide insights into?
- A) Crystal lattice structure
 - B) Electronic band structure
 - C) Phonon dispersion relations
 - D) Quantum tunnelling
50. In Raman spectroscopy, which of the following types of scattering is responsible for the Raman effect?
- A) Rayleigh scattering
 - B) Elastic scattering
 - C) Inelastic scattering
 - D) Compton scattering

SECTION II (RESEARCH METHODOLOGY)

51. Research is
- A) Producing available knowledge again and again
 - B) Finding solution to any problem
 - C) Working in a scientific way to search for truth of any problem.
 - D) None of the above
52. Computed measure of how much scores vary around the mean score.
- A) range
 - B) standard deviation
 - C) normal curve
 - D) skewed distribution
53. Which of the following statements is true?
- A) The mean is a continuous variable.
 - B) The variance and standard deviation of a normal population are equal.
 - C) For large samples, the distribution of scores is approximately normal.
 - D) None of the above
54. Taking someone else's words or ideas and taking credit for them as your own.
- A) cite
 - B) plagiarism
 - C) paraphrase
 - D) credit
55. What steps are involved in a central tendency test?
- A) Addition, subtraction, and division.
 - B) Determination of mean, median, and mode.
 - C) Addition, subtraction, multiplication, and division.
 - D) None of the above
56. Random sampling is also called _____.
- A) Availability sampling
 - B) Probation sampling
 - C) Probability sampling
 - D) Prospect sampling
57. What is the Median of the following data sample?
2, 7, 4, 8, 9, 10, 6, 12, 13
- A) 8
 - B) 11
 - C) 9
 - D) 10
58. Which of the following statements is CORRECT?
- A) Research is a hurried activity.
 - B) Research starts with a problem and ends with a problem.
 - C) Research is not a contributing factor of progress.
 - D) Research is an investigation where you look for answers that are already there.

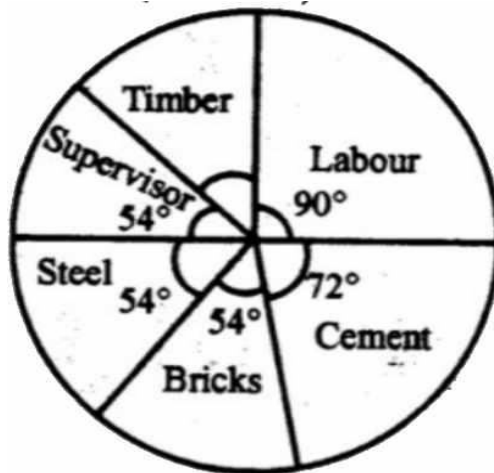
59. Which of the following has same mean median and mode?
- A) 6,5,2,4,3,4,1
 - B) 4,2,2,1,3,2,3
 - C) 2,3,7,3,8,3,2
 - D) 4,3,4,3,4,6,4
60. Resource libraries, economic census, trade shows & associations would be examples of what kind of data sources?
- A) Tertiary
 - B) Secondary
 - C) Primary
 - D) Unprofessional
61. The purpose of correlation research is to:
- A) study the relationship between two or more than two variables
 - B) predict the criterion variable on the basis of predictor variable
 - C) Both (1) and (ii)
 - D) Neither (i) Nor(ii)
62. It is sometimes called “central location” or just “center”. It is a way to describe what’s typical for a set of data. It is called.
- A) Middle destination
 - B) Center fold
 - C) Central Tendency
 - D) Mid frequency
63. Which is NOT a step of the scientific method?
- A) Hypothesis
 - B) Analyse data
 - C) Count items
 - D) Report Findings
64. In order to pursue the research, which of the following is priorly required?
- A) Developing a research design
 - B) Formulating a research question
 - C) Deciding about the data analysis procedure
 - D) Formulating a research hypothesis
65. Every person in the population has an equal chance of being selected -which sampling method
- A) Systematic sampling
 - B) Quota sampling
 - C) Volunteer sampling
 - D) Random sampling

66. When a distribution of scores is skewed, which of the following is the most representative measure of central tendency?
- A) Inference
 - B) Standard deviation
 - C) Mean
 - D) Median
67. An even spread of a variable that is symmetrical about the mean median and mode.
- A) bar graph
 - B) histogram
 - C) scatter graph
 - D) normal distribution
68. A diagram with rectangles showing values or numbers.
- A) Pictogram
 - B) Pie chart
 - C) Bar chart
 - D) Line graph
69. Type of research that solve practical issues is;
- A) Fundamental research
 - B) Exploratory research
 - C) Applied research.
 - D) Empirical research
70. What should not be included in the conclusion?
- A) literature review
 - B) summary
 - C) implication
 - D) major findings
71. A variable that is being manipulated is_____
- A) Independent variable
 - B) dependent variable
 - C) confounding variable
 - D) extraneous variable
72. What is qualitative research?
- A) Observation and description of activities, situations, attitudes, or behaviors of a specific group of people.
 - B) Analysis of numerical data.
 - C) Numerical comparisons and statistical inferences.
 - D) None of above
73. A standard deviation can never be
- A) positive
 - B) negative
 - C) zero
 - D) None

74. The sample standard deviation is denoted by:
- A) s
 - B) p
 - C) Σ
 - D) σ
75. First step of an investigation is _____ .
- A) collection of data.
 - B) presentation of data.
 - C) analysis of data.
 - D) explanation of data.
76. The sum of absolute deviations about median is _____.
- A) the least
 - B) the greatest
 - C) zero
 - D) equal
77. When the value of $r=0$, it is said to be _____.
- A) no correlation.
 - B) positive.
 - C) perfect positive.
 - D) perfect negative.
78. The straight-line trend is represented by the equation _____.
- A) $y=a+bx$
 - B) $y=mx$
 - C) $y=ax/ay$
 - D) $y=a*bx$
79. In discrete and continuous frequency distributions $N=$ ____ .
- A) the sum of frequency.
 - B) number of observations.
 - C) minimum value.
 - D) maximum value.
80. _____ is used to compare the variability of two or more than two series.
- A) Mean.
 - B) Standard deviation.
 - C) Coefficient of variation.
 - D) Mean deviation.
81. The simplest device for ascertaining whether two variables are related is to prepare a dot chart is called _____ .
- A) graphical method.
 - B) scatter diagram method.
 - C) method of least square.
 - D) concurrent deviation method.

82. A bag contains 10 black and 20 white balls; a ball is drawn at random. What is the probability that it is black?
- A) $\frac{1}{2}$
 - B) $\frac{1}{3}$
 - C) 0
 - D) 3
83. Diagrams are for _____
- A) the use of exports.
 - B) better quantitative picture.
 - C) better mental appeal
 - D) the use of imports.
84. Which of the following is not a type of research design?
- A) Experimental design
 - B) Descriptive design
 - C) Correlational design
 - D) Probability design
85. What is a research hypothesis?
- A) A tentative explanation for a phenomenon
 - B) A statement that is proven to be true
 - C) A prediction of what the researcher expects to find
 - D) A statement of fact
86. What is the purpose of a pilot study?
- A) To test the feasibility of the research design
 - B) To test the reliability and validity of the measures
 - C) To determine the appropriate sample size
 - D) To collect preliminary data
87. In five One-Day Internationals, a batsman has scored 31,97,112, 63, and 12 runs. the quality deviation of the info is-
- A) 21.78
 - B) 23.79
 - C) 25.79
 - D) 26.77
88. Determine the mode of the decision received seven days in a row: 11,13,13,17,19,23,25
- A) 11
 - B) 13
 - C) 17
 - D) 23

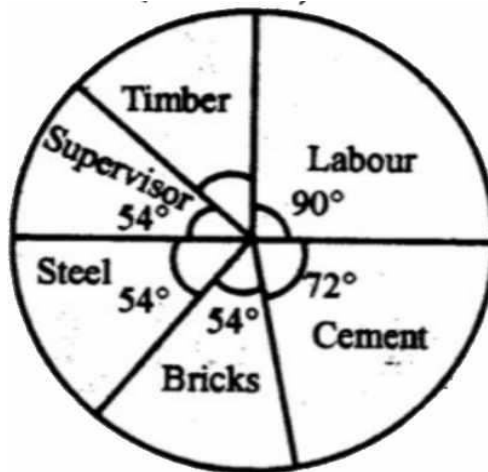
89. The following pie chart comprises the cost of constructing one house. The total cost was Rs. 6 lakhs



The amount spent on cement is

- A) Rs.2,00,000
- B) Rs.1,60,000
- C) Rs.1,20,000
- D) Rs.1,00,000

90. Referring to chart below,



the amount spent on cement, steel and supervision is what percent of the total cost of construction?

- A) 40%
- B) 45%
- C) 50%
- D) 55%

91. Table shows the mobile phones sold on different days by different sellers. Read the table carefully and answer the questions.

Mobiles Phones Sellers	Day						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
P	40	45	48	28	50	24	20
Q	90	92	27	12	16	98	26
R	80	36	30	13	28	62	47
S	60	46	12	64	52	34	76
T	48	18	58	69	70	10	15

Find the difference of mobile phones sold by P and R together on Monday to the mobile phones sold by S and T on Wednesday.

- A) 60
- B) 50
- C) 80
- D) 20

92. Referring to above table, Find the ratio of mobile phones sold by Q on Tuesday and Saturday together to the mobile phones sold by R on Thursday and Sunday together.

- A) 7 : 19
- B) 19 : 5
- C) 19 : 6
- D) 2 : 5

93. The frequency distribution of a numerical data can be graphically represented by a _____

- A) Histogram
- B) Telegram
- C) Monogram
- D) Anagram

94. Which one of the following is not the graphical representation of statistical data:

- A) Bar graph
- B) Histogram
- C) Frequency polygon
- D) Cumulative frequency distribution

95. In a histogram, each class rectangle is constructed with base as

- A) frequency
- B) class-intervals
- C) range
- D) size of the class

96. What does the command `\documentclass{article}` do in LaTeX?
- A) It sets the document class as an article
 - B) It creates a new section in the document
 - C) It sets the font style of the document
 - D) It creates a new document
97. What does the command `\begin{center}` do in LaTeX?
- A) It creates a new center-aligned section.
 - B) It sets the font size to center aligned.
 - C) It creates a new paragraph.
 - D) It centers the text or content.
98. Which of the following procedures would not be included in a programme of qualitative research?
- A) Assessment of effect size.
 - B) Development of appropriate research questions.
 - C) Clarification of the logic linking the data to research propositions.
 - D) Explanation of criteria for data interpretation.
99. What is the most common method of data collection in quantitative research?
- A) Interviews
 - B) Focus groups
 - C) Observation
 - D) Surveys/questionnaires
100. Which statistical test is used to determine if there is a significant difference between the means of two or more groups in quantitative research?
- A) t-test
 - B) ANOVA (Analysis of Variance)
 - C) Chi-square test
 - D) Regression analysis