

Reg. No. :

Name :

**Common Entrance Examination, for Admission to the M.Phil
Courses, 2020**

PHYSICS

Time : 3 Hours

Max. Marks : 100

I. Answer **all** questions. Each question carries 1 mark.

1. Which one of the following is a fermion?

(a) α particle(b) ${}_4\text{Be}^2$ nucleus

(c) Hydrogen atom

(d) deuteron

2. Find the Laplace transform of $\delta(t)$

(a) 1

(b) 0

(c) ∞

(d) 2

3. Which of the following expressions represents the correct distribution of the electrons in the conduction band? ($gc(E)$ =density of quantum states, $f_F(E)$ =Fermi dirac probability)

(a) $n(E) = gc(E) * f_F(E)$ (b) $n(E) = gc(-E) * f_F(E)$ (c) $n(E) = gc(E) * f_F(-E)$ (d) $n(E) = gc(-E) * f_F(-E)$

4. If the sheet of a Bakelite is inserted between the plates of an air capacitor, the capacitance will be
- (a) decrease (b) increase
(c) remains unchanged (d) become zero
5. According to quantum mechanics, for the particle moving in a box
- (a) Energy levels are discrete and equispaced
(b) Energy levels are continuous
(c) Energy levels are discrete but not equispaced
(d) Energy is always zero
6. A 2×4 decoder with an enable input can function as a
- (a) 4×1 multiplexer
(b) 1×4 demultiplexer
(c) 4×2 encoder
(d) 4×2 priority encoder
7. A Zener diode with an operating voltage of 10 V at 25°C has a positive temperature coefficient of 0.07% per $^\circ\text{C}$ of the operating voltage. The operating voltage of this Zener diode at 125°C is
- (a) 12.0 V (b) 11.7 V
(c) 10.7 V (d) 9.3 V

8. Divergence of $\vec{F}(x, y, z) = e^{xy}\hat{i} - \cos y\hat{j} + (\sin z)^2\hat{k}$
- $ye^{xy} + \cos y + 2 \sin z \cdot \cos z$
 - $ye^{xy} - \sin y + 2 \sin z \cdot \cos z$
 - 0
 - $ye^{xy} + \sin y + 2 \sin z \cdot \cos z$
9. Which one of the following CANNOT be explained by considering a harmonic approximation for the lattice vibrations in solids?
- Deby's T^3 law
 - Dulong Petit's law
 - Optical branches in lattices
 - Thermal expansion
10. The thermal conductivity of a given material reduces when it undergoes a transition from its normal state to the superconducting state. The reason is.
- The Cooper pairs cannot transfer energy to the lattice
 - Upon the formation of Cooper pairs, the lattice becomes less efficient in heat transfer
 - The electrons in the normal state lose their ability to transfer heat because of their coupling to the Cooper pairs
 - The heat capacity increases on transition to the superconducting state leading to a reduction in thermal conductivity
11. Let \vec{r} be the position vector of the point $P(x, y, z)$ in the three-dimensional real vector space and $\phi(x, y, z)$ be a harmonic function (that satisfies Laplace's equation), then $\vec{F} = \vec{\nabla} \phi + \vec{r}$ is
- neither solenoidal nor irrotational
 - solenoidal but not irrotational
 - irrotational but not solenoidal
 - both solenoidal and irrotational

12. The power per unit velocity of a wave with electric field as 8 units and density 10 units is
- (a) 40 (b) 20
(c) 80 (d) 160
13. The probability of finding a particle in differential region dx is.
- (a) $\psi(x, t) dx$
(b) $\psi(x, t) * dx$
(c) $[\psi(x, t) * \psi(x, t)] dx$
(d) $\psi(x, t) * \psi(x, t) dx = |\psi(x, t)|^2 dx$
14. The density of electrons in a crystal below the Fermi level E_F varies as
- (a) $E_F^{1/2}$ (b) $E_F^{2/3}$
(c) $E_F^{3/2}$ (d) $E_F^{5/2}$
15. A plane electromagnetic wave traveling in free space is incident normally on a material of refractive index $3/2$. Assuming no absorption, its reflectivity is
- (a) 4% (b) 16%
(c) 20% (d) 50%
16. The eigen values of a matrix are $i, -2i$ and $3i$. The matrix is
- (a) Unitary (b) anti-unitary
(c) Hermitian (d) anti-hermitian

17. The power in an amplitude modulated wave having modulation 100% and carrier power 10 W is
- (a) 10 W (b) 15 W
(c) 20 W (d) 25 W
18. The number of distinct ways of placing four bosons into five distinguishable boxes is
- (a) 40 (b) 50
(c) 60 (d) 70
19. The limit point of the poles of a function $f(z)$ is
- (a) A pole
(b) A non-isolated singularity
(c) An isolated singularity
(d) A non-isolated essential singularity
20. The role of a project supervisor is to
- (a) provide academic support, guidance and critical feedback on your work
(b) give you a reading list
(c) negotiate access to the research setting on the students behalf
(d) ensure you keep to your schedule and deadlines
21. Which of the following is a criterion for a good research question?
- (a) Questions should be long and use complex terms
(b) Questions should show where my research biases are
(c) Questions should sound contemporary
(d) Questions should connect with established theory and research

22. Which of the following does not come under sub-classification of quantitative research?
- (a) Inferential approach
 - (b) Experimental approach
 - (c) Simulation approach
 - (d) Relative approach
23. Which of the following should be included in a research proposal?
- (a) Your academic status
 - (b) Your academic
 - (c) Your choice of research methods and reasons for choosing them
 - (d) All of the above
24. In the process of conducting research, Formulation of hypothesis is followed by
- (a) Definition of research
 - (b) Review of concepts
 - (c) Review of theories
 - (d) Design of research
25. For any operator \hat{A} , $i(A^+ - A)$ is
- (a) Unitary
 - (b) Orthogonal
 - (c) Hermitian
 - (c) Anti-Hermitian
26. The numerical error in the trapezoidal rule of step size h is of the order of
- (a) h^3
 - (b) h^4
 - (c) h
 - (d) h^2

27. If the equation of state for a gas with internal energy U is $PV = \frac{2}{3}U$, then the value of the ratio C_p / C_v is
- (a) $5/2$ (b) $3/5$
(c) $2/5$ (d) $5/3$
28. The Lagrangian for a charged particle in an electromagnetic field is given by
- (a) $T - e\phi + (e/c) A.v$ (b) $T + e\phi + (e/c) A.v$
(c) $T + e\phi - (e/c) A.v$ (d) $T - e\phi - (e/c) A.v$
29. The lowest quantum mechanical energy of a particle confined in a one-dimensional box of size L is 2eV . The energy of the quantum mechanical ground state for a system of three non-interacting spin $1/2$ particles is
- (a) 6 eV (b) 10 eV
(c) 12 eV (d) 16 eV
30. A photon has a spin of
- (a) 2 (b) $1/2$
(c) 1 (d) 0
31. The relative magnetic permeability of a type-I super conductor is
- (a) 0 (b) -1
(c) 2π (d) 3π
32. The value of integral $\int_{-\infty}^{\infty} \frac{1}{x^2 + 1} dx$ is
- (a) $-\pi$ (b) $+\pi$
(c) 0 (d) Indeterminate

33. In the sp configuration, which of the term symbols lies deepest?
- (a) 1P_1 (b) 3P_0
 (c) 3P_2 (d) 3P_1
34. The number of independent components for a general electromagnetic field tensor is
- (a) 4 (b) 6
 (c) 8 (d) 9
35. The order of magnitude of the binding energy per nucleon in a nucleus is
- (a) 10^{-5} MeV (b) 10^{-3} MeV
 (c) 0.1 MeV (d) 10 MeV
36. The logic expression $\overline{A}BC + \overline{A}\overline{B}C + A\overline{B}\overline{C} + A\overline{B}C$ can be simplified to
- (a) A XOR C (b) A AND \overline{C}
 (c) 0 (d) 1
37. An amplifier has a gain of 300. When negative feedback is applied, the gain is reduced to 240, then the feedback ratio is
- (a) 5/4 (b) 1/1200
 (c) 60 (d) -1/300
38. The volume of a radiation cavity at 200K is adiabatically increased from 10 cm^3 to 640 cm^3 . The temperature of the cavity changes to
- (a) 800 K (b) 700 K
 (c) 600 K (d) 500 K

39. If a fine structure splitting between $2P_{3/2}$ and $2P_{1/2}$ levels of hydrogen atom is 0.4 cm^{-1} , the corresponding splitting in Li^{2+} will approximately be
- (a) 1.2 cm^{-1} (b) 10.8 cm^{-1}
 (c) 32.4 cm^{-1} (d) 36.8 cm^{-1}
40. The value of the Lande g factor for a fine structure level having the quantum numbers. $L = 1$, $J = 2$ and $S = 1$ is
- (a) $11/6$ (b) $4/3$
 (c) $8/3$ (d) $3/2$

(40 × 1 = 40 Marks)

II. Answer all questions. Each question carries 5 marks.

41. What are the characteristics of an ideal op amp?
42. What are scalar and vector potentials? Deduce the Maxwell's equations in terms of these potentials.
43. What is Hall Effect? Derive an expression for the Hall coefficient.
44. State and explain D'Alembert's principle.
45. Compute the integral $\int_0^\infty \frac{dx}{(1+x^4)}$ using the residue theorem.
46. What is mutual exclusion principle? Give examples.
47. State the steps in the construction of a questionnaire.
48. Define hypothesis and state the characteristics of a good hypothesis.
49. What is Presentation tool? Explain its features and functions.

50. List out the advantages and disadvantages of sampling.
51. Explain the method of least square linear fitting with an example.
52. What is Chi-square test? Explain the significance in statistical analysis of any research problem.

(12 × 5 = 60 Marks)

Physics.

K 1100.

ANSWER KEY TO THE QUESTION PAPER

QUESTION NUMBER	ANSWER KEY
1	D
2	A
3	A
4	B
5	C
6	B
7	C
8	D
9	D
10	D
11	C
12	C
13	B
14	C
15	A
16	D
17	A
18	D
19	D
20	A

ANSWER KEY TO THE QUESTION PAPER

21	D
22	D
23	C
24	D
25	C
26	D
27	B
28	A
29	C
30	C
31	A
32	A
33	B
34	B
35	D
36	A
37	B
38	D
39	C
40	D