

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

Roll No.

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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 30 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 change 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 pages 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 : 24

ROUGH WORK

रफ़ कार्य

Research Entrance Test-2017

No. of Questions : 50

प्रश्नों की संख्या : 50

Time : 2 Hours

Full Marks : 200

समय : 2 घण्टे

पूर्णाङ्क : 200

Note: (1) This Question Booklet contains **40** Multiple Choice Questions followed by **10** Short Answer Questions.

इस प्रश्न पुस्तिका में **40** वस्तुनिष्ठ व **10** लघु उत्तरीय प्रश्न हैं।

(2) 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.

अधिकधिक वस्तुनिष्ठ प्रश्नों को हल करने का प्रयत्न करें। प्रत्येक वस्तुनिष्ठ प्रश्न **3 (तीन)** अंकों का है। प्रत्येक गलत उत्तर के लिए **1 (एक)** अंक काटा जायेगा। प्रत्येक अनुत्तरित प्रश्न का प्राप्तांक शून्य होगा। यदि वस्तुनिष्ठ प्रश्नों के एकाधिक वैकल्पिक उत्तर सही उत्तर के निकट प्रतीत हों, तो निकटतम सही उत्तर दें।

(3) 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.

केवल **5 (पाँच)** लघुउत्तरीय प्रश्नों के उत्तर दें। प्रत्येक प्रश्न **16 (सोलह)** अंकों का है तथा उनका उत्तर **150-200** शब्दों के बीच होना चाहिए। इसके लिए इस पुस्तिका में लगे हुए सादे **5 (पाँच)** पृष्ठों का ही उपयोग आवश्यक है। प्रत्येक प्रश्न का उत्तर एक नए पृष्ठ से, प्रश्न संख्या लिखकर शुरू करें।

1. Booklungs are found in :

- | | |
|--------------|------------------|
| (1) Amoeba | (2) Polystomella |
| (3) Euglypha | (4) Arachnids |

2. Silk is obtained from :

- | | |
|----------------|-----------------------|
| (1) Adult moth | (2) Caterpillar stage |
| (3) Egg | (4) Cocoon |

3. Neurogenic heart is found in :

- | | |
|------------------|-------------------|
| (1) Human beings | (2) Rat |
| (3) Rabbit | (4) Invertebrates |

4. Epiphysis is also known as :

- | | |
|-------------|------------------|
| (1) Pineal | (2) Pituitary |
| (3) Thyroid | (4) Hypothalamus |

5. Simplest and smallest form of amino acid is :

- | | |
|-------------|--------------|
| (1) Glycine | (2) Proline |
| (3) Lysine | (4) Argenine |

6. PCOS is related to :

- | | |
|------------|-------------|
| (1) Ovary | (2) Uterus |
| (3) Testes | (4) Oviduct |

7. Seminogelin is secreted by :

- | | |
|------------------|---------------------|
| (1) Epididymis | (2) Seminal Vesicle |
| (3) Thecal cells | (4) Oviduct |

8. First cleavage in frog is :

- | | |
|----------------|-----------------|
| (1) Horizontal | (2) Meridional |
| (3) Equatorial | (4) Latitudinal |

9. Which of the following is nuclear receptor ?

- | | |
|--------|----------|
| (1) AR | (2) GPCR |
| (3) IR | (4) MT1 |

10. Cryptorchidism is related to :

- | | |
|------------|--------------|
| (1) Testes | (2) Thyroid |
| (3) Ovary | (4) Pancreas |

Multiple choice Questions

11. The peak of Maxwell-Boltzmann distribution for velocity shifts towards a higher value of velocity :
- (1) At higher temperature along with decrease in height.
 - (2) At higher temperature along with increase in height.
 - (3) At lower temperature along with decrease in height.
 - (4) At lower temperature along with increase in height.
12. For a Bose gas, which of the following statements about its chemical potential μ is necessarily correct ?
- (1) $\mu = 0$
 - (2) $\mu \geq 0$
 - (3) No restriction on μ
 - (4) $\mu \leq \epsilon_0$, where ϵ_0 is the minimum energy of the system.
13. Which one of the following functions $y = f(x)$, can not be fitted with experimental data using linear least square fit method ?
- (1) $y = a_0 + a_1x + a_2x^2$
 - (2) $y = a_0 + \frac{a_1}{x^2}$
 - (3) $y = \sin(a_0x)$
 - (4) $y = x^n$

Where a_0 , a_1 and a_2 are constants.

14. Photosynthesis involves :

- (1) CO_2 , N_2 and carbohydrates to produce oxygen and energy.
- (2) CO_2 , H_2O and energy to produce carbohydrates and oxygen.
- (3) CO_2 , N_2 and H_2O to produce urea and oxygen.
- (4) CO_2 , Carbohydrates and energy to produce oxygen and H_2O .

15. At the transition temperature of a first order phase transition for a system :

- (1) The specific heat diverges and the entropy remains the same.
- (2) The specific heat diverges and the entropy has finite discontinuity.
- (3) The specific heat remains finite and the entropy has finite discontinuity.
- (4) The specific heat has finite discontinuity and the entropy diverges.

16. The central force Which causes a mass to move in a spiral orbit given by $r = r_0 e^{k\theta}$, k is constant, varies as :

- | | |
|--------------|--------------|
| (1) r^{-3} | (2) r^{-4} |
| (3) r^{-5} | (4) r^{-2} |

17. The vector potential which does not produce a uniform magnetic field,

$2B_0 \hat{x}$ is :

- (1) $(0, B_0 Z, -B_0 Y)$ (2) $(0, -B_0 Z, B_0 Y)$
 (3) $(0, -2B_0 Z, 0)$ (4) $(0, 0, 2B_0 Y)$

18. The Lagrangian of a system is given by $L(r, \theta, \dot{r}, \dot{\theta}) = \frac{1}{2} m (\dot{r}^2 + r^2 \dot{\theta}^2) + \frac{\alpha}{r}$

Which of the following is not correct ?

- (1) $Mr^2 \dot{\theta}$ is constant of motion
 (2) θ is cyclic coordinate
 (3) Total linear momentum is conserved
 (4) Total energy is conserved
19. The ground state wave function for the 1-d system described by the potential $V(x) = 0$ for $-L \leq x \leq L$

= ∞ elsewhere is :

- (1) $A \cos \frac{\pi x}{L}$ (2) $A \sin \frac{\pi x}{L}$
 (3) $A \sin \frac{\pi x}{2L}$ (4) $A \cos \frac{\pi x}{2L}$

20. In a 1-d SHO problem the particle is found in the state $\psi(x) = x$. The probability of finding the particle in the ground state is :

- (1) 0 (2) $\frac{1}{(2\pi)^{1/2}}$
 (3) $\frac{1}{\pi^{1/4}}$ (4) $\frac{1}{\sqrt{2}\pi^{1/4}}$

Where SHO corresponds to Simple Harmonic Oscillator.

21. Consider the Scatterings of two electrons in the spin triplet state. If the scattered wave function is given by $\psi_{sc}(\theta, \phi) = \psi_{in} + f(\theta, \phi) \frac{e^{ikr}}{r}$, Where ψ_{in} is the wave function for incident particles. The $\frac{d\sigma}{d\Omega}$ for this scattering is given by :

- (1) $|f(\theta, \phi)|^2$ (2) $|f(\theta, \phi) + f(\pi - \theta, \pi + \phi)|^2$
 (3) $|f(\theta, \phi) - f(\pi - \theta, \pi + \phi)|^2$ (4) $|f(\theta, \phi) + f(\pi - \theta, \pi - \phi)|^2$

22. Which one of the following nuclear reactions is possible ?

- (1) $^{13}\text{N}_7 \rightarrow ^{13}\text{C}_6 + \beta^+ + \nu_e$ (2) $^{13}\text{N}_7 \rightarrow ^{13}\text{C}_6 + \beta^-$
 (3) $^{13}\text{N}_7 \rightarrow ^{13}\text{C}_6 + \beta^+ + \nu_e$ (4) $^{13}\text{N}_7 \rightarrow ^{13}\text{C}_6 + \beta^- + \nu_e$

23. Which one of the followings processes is allowed by strong interactions ?

(1) $\pi^- + p \rightarrow k^+ + p$

(2) $\pi^- + p \rightarrow k^- + \Sigma^-$

(3) $n + p \rightarrow d + \gamma$

(4) $K^- \rightarrow \pi^- + \pi^0$

24. The diffusion current density in a piece of germanium having electron concentration gradient 1.5×10^{22} electrons/ m^3 and diffusion coefficient of electron as 1.2×10^{-3} m^2 /sec is :

(1) 1.8×10^{19} A/ m^2

(2) 2.88 A/ m^2

(3) 1.92×10^{22} A/ m^2

(4) 28.8 A/ m^2

25. The resulting change in emitter current for a change in the collector current of 2mA with $\alpha = 0.98$ is :

(1) 1.96 mA

(2) 2.04 mA

(3) 2 mA

(4) 0.98 mA

26. Totem pole output in a TTL NAND Gate is used due to :

(1) High impedance

(2) Low output impedance

(3) Zero input impedance

(4) Infinite Output impedance

27. The wave vector associated with free electrons at Fermi-Surface has magnitude :

(1) $\left(\frac{2mE_F}{\hbar^2}\right)^{1/2}$

(2) $\frac{2mE_F}{\hbar^2}$

(3) $\left(\frac{2m}{\hbar^2}\right)^{1/2}$

(4) $\left(\frac{2mE_F}{\hbar^2}\right)^{3/2}$

28. If the number density of a free electron gas in three dimensions is increased eight times, its Fermi temperature will :

(1) Decreases by a factor of 4 (2) Increases by a factor of 4

(3) Increases by a factor of 8 (4) Decreases by a factor of 8

29. Atomic packing factor for fcc lattice is approximately :

(1) 34%

(2) 52%

(3) 68%

(4) 74%

30. For good conductors, the skin depth varies inversely with :

(1) ω (2) ω^2 (3) $\sqrt{\omega}$ (4) ω^i

31. A monochromatic electromagnetic wave incident on an ionospheric surface is :

- (1) Mainly transmitted if its frequency is low
- (2) Mainly reflected if its frequency is low
- (3) Completely absorbed irrespective of its frequency
- (4) Mainly reflected if its frequency is very high

32. Which of the following is not a magneto hydrodynamic (MHD) wave ?

- (1) Sound wave
- (2) Light wave
- (3) Magneto sonic wave
- (4) Alfvén wave

33. For ionospheric plasma the critical frequency for propagation is given by :

- (1) $f_c = \frac{9}{\sqrt{N}}$
- (2) $f_c = 100\sqrt{N}$
- (3) $f_c = 9\sqrt{N}$
- (4) $f_c = \frac{100}{\sqrt{N}}$

Where N is plasma density

34. The energy density of electromagnetic wave in vacuum is given by

$$(1) \frac{E^2}{2\epsilon_0} + \frac{B^2}{2\mu_0}$$

$$(2) \frac{1}{2}\epsilon_0 E^2 + \frac{1}{2}\mu_0 B^2$$

$$(3) \frac{E^2 + B^2}{2}$$

$$(4) \frac{1}{2}\epsilon_0 E^2 + \frac{B^2}{2\mu_0}$$

35. In HCl molecule, the energy gap between the two vibrational level is ~ 0.36 eV. What will be its zero point energy ?

$$(1) 0$$

$$(2) 0.18 \text{ eV.}$$

$$(3) 0.36 \text{ eV.}$$

$$(4) 0.54 \text{ eV.}$$

36. The series whose n th term is $\frac{2^n}{n^3}$ is :

(1) Convergent

(2) Divergent

(3) Oscillatory

(4) Damped

37. For $0 < \theta < \pi$ the matrix $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$:

(1) Has no real eigen value

(2) Is symmetric

(3) Is skewsymmetric

(4) Is orthogonal

38. The residue of $\cot z$ at $z = 0$ is :

$$(1) -1$$

$$(2) \pi$$

$$(3) 1$$

$$(4) \frac{1}{4} \sin z$$

39. The intensity of an atomic spectral line will be maximum for :

(1) $\Delta L = -1$ $\Delta J = 0$

(2) $\Delta L = +1$ $\Delta J = 0$

(3) $\Delta L = +1$ $\Delta J = -1$

(4) $\Delta L = -1$ $\Delta J = -1$

40. The spacing between the two mirrors of a gas laser cavity is 10 cm. What will be the spacing between two consecutive longitudinal modes .

(1) 1000 MHz

(2) 1500 MHz

(3) 2000 MHz

(4) 2500 MHz

Short Answer Questions

Note: 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.

01. A particle of mass m is free to slide on a smooth helical wire whose equations in cylindrical coordinates are $\rho = a$, $Z = b\phi$. a , b are constants. The particle is released from rest at $\rho = a, \phi = 0, z = 0$. Discuss the motion of the particle.

02. The partition function of a system is given by $Z = e^{\alpha T^{\gamma}}$,

Where α is a constant. Calculate the internal energy, pressure and entropy of the system.

03. Calculate $\langle \psi_{1s} | \frac{1}{r} | \psi_{1s} \rangle$ for H-atom problem. $\psi_{1s} = \psi_{100}$ represents the ground state of the system.

04. What is parity of a particle? Discuss parity violation in the context of nuclear β -decay.

05. Compute Debye length (λ_D) and number of particles (N_D) in a Debye sphere for Earth's ionosphere with plasma density $n = 10^{12} \text{ m}^{-3}$ $KT_e = 0.1 \text{ eV}$.

06. Prove that for electromagnetic wave, the electric field vector \vec{E} , magnetic field vector \vec{B} and propagation vector \vec{R} are perpendicular to each other.

07. Describe Nyquist criterion for zero inter symbol interference (ISI). How, ISI is eliminated ?
08. What is Raman effect ? Does the Raman shift depend on the excitation frequency ? Compute the ratio of intensities of stokes and corresponding anti-stokes Raman bands.
09. Write down the expression for effective Mass of electron in solids. With the help of effective mass vs wave vector curve, explain the variation of effective mass. Explain the concept of negative effective mass.
10. Evaluate the following integral using Cauchy integral formula

$$\int_C \frac{4-3z}{z(z-1)(z-2)} dz$$

Where C is the circle $|z|=3/2$

Question No.

Page for Short Answer

Question No.

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ROUGH WORK

रफ़ कार्य

अभ्यर्थियों के लिए निर्देश

(इस पुस्तिका के प्रथम आवरण पृष्ठ पर तथा उत्तर-पत्र के दोनों पृष्ठों पर केवल नीली-काली बाल-प्वाइंट पेन से ही लिखें)

1. प्रश्न पुस्तिका मिलने के 30 मिनट के अन्दर ही देख लें कि प्रश्नपत्र में सभी पृष्ठ मौजूद हैं और कोई पृष्ठ छूटा नहीं है। पुस्तिका दोषयुक्त पाये जाने पर इसकी सूचना तत्काल कक्ष-निरीक्षक को देकर सम्पूर्ण प्रश्नपत्र की दूसरी पुस्तिका प्राप्त कर लें।
2. परीक्षा भवन में लिफाफा रहित प्रवेश-पत्र के अतिरिक्त, लिखा या सादा कोई भी खुला कागज साथ नहीं लाये।
3. उत्तर-पत्र अलग से दिया गया है। इसे न तो मोड़ें और न ही विकृत करें। दूसरा उत्तर-पत्र नहीं दिया जायेगा। यद्यपि उत्तर-पत्र का ही मूल्यांकन किया जायेगा।
4. अपनी अनुक्रमांक तथा उत्तर-पत्र का क्रमांक प्रथम आवरण-पृष्ठ पर पेन से निर्धारित स्थान पर लिखें।
5. उत्तर-पत्र के प्रथम पृष्ठ पर पेन से अपना अनुक्रमांक निर्धारित स्थान पर लिखें तथा नीचे दिये वृत्तों को गाढ़ा कर दें। जहाँ-जहाँ आवश्यक हो वहाँ प्रश्न-पुस्तिका का क्रमांक तथा सेट का नम्बर उचित स्थानों पर लिखें।
6. उत्तर-पत्र के आर० पत्र पर अनुक्रमांक संख्या, प्रश्नपुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्नपुस्तिका पर अनुक्रमांक और ओ० एम० आर० पत्र संख्या की प्रविष्टियों में उपरिलेखन की अनुमति नहीं है।
7. प्रत्येक प्रविष्टियों में कोई भी परिवर्तन कक्ष निरीक्षक द्वारा प्रमाणित होना चाहिये अन्यथा यह एक अनुचित प्रयोग माना जायेगा।
8. प्रश्न पुस्तिका में प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं। प्रत्येक प्रश्न के वैकल्पिक उत्तर के लिए उत्तर-पत्र की सम्बन्धित पंक्ति के सामने दिये गये वृत्त को उत्तर-पत्र के प्रथम पृष्ठ पर दिये गये निर्देशों के अनुसार पेन से गाढ़ा करना है।
9. प्रत्येक प्रश्न के उत्तर के लिए केवल एक ही वृत्त को गाढ़ा करें। एक से अधिक वृत्तों को गाढ़ा करने से अथवा एक वृत्त को अपूर्ण भरने पर वह उत्तर गलत माना जायेगा।
10. उत्तर देना एक बार स्याही द्वारा अंकित उत्तर बदला नहीं जा सकता है। यदि आप किसी प्रश्न का उत्तर नहीं देना चाहते हैं, तो संबंधित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर शून्य अंक दिये जायेंगे।
11. प्रश्न कागज के लिए प्रश्न-पुस्तिका के मुखपृष्ठ के अंदर वाला पृष्ठ तथा उत्तर-पुस्तिका के अंतिम पृष्ठ का प्रयोग करें।
12. परीक्षा के उपरान्त केवल ओ एम आर उत्तर-पत्र परीक्षा भवन में जमा कर दें।
13. परीक्षा समाप्त होने से पहले परीक्षा भवन से बाहर जाने की अनुमति नहीं होगी।
14. यदि कोई अभ्यर्थी परीक्षा में अनुचित साधनों का प्रयोग करता है, तो वह विश्वविद्यालय द्वारा निर्धारित जुर्माने का कार्का, भागी होगा/होगी।