COMMON P.G. ENTRANCE TEST–2022 (CPET-2022)

Subject Code : **78**

Test Booklet No.:

Entrance Subject : **Physics/Applied Physics/ Applied Physics and Ballistic**

Hall Ticket No.:

TEST BOOKLET

Time Allowed : **90** Minutes

Full Marks : **70**

INSTRUCTIONS TO CANDIDATES

1. **Please do not open this Question Booklet until asked to do so.**
2. Check the completeness of the Question Booklet immediately after opening.
3. Enter your **Hall Ticket No.** on the Test Booklet in the box provided alongside. **Do not** write anything else on the Test Booklet.
4. Fill up & darken Hall Ticket No. & Test Booklet No. in the OMR Answer Sheet as well as fill up Test Booklet Serial No. & OMR Answer Sheet Serial No. in the Attendance Sheet carefully. Wrongly filled up OMR Answer Sheets are liable for rejection.
5. Each question has four answer options marked (A), (B), (C) & (D).
6. Answers are to be marked on the Answer Sheet, which is provided separately.
7. Choose the most appropriate answer option and darken the oval completely, corresponding to (A), (B), (C) or (D) against the relevant question number.
8. Use only **Blue/Black Ball Point Pen** to darken the oval for answering.
9. Please do not darken more than one oval against any question, as scanner will read such markings as wrong answer.
10. **Each question carries equal marks. There will be no negative marking for wrong answer.**
11. **Electronic items such as calculator, mobile, etc., are not permitted inside the examination hall.**
12. Don't leave the examination hall until the test is over and permitted by the invigilator.
13. **The candidate is required to handover the original OMR sheet to the invigilator and take the question booklet along with the candidate's copy of OMR sheet after completion of the test.**
14. Sheet for rough work is appended in the Test Booklet at the end.

1. The type of the differential equation $\frac{d^2y}{dx^2}+\sqrt{y}=e^{-x}\sin x$ is

(A) linear and homogeneous
(B) linear and non-homogeneous
(C) non-linear and homogeneous
(D) non-linear and non-homogeneous

2. The condition at which the damped harmonic oscillation of oscillator is oscillatory ________ .
(A) Over damped condition
(B) Under damped conditions
(C) Both over damped and critically damped condition
(D) Critically damped condition

3. $grad\ r^3$, for r is the magnitude of position vector, will be

(A) $3r^2.\vec{r}$
(B) $3r.\vec{r}$
(C) $4r^3.\vec{r}$
(D) $4r^2.\vec{r}$

4. The value of the complex integral $\int_C \frac{Z^2\,dZ}{(Z-1)^2\,(Z+2)}$ for C encloses the circle $|Z|=1$, will be:

(A) $\frac{10\pi i}{9}$
(B) $\frac{8\pi i}{9}$
(C) $2\pi i$
(D) $\frac{14\pi i}{9}$

5. For $g(\omega)$ is the Fourier transformation (F.T.) of $f(t)$, then Fourier transformation of $f\left(\frac{t}{2}\right)$ is

(A) $\frac{1}{2}g\left(\frac{\omega}{2}\right)$

(B) $2g\left(\frac{\omega}{2}\right)$

(C) $2g(2\omega)$

(D) $\frac{1}{2}g(2\omega)$

6. The Legendre polynomial $P_n(x)$ relates to the generating function as $\sum_{n=0}^{\infty} Z^n P_n(x)$ to be:

(A) $(1+2xZ+Z^2)^{-1}$

(B) $(1+2xZ-Z^2)^{-1}$

(C) $(1-2xZ-Z^2)^{-1}$

(D) $(1-2xZ+Z^2)^{-1}$

7. In the Fourier series expansion of the function $f(x)=\frac{1}{4}(\pi-x)^2$, the coefficient a_o will be

(A) $\frac{\pi^2}{6}$

(B) $\frac{\pi^2}{12}$

(C) $\frac{5\pi^2}{6}$

(D) $\frac{5\pi^2}{12}$

8. If the Lagrangian does not depend on time explicitly, then

(A) the Hamiltonian is constant

(B) the Hamiltonian can not be constant

(C) the Kinetic energy is constant

(D) the potential energy is constant

9. The generalized momentum p_x of a particle of mass m with velocity v_x in an electropmagnetic field with charge q and x-component of vector potential A_x can be

(A) $p_x = m v_x + \frac{A_x}{q}$

(B) $p_x = m v_x + q v_x A_x$

(C) $p_x = m v_x - q A_x$

(D) $p_x = m v_x + q A_x$

10. The moment of inertia about a tangent in the plane of a circular ring of radius R and Mass M, is given by:

(A) $\frac{1}{2} M R^2$

(B) $\frac{3}{2} M R^2$

(C) $\frac{1}{4} M R^2$

(D) $\frac{2}{3} M R^2$

11. Elastic potential energy in a stretched wire is given by:

(A) ½(Stress/Strain)

(B) ½ (Stress× Strain)

(C) 2 (Stress×Strain)

(D) (Stress× Strain)

12. Lagrangian of a simple pendulom is $L = \frac{1}{2} m l^2 \dot{\theta}^2 - m g l (1 - \cos\theta)$. Choose the wrong expression with respect to the given Lagrangian.

(A) $p_\theta = m l^2 \dot{\theta}$

(B) $\dot{p}_\theta = \frac{m}{g l \sin\theta}$

(C) $l \ddot{\theta} + g \sin\theta = 0$

(D) $\frac{1}{\dot{\theta}} \frac{\partial L}{\partial \dot{\theta}} = m l^2$

13. The Lagrangian of a free particle in spherical polar coordinate system as $L = \frac{1}{2} m \left(\dot{r}^2 + r^2 \dot{\theta}^2 \right)$, indicates

(A) $\dot{r}$ is cyclic

(B) $\dot{\theta}$ is cyclic

(C) θ is Cyclic

(D) p_θ is not conserved

14. The correct set of Hamilton's equation of motion with $H = H\left(q_k,\ p_k, t\right)$ refers

(A) $\dot{q}_k = -\frac{\partial H}{\partial p_k}$ *and* $\dot{p}_k = \frac{\partial H}{\partial q_k}$

(B) $\dot{q}_k = \frac{\partial H}{\partial p_k}$ *and* $\dot{p}_k = \frac{\partial H}{\partial q_k}$

(C) $\dot{q}_k = \frac{\partial H}{\partial p_k}$ *and* $\dot{p}_k = -\frac{\partial H}{\partial q_k}$

(D) $\dot{q}_k = -\frac{\partial H}{\partial p_k}$ *and* $\dot{p}_k = -\frac{\partial H}{\partial q_k}$

15. Find the eigen value of an operator $\hat{Q} = i\frac{d}{dx}$ for the wave function (eigen state) $\psi = \frac{1}{\sqrt{2}} e^{ix}$

(A) $\frac{1}{\sqrt{2}}$

(B) $-i\frac{1}{\sqrt{2}}$

(C) i

(D) -1

16. In Vander-Waal's gas equation $\left(P + \frac{a}{V^2} \right)\left(V - b \right) = RT$, the term $\frac{a}{V^2}$ represents

(A) Effective area of molecule
(B) Mean velocity of gas molecule
(C) Volume occupied by gas molecule
(D) Attractive force between molecules

17. The operator form of $\left(\hat{x}+\hat{P}_x\right)^2$, for $\hat{x}$ and $\hat{P}_x$ are the x-component of position and momentum operator , is expressed as :

(A) $x^2 - \hbar^2 \dfrac{\partial^2}{\partial x^2} - i\hbar\left(2x\dfrac{\partial}{\partial x}+1\right)$

(B) $x^2 + \hbar^2 \dfrac{\partial^2}{\partial x^2} + i\hbar\left(2x\dfrac{\partial}{\partial x}+1\right)$

(C) $x^2 - \hbar^2 \dfrac{\partial^2}{\partial x^2} - i\hbar\left(2x\dfrac{\partial}{\partial x}+1\right)$

(D) $-x^2 + \hbar^2 \dfrac{\partial^2}{\partial x^2} - i\hbar\left(2x\dfrac{\partial}{\partial x}+1\right)$

18. 20 gm of ice (latent heat 80 cal/gm) at 0^{o}C is converted in to water at same temperature. The change in entropy will be

(A) 5.86 cal/K

(B) 2.93 cal/K

(C) 7.24 cal/K

(D) 4.36 cal/K

19. The wave function of a certain particle in the region $0 \le x \le L$ is given by $\psi = A\,Sin\,x$, for A to be normalization constant. The correct value of normalization constant A will be,

(A) $\dfrac{L}{\sqrt{2}}$

(B) $\dfrac{2}{\sqrt{L}}$

(C) $\sqrt{\dfrac{L}{2}}$

(D) $\sqrt{\dfrac{2}{L}}$

20. Light of wavelength 3500 Å is incident on two metals A and B. Which metal will yield more photoelectrons if their work functions are 5 eV and 2 eV respectively?
(A) A
(B) B
(C) A & B
(D) C

21. The de-Broglie wavelength is equal to compton wavelength of a particle. The speed of the particle will be

(A) C

(B) $\frac{c}{2}$

(C) $\frac{c}{\sqrt{2}}$

(D) $\frac{c}{\sqrt{3}}$

22. The condition of particle equilibrium is

(A) Equality in temperatures

(B) Equality in pressures

(C) Equality of chemical potentials

(D) Equality in entropy

23. Two capacitors of capacitances C_1=3μF & C_2=6μF arranged in series are connected in parallel with a third capacitor C_3=4μF. The arrangement is connected to a 6.0V battery. Calculate the total energy stored in the capacitors.

(A) 1.5×10^{-4} J

(B) 1.9×10^{-4} J

(C) 2×10^{-4} J

(D) 1.08×10^{-4} J

24. In which type of process the change of entropy is zero

(A) Isotropic

(B) Isochoric

(C) Adiabatic

(D) Isobaric

25. The electric field at a distance 0.05 m from a sheet charge distribution of surface charge density $2x10^{-8}$ C/m^{2}will be____________

(A) 0.11×10^4 V/m

(B) 0.18×10^4 V/m

(C) 0.22×10^4 V/m

(D) 0.32×10^4 V/m

26. The number of ways in which N identical bosons can be distributed in two energy levels, is
(A) $N+1$

(B) $N-1$

(C) $(N+1)/2$

(D) $(N-1)/2$

27. Which one of the following is a fermion?

(A) Alpha- particle

(B) $4Be^2$ nucleus

(C) Hydrogen atom

(D) Electron

28. In Quantum statistics, the particles are:

(A) Identical and Distinguishable

(B) Identical and Indistinguishable

(C) Molecule only

(D) Photons only

29. An α - particle is same as

(A) a Helium nucleus

(B) a Hydrogen nucleus

(C) a proton

(D) a positron

30. Nuclei having the same number of neutrons but a different mass number are:

(A) Isotopes

(B) Isobars

(C) Isotones

(D) Isotherms

31. The ratio of intensity at maxima & minima in the interference pattern is 25:9. What will be the ratio of the widths of the two slits in Young's interference experiment?

(A) 16:1

(B) 1:16

(C) 9:16

(D) 16:9

32. For A as the mass number of the nucleus, the volume of the nucleus is directly proportional to

(A) $A^{1/3}$

(B) $\sqrt{A}$

(C) A^3

(D) A

33. In neutral atom, the electrons are bound to the nucleus by

(A) Magnetic force

(B) Electrostatic force

(C) Gravitational force

(D) Centripetal force

34. The Distribution of energy spectrum of a perfectly black-body is best represented by

(A) Wiens's Law

(B) Stefan's Law

(C) Plank's Law

(D) Kirchoff''s Law

35. Three Blocks P, Q and R of same material and same mass are showing blue, yellow and red, by showing temperatures T_1, T_2 and T_3, respectively. Choose the correct trend of the temperatures.

(A) $T_1 < T_2 < T_3$

(B) $T_1 > T_2 > T_3$

(C) $T_2 > T_1 > T_3$

(D) $T_1 > T_3 > T_2$

36. The angle between the axes of a polarizer and analyzer is 60^o. At what percentage the intensity of light will decrease after passing through the analyzer?

(A) 30 %

(B) 40 %

(C) 50 %

(D) 60 %

37. The second order maxima in a plane diffraction grating is found at an angle of 30^o when a monochromic collimated light beam of wavelength 628 nm incident on it. The grating element will be

(A) 6.42 μm

(B) 5.02 μm

(C) 3.48 μm

(D) 2.51 μm

38. The ratio of maxima to minima of in interference of two coherent sources is found to be 64:1. The ratio of amplitudes of these coherent sources will be

(A) 3:4

(B) 5: 7

(C) 9:7

(D) 11:6

39. Appearance of different colour in oil fil floating on the surface of water is due to

(A) Interference

(B) Diffraction

(C) Dispersion

(D) Polarization

40. What is the phase difference between two points on a wavefront?

(A) $\frac{\pi}{2}$

(B) $\frac{\pi}{4}$

(C) Zero

(D) $\frac{\pi}{6}$

41. Brewster's law in terms of refractive index can be expressed as:

(A) $\mu = \sin i_p$

(B) $\mu = \cos i_p$

(C) $\mu = \tan i_p$

(D) $\mu = \cot i_p$

42. The electric field and magnetic field of an electromagnetic wave are given as

E= 2î +3ĵ, H= -3î +2ĵ

The magnitude of the Poynting vector will be

(A) 11
(B) 8
(C) 6
(D) 13

43. The displacement current can be there in a

(A) Resistor
(B) Capacitor
(C) Inductor
(D) Solenoid

44. The energy stored in a magnetic field is

(A) $\frac{B^2}{2\mu_0}$
(B) $\frac{B^2}{\mu_0}$
(C) $\frac{B}{2\mu_0}$
(D) $\frac{B}{\mu_0}$

45. Sodium lamp is radiating power of 50W. The root mean square value of electric field strength at a distance 3m from the lamp is:

(A) 1.29 V/m
(B) 12.9 V/m
(C) 18.2 V/m
(D) 182 V/m

46. A particle is executing forced oscillation with quality factor 12500. If the natural angular frequency associated with the forced oscillation is 12.5 s^{-1}, then the damping coefficient will be

(A) 1.5 x 10^{-3} m/s
(B) 2.5 x 10^{-3} m/s
(C) 5 x 10^{-3} m/s
(D) 7.5 x 10^{-3} m/s

47. Escape velocity is equal to (for r = radius of earth or any other planet for that matter, g as acceleration due to gravity)

(A) $r\sqrt{2g}$
(B) $g\sqrt{2r}$
(C) $\sqrt{\frac{2g}{r}}$
(D) $\sqrt{2gr}$

48. A 2 kg mass attached to a spring of spring constant 8 N/m will have the resonance when the frequency of the external source will be

(A) $\frac{4}{\pi} Hz$

(B) $\frac{2}{\pi} Hz$

(C) $\frac{3}{\pi} Hz$

(D) $\frac{1}{\pi} Hz$

49. Two forces act at an angle of 120^o. If the greater force is 80 N and their resultant is perpendicular to the smaller force, the smaller force is

(A) 20 N

(B) 40N

(C) 60 N

(D) 80N

50. A ball moving with a velocity of 5m/sec impinges a fixed plane at an angle of 45^o and its direction after impact is equally inclined to the line of impact. If the coefficient of restitution is 0.5, the velocity of the ball after impact will be:

(A) 0.5 m/sec

(B) 1.5 m/sec

(C) 2.5 m/sec

(D) 3.5 m/sec

51. If an element has a Body-Centred Cubic (BCC) structure with atomic radius 0.5 Å, then the lattice constant will be

(A) 0.5 Å

(B) 2.52 Å

(C) 0.75 Å

(D) 1.15 Å.

52. The Hall coefficient of a material is found to be 5 $m^{-3}C^{-1}$. The carrier density of the material is

(A) 1.25×10^{18} m^{-3}

(B) 2.25×10^{18} m^{-3}

(C) 3.25×10^{18} m^{-3}

(D) 0.25×10^{18} m^{-3}

53. The relative permittivity of a material is 4. The speed of light (c) inside the material can be:

(A) c/2

(B) 2c/3

(C) c

(D) 3c/4

54. Which among the following does not represents property of a LASER source?

(A) Low Intensity

(B) Coherent

(C) Directional

(D) Stimulated emission

55. What type of magnetic behaviour is observed in Type I superconductor?
(A) Perfect diamagnetism
(B) Perfect paramagnetism
(C) Perfect ferromagnetism
(D) Perfect ferrimagnetism

56. The efficiency of a full wave rectifier is
(A) 18.5%
(B) 35.6%
(C) 40.5%
(D) 81.2 %

57. If the electron density of N-type Si is 2x 10^{16} cm^{-3} then what is its hole density.
(A) 2×10^3 cm^{-3}
(B) 4×10^3 cm^{-3}
(C) 5×10^3 cm^{-3}
(D) 6×10^3 cm^{-3}

58. A reverse bias PN-junction has
(A) Very narrow depletion layer
(B) Almost no current
(C) Very low resistance
(D) Large current flow

59. A transistor can be operated by ______ numbers of configurations?
(A) 1
(B) 2
(C) 3
(D) 4

60. For a BJT, the common base current gain is 0.95. Its common emitter current gain will be:
(A) 38
(B) 26
(C) 19
(D) 58

61. The phenomenon of production of induced emf in a coil when a changing current passes through it is called
(A) Mutual induction
(B) Self induction
(C) Polarization
(D) Magnetization

62. Kinetic theory of gases assumes that the collisions between the molecules are
(A) Perfectly elastic
(B) Perfectly inelastic
(C) Partly elastic
(D) Partly inelastic

63. For a reversible adiabatic process (for C_P and C_V are specific heats at constant pressure and volume, respectively), which one is incorrect?

(A) $\left(\frac{\partial T}{\partial V}\right) \quad \alpha \quad (C_V - C_P)$

(B) $\left(\frac{\partial T}{\partial V}\right) \quad \alpha \quad \frac{1}{(C_V - C_P)}$

(C) $\left(\frac{\partial T}{\partial V}\right) \quad \alpha \quad \frac{1}{C_V}$

(D) $\left(\frac{\partial T}{\partial V}\right) \quad \alpha \quad \frac{1}{V}$

64. An ideal refrigerator has a freezer at temperature -12°C. The co-efficient of performance of the engine is 5. The temperature of the air(to which the heat ejected) is

(A) 50°C

(B) 45.2°C

(C) 40.2°C

(D) 37.5°C

65. $\left(\frac{\partial S}{\partial V}\right)_T =$ ____________

(A) $\left(\frac{\partial T}{\partial P}\right)_S$

(B) $\left(\frac{\partial P}{\partial T}\right)_V$

(C) $\left(\frac{\partial V}{\partial T}\right)_P$

(D) $\left(\frac{\partial P}{\partial S}\right)_V$

66. $(312)_8$ in decimal system will be

(A) $(201)_{10}$

(B) $(202)_{10}$

(C) $(203)_{10}$

(D) $(204)_{10}$

67. What is the addition of the binary number 101001+010011 =?

(A) 010100

(B) 111100

(C) 000111

(D) 101110

68. A digital circuit that can store only one bit is a

(A) Register

(B) NOR Gate

(C) Flip-flop

(D) XOR Gate

69. One nibble is equal to ______ bits

(A) 4

(B) 2

(C) 16

(D) 8

70. The output of an OR gate is connected to both the inputs of a NAND gate. The combination will serve as a

(A) AND gate

(B) NOT gate

(C) NAND gate

(D) NOR gate

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ROUGH WORK