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**TEST BOOKLET**

Sl. No. **02544**

**Subject Code : 20**

**Subject : Physics**

**LECTURERS FOR NON-GOVT. AIDED COLLEGES OF ODISHA**

**Time Allowed : 3 Hours**

**Maximum Marks : 165**

**: INSTRUCTIONS TO CANDIDATES :**

1. **IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET CONTAINS 31 PAGES AND DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.**
2. You have to enter your **Roll No.** on the Test Booklet in the Box provided alongside. **DO NOT** write anything else on the Test Booklet. 

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3. The Test Booklet contains **165** questions. Each question comprises four answers. You have to select the correct answer which you want to mark (darken) on the Answer Sheet. In case, you feel that there is more than one correct answer, you should mark (darken) the answer which you consider the best. In any case choose **ONLY ONE** answer for each question. If more than one answer is darkened it will be considered as wrong.
4. You have to mark (darken) all your answers **ONLY** on the **separate OMR Answer Sheet** provided, by using **BLACK BALL POINT PEN**. You have to do rough work on the space provided in the Test Booklet only. See instruction in the Answer Sheet.
5. All questions carry equal marks, i.e. of one mark for each correct answer and each wrong answer will result in negative marking of **0.25** mark.
6. Before you proceed to mark (darken) in the Answer Sheet the answers to various questions in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per the instructions in your Admit Card.
7. After you have completed filling in all your answers on the Answer Sheet and after completion of the examination, you should hand over to the Invigilator the **Original Answer Sheet (OMR Answer Sheet)** issued to you. You are allowed to take with you the candidate's copy/second page of the Answer Sheet along with the Test Booklet after completion of the examination for your reference.

**Candidate's full signature**

**Invigilator's signature**

RS - 17/22

( Turn over )

2018

1. Let  $f(x, y, z) = \frac{1}{\sqrt{x^2 + y^2 + z^2}}$ , which is defined everywhere except at the origin. Compute  $\int \nabla f \cdot dr$  where  $c$  is any curve from  $(1, 2, 2)$  to  $(3, 4, 0)$  :
- (A)  $-\frac{3}{15}$   
 (B)  $-\frac{2}{15}$   
 (C)  $-\frac{6}{15}$   
 (D)  $-\frac{15}{4}$
2. If  $F$  is the conservative vector field, then  $\nabla \times F = ?$
- (A)  $\pi$   
 (B)  $2\pi$   
 (C)  $4\pi$   
 (D)  $0$
3. Calculate the divergence of  $F$ , if  $F = -x^2i + 2xyj$  :
- (A)  $6$   
 (B)  $1$   
 (C)  $0$   
 (D)  $5$
4. Estimate the flux of  $F$  across a small circle  $C$  of a radius  $a$  if  $\text{div } F$  at the center of the circle is  $3$  :
- (A)  $6\pi a^2$   
 (B)  $6\pi a$   
 (C)  $3\pi a^2$   
 (D)  $0$
5. Let  $F$  be defined on a simple connected region in space. If  $\text{curl } F = 0$ , then  $F$  is :
- (A) Conservative  
 (B) Non-conservative  
 (C) Rotational  
 (D) Irrotational
6. Which one of the following functions satisfies the functional equation  $f(f(x)) = x$  for every real number  $x$  :
- (A)  $f(x) = 2x$   
 (B)  $f(x) = x^2$   
 (C)  $f(x) = 2 - x$   
 (D)  $f(x) = 2\sqrt{x}$
7. What is the value of  $\arg z + \arg |\bar{z}|$  ?
- (A)  $2\pi$   
 (B)  $2n\pi$   
 (C)  $3\pi$   
 (D)  $0$

8. If  $u$  is a Harmonic function, the value of  $\nabla^2 u$  is :

(A)  $\frac{2\pi}{3}$

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

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

(D)  $\frac{3\pi}{2}$

9. The modulus of the product of any number of complex quantities is equal to the :

(A) Product of their moduli

(B) Complex conjugate of their moduli

(C) Sum of their moduli

(D) Division of their moduli

10. The recursion relation of gamma function can be written as :

(A)  $\Gamma(m+n) = \Gamma(m) \times \Gamma(n)$

(B)  $\Gamma(n+1) = n \Gamma(n)$

(C)  $\Gamma(m+n) = \Gamma(m) + \Gamma(n)$

(D)  $\Gamma(n+1) = n \Gamma(1)$

11. The beta function value of the integral

$$I = \int_0^{\infty} \frac{x^3}{(1+x)^5} dx \text{ is :}$$

(A) 4

(B) 1/4

(C) 0

(D) 3/5

12. A Fourier series is defined as an expansion of a function in a series of :

(A) Sines function only

(B) Cosines function only

(C) Both (A) and (B)

(D) None of these

13. The expansion of  $e^{\sin(x)}$  is :

(A)  $1 + x + x^2/2 + x^4/8 + \dots$

(B)  $1 + x + x^2/2 - x^4/8 + \dots$

(C)  $1 + x - x^2/2 + x^4/8 + \dots$

(D)  $1 + x + x^3/6 - x^5/10 + \dots$

14. The value of  $(1+i)^{10}$  is ..... ?

(A) 16i

(B) 2i

(C) 0

(D) 32i

15. Who discovered Fourier series ?
- (A) Jean Baptiste de Fourier  
 (B) Fourier Joseph  
 (C) Jean Baptiste Joseph Fourier  
 (D) Jean Fourier
16. What is the fundamental period of the signal :  $e^{j\omega t}$  ?
- (A)  $2\pi/\omega$   
 (B)  $2\pi/\omega^2$   
 (C)  $2\pi/\omega^3$   
 (D)  $4\pi/\omega$
17. What is unit of Dirac function ?
- (A)  $x$   
 (B)  $x^{-1}$   
 (C)  $t$   
 (D)  $t^{-1}$
18. The function  $g(z) = \frac{\cos(z) - 1}{z^2}$  has an isolated singularity at the point ?
- (A)  $z = 0$   
 (B)  $z = 1/2$   
 (C)  $z = -1/2$   
 (D)  $z = 1$
19. A system for which the potential  $V$  is purely a function of co-ordinates is called as :
- (A) Non-conservative system  
 (B) Non-dimensional system  
 (C) Conservative system  
 (D) Multi-dimensional system
20. For a system with  $N$  dimension and 3 holonomic constraints, how many generalised co-ordinates are needed to describe the system ?
- (A)  $N + 6$   
 (B)  $N - 3$   
 (C)  $N - 6$   
 (D)  $N + 3$
21. For a Lagrangian  $L(q, \dot{q}, t)$ , write an expression for the variation  $\delta L$  corresponding to a free particle :
- (A)  $\delta L = m\dot{q} + \delta q$   
 (B)  $\delta L = m\dot{q}$   
 (C)  $\delta L = m\dot{q} / \delta q$   
 (D)  $\delta L = m\dot{q} \delta q$

22. Consider a free particle in 2D space.

Obtain Lagrangian in  $(r, \theta)$  spherical coordinate system ?

(A)  $L = \frac{1}{2}m(\dot{r} + r^2\dot{\theta}^2)$

(B)  $L = \frac{1}{2}m(\dot{r} - r\dot{\theta})$

(C)  $L = \frac{1}{2}m(\dot{r} + r\dot{\theta}^2)$

(D)  $L = \frac{1}{2}m(\dot{r} + r\dot{\theta})$

23. What is the Lagendre transformation of the function  $f(x) = e^x$  ?

(A)  $\ln p(p-1)$

(B)  $\ln p - 1$

(C)  $p(\ln p - 1)$

(D)  $\ln(\ln p - 1)$

24. A particle with position  $x$  and momentum  $p$  has angular momentum  $L = x \times p$ . Evaluate the Poission bracket  $\{p_i, L_k\}$ . The indices  $i, j$  and  $k$  correspond to Cartesian components :

(A)  $p_{jk}$

(B)  $x_j$

(C)  $p_j$

(D)  $x_{jk}$

25. The Lagrange's equation of motion

$$\frac{d}{dt} \left[ \frac{dL}{dq} \right] - \frac{dL}{dq} = 0 \text{ can be used}$$

for :

(A) Conservative and non-holonomic systems

(B) Conservative and holonomic systems

(C) Non-conservative and non-holonomic systems

(D) Non-conservative and holonomic systems

26. If the Lagrangian,  $L$ , is unchanged under the translation of the system along the time  $t$  leads conservation of :

(A) Linear momentum

(B) Energy

(C) Angular momentum

(D) Parity

27. If  $\{p_i, q_j\}$ ,  $\{q_i, q_j\}$  are the Lagrangian brackets and  $[p_i, p_j]$ ,  $[q_i, p_j]$  are Poisson brackets then which below equation is correct :

(A)  $\sum_{i=1}^n \{p_i, q_i\} [p_i, p_j] + \sum_{i=1}^n \{q_i, q_i\} [q_i, p_j] = \delta_{ij}$

(B)  $\sum_{i=1}^n \{p_i, q_i\} [p_i, p_j] + \sum_{i=1}^n \{q_i, q_i\} [q_i, p_j] = \delta_{ij}$

(C)  $\sum_{i=1}^n \{p_i, q_i\} [p_i, p_j] + \sum_{i=1}^n \{q_i, q_i\} [q_i, p_j] = 0$

(D)  $\sum_{i=1}^n \{p_i, q_i\} [p_i, p_j] + \sum_{i=1}^n \{q_i, q_i\} [q_i, p_j] = \delta_{ii}$

28. Which value of the bracket form transformation is called canonical ?

(A)  $[Q, P] = 0$

(B)  $[P, P] = 1$

(C)  $\{Q, P\} = 1$

(D)  $[Q, P] = 1$

29. Identify the Jacobi identity :

(A)  $[A, [B, C]] + [B, [C, A]] + [C, [A, B]] = 0$

(B)  $[A, [B, C]] + [B, [A, C]] + [C, [A, B]] = 0$

(C)  $[A, [B, C]] + [B, [A, C]] + [C, [A, B]] = 0$

(D)  $[A, [B, C]] + [B, [C, A]] + [C, [A, B]] = 0$

30. The mathematical representation of spherical wave travelling outwards from a point source is :

(A)  $Ae^{ikr}$

(B)  $Ae^{-ikr/r}$

(C)  $Ae^{ikr}$

(D)  $Ae^{-ikr}$

31. In a simple harmonic oscillator, when the particle is at the mean position  $y = 0$  then, what is the value of kinetic and potential energy ?

(A) Kinetic energy is maximum and potential energy is zero

(B) Kinetic energy is zero and potential energy is zero

(C) Kinetic energy is zero and potential energy is maximum

(D) Kinetic energy is maximum and potential energy is maximum

32. The rigid spheres are connected by a light flexible rods with relative masses  $m_1 : m_2 : m_3 = 1 : 2 : 1$ . What are the normal modes of the system in the x direction :
- (A)  $x_1 + x_3$ , and  $x_1 + 2x_2 + x_3$   
 (B)  $x_1 - x_3$ , and  $x_1 + 2x_2 + x_3$   
 (C)  $x_1 + x_3$ , and  $x_1 - 2x_2 + x_3$   
 (D)  $x_1 - x_3$ , and  $x_1 - 2x_2 + x_3$
33. Consider the problem of two particles of similar mass  $M$  connected by a spring of constant  $K_{12}$  and further each particle connected to fixed points with springs of constant  $K$ . If the motion of particles is restricted to direction along the x-axis only, so the system has two degrees of freedom  $x_1$  and  $x_2$  that give the displacement of the masses from their respective equilibrium position, what is the kinetic energy of the system ?
- (A)  $T = \frac{1}{2}K(\dot{x}_1^2 + \dot{x}_2^2)$   
 (B)  $T = \frac{1}{2}M(\dot{x}_2^2 - \dot{x}_1^2)$   
 (C)  $T = \frac{1}{2}M(\dot{x}_1^2 + \dot{x}_2^2)$   
 (D)  $T = \frac{1}{2}K(\dot{x}_1^2 - \dot{x}_2^2)$
34. The ratio of intensity of magnetisation to the magnetisation force is known as :
- (A) Flux density  
 (B) Susceptibility  
 (C) Relative permeability  
 (D) None of these
35. A conductor of length  $L$  has current  $I$  passing through it, when it is placed parallel to a magnetic field. The force experienced by the conductor will be :
- (A) Zero  
 (B)  $BLI$   
 (C)  $B^2LI$   
 (D)  $BLI^2$
36. The force between two long parallel conductors is inversely proportional to :
- (A) Radius of conductors  
 (B) Current in one conductors  
 (C) Product of current in two conductors  
 (D) Distance between the conductors

37. A square cross-sectional magnet has a pole strength of  $1 \times 10$  Wb and cross sectional area of  $20 \text{ mm} \times 20 \text{ mm}$ . What is the strength at a distance of  $100 \text{ mm}$  from the unitpole in air :
- (A)  $63.38 \text{ N/Wb}$   
 (B)  $633.8 \text{ N/Wb}$   
 (C)  $6338 \text{ N/Wb}$   
 (D)  $63380 \text{ N/Wb}$
38. Magnetic field inside a solenoid is :
- (A) Zero  
 (B) Infinite  
 (C) Strong  
 (D) Uniform
39. When a charged particle moves at right angle to a magnetic field quantity that changes is :
- (A) Momentum  
 (B) Energy  
 (C) Speed  
 (D) Moment of Inertia
40. Value of magnetic field that will cause a max force of  $7 \times 10^{-3} \text{ N}$  on a  $20 \text{ cm}$  wire carrying current of  $10 \text{ A}$  will be :
- (A)  $1.5 \times 10^{-3} \text{ T}$   
 (B)  $3.5 \times 10^{-3} \text{ T}$   
 (C)  $4.5 \times 10^{-3} \text{ T}$   
 (D)  $2.5 \times 10^{-3} \text{ T}$
41. If a current carrying conductor is placed in uniform magnetic field parallel to direction of field then force experienced by conductor will be :
- (A)  $ILB \times \cos\theta$   
 (B)  $IBL$   
 (C) Zero  
 (D)  $ILB \times \sin\theta$
42. Consider a long coaxial cable of radius  $b$  and length  $l$ , with a center conductor of radius  $a$ . The outer shield is a perfect conductor and is shorted to the linear conductor at the right end. At  $t = 0$ , a voltage  $V_0$  is suddenly applied at the left end and remains constant thereafter. Assuming the current is uniform along the length of the cable  $l \gg b$ , what is the current as a function of time  $I(t)$  :
- (A)  $\frac{V_0}{R}(1 + e^{\frac{r}{l}t})$   
 (B)  $\frac{V_0}{R}(e^{\frac{r}{l}t})$   
 (C)  $\frac{V_0}{R}(e^{-\frac{r}{l}t})$   
 (D)  $\frac{V_0}{R}(1 - e^{-\frac{r}{l}t})$



43. A circular wire of radius  $R$  is centered at the origin, while straight segment extend to uniform along the  $x$ -axis. A uniform current  $I_0$  is suddenly turned on at  $t = 0$ , remaining constant thereafter. What will be the scalar potential at the origin ?
- (A)  $2\pi$   
 (B)  $\Pi$   
 (C) Zero  
 (D)  $I_0/R^2$
44. In a source free region, the value of Maxwell equation  $\nabla \cdot E$  is equal to :
- (A) 0  
 (B)  $\rho$   
 (C)  $\rho/\epsilon$   
 (D)  $\rho/\epsilon_0$
45. Find the force on a charge  $2C$  in a field  $1 V/m$  :
- (A) 0 N  
 (B) 2 N  
 (C) 1 N  
 (D) 3 N
46. Find the electric field intensity of two charges  $2C$  and  $-1C$  separated by a distance  $1m$  in air :
- (A)  $18 \times 10^9$   
 (B)  $36 \times 10^9$   
 (C)  $9 \times 10^9$   
 (D)  $-18 \times 10^9$
47. For a test charge palced at infinity, the electric field will be :
- (A) Unity  
 (B) 0  
 (C)  $\infty$   
 (D)  $-\infty$
48. Three charged cylindrical sheets are present in three spaces with  $\sigma = 5$  at  $R = 2m$   $\sigma = -2$  at  $R = 4m$  and  $\sigma = -3$  at  $R = 5m$ . Find the flux density at  $R = 1m$  :
- (A) 0  
 (B) 2  
 (C) 1  
 (D) 3

49. Gauss law can be evaluated in which coordinate system ?

- (A) Cartesian
- (B) Cylinder
- (C) Spherical
- (D) Depends on the Gaussian surface

50. Find the Maxwell equation derived from Faraday's law :

- (A)  $\text{Div} (H) = J$
- (B)  $\text{Div} (D) = I$
- (C)  $\text{Curl} (E) = -dB/dt$
- (D)  $\text{Curl} (B) = -dH/dt$

51. The charge build up in the capacitor is due to which quantity ?

- (A) Conduction current
- (B) Displacement current
- (C) Convection current
- (D) Direct current

52. Find the electric flux density of a material with charge density 16 units in unit volume :

- (A) 1/16
- (B) 16t
- (C) 16
- (D) 162

53. Identify which type of polarization depends on temperature ?

- (A) Electronic
- (B) Ionic
- (C) Interfacial
- (D) Orientational

54. Find the reflection coefficient of the wave passing through two media having intrinsic impedances of 4 and 9 respectively :

- (A) 0.38
- (B) 1
- (C) 0.5
- (D) 0.1

55. Find the vector potential when the field intensity  $60\hat{x}$  varies from  $(0, 0, 0)$  to  $(1, 0, 0)$ :
- (A) 120  
 (B) -20  
 (C) -180  
 (D) 60
56. The Laplacian of the magnetic vector potential will be :
- (A)  $-\mu J$   
 (B)  $-\mu I$   
 (C)  $-\mu B$   
 (D)  $-\mu H$
57. The guided phase constant of a TEM wave in a waveguide with a phase constant of 2.8 units is :
- (A) 2.8  
 (B) 1.4  
 (C) 0  
 (D) Infinity
58. The mode of propagation is determined by which factors ?
- (A) Type of excitation device  
 (B) Location of excitation device  
 (C) Type and location of the excitation device  
 (D) Waveguide characteristics
59. The waveguide imitates which type of filter characteristics ?
- (A) Low pass filter  
 (B) High pass filter  
 (C) Band pass filter  
 (D) Band reject filter
60. The resonant circuit in a waveguide refers to the :
- (A) Tank circuit  
 (B) RC circuit  
 (C) Bridge circuit  
 (D) Attenuator circuit
61. The attenuation constant is 0.5 units. The skin depth will be :
- (A) 0.5  
 (B) 0.25  
 (C) 2  
 (D) 4
62. The Smith chart is a polar chart which plots :
- (A) R vs Z  
 (B) R vs  $Z_{norm}$   
 (C) T vs Z  
 (D) T vs  $Z_{norm}$

63. In lossy dielectric, the phase difference between the field  $E$  and the magnetic field  $H$  is :
- (A) 90  
(B) 60  
(C) 50  
(D) 0
64. Which equation will hold good for a magnetic material ?
- (A) Line integral of  $H$  is zero  
(B) Surface integral of  $B$  is zero  
(C) Line integral of  $B$  is zero  
(D) Surface integral of  $H$  is zero
65. The capacitance per unit length and the characteristic impedance of a lossless transmission line are  $C$  and  $Z$  respectively. The velocity of a travelling wave on the transmission line is :
- (A)  $ZC$   
(B)  $1/ZC$   
(C)  $Z/C$   
(D)  $C/Z$
66. Which one of the following field patterns represents a TEM wave travelling in the positive  $x$  direction ?
- (A)  $E = +8y, H = -4z$   
(B)  $E = +2z, H = +2y$   
(C)  $E = -2y, H = -3z$   
(D)  $E = -3y, H = +4z$
67. Consider a 4-fold degenerate state with orthonormal eigen functions  $u_1, u_2, u_3$  and  $u_4$ . There is a perturbation  $H'$ . It is given that  $H'_{12} = H'_{21} = -g$ ;  $g > 0$  and all the other matrix elements are zero. Find the splitting and corresponding wave functions :
- (A)  $g, -g, 0, 0$   
(B)  $2g, g, 0, 0$   
(C)  $g, g, 0, 0$   
(D)  $g, 0, 0, 0$

68. Consider a 4-fold degenerate state with orthonormal eigen functions  $u_1, u_2, u_3$  and  $u_4$ . There is a perturbation  $H'$ . It is given that  $H'_{12} = H'_{21} = -g$ ;  $g > 0$  and all the other matrix elements are zero. Find the wave functions of the split levels :

- (A)  $u_1, u_2, u_3$  and  $u_4$   
 (B)  $\frac{u_1 - u_2}{\sqrt{2}}, \frac{u_1 + u_2}{\sqrt{2}}, u_3$  and  $u_4$   
 (C)  $\frac{u_1 - 2u_2}{\sqrt{2}}, \frac{u_1 + 2u_2}{\sqrt{2}}, u_3$  and  $u_4$   
 (D)  $\frac{u_1 - 3u_2}{\sqrt{2}}, \frac{u_1 + 3u_2}{\sqrt{2}}, u_3$  and  $u_4$

69. Consider a 4-fold degenerate state with orthonormal eigen functions  $u_1, u_2, u_3$  and  $u_4$ . There is a perturbation  $H'$ . It is given that  $H'_{11} = H'_{22} = 2g$ ,  $H'_{12} = H'_{21} = g$  and all the other matrix elements are zero. Find the splitting and corresponding wave functions :

- (A)  $g, g, 0, 0$   
 (B)  $2g, g, 0, 0$   
 (C)  $3g, g, 0, 0$   
 (D)  $4g, g, 0, 0$

70. Consider a 4-fold degenerate state with orthonormal eigen functions  $u_1, u_2, u_3$  and  $u_4$ . There is a perturbation  $H'$ . It is given that  $H'_{11} = H'_{22} = 2g$ ,  $H'_{12} = H'_{21} = g$  and all the other matrix elements are zero. Find the wave functions of the split levels :

- (A)  $u_1, u_2, u_3$  and  $u_4$   
 (B)  $\frac{u_1 - u_2}{\sqrt{2}}, \frac{u_1 + u_2}{\sqrt{2}}, u_3$  and  $u_4$   
 (C)  $\frac{u_1 - 2u_2}{\sqrt{2}}, \frac{u_1 + 2u_2}{\sqrt{2}}, u_3$  and  $u_4$   
 (D)  $\frac{u_1 - 3u_2}{\sqrt{2}}, \frac{u_1 + 3u_2}{\sqrt{2}}, u_3$  and  $u_4$

71. A Crooke's Tube (a tube containing rarefied gas through which a current is passed between a cathod and an anode) was used in the discovery of the electron by :

- (A) R. A. Millikan  
 (B) J. J. Thosmson  
 (C) J. S. Townsend  
 (D) M. Planck

72. When an electron falls from an orbit where  $n = 2$  to  $n = 1$  ?
- (A) A photon is emitted  
 (B) A photon is absorbed  
 (C) No change in atomic energy  
 (D) The atomic energy decreases to zero
73. When an electron jumps from an orbit where  $n = 1$  to  $n = 4$ , its energy in terms of the energy of the ground level ( $E_1$ ) is :
- (A)  $E_1/9$   
 (B)  $E_1/16$   
 (C)  $2 E_1$   
 (D)  $16 E_1$
74. Which of the following is a limitation of the Bohr Model of the atom ?
- (A) It does not explain atomic spectra  
 (B) It successfully predicts the intensity of the photons emitted when electrons change energy levels  
 (C) The model only applies to Hydrogen like atoms  
 (D) The model only applies to light atoms
75. The Compton Effect supports which of the following theories ?
- (A) Special Theory of Relativity  
 (B) Light is a wave  
 (C) Thomson model of the atom  
 (D) Light is a particle
76. Neutrons have a :
- (A) Positive charge and a mass approximately equal to an proton  
 (B) Positive charge and a mass approximately equal to an electron  
 (C) Neutral charge and a mass approximately equal to an proton  
 (D) Neutral charge and a mass approximately equal to an electron

77. Which of the following formulas can be used to determine the de Broglie wavelength ?
- (A)  $\lambda = hmv$   
 (B)  $\lambda = h/mv$   
 (C)  $\lambda = mv/h$   
 (D)  $\lambda = hm/c$
78. Which one of the following objects, moving at the same speed, has the greatest de Broglie wavelength ?
- (A) Neutron  
 (B) Electron  
 (C) Tennis ball  
 (D) Bowling
79. Heisenberg's Uncertainty Principle states :
- (A) The more precise a particle's energy can be measured, the less precise its position can be measured  
 (B) A particle's position can be measured exactly  
 (C) A particle's energy can be measured exactly  
 (D) The more precise a particle's momentum can be measured, the less precise its position can be measured
80. Knowledge of the wave function of a particle enables the probabilities of the particle's position, momentum, energy and other characteristics to be calculated. In classical physics, what is the analogue of the wave function ?
- (A) The particle's momentum  
 (B) The particle's energy  
 (C) The particle's mass  
 (D) The sum of the forces on the particles
81. Which theory explains the interaction of photons with matter (electrons) ?
- (A) Quantum Chromodynamics  
 (B) The Standard Model  
 (C) String Theory  
 (D) Quantum Electrodynamics

82. Which theory explains the attraction between protons and neutrons ?
- (A) Quantum Chromodynamics  
 (B) Quantum Electrodynamics  
 (C) String Theory  
 (D) The Grand Unified Theory
83. Suppose you add a constant  $V_0$  to the potential energy, which show the wavefunction with a time dependent phase factor :  $\exp(-i V_0 t/\hbar)$ . What effect does this have on the expectation value of a dynamical variables :
- (A) Effect on phase factor  
 (B) No effect on the expectation value  
 (C) Effect both phase and expectation value  
 (D) No effect on phase factor
84. Suppose a particle starts out in a linear combination of just two stationary states :  
 $\psi(x, 0) = c_1\psi_1(x) + c_2\psi_2(x)$ . What is the angular frequency ?
- (A)  $(E_1 - E_2) / \hbar$   
 (B)  $(E_1 + E_2) / \hbar$   
 (C)  $(C_1 - C_2) / \hbar$   
 (D)  $(C_1 + C_2) / \hbar$
85. A particle in the infinite square well has the initial wavefunction  $\psi(x, 0) = Ax(a - x)$ , where  $(0 \leq x \leq a)$ , what is a value of  $\psi$  outside the well ?
- (A) 1  
 (B) a  
 (C) 0  
 (D) -a
86. In harmonic oscillator the motion is governed by which law ?
- (A) Euler's law  
 (B) Schrödinger's law  
 (C) Hooke's law  
 (D) Ampere's law
87. What is the 1st excited energy states in the simple harmonic oscillator ?
- (A)  $3/2 \hbar\omega$   
 (B)  $5/2 \hbar\omega$   
 (C)  $1/2 \hbar\omega$   
 (D)  $\hbar\omega$



88. A free particle has the initial wave function  $\psi(x, 0) = Ae^{-a|x|}$ , where  $A$  and  $a$  are positive real constants. What is the normalized value of  $\psi(x, 0)$ ?
- (A)  $\sqrt{2a}$   
 (B)  $1/\sqrt{a}$   
 (C)  $\sqrt{a}$   
 (D)  $1/\sqrt{2a}$
89. A free particle has the initial wave function  $\psi(x, 0) = Ae^{-ax^2}$ , where  $A$  and  $a$  are constants. What is the expectation value of  $\langle p \rangle$ ?
- (A)  $a\hbar$   
 (B) 0  
 (C) 1  
 (D)  $-a\hbar$
90. A free particle has the initial wave function  $\psi(x, 0) = Ae^{-ax^2}$ , where  $A$  and  $a$  are constants. What uncertainty principle hold for the above?
- (A)  $\langle x \rangle \langle p \rangle \geq \hbar/2$   
 (B)  $\Delta x \Delta p \geq \hbar/2$   
 (C)  $\Delta x \Delta p > \hbar/2$   
 (D)  $\sigma_x \sigma_p \geq \hbar/2$
91. Two functions are orthogonal if:
- (A) Their inner product is 1  
 (B) Their inner product is 0  
 (C) They are normalized  
 (D) They are mutually orthogonal
92. If two (or more) linearly independent eigenfunctions share the same eigenvalue, then the spectrum is said to be:
- (A) Degenerate  
 (B) Non-degenerate  
 (C) Normalized  
 (D) Orthogonal
93. What is the first excited energy of the hydrogen atom, if the ground state is  $-13.6$  eV?
- (A)  $-6.8$   
 (B)  $-13.6$   
 (C)  $-3.4$   
 (D)  $-1.7$

94. If the Bohr's radius is  $a$ , what is the most probable value of  $r$ , in the ground state of hydrogen ?

- (A)  $4a$
- (B)  $3a$
- (C)  $2a$
- (D)  $a$

95. Consider the earth-sun system as a gravitational analog to the hydrogen atom. What is the potential energy function ?

- (A)  $V(r) = -G \frac{Mm}{r}$
- (B)  $V(r) = -\frac{e^2}{4\pi\epsilon_0} \frac{Mm}{r}$
- (C)  $V(r) = G \frac{Mm}{r}$
- (D)  $\frac{e^2}{4\pi\epsilon_0} \frac{Mm}{r}$

96. Which one is the Pauli spin matrix for  $\sigma_x$  ?

- (A)  $\begin{pmatrix} 0 & i \\ i & 0 \end{pmatrix}$
- (B)  $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$

(C)  $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

(D)  $\begin{pmatrix} i & 0 \\ 0 & i \end{pmatrix}$

97. Suppose a spin  $1/2$  particle is in the state  $x = \frac{1}{\sqrt{6}} \begin{pmatrix} 1+i \\ 2 \end{pmatrix}$ . What is the probability of getting  $\hbar/2$ , if you measure  $S_z$  ?

- (A)  $5/6$
- (B)  $2/3$
- (C)  $1/6$
- (D)  $1/3$

98. A spinning charged particle constitutes a magnetic dipole. Its magnetic dipole moment is  $\mu$ , is proportional to its spin angular momentum  $S$ , then which one is true ?

- (A)  $\mu = -\gamma \times S$
- (B)  $\mu = \gamma S$
- (C)  $\mu = \gamma \times S$
- (D)  $\mu = -\gamma S$

99. The Stark effect is the shifting and splitting of spectral lines of atoms and molecules due to the presence of what ?
- (A) An external magnetic field
  - (B) An external electromagnetic wave
  - (C) An external electric field
  - (D) None of these
100. The first law of thermodynamics is conservation of :
- (A) Momentum
  - (B) Energy
  - (C) Both of these
  - (D) None of these
101. The change in entropy is :
- (A) Positive in a reversible change
  - (B) Negative in an irreversible change
  - (C) Positive in an irreversible change
  - (D) Negative in a reversible change
102. From the following change in entropy depends what ?
- (A) Only on the transfer of heat
  - (B) Only on change of temperature
  - (C) On the transfer of mass
  - (D) On the thermodynamic state
103. The Gibb's function  $G$  in thermodynamics is defined as  $G = H - TS$ . In an isothermal, isobaric, reversible process,  $G$  :
- (A) Remains constant but not zero
  - (B) Varies linearly
  - (C) Varies non-linearly
  - (D) Is zero
104. When applied to solar radiation, Planck's law reduces to Wien's law in which region :
- (A) Ultraviolet region
  - (B) Microwave region
  - (C) Infrared region
  - (D) Visible region

105. According to Maxwell's law of distribution of velocities of molecules, the most probable velocity is :

- (A) Greater than the mean velocity
- (B) Equal to the mean velocity
- (C) Equal to root mean square velocity
- (D) Less than the root mean square velocity

106. In a micro canonical ensemble, a system A of fixed volume is in contact with a large reservoir B. Then which situation will arise :

- (A) A can exchange only energy with B
- (B) A can exchange only particles with B
- (C) A can exchange neither energy nor particles with B
- (D) A can exchange both energy and particles with B

107. In case of Bose-Einstein condensation :

- (A) Number of particles increase in lower energy levels at low temperatures and high pressures

(B) Number of particles decreases in lower energy levels at low temperatures and high pressures

(C) Number of particles increase in lower energy levels at high temperatures and low pressures

(D) Number of particles decrease in lower energy levels at high temperatures and low pressures

108. The quantum statistics reduces to classical statistics under which following condition :

(A)  $\rho \lambda^3 \approx 1$

(B)  $\rho \lambda^3 \gg 1$

(C)  $\rho \lambda^3 \ll 1$

(D)  $\rho = 0$

109. Specific heat of metals can be expressed as :

(A)  $T^3$

(B)  $AT + BT^2$

(C)  $AT^2 + BT^3$

(D)  $AT + BT^3$

110. The representation of octal number  $(532.2)_8$  in decimal is :
- (A)  $(346.25)_{10}$   
 (B)  $(532.864)_{10}$   
 (C)  $(340.67)_{10}$   
 (D)  $(531.668)_{10}$
111. The largest two digit hexadecimal number is :
- (A)  $(FE)_{16}$   
 (B)  $(FD)_{16}$   
 (C)  $(FF)_{16}$   
 (D)  $(EF)_{16}$
112. The expression for Absorption law is given by :
- (A)  $A + AB = A$   
 (B)  $A + AB = B$   
 (C)  $AB + AA' = A$   
 (D) None of these
113.  $A(A + B) = ?$
- (A)  $AB$   
 (B)  $1$   
 (C)  $(1 + AB)$   
 (D)  $A$
114. How many AND gates are required to realize  $Y = CD + EF + G$  ?
- (A) 4  
 (B) 5  
 (C) 3  
 (D) 2
115. According to the IC fabrication process logic families can be divided into two broad categories as :
- (A) RTL and TTL  
 (B) HTL and MOS  
 (C) ECL and DTL  
 (D) Bipolar and MOS
116. The difference between a flip-flop and latch is :
- (A) Both are same  
 (B) Flip-flop consist of an extra output  
 (C) Latches has two inputs but flip-flop has two  
 (D) None of these

117. The circuit that is primarily responsible for certain flip-flops to be designated as edge-triggered is the :

- (A) Edge-detection circuit
- (B) NOR latch
- (C) NAND latch
- (D) Pulse-steering circuit

118. The observation that a bubbled input OR gate is interchangeable with a bubbled output AND gate is referred to as :

- (A) A Karnaugh map
- (B) DeMorgan's second theorem
- (C) The commutative law of addition
- (D) The associative law of multiplication

119. Repeatable entity of a crystal structure is known as :

- (A) Crystal
- (B) Lattice
- (C) Unit cell
- (D) Miller indices

120. Atomic packing factor is :

- (A) Distance between two adjacent atoms
- (B) Projected area fraction of atoms on a plane
- (C) Volume fraction of atoms in cell
- (D) None of these

121. Miller indices for Octahedral plane in cubic crystal ?

- (A) (100)
- (B) (111)
- (C) (110)
- (D) None of these

122. Schottky-defect in ceramic material is :

- (A) Pair of nearby cation and anion vacancies
- (B) Vacancy-interstitial pair of cations
- (C) Interstitial impurity
- (D) Substitutional impurity

123. Calculate the drift velocity of the free electrons with mobility of  $3.5 \times 10^{-3} \text{m}^2/\text{Vs}$  in copper for an electric field strength of  $0.5 \text{V/m}$  :

- (a) 3.5 m/s
- (b)  $1.75 \times 10^3 \text{m/s}$
- (c) 11.5m/s
- (d)  $1.75 \times 10^{-3} \text{m/s}$

124. The Fermi temperature of a metal is 24600K. The Fermi velocity is :

- (a) 0.5 m/s
- (b) 1.38 m/s
- (c)  $0.8633 \times 10^6 \text{m/s}$
- (d)  $9.11 \times 10^{-3} \text{m/s}$

125. Which of the following causes acoustical grating ?

- (a) Magnetic waves
- (b) Electric waves
- (c) Magnetostriction effect
- (d) Ultrasonic waves

126. Amount of energy that valence electron must have in order to jump from Valence band to conduction band is called ?

- (A) Energy band
- (B) Energy gap
- (C) Energy baud
- (D) Energy core

127. For paramagnetic material, which of the following is correct ?

- (A) Magnetic susceptibility  $< 0$
- (B) Magnetic susceptibility  $> 0$
- (C) Magnetic susceptibility = 0
- (D) None of the mentioned

128. With an increase in the area of hysteresis curve, power loss will :

- (A) Increases
- (B) Decreases
- (C) First decreases then increases
- (D) First increases then decreases

129. Which of the following parameter is used to assess the magnetic ability of the material ?

- (A) Magnetic flux density
- (B) Magnetization
- (C) Magnetic dipole moment
- (D) Susceptibility

130. When the electrical conductivity of semiconductor is only due to the breaking of its covalent bonds, then the semiconductor is said to be :

- (A) Donor
- (B) Acceptor
- (C) Intrinsic
- (D) Extrinsic

131. Paul Langevin's theory of diamagnetism applies to materials containing atoms with closed shells. A field with intensity B, applied to an electron with charge e and mass m, gives rise to Larmor procession. If the number of revolutions per unit time is  $\omega/2\pi$  then the current for an atom with Z electrons is :

(A)  $I = - \frac{Ze^2B}{4\pi m}$

(B)  $I = - \frac{Ze^2\omega}{4\pi m}$

(C)  $I = \frac{Ze^2\omega}{4\pi m}$

(D)  $I = \frac{Ze^2B}{4\pi m}$

132. Pauli paramagnetism plays an interesting role in superconductivity. Pauli paramagnetic splitting refers to :

- (A) Creation of Cooper pairs by a magnetic field
- (B) Annihilation of Cooper pairs by a magnetic field
- (C) Creation of Cooper pairs by an electric field
- (D) None of these

133. An unknown chemical element is presented by the following formula  ${}^A_ZX$ . What is the name of index Z ?

- (A) Atomic mass number
- (B) Atomic number
- (C) Principle quantum number
- (D) Orbital quantum number



134. An unknown chemical element is presented by the following formula

${}^A_ZX$ . What is the name of index A?

- (A) Atomic mass number
- (B) Atomic number
- (C) Principle quantum number
- (D) Orbital quantum number

135. The atomic number is equivalent to which of the following :

- (A) The number of neutrons in the atom
- (B) The number of protons in the atom
- (C) The number of nucleons in the atom
- (D) The number of  $\alpha$ -particles in the atom

136. The atomic mass number is equivalent to which of the following :

- (A) The number of neutrons in the atom
- (B) The number of protons in the atom
- (C) The number of nucleons in the atom
- (D) The number of  $\alpha$ -particles in the atom

137. Which of the following particles has the smallest mass ?

- (A) Proton
- (B) Electron
- (C) Neutron
- (D) Nucleus

138. Which of the following statements about the mass of an atom is true ?

- (A) It is evenly divided between the protons and the orbiting electrons
- (B) It is evenly divided between the nucleons and the orbiting electrons
- (C) It is concentrated in the electron cloud
- (D) It is concentrated in the nucleus

139. Which of the following is correct for the number of neutrons in the nucleus ?

- (A)  $N = A - Z$
- (B)  $N = Z - A$
- (C)  $N = Z + A$
- (D)  $N = Z$

140. How many electrons are in the  $^{12}_6\text{C}$  atom ?
- (A) 12
  - (B) 6
  - (C) 18
  - (D) 3
141. How many nucleus are in the  $^{20}_{10}\text{Ne}$  atom ?
- (A) 12
  - (B) 30
  - (C) 18
  - (D) 20
142. How many neutrons are in the  $^{23}_{11}\text{Na}$  atom ?
- (A) 12
  - (B) 11
  - (C) 18
  - (D) 24
143. How many protons are in the  $^{14}_7\text{N}$  atom ?
- (A) 14
  - (B) 6
  - (C) 7
  - (D) 10
144. What law did Ernest Rutherford use to estimate the size of the nucleus ?
- (A) Conservation of nucleon number
  - (B) Conservation of angular momentum
  - (C) Conservation of linear momentum
  - (D) Conservation of energy
145. Why are nuclear energy levels more complex than electron energy levels ?
- (A) Nuclear energy levels depend only on attractive forces
  - (B) Nuclear energy levels depend on attractive and repulsive forces
  - (C) Nuclear energy levels are an order of one hundred times as great as electron energy levels
  - (D) Electron energy level depend on the interaction between neutrons and electrons
146. Which of the following about the nuclear force is true ?
- (A) It is an attractive force between electrons and protons in an atom
  - (B) It is an attractive force between electrons and neutrons in an atom
  - (C) It is a strong, short-range, attractive force between the nucleons
  - (D) It is much weaker than the gravitational force

147. What force is responsible for the radioactive decay of the nucleus ?
- (A) Gravitational force  
 (B) Weak nuclear force  
 (C) Strong nuclear force  
 (D) Electromagnetic force
148. Isotopes of an element :
- (A) Have the same number of protons and electrons, but a different number of neutrons  
 (B) Have the same number of protons and neutrons, but a different number of electrons  
 (C) Have different number of protons  
 (D) Have different number of electrons
149. Binding energy is :
- (A) The amount of energy required to break a nucleus apart into protons and neutrons  
 (B) The amount of energy required to break a nucleus apart into protons and electrons  
 (C) The amount of energy required to break a nucleus apart into electrons and neutrons  
 (D) The amount of energy released when neutrons change energy levels.
150. If  $m_H$  is the atomic mass of Hydrogen,  $m_n$  is the mass of a neutron,  $M$  is the atomic mass of the atom, which of the following is the mass defect formula ?
- (A)  $\Delta m = Z \cdot m_H + N \cdot m_n - M$   
 (B)  $\Delta m = Z \cdot m_H + N \cdot m_n + M$   
 (C)  $\Delta m = Z \cdot m_H - N \cdot m_n - M$   
 (D)  $\Delta m = M - Z \cdot m_H - N \cdot m_n$
151. When nucleons form a stable nucleus, binding energy is :
- (A) Created from nothing  
 (B) Destroyed into nothing  
 (C) Released as high energy photons or particles  
 (D) Absorbed as high energy photons or particles

152. When a nucleus is divided into its constituents, energy is :

- (A) Created from nothing
- (B) Destroyed into nothing
- (C) Transformed into visible light
- (D) Absorbed by the nucleus which then breaks it apart

153. An isotope with a high Binding Energy per nucleon :

- (A) Will decay in short period of time
- (B) Is very unstable
- (C) Is very stable
- (D) Has very few electrons

154. Why do heavier nuclei have greater ratio of neutrons to protons than lighter nuclei ?

- (A) To add more nucleons so that the binding energy is greater
- (B) To provide a greater weak nuclear force

(C) To provide more attractive electromagnetic force

(D) To provide more attractive strong nuclear force to balance the repulsive electromagnetic force

155. Which of the following is the alpha particle?

- (A)  ${}^0_{+1}e$
- (B)  ${}^0_{-1}e$
- (C)  ${}^0_1n$
- (D)  ${}^4_2\text{He}$

156. Which of the following is the  $\beta^-$  particle?

- (A)  ${}^0_{+1}e$
- (B)  ${}^0_{-1}e$
- (C)  ${}^0_1n$
- (D)  ${}^1_1\text{H}$

157. Which of the following is the  $\beta^+$  particle?

- (A)  ${}^0_{+1}e$
- (B)  ${}^0_{-1}e$
- (C)  ${}^0_1n$
- (D)  ${}^1_1\text{H}$

158. Which of the following about the gamma ray is true ?

- (A) It carries a positive charge
- (B) It carries a negative charge
- (C) It has zero rest mass and a neutral charge
- (D) It can be deflected by an electric field

159. Which type of radiation is stopped by a sheet of paper ?

- (A) Alpha particle
- (B) Beta particle
- (C) Gamma ray
- (D) X-ray

160. What is the missing element from the following equation  ${}^{226}_{88}\text{Ra} \rightarrow {}^4_{+2}\text{He} + ?$

- (A)  ${}^{230}_{86}\text{Rn}$
- (B)  ${}^{220}_{86}\text{Rn}$
- (C)  ${}^{228}_{86}\text{Rn}$
- (D)  ${}^{222}_{86}\text{Rn}$

161. What is the missing element from the following equation  ${}^{14}_6\text{C} \rightarrow {}^0_{+1}\text{e} + ?$

- (A)  ${}^{13}_7\text{N}$
- (B)  ${}^{14}_7\text{N}$
- (C)  ${}^{17}_8\text{O}$
- (D)  ${}^{16}_8\text{O}$

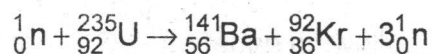
162. A 100g sample of a radioactive element has a half-life of 5 days. How many grams of radioactive material will remain after 15 days ?

- (A) 100g
- (B) 50g
- (C) 25g
- (D) 12.5g

163. A reaction that releases more energy than is put into it is called :

- (A) Endothermic
- (B) Exothermic
- (C) Nuclear
- (D) Chemical

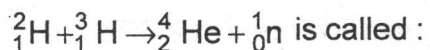
164. The following reaction :



is called :

- (A) Fusion
- (B) Fission
- (C) Alpha decay
- (D) Beta decay

165. The following reaction :



- (A) Fusion
- (B) Fission
- (C) Alpha decay
- (D) Beta decay



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