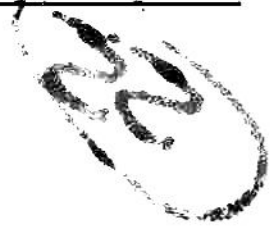
FOR ROUGH WORK



Research Entrance Test – 2015

No. of Questions : 50

Time : 2 Hours *Full Marks : 200*

Note : (i) This Question Booklet contains **40** Multiple Choice Questions followed by 10 Short Answer Questions.

(ii) Attempt as many MCQs as you can. Each MCQ carries **3 (Three)** marks. **1 (One)** mark will be deducted for each incorrect answer. ***Zero*** *mark will be* awarded for each unattempted question. If more than **one** alternative answers of MCQs seem to be approximate to the correct answer, choose the closest one.

(iii) Answer only **5** Short Answer Questions. Each question carries **16 (Sixteen)** marks and should be answered in **150-200** words. Blank **5 (Five)** pages attached with this booklet shall only be used for the purpose. Answer each question on separate page, after writing Question No.

1. Neoprene is polymer of :

   (1) Orlon (2) SAN (3) ABS (4) All of these

2. The reagent that can be used to distinguish between Glucose and Fructose is :

   (1) Bromine water (2) Fehling's solution

   (3) Tollen's reagent (4) Phenyl hydrazine

3. What will happen if a lysosome leaks inside the cell ?

   (1) The lysosomal enzymes will digest cell organelles

   (2) The lysosomal enzymes will become nonfunctional at pH 7.4 of the cytoplasm

   (3) The lysosomal enzymes will be secreted out of the cell

   (4) The leaked suicidal bag will make cell to commit suicide

4. Oxygen evolved during photosynthesis in plants comes from :

   (1) Splitting of water molecules

   (2) Breakdown of carbon dioxide

   (3) Carbohydrates accumulated by plants

   (4) Lipids

5. The contribution of Gregor Johann Mendel is related to the area of :

   (1) Plant classification (2) Genetics

   (3) Cell structure (4) Plant functions

6. Himalaya is :

   (1) Paleozoic tectonic mountain (2) Recent Folded mountain

   (3) Indian mountain (4) Eurasian mountain

7. A particle executes simple harmonic motion under the restoring force provided by a spring. The time period is T. If the spring is dived in two equal parts and one part is used to continue the simple harmonic motion, the time period will :

   (1) remain T (2) become 2T

   (3) become T/2 (4) become $T/\sqrt{2}$

8. The efficiency of the Carnot's engine working between the steam point and the ice point is :

(1) 36.81% (2) 26.81% (3) 40% (4) 16.8%

9. If $\vec{a} = 2i - 3j + 4k$ and $\vec{b} = 3i + 2j$, then the angle between $\vec{a}$ and $\vec{b}$ is :

(1) 45° (2) 90° (3) 180° (4) 120°

10. The value of the integral $\int_0^{\frac{\pi}{2}} \frac{\sqrt{\sin x}}{\sqrt{\sin x} + \sqrt{\cos x}} dx$ is

(1) π (2) $\frac{\pi}{2}$ (3) $\frac{\pi}{4}$ (4) $-\frac{\pi}{4}$

11. The operation of a logarithmic amplifier is based on :

(1) The non-linear operation of an op-amp

(2) The logarithmic characteristics of a p-n junction diode

(3) The reverse-breakdown characteristics a p-n junction diode

(4) The logarithmic charge and discharge of an RC circuit

12. A phase locked loop is locked onto an incoming signal with a frequency of 1 MHz at a phase angle of 50°. The VCO signal is at a phase angle of 20°. The peak amplitude of the incoming signal is 0.5 volts and that of VCO output signal is 0.7 volts. The VCO frequency and the control voltage being fed back to the VCO at this point are :

(1) 0.35 MHz, 0.15 volt (2) 1 MHz, 0.15 volt

(3) $\frac{\pi}{6}$ MHz, 0.17 volt (4) 2.8 MHz, 0.17 volt

13. The collector leakage current in a transistor is 5 μA in common-base arrangement. If now transistor is connected in common-emitter arrangement, what will be leakage current (given $\beta = 50$) :

(1) 255 μA (2) 25 μA (3) 0.98 μA (4) 9.8 μA

14. For an oscillator to properly start, the gain around the feedback loop must initially be :

(1) 1 (2) <1 (3) >1 (4) infinite

15. Radiation pattern of which of the following antenna types is the most directional ?

(1) Short electric doublet (2) Half wave dipole

(3) Full wave dipole (4) Antenna array

16. One condition for oscillation is :

(1) A phase shift around feedback loop of 180°

(2) A gain around the feedback loop of one third

(3) A phase shift around the feedback loop of 0°

(4) A gain around the feedback loop of less than 1

17. The ratio of stimulated to spontaneous emission rates is *equal to* :

(1) $\frac{1}{e^{\frac{h\upsilon}{KT}}}$ (2) $e^{\frac{2h\upsilon}{KT}} - 1$ (3) 1 (4) $e^{\frac{h\upsilon}{KT}} - 1$

18. Regarding the fine structure of lines of hydrogen atoms which of the following is not *correct* :

(1) It can be explained considering spin-orbit interaction and relativistic variation of mass

(2) n = 1 level does not split and does not shift from Bohr level

(3) n = 2 level splits into three; two of them are degenerate

(4) n = 3 level splits into 5; containing two sets of doubly degenerate level

19. Zeeman effect causes D_2 line of sodium $(2_{P_{3/2}} \rightarrow 2_{S_{1/2}})$ to split into :

(1) 5 lines (2) 4 lines (3) 6 lines (4) 8 lines

20. For Raman spectrum to be observed between vibrational or rotational states :

(1) The polarizability should change

(2) The dipole moment should change

(3) The molecule should be polar

(4) The molecule be non-polar

21. Carbon atom (z = 6) obeys L-S coupling, which state has the lowest energy in first excited state contiguration ?

(1) $^3P_0$

(2) $^3P_1$

(3) $^1P_1$

(4) $^1S_0$

22. The reciprocal lattice of a face centred cubic lattice is :

(1) Tetragonal

(2) Orthorhombic

(3) Body centred cubic

(4) Hexagonal

23. Which of the following statements is true about the effective mass of electron in crystals ?

(1) It is negative near the bottom of energy band

(2) It is negative near the top of energy band

(3) It is constant througout the band

(4) It is positive near the top of energy band

24. Which of the statements about Hall effect at room temperature is false ?

(1) Voltage is developed perpendicular to both, electric and magnetic fields

(2) Hall effect is used to determine the nature of the charge carrier

(3) Hall effect is used to determine the carrier concentration

(4) Hall coefficient generally depends on the size of the crystal

25. If the fermi energy of a metal at 0K is 10 eV, the mean energy of the electron in the metal at 0K is :

(1) 1.5 eV

(2) 12 eV

(3) 6 eV

(4) 2.5 eV

26. If a one-dimensional charged harmonic oscillator is subjected to a constant electric field $\vec{E}$ described by a Hamiltonian $H = H_0 + V(x)$, where $H_0 = \frac{p^2}{2m} + \frac{1}{2}m\omega^2 x^2$ and $V(x) = -qEx$, the first order correction to the energy eigen value due to V(x) is :

(1) 0

(2) $\frac{1}{2}\hbar\omega - \frac{q^2E^2}{2m\omega^2}$

(3) $\frac{1}{2}\hbar\omega + \frac{q^2E^2}{2m\omega^2}$

(4) $\frac{1}{2}\hbar\omega$

27. If a system of three non-interacting spin $\frac{1}{2}$ Fermions are confined to move in a one-dimensional infinite potential well of length 'a', the ground state energy is :

(1) $\frac{7\hbar^2\pi^2}{ma^2}$ (2) $\frac{5\hbar^2\pi^2}{ma^2}$ (3) $\frac{9\hbar^2\pi^2}{ma^2}$ (4) $\frac{11\hbar^2\pi^2}{ma^2}$

28. If the Hamiltonian of a two level system is $H = \alpha(|\psi_1><\psi_1| + |\psi_2><\psi_2|) + \beta(|\psi_1><\psi_2| + |\psi_2><\psi|)$, one of the eigen values is :

(1) $\alpha - \beta$

(2) $\sqrt{\alpha^2 + \beta^2}$

(3) $\sqrt{\alpha^2 - \beta^2}$

(4) 0

29. The relative root mean square fluctuation in the number of particles in a grand canonical ensemble is proportional to :

(1) Isothermal compressibility

(2) Specific heat

(3) Susceptibility

(4) Entropy

30. In an ideal Bose gas, the relative condensed Boson density varies with temperature as :

(1) $1 - \left(\frac{T}{T_c}\right)^{3/2}$

(2) $1 - \left(\frac{T}{T_c}\right)^{2/3}$

(3) $\left(\frac{T}{T_c}\right)^{3/2}$

(4) $\left(\frac{T}{T_c}\right)^{2/3}$

31. The repulsive coulomb energy of a proton going inside $^{120}_{50}Sn$ nucleus is :

(1) 13×10^6 eV

(2) 1.3×10^6 eV

(3) 26×10^6 eV

(4) 6.5×10^6 eV

32. The internal conversion coefficient can be determined :

(1) Only from conversion electron width Γ_e

(2) Only from γ-ray radiative width Γ_r

(3) both Γ_e and Γ_r

(4) need Γ_e , Γ_r and energy diffrenece between L-shell and K-shell

33. Fermi energy of a nucleus of mass number A at 0K varies with :

(1) $A^{2/3}$ (2) $A^{-2/3}$

(3) A (4) it is independent of A

34. If the rest mass of the exchange Pion is 140 MeV, the corresponding range of nuclear force is :

(1) 2.4 fermi (2) 10.4 fermi

(3) 0.4 fermi (4) 1.4 fermi

35. The power radiated by an electric dipole is proportional to the angular frequency ω as :

(1) ω (2) ω^2

(3) ω^3 (4) ω^4

36. The direction of propagation of electromagnetic wave is given by :

(1) $\vec{E}.\vec{B}$ (2) $\vec{E}$

(3) $\vec{E} \times \vec{B}$ (4) $\vec{B}$

37. For a good conductor, the skin depth varies with angular frequency inversely as

(1) ω (2) ω^2

(3) $\omega^{1/2}$ (4) ω^4

38. For ionospheric plasma, the critical frequency for propagation is related to the electron density N of the ionosphere as :

(1) $fc = \frac{9}{\sqrt{N}}$ (2) $fc = 9\sqrt{N}$

(3) $fc = 100\sqrt{N}$ (4) $fc = \frac{100}{N}$

39. The electromagnetic field equation in terms of vector and scalar potentials $\vec{A}$ & Φ respectively is represented by :

(1) $\nabla^2\Phi + \frac{\partial}{\partial t}(\text{div } \vec{A}) = \frac{-\rho}{\epsilon}$ (2) $\nabla^2\Phi + \frac{\partial}{\partial t}(\text{div } \vec{A}) = \frac{\rho}{\epsilon}$

(3) $\nabla^2\vec{A} + \frac{\partial}{\partial t}(\text{div } \Phi) = -\frac{\rho}{\epsilon}$ (4) $\nabla^2\vec{A} + \frac{\partial}{\partial t}(\text{div } \Phi) = \frac{\rho}{\epsilon}$

40. *The ratio of electric* field vector $\vec{E}$ and magnetic field vector $\vec{H}$ *i.e.* $\frac{\vec{E}}{\vec{H}}$ has the dimension of :

(1) Inductance

(2) Capacitance

(3) Resistance

(4) Current

Attempt any five questions. Write answer in 150-200 words. Each question carries 16 marks. Answer each question on separate page, after writing Question Number.

1. Explain, why the refractive index of ionosphere is less than one for radiowaves. Discuss critical frequency in reference to ionospheric radiowave propagation.

2. The sepatation between adjacent energy levels of a given multiplet is in the ratio 3:5. Using lande interval rule, assign the quantum numbers L, S and J to the three levels.

3. The normal modes of CO_2 molecules are; $\upsilon_1 = 1330cm^{-1}$, $\upsilon_2 = 667cm^{-1}$ and $\upsilon_3 = 2349cm^{-1}$. Evaluate the zero point energy of CO_2 molecule.

4. Discuss the salient feature of dispersion relation for vibrating diatomic linear chain.

5. What are different types of superconductors ? Explain the meaning of isotope effects and penetration depth.

6. A particle is assumed to be in the ground state of a one-dimensional harmonic oscillator. At t = 0, a perturbation $v(x,t) = v_0 x e^{-t/\tau}$.

   (τ being the characteristic time of the oscillator) is turned on. Calculate the first order transition probability, the system makes a transition to nth excited state after a sufficiently long time. What would be the value of n ?

7. In an ideal Fermi gas, obtain the relation between the electron density (n) and the Fermi wave vector (k_F). Calculate the ground state energy of the Fermi gas and express it in terms of Fermi energy ($\in_F$).

8. Explain, how electric quadrapole moment and magnetic moment of the deutron nucleus was considered as an evidence of tensor force presence in the nucleus.

9. Using Maxwell's equations, obtain continuity equation and Coulomb's law.

10. A distant galaxy contains a cloud of protons and anti-protons both with density having the value $n = 10^6 / m^3$ and temperature 100 K. Calculate the Debye length (λ_D) and the number density (N_D) in Debye sphere.

Roll No. : .....

Q. No. :

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FOR ROUGH WORK

RET/15/Test B | **881** | **Physics**

Question Booklet No. **121**

*(To be filled up by the candidate by **blue/black ball-point pen**)*

Roll No. | | | | | | | | | |

Roll No. (Write the digits in words) .....

Serial No. of OMR Answer Sheet .....

Day and Date ....

(Signature of Invigilator)

INSTRUCTIONS TO CANDIDATES

(Use only ***blue/black ball-point pen*** in the space above and on both sides of the ***Answer Sheet***)

1. Within 10 minutes of the issue of the Question Booklet, Please ensure that you have got the correct booklet and it contains all the pages in correct sequence and no page/question is missing. In case of faulty Question Booklet, bring it to the notice of the Superintendent/Invigilators immediately to obtain a fresh Question Booklet.
2. Do not bring any loose paper, written or blank, inside the Examination Hall ***except the Admit Card without its envelope.***
3. ***A separate Answer Sheet is given. It should not be folded or mutilated. A second Answer Sheet shall not be provided.***
4. Write your Roll Number and Serial Number of the Answer Sheet by pen in the space provided above.
5. ***On the front page of the Answer Sheet, write by pen your Roll Number in the space provided at the top, and by darkening the circles at the bottom. Also, wherever applicable, write the Question Booklet Number and the Set Number in appropriate places.***
6. ***No overwriting is allowed in the entries of Roll No., Question Booklet No. and Set No. (if any) on OMR sheet and Roll No. and OMR sheet No. on the Question Booklet.***
7. ***Any changes in the aforesaid-entries is to be verified by the invigilator, otherwise it will be taken as unfair means.***
8. ***This Booklet contains 40 multiple choice questions followed by 10 short answer questions. For each MCQ, you are to record the correct option on the Answer Sheet by darkening the appropriate circle in the corresponding row of the Answer Sheet, by pen as mentioned in the guidelines given on the first page of the Answer Sheet. For answering any five short Answer Questions use five Blank pages attached at the end of this Question Booklet.***
9. For each question, darken only one circle on the Answer Sheet. If you darken more than one circle or darken a circle partially, the answer will be treated as incorrect.
10. ***Note that the answer once filled in ink cannot be changed.*** If you ***do not wish to attempt*** a question, leave all the circles in the corresponding row blank (such question will be awarded zero marks).
11. For rough work, use the inner back page of the title cover and the blank page at the end of this Booklet.
12. Deposit ***both OMR Answer Sheet and Question Booklet*** at the end of the Test.
13. You are not permitted to leave the Examination Hall until the end of the Test.
14. *If a candidate attempts to use any form of unfair means, he/she shall be liable to such punishment as the University may determine and impose on him/her.*

Total No. of Printed Pages : 19