

**RET/13/Test B****881****Physics**Question Booklet No. .... **115** .....(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**

**FOR ROUGH WORK**

# Research Entrance Test – 2013

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. Most of the land precipitation and evaporation on earth takes place over the :
  - (1) land masses
  - (2) oceans and seas
  - (3) poles of the planet
  - (4) subtropical latitudes
  
2. The downstream portion of a river :
  - (1) generally becomes more sluggish
  - (2) usually has turbulent flows
  - (3) generally is of higher velocity, which is marked by reduced turbulence
  - (4) has lower discharges than do upstream portions
  
3. Which of the following is not a fatty acid ?
  - (1) Stearic acid
  - (2) Palmitic acid
  - (3) Oleic acid
  - (4) Phenyl acetic acid
  
4. Which of the following compounds is not an antibiotic ?
  - (1) Penicillin
  - (2) Chloramine-T
  - (3) Streptomycin
  - (4) Chloramphenicol
  
5. The acceleration with which a particle moves in a straight line, according to the law  $v^2 = 4a(x \sin x + \cos x)$ ,  $v$  being the velocity of the particle at a distance  $x$  from a fixed point, is :
  - (1) 0
  - (2)  $2ax \cos x$
  - (3)  $4ax \cos x$
  - (4)  $2ax \sin x$

6. If  $\begin{bmatrix} 2 & 4 \\ 1 & 3 \end{bmatrix} A \begin{bmatrix} 0 & 2 \\ 1 & 3 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ , then the matrix A is :

(1)  $\begin{bmatrix} 3 & -4 \\ 3/4 & -1 \end{bmatrix}$

(2)  $\begin{bmatrix} -13/4 & 3/2 \\ 5/4 & -1/2 \end{bmatrix}$

(3)  $\begin{bmatrix} -17/4 & 3/4 \\ -7/4 & -1/4 \end{bmatrix}$

(4)  $\begin{bmatrix} 5/4 & 11/4 \\ 3 & -9/4 \end{bmatrix}$

7. If the error in the measurement of radius of sphere is 0.3%, then the percentage error in the measurement of its volume is :

(1) 0.15%

(2) 0.6%

(3) 0.9%

(4) 0.03%

8. The resistance of series combination of two resistances is S. When they are joined in parallel, the total resistance is P. If  $S = nP$ , then the minimum possible value of n is :

(1) 3

(2) 4

(3) 2.1

(4) 0.89

9. Mitochondria are associated with the function of :

(1) cellular digestion

(2) circulation

(3) protein synthesis

(4) cellular respiration

10. In which parts of eyes, rods and cones are present ?

(1) Retina

(2) Iris

(3) Cornea

(4) Lens

11. The constraint in a rigid body is :

- (1) Nonholonomic and conservative
- (2) Holonomic and scleronomic
- (3) Holonomic and dissipative
- (4) Holonomic and rheonomic

12. The Hamiltonian of a system in spherical polar coordinate is written as

$H = p_r^2 + \frac{p_\theta^2}{r} + \frac{p_\phi^2}{r^2 \sin^2 \theta} + ar^2 \sin^2 \theta$ . Which of the following statement is correct for this system ?

- (1)  $p_r$  is conserved
- (2)  $p_\theta$  is conserved
- (3)  $p_\phi$  is conserved
- (4) Total angular momentum is conserved

13. The transformation  $q \rightarrow \alpha P$  and  $p \rightarrow \beta Q$  will be canonical, if :

- (1)  $\alpha = \beta$
- (2)  $\alpha = -\beta$
- (3)  $\alpha\beta = 1$
- (4)  $\alpha\beta = -1$

14. Which of the following is not a eigen function of Parity operator in one dimension ?

- (1)  $x \sin x$
- (2)  $\cos x + x \sin x$
- (3)  $x \cos x + \sin x$
- (4)  $x(\cos x + \sin x)$

15. The ground state energy eigen value of the system described by

$$H = \frac{p^2}{2m} + \frac{1}{2}m(x^2 + 2x) \text{ is :}$$

- (1)  $\frac{1}{2}(\hbar - m)$  (2)  $\frac{1}{2}(\hbar + m)$   
(3)  $\frac{1}{2}(\hbar + 2m)$  (4)  $\frac{1}{2}(\hbar - 2m)$

16. The state of a spin  $\frac{1}{2}$  particle is described by  $\begin{pmatrix} 1+2i \\ 1-i \end{pmatrix}$ . What is the probability of finding it in the spin down state ?

- (1)  $\frac{5}{7}$  (2)  $\frac{2}{3}$   
(3)  $\frac{1}{3}$  (4)  $\frac{2}{7}$

17. The threshold kinetic energy of the following process is :

- (1)  $2m_p c^2$  (2)  $4m_p c^2$   
(3)  $6m_p c^2$  (4)  $7m_p c^2$

18. The quark content of the particle  $\Delta^0$  is :

- (1) uud (2) udd  
(3) uds (4) ubb

19. Diamond has the following crystal structure :

- (1) Simple cubic (2) Face centred cubic  
(3) Body centred cubic (4) Hexagonal

20. In face centred cubic structure the close packed plane is given by :

- (1) (110) (2) (021)  
(3) (111) (4) (100)

21. The periodicity in the de Haas-van Alphen effect measures the extremal cross-section area  $S$  in  $k$  space of the Fermi surface, the cross section being taken perpendicular to  $B$ . The oscillation  $\Delta\left(\frac{1}{B}\right)$  is given by :

- (1)  $\frac{\hbar cs}{2\pi e}$  (2)  $\frac{\hbar es}{2\pi e}$   
(3)  $\frac{2\pi e}{\hbar cs}$  (4)  $\frac{2\pi e}{\hbar cs^2}$

22. Specific heat of a solid due to electron varies as :

- (1)  $C_v = \text{constant}$  (2)  $C_v \propto T$   
(3)  $C_v \propto T^2$  (4)  $C_v \propto T^{-1}$

23. A certain common-emitter amplifier has a voltage gain of 100. If the emitter bypass capacitor is removed :

- (1) the circuit will become unstable  
(2) the voltage gain will decrease  
(3) the voltage gain will increase  
(4) the Q-point will shift

24. Amplitude modulation is basically a :

- (1) summing of two signals  
(2) multiplication of two signals  
(3) subtraction of two signals  
(4) non-linear process



25. The beam width between half powerpoints of a half wave dipole antenna is :
- (1)  $78^\circ$                       (2)  $90^\circ$                       (3)  $47^\circ$                       (4)  $120^\circ$
26. A certain non-inverting operational amplifier has an  $R_i = 1\text{ k}\Omega$  and an  $R_f = 100\text{ k}\Omega$ . The closed loop gain is :
- (1)  $10^5$                       (2) 100                      (3) 101                      (4)  $10^3$
27. If rotational partition function for a diatomic molecule is  $Z_r$ , the rotational partition function  $Z_R$  of a gas consisting of the three non-interacting diatomic molecules will be equal to :
- (1)  $3Z_r$                       (2)  $8Z_r$                       (3)  $Z_r^3$                       (4)  $Z_r$
28. If a gas consists of only two particles and there are three possible states, the probability that the two particles are found in the same state in Fermi-Dirac distribution equals :
- (1)  $\frac{1}{2}$                       (2) 1                      (3) 0                      (4)  $\frac{2}{3}$
29. The poynting vector  $\vec{S}$  of an electromagnetic wave is :
- (1)  $\vec{S} = \vec{E} \times \vec{B}$                       (2)  $\vec{S} = \vec{E} \times \vec{H}$
- (3)  $\vec{S} = \frac{\vec{E}}{\vec{H}}$                       (4)  $\vec{S} = \frac{\vec{E}}{\vec{B}}$
30. If magnetic monopole existed, then which of the following Maxwell's equation would be modified ?
- (1)  $\text{div } \vec{D} = \rho$                       (2)  $\text{div } \vec{B} = 0$
- (3)  $\text{curl } \vec{E} = -\frac{\partial \vec{B}}{\partial t}$                       (4)  $\text{curl } \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

31. A material has  $\sigma = 10^{-2} \text{ s/m}$  and  $\epsilon = 2\epsilon_0$ . At what frequency the conduction current would be equal to the displacement current ?

- (1) 40 MHz (2) 10 Hz  
(3) 60 MHz (4) 50 Hz

32. The Debye length  $\lambda_D$  for earth's ionosphere with plasma density  $n_e = 10^{12} \text{ m}^{-3}$  and  $KT_e = 0.1 \text{ eV}$  is given by :

- (1) 120 m (2)  $80 \times 10^{-5} \text{ m}$   
(3)  $2.3 \times 10^{-3} \text{ m}$  (4)  $1.5 \times 10^2 \text{ m}$

33. A is a real symmetric matrix given by,

$$A = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

which of the following is not an eigen vector of A ?

- (1)  $\frac{\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}}$  (2)  $\frac{\hat{i}}{\sqrt{2}} - \frac{\hat{j}}{\sqrt{2}}$   
(3)  $\hat{k}$  (4) 0

34. The function  $e^{-t(t-2x)}$  is a generating function of :

- (1) Hermite polynomials  
(2) Laguerre polynomials  
(3) Legendre polynomials  
(4) Bessel function

35. Square root of  $\sqrt{\frac{3-i}{4+2i}}$ , where  $i = \sqrt{-1}$ , is given by :

(1)  $\pm e^{-(i\pi/8)}$

(2)  $\pm \frac{1}{2^{\frac{1}{4}}} e^{-(i\pi/8)}$

(3)  $\pm \pi e^{-(i\pi/8)}$

(4)  $\pm \frac{1}{2^{\frac{1}{4}}} e^{(i\pi/8)}$

36. Evidence of the expanding universe comes from :

(1) blue shift of light from distant stars

(2) red shift of light from distant stars

(3) Fraunhofer lines observed in spectrum of light from distant stars

(4) Lamb shift

37. Ground state of C atom is :

(1)  $^3P_0$

(2)  $^3P_2$

(3)  $^1S_0$

(4)  $^1D_1$

38. Fundamental vibrational mode of  $O_2$  molecule is :

(1) IR active

(2) Raman active

(3) Forbidden in IR and Raman both

(4) not related to IR and Raman activity

39. The active medium in a laser system corresponds to :

(1) Positive temperature in Kelvin

(2) Negative temperature in Kelvin

(3) Normal thermal equilibrium state

(4) Complex value of temperature

40. Which of the following is true ?

- (1) NMR and ESR have the same origin
- (2) NMR is related to Stark effect while ESR is related to Zeeman effect
- (3) NMR is related to Zeeman effect while ESR is related to Stark effect
- (4) None of the above is correct

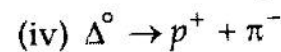
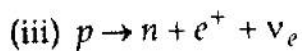
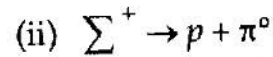
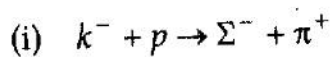
*Attempt any five questions. Write answer in 150-200 words. Each question carries 16 marks. Answer each question on separate page, after writing Question Number.*

1. Write the Lagrangian of a system consisting an electron and a proton in 3-d space. How this Lagrangian will change if (i) a magnetic field  $\vec{B} = B_0 \hat{k}$  and (ii) an electric field  $\vec{E} = E_0 \hat{x}$  is applied externally ?
2. Find the energy eigen values and eigen functions of a particle subjected to the potential :

$$V(x, y) = 0 \quad \text{if } 0 \leq x \leq a, 0 \leq y \leq b$$
$$= \infty \quad \text{elsewhere}$$

Find the ground state energy if three identical spin half particle is subjected to this potential.

3. Consider the following processes :



(a) Which of these are forbidden and why ?

(b) Mention the type of interactions cause the allowed process.

(c) Draw the lowest order Feynman diagrams for any one of the allowed processes.

4. Define Burger's vector of a dislocation and discuss the difference between edge and screw dislocations on the basis of their Burger vector.
5. Does the magnetic susceptibility  $\chi_{\perp}$  for an antiferromagnetic material below Neel temperature depend on temperature? Explain your answer.
6. A plasma consisting of ions and electrons oscillates with angular frequency  $\omega$ , show that :

$$\omega = \omega_{pe} \left[ 1 + \frac{m_i}{m_e} \right]^{\frac{1}{2}}$$

Where  $\omega_{pe}$  is the electron plasma oscillation frequency and  $m_i$  and  $m_e$  are the masses of ions and electrons respectively.

7. Find the maximum power that can be received over a distance of 1.5 km in free space for 1.5 GHz radiation radiated from a transmitting antenna having gain of 25 dB and receiving antenna with a gain of 30 dB. Power transmitted from the antenna is 200 watts.
8. On the basis of rotational Raman spectrum how would you conclude that  $O_2$  is a centrosymmetric molecule?
9. Evaluate the integral :

$$\int_0^{\infty} \frac{\sin x}{x} dx$$

using the method of calculus of residues.

10. A particle moving with velocity  $u$  collides with a like particle at rest. After collision the two particles leave in directions making angle  $\theta$  and  $\alpha$  with the initial direction of the motion of the colliding particles. Prove that :

$$\tan \alpha \tan \theta = \frac{2}{1+r}$$

where  $r = \frac{1}{\sqrt{1-u^2/c^2}}$ .

*Roll No. :* .....

---

**Q. No. :**

**Roll No. :** .....

---

**Q. No. :**

*Roll No.:* .....

---

**Q. No. :**



*Roll No. : .....*

---

**Q. No. :**

*Roll No. :* .....

---

**Q. No. :**

**FOR ROUGH WORK**

