Test Booklet Series

A

Test Booklet
(Physics)

Test Booklet No.

Name of Applicant ..... Answer Sheet No. .....

Applicant ID/Roll No. : ..... Signature of Applicant : .....

Date of Examination : ..... Signature of the Invigilator(s)

Time of Examination : ..... 1. .....

2. .....

Duration : 2 Hour] **[Maximum Marks : 100**

IMPORTANT INSTRUCTIONS

(i) The question paper is in the form of Test-Booklet containing **100 (Hundred)** questions. All questions are compulsory. Each question carries four answers marked (A), (B), (C) and (D), out of which only one is correct. Choose the correct option or the most appropriate option.

(ii) On receipt of the Test-Booklet (Question Paper), the candidate should immediately check it and ensure that it contains all the pages, i.e., **100** questions. Discrepancy, if any, should be reported by the candidate to the invigilator immediately after receiving the Test-Booklet.

(iii) A separate Answer-Sheet is provided with the Test-Booklet/Question Paper. On this sheet there are **100** rows containing four circles each. One row pertains to one question.

(iv) The candidate should write his/her Application ID/Roll number at the places provided on the cover page of the Test-Booklet/Question Paper and on the Answer-Sheet and NOWHERE ELSE.

(v) No second Test-Booklet/Question Paper and Answer-Sheet will be given to a candidate. The candidates are advised to be careful in handling it and writing the answer on the Answer-Sheet.

(vi) For every correct answer of the question **One (1) mark will be awarded**.

(vii) Marking shall be done only on the basis of answers responded on the Answer-Sheet.

(viii) To mark the answer on the Answer-Sheet, candidate should darken the appropriate circle in the row of each question with Blue or Black pen.

(ix) For each question only **one** circle should be **darkened** as a mark of the answer adopted by the candidate. If more than one circle for the question are found darkened or with one black circle any other circle carries any mark, the answer will be treated as incorrect.

(x) The candidates should not remove any paper from the Test-Booklet/Question Paper. Attempting to remove any paper shall be liable to be punished for use of unfair means.

(xi) Rough work may be done on the blank space provided in the Test-Booklet/Question Paper only.

(xii) *Mobile phones (even in Switch-off mode) and such other communication/programmable devices are not allowed inside the examination hall.*

(xiii) No candidate shall be permitted to leave the examination hall before the expiry of the time.

DO NOT OPEN THIS QUESTION BOOKLET UNTIL ASKED TO DO SO.

PART–A

1. Research is
   (A) Searching again and again
   (B) Finding a solution to any problem
   (C) Working in a scientific way to search for the truth of any problem
   (D) None of the above

2. The conceptual framework in which research is conducted is called a
   (A) Synopsis of research
   (B) Research design
   (C) Research hypothesis
   (D) Research paradigm

3. What are the main characteristics of Scientific Research?
   (A) Empirical
   (B) Theoretical
   (C) Experimental
   (D) All the above

4. Which research design will be most appropriate to study the relationship between the level of aspirations and achievement of rural children?
   (A) Experimental Research Design
   (B) Ex Post Facto Research Design
   (C) Historical Research Design
   (D) Survey Research Design

5. The principles of fundamental research are used in:
   (A) action research
   (B) applied research
   (C) philosophical research
   (D) historical research

6. A shift in attitude in respondents between two points during data collection is called
   (A) Reactive effect
   (B) Maturation effect
   (C) Regression effect
   (D) Conditioning effect

7. Ethical Norms in research do not involve guideline for:
   (A) Thesis Format
   (B) Copyright
   (C) Patenting Policy
   (D) Data sharing Policy

8. The primary objective of an experimental research design is to:
   (A) Explore an unknown topic.
   (B) Establish cause-and-effect relationships.
   (C) Describe a population or situation.
   (D) Examine the relationship between variables without manipulation.

9. The research that aims at immediate application is:
   (A) Action Research
   (B) Empirical Research
   (C) Conceptual Research
   (D) Fundamental Research

10. A null hypothesis is
   (A) when there is no difference between the variables
   (B) the same as research hypothesis
   (C) subjective in nature
   (D) when there is difference between the variables

11. When the researcher rejects a true null hypothesis a ---------- error occurs.
   (A) Type I
   (B) Type A
   (C) Type II
   (D) Type B

12. The researcher is usually interested in supporting ..... when he or she is engaging in hypothesis testing:
   (A) The alternative Hypothesis
   (B) The null Hypothesis
   (C) Both alternative and null Hypothesis
   (D) Neither the alternative or null Hypothesis

13. A research design is often described as the "blueprint" for a research project. This emphasizes its role in:
   (A) Collecting data
   (B) Analysing data
   (C) Providing a strategy and framework for the study
   (D) Presenting findings

14. What is a cross-sectional research design?
(A) A design in which a data is collected at one point of time.
(B) A design in which data is collected over a period of time.
(C) A design in which data is collected from a representative sample of the population.
(D) A design in which data is collected from a non-representative sample of the population.

15. Match the measurement scale to the given variables:

Scale of measurement	**Variable**
(a) Nominal	(i) Height of student
(b) Ordinal	(ii) Time of day
(c) Interval	(iii) Caste
(d) Ratio	(iv) Rank of Army Personnel

Choose the correct answer from the options given below:
(A) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(B) (a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)
(C) (a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)
(D) (a) – (iv), (b) – (i), (c) – (ii), (d) – (iii)

16. Which is the simplest form of Measurement?
(A) Ordinal (B) Nominal
(C) Ratio (D) Interval

17. The data is obtained through a survey conducted is called:
(A) Primary data (B) Secondary data
(C) Continuous data (D) Qualitative data

18. A survey in which the information is collected from each and every individual of the population is known as:
(A) Sample survey (B) Pilot survey
(C) Biased survey (D) Census survey

19. Interview is an example of which data?
(A) Primary data (B) Secondary data
(C) Both (A) and (B) (D) None of the above

20. What is the process of organizing raw data into rows and columns for systematic analysis called?
(A) Compilation
(B) Presentation
(C) Tabulation
(D) Classification

21. The graphical representation of a frequency distribution is called
(A) Bar chart
(B) Line chart
(C) Histogram
(D) Pie char

22. Identify the correct sequence of research steps:
(A) Selection of topic, review of literature, data collection, interpretation of findings
(B) Review of literature, selection of topic, data collection, and interpretation of findings
(C) Selection of topic, data collection, review of literature, interpretation of findings
(D) Selection of topic, review of literature, interpretation of findings, data collection

23. When a research problem is related to heterogeneous population, the most suitable sampling method is:
(A) Cluster Sampling
(B) Stratified Sampling
(C) Convenient Sampling
(D) Lottery Method

24. A researcher wants to study the long-term effects of a new teaching method on student performance over several years. Which research design would be most appropriate?
(A) Cross-sectional design
(B) Case study design
(C) Longitudinal design
(D) Survey design

25. From the list given below identify those which are called non-probability sampling procedures:
(i) Simple random sampling
(ii) Dimensional sampling
(iii) Snowball sampling
(iv) Cluster sampling
(v) Quota sampling
(vi) Stratified sampling
Choose the correct option
(A) (i), (ii) and (iii)
(B) (ii), (iv) and (v)
(C) (i), (iii) and (v)
(D) (ii). (iii) and (v)

26. Among the following types of sampling techniques, which one is also known as 'Judgmental' sampling?

(A) Quota sampling
(B) Convenience Sampling
(C) Cluster Sampling
(D) Purposive Sampling

27. The primary objective of an experimental research design is to:

(A) Explore an unknown topic.
(B) Establish cause-and-effect relationships.
(C) Describe a population or situation.
(D) Examine the relationship between variables without manipulation.

28. "Students from the pure mathematics background can crack a bank recruitment test"—Which type of hypothesis is this?

(A) Relational Hypothesis
(B) Descriptive hypothesis
(C) Two tailed Hypothesis
(D) Null Hypothesis

29. Parametric tests make assumptions on:

(A) The population size
(B) The underlying distribution
(C) The sample size
(D) The mean sample

30. If the researcher has a nominal data, which non parametric test will he/she can use:

(A) T-test
(B) Z-test
(C) Chi square test
(D) All the above

31. If a researcher needs to verify whether there is a significant difference between the means of two groups to test a hypothesis, which statistical method would he/she employ?

(A) Chi-square test
(B) Correlation coefficient
(C) Sign-test
(D) Student's t-test

32. Chi-square is used to analyse:

(A) Scores
(B) Ranks
(C) Frequencies
(D) None of these

33. On which of the following does the critical value for a chi-square statistic rely?

(A) The degrees of freedom
(B) The sum of the frequencies
(C) The row totals
(D) The number of variables

34. Calculated value of chi-square is always.....

(A) Positive
(B) Negative
(C) Zero
(D) None of these

35. Which of the following best describes the purpose of using ANOVA in research?

(A) ANOVA is used to compare the means of two groups.
(B) ANOVA is use to compare the means of more than two groups.
(C) ANOVA is used to determine the correlation between two variables.
(D) ANOVA is used to determine the interaction effect between dependent variables.

36. What do ANOVA calculate?

(A) T-Ratio
(B) Chi-square
(C) Z-Ratio
(D) F-Ratio

37. What is the primary goal of factor analysis?

(A) To predict a dependent variable from multiple independent variables.
(B) To reduce a large number of variables into a smaller set of underlying factors.
(C) To determine the causal relationship between variables.
(D) To calculate the correlation between two variables.

38. Which assumption is required for factor analysis?

(A) Extreme collinearity exists among variables.
(B) Variables have a skewed distribution.
(C) A linear relationship exists among variables.
(D) There are many outliers in the data.

39. When using Principal Component Analysis (a common method for factor analysis), what does the first principal component capture?
(A) The minimum variance.
(B) The mean deviation.
(C) The maximum variance.
(D) The average variance.

40. Which statistical measure is used to assess the sampling adequacy for conducting factor analysis?
(A) Kaiser-Meyer-Olkin (KMO) measure.
(B) Bartlett's test of sphericity.
(C) Eigenvalue.
(D) All of the above.

41. The process by which we estimate the value of dependent variable on the basis of one or more independent variable is called:
(A) Correlation
(B) Regression
(C) Residual
(D) Slope

42. The major characteristic of correlation analysis is to seek out
(A) Differences among variables
(B) Variations among variables
(C) Association among variables
(D) Regression among variables

43. A correlation coefficient (r) of –1.0 indicates a:
(A) Perfect positive correlation
(B) Weak positive correlation
(C) No correlation
(D) Perfect negative correlation

44. The statistical tool that studies the degree of association between two variables is called:
(A) Regression
(B) Standard error
(C) Index numbers
(D) Correlation

45. Which type of correlation analysis is appropriate for examining the relationship between variables with non-linear relationships?
(A) Pearson's correlation
(B) Spearman's rank correlation
(C) Both Pearson's and Spearman's
(D) Neither Pearson's nor Spearman's

46. What is the primary goal of cluster analysis?
    (A) Classifying data into predefined groups.
    (B) Predicting a continuous value.
    (C) Grouping similar data points together based on their characteristics.
    (D) Reducing the number of variables in a dataset.

47. The primary purpose of conjoint analysis is to:
    (A) Identify which customer segments are most profitable.
    (B) Determine the price elasticity of demand for an existing product.
    (C) Quantify the value that consumers place on different features of a product or service.
    (D) Predict sales volume for a new product with absolute certainty.

48. The most common type of conjoint analysis, which presents respondents with sets of product profiles and asks them to choose the one they prefer most, is known as:
    (A) Adaptive Conjoint Analysis (ACA).
    (B) Choice-Based Conjoint (CBC).
    (C) Full-Profile Conjoint Analysis.
    (D) Self-Explicated Conjoint Analysis.

49. Which statement is an accurate representation of a "trade-off" in conjoint analysis?
    (A) A decision to buy a product from one brand over another.
    (B) A decision to delay a purchase until a later date.
    (C) A customer choosing a larger screen over longer battery life for a phone.
    (D) A customer buying a product with all the most desired features.

50. What is the primary purpose of discriminant analysis?
    (A) To determine the effect of independent variables on a continuous dependent variable.
    (B) To identify the underlying structure or dimensions within a set of variables.
    (C) To classify cases into two or more distinct, pre-defined groups based on a set of predictor variables.
    (D) To cluster data points into a specific number of groups based on their similarities.

PART–B

(Physics)

51. De Broglie wavelength of a 0.1 kg pallet having a velocity of 100 ms^{-1} is

(A) 6.63×10^{-2} Å (B) 6.63×10^{-20} Å

(C) 6.63×10^{-25} Å (D) 6.63×10^{-35} Å

(Where Å stands for 1 Angstrom)

52. The lifetime of a Δ-particle (rest mass of about 1232 MeV/c^2) is about 10^{-23} sec, what is the expected spread (or FWHM of Gaussian mass profile) in its measured mass?

(A) 120 MeV/c^2 (B) 22.0 MeV/c^2

(C) 5.20 MeV/c^2 (D) 320 eV/c^2

53. The quantity $\frac{h}{mc}$ is called the Compton wavelength, the Compton wavelength of an electron is :

(A) 2.43 Å (B) 2.43×10^{-6} m

(C) 2.43×10^{-20} m (D) 0.0243 Å

54. The ground state energy of a positronium atom is :

(A) 13.6 eV (B) 6.8 eV

(C) 27.2 eV (D) 1.36 eV

55. Total scattering cross-section (σ) for a low-energy hard-sphere scattering from a sphere of radius "a" is

(A) $\sigma \sim a^2$ (B) $\sigma << a^2$

(C) $\sigma \sim 4\pi a^2$ (D) $\sigma \sim \pi a^2$

56. A spin-half particle is in a quantum state $X = \frac{1}{\sqrt{6}} \begin{pmatrix} 1+i \\ 2 \end{pmatrix}$. The probability of getting $\hbar/2$ spin value for the measurement of component of the spin is :

(A) 1/3 (B) 2/3

(C) 0 (D) 1/4

57. The radius of $^{216}_{83}Bi$ isotope is about :

(A) 3.2 fm (B) 3 Å

(C) 15.9 fm (D) 7.2 fm

58. According to the liquid drop model, the atomic no. of the most stable isobars with A = 125 is :

(A) 52 (B) 45

(C) 57 (D) 63

59. Spin and parity of $^{47}_{20}Ca$ is :

(A) $1/2^+$ (B) $3/2^-$

(C) $7/2^-$ (D) $5/2^+$

60. A radioactive specimen can decay by alpha and beta decay simultaneously. The average lifetime of alpha decay is 1620 years, while for beta decay average lifetime is 520 Years. What will be the half-life time of the specimen?

(A) 1483 Years (B) 394 Years

(C) 273 Years (D) 1123 Years

61. The ripple factor of a full-wave rectifier is :

(A) 0.32 (B) 0.21

(C) 0.82 (D) 0.48

62. When a metal is heated, its resistance will :

(A) Increases with temperature

(B) Remains same with temperature variation

(C) Decreases with temperature

(D) Increases exponentially with temperature

63. The packing fraction of the body-centred crystal lattice structure is :

(A) 52% (B) 92%

(C) 68% (D) None of these

64. A body at 200 K radiates energy at the rate of R. At 600 K, it will radiate at ;

(A) 9 times of R (B) 243 times of R

(C) 27 times of R (D) 81 times of R

65. Which quantity is relativistically invariant :

(A) $\vec{E} \cdot \vec{B}$ (B) $E^2 + c^2B^2$

(C) E^2 (D) B^2

66. Which statement is true for radiation emitted by an electric dipole configuration?

(A) Maximum radiation flux is along the dipole direction

(B) Radiation flux is inversely proportional to the angular frequency of oscillation

(C) Radiation flux is maximum perpendicular to the dipole direction

(D) It is independent of the electrical dipole moment

67. Capacitance of two concentric spherical metal shells, with radii 'a' and 'b' is :

(A) $4\pi\varepsilon_0 a$ (B) $4\pi\varepsilon_0 \dfrac{a + b}{b}$

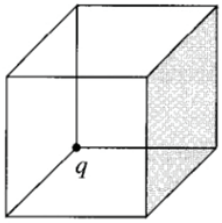
(C) $4\pi\varepsilon_0 \dfrac{ab}{b - a}$ (D) $4\pi\varepsilon_0 \dfrac{a - b}{ab}$

68. Which atom will have the highest atomic polarizability (α)?

(A) H (B) Be

(C) Ar d) K

69. A point charge 'q' is placed at one corner of a cube. What will be the flux through the shaded side of the cube?



(A) $\frac{q}{\varepsilon_0}$

(B) $\frac{q}{3\varepsilon_0}$

(C) $\frac{q}{12\varepsilon_0}$

(D) $\frac{q}{24\varepsilon_0}$

70. During a first-order phase transition, which quantity does not change?

(A) Temperature

(B) Entropy

(C) Internal energy

(D) Volume

71. In a metal at absolute zero temperature, the Fermi level represents :

(A) The bottom of the conduction band

(B) The energy level where the occupation probability is 1/2

(C) The top of the valence band

(D) The energy gap between the valence and conduction bands

72. If the Lagrangian does not explicitly depend on a generalized coordinate q_i, then :

(A) The generalized momentum p_i is conserved

(B) The kinetic energy is conserved

(C) The potential energy is conserved

(D) The coordinate q_i is conserved

73. In a central force problem, angular momentum is conserved because the force is :

(A) Always attractive

(B) Perpendicular to the velocity, making torque zero

(C) Directed along the position vector, making torque zero

(D) Dependent on time

74. A rod of proper length L_0 = 10 m is oriented parallel to the direction of motion in a frame moving at a velocity of 0.6 times the speed of light relative to the observer. The length measured by the stationary observer is :

(A) 10 m (B) 8 m

(C) 12 m (D) 6 m

75. The linear Stark effect, where energy shift $E \propto E$ (electric field), is prominent in :

(A) Alkali atoms with non-degenerate states

(B) Hydrogen atom due to n^2 degeneracy

(C) Helium-like ions in quadratic regime

(D) Molecules with permanent dipoles

76. In the Raman spectrum, Stokes lines appear at :

(A) Higher frequencies than the incident light (blue-shifted)

(B) Lower frequencies than the incident light (red-shifted)

(C) The same frequency as the incident light (Rayleigh)

(D) Frequencies independent of molecular vibrations

77. The Raman activity of a vibrational mode requires a change in :

(A) The molecular dipole moment (IR active)

(B) The molecular polarizability tensor

(C) The electron density only

(D) The nuclear spin

78. The g-factor for a free electron is exactly 2.0023, deviating from 2 due to :

(A) Relativistic corrections and spin-orbit coupling

(B) Hyperfine interactions of electrons with each other

(C) Sample temperature

(D) Microwave power saturation

79. Hyperfine structure in ESR spectra arises from :

(A) Coupling of electron spin to nuclear spin I, splitting lines by A (hyperfine constant)

(B) Isotopic abundance variations

(C) Doppler broadening

(D) Electron-electron repulsion

80. ESR is particularly useful for studying :

(A) Diamagnetic molecules only

(B) Nuclear spins in NMR

(C) Vibrational modes in IR

(D) Paramagnetic species like radicals, transition metals in biology

81. The magnetic susceptibility χ of a paramagnet follows Curie's law :

(A) $\chi = C/T$, where C is the Curie constant

(B) $\chi = CT$, where C is the Curie constant

(C) $\chi = -C/T^2$, where C is the Curie constant

(D) χ independent of T

82. Which of the following is a classic diamagnetic material?

(A) Iron (Fe)

(B) Aluminum (Al)

(C) Copper (Cu)

(D) Nickel (Ni)

83. The phenomenon of perfect diamagnetism ($\chi = -1$) is observed in :

(A) Copper wires

(B) Superconductors

(C) Iron cores in transformers

(D) Paramagnetic salts

84. Superconductivity was first discovered in :

(A) 1911 by Heike Kamerlingh Onnes in mercury

(B) 1900 by Max Planck in lead at room temperature

(C) 1933 by Meissner and Ochsenfeld in tin

(D) 1986 by Bednorz and Müller in ceramics

85. The DC Josephson effect allows :

(A) AC current at frequency 2 eV/h

(B) Magnetic flux quantization in loops

(C) Resistive shunting above critical current

(D) Tunneling between two superconductors separated by a thin insulator

86. Neutrino oscillations imply that neutrinos have :

(A) Zero mass and travel at speed of light

(B) Non-zero masses and mixing between flavours

(C) Charge, allowing electromagnetic interactions

(D) Neutrino chirality in weak decays

87. CP violation was first observed in :

(A) K^0 meson decays in 1964

(B) β-decay of neutrons

(C) Muon g-2 anomaly

(D) Proton-antiproton collisions

88. The W^+ and W^- bosons mediate :

(A) The strong force, with charge 0

(B) Charged-current weak interactions

(C) Electromagnetic force, massless

(D) Higgs self-interaction

89. Which of these is not analytic anywhere?

(A) e^z

(B) sin (z)

(C) cos (z)

(D) $|z|$

90. What will be the unit vector normal to the surface $4x^2 + 4y = z$ at point (1, 1, 7)?

(A) $\left(\frac{6}{\sqrt{53}}, \frac{3}{\sqrt{53}}, \frac{10}{\sqrt{53}}\right)$

(B) $\left(\frac{6}{\sqrt{53}}, \frac{4}{\sqrt{53}}, \frac{-1}{\sqrt{53}}\right)$

(C) $\left(\frac{6}{\sqrt{5}}, \frac{3}{\sqrt{5}}, \frac{10}{\sqrt{5}}\right)$

(D) $\left(\frac{6}{\sqrt{53}}, \frac{13}{\sqrt{53}}, \frac{10}{\sqrt{53}}\right)$

91. In a laser cavity, the role of mirrors is to :

(A) Generate photons

(B) Absorb unwanted wavelengths

(C) Provide feedback for amplification

(D) Cool the active medium

92. What is the ideal input impedance of an operational amplifier?

(A) Zero

(B) Infinite

(C) Finite but high

(D) 50 Ω

93. A key difference between a latch and a flip-flop is that :

(A) Latches are edge-triggered, while flip-flops are level-triggered

(B) Flip-flops are level-triggered, while latches are edge-triggered

(C) Latches require a clock, while flip-flops do not

(D) Both are identical in operation

94. A 4-bit shift register can be implemented using :

(A) Four AND gates

(B) Four multiplexers

(C) Four JK flip-flops in parallel

(D) Four D flip-flops connected in series

95. The range of a typical alpha particle in air is :

(A) 1 cm
(B) 0.1 cm
(C) 60 cm
(D) 7 cm

96. For gamma detection in a nuclear physics experiments, we use :

(A) Si based detector
(B) Ge based detector
(C) GM detector
(D) Gas detector

97. The thermal energy of a neutron at room temperature is about :

(A) 0.025 eV
(B) 0.25 eV
(C) 0.001 eV
(D) 1.36 eV

98. The entropy production in an irreversible process is always :

(A) Zero
(B) Negative
(C) Positive
(D) Equal to the heat transferred

99. The Carnot cycle consists of how many processes?

(A) Two : isothermal and adiabatic
(B) Three : isobaric, isothermal, and adiabatic
(C) Four : two isothermal and two adiabatic
(D) Four : reversible expansions

100. Who discovered fission?

(A) Chadwick & Geiger
(B) Rutherford
(C) Marie Curie
(D) Otto Hahn & Fritz Strassmann

ROUGH WORK