# Physics
## Paper II

**Time Allowed : 75 Minutes]** **[Maximum Marks : 100**

**Note :** This paper contains **Fifty (50)** multiple choice questions, each question carrying **Two (2)** marks. *All* questions are compulsory.

1. The trace of an antisymmetric matrix is :

   (A) real

   (B) zero

   (C) pure imaginary

   (D) unity

2. What is the volume of a parallelopiped spanned by the vectors :

   $\left(\hat{i}+\hat{j}\right), \left(\hat{j}+\hat{k}\right), \left(\hat{k}+\hat{i}\right)$ ?

   (A) zero

   (B) 1

   (C) 2

   (D) 3

3. In an X-ray diffraction experiment the incident radiation has a linewidth of 0.1%. Assuming ideal situation what will be the angular width $\delta\theta$ of a diffraction line at a scattering angle of $\pi/2$ ?

   (A) 0.001 rad

   (B) 0.01 rad

   (C) 0.005 rad

   (D) 0.002 rad

4. An experiment involves measurement of two random variables A and B. The measurement error in A is 0.1% and that in B is 0.2%. The error in measurement of (A + B) will then be :

   (A) 0.1%

   (B) 0.2%

   (C) 0.03%

   (D) 0.0225%

5. The step function

$$\theta(u) = \begin{cases} 1 & u > 0 \\ 0 & u < 0 \end{cases}$$

is given by the integral

$$\frac{1}{2\pi i} \oint_C \frac{e^{izu}}{z} dz$$

when the contour C is :

(A) circle of radius $a$ with origin as centre

(B) a semicircle comprising real axis and half the arc of circle above the real axis

(C) a semicircle as in (B) above but avoiding the origin by indenting the real axis by a semicircle of radius $\varepsilon$ above the real axis

(D) a semicircle comprising the imaginary axis and an infinite arc of circle on the right side of origin

6. The value of $\nabla(r^2)$ is :

(A) $\hat{r}$

(B) $2\underset{\sim}{r}$

(C) $2|\underset{\sim}{r}|$

(D) zero

7. The value of $\nabla^2(1/r)$ is :

(A) $-1/r^2$

(B) $-4\pi\delta(r)$

(C) $4\pi$

(D) zero

8. If A is an antisymmetric matrix of odd order $n$, then the determinant of A is :

(A) positive real number

(B) negative real number

(C) zero

(D) real number $(-1)^{(n+1)/2}$

9. Band structure in crystalline structure is due to :

(A) finite mass of electrons

(B) periodic nature of potential

(C) uniform density of the solid

(D) spherically symmetric nature of the potential

10. The ground state energy of a particle in infinite square well is 1 eV. If four particles obeying Bose-Einstein statistics are kept in this well, then the ground state energy will be :

(A) 30 eV

(B) 10 eV

(C) 4 eV

(D) 1/4 eV

11. The maximal set of commuting observables for a system in spherically symmetric potential is given by :

(A) H, $L^2$, $L_z$

(B) H, $L_x$, $L_y$, $L_z$

(C) $p^2$, $L^2$, $L_z$

(D) $L^2$, $L_z$

12. Which of the following is *not* a consequence of Heisenberg's uncertainty principle ?

(A) Absence of electrons in atomic nuclei

(B) Extra stability of benzene molecule

(C) Repulsive part of van der Waals' interaction

(D) Antisymmetric nature of wave function of electrons

13. The stationary eigenfunction for Hamiltonian of a particle of mass $m$ in one-dimensional potential $V(x)$ is given to be :

$$\psi(x) = A \exp(-bx^2/2),$$

where A and $b$ are real positive constants. It follows that :

(A) $V(x)$ = constant

(B) $V(x) \propto 1/x$

(C) $V(x) \propto x^2$

(D) $V(x) \propto x^3$

14. If the $\phi$ dependent part of an eigenfunction of an electron in a hydrogen atom $e^{2i\phi}$, then the minimum principal and minimum orbital angular momentum quantum numbers $n$ and $l$ respectively for this eigenfunction will be :

(A) $n = 3,\ l = 2$

(B) $n = 2,\ l = 2$

(C) $n = 2,\ l = 1$

(D) $n = 1,\ l = 2$

15. The wave function of a particle moving in one-dimensional time independent potential $V(x)$ is represented by $\psi(x) = e^{-iax + b}$, where $a$ and $b$ are real constants. This means that the potential $V(x)$ is of the form :

(A) $V(x) \propto x$

(B) $V(x) \propto x^2$

(C) $V(x)$ = constant

(D) $V(x) = e^{-ax} + b$

16. The eigenvalues of a Hermitian operator must be :

(A) Complex

(B) Real

(C) Positive

(D) Negative

17. If the Q factor of a coil which is $W_0L/R$ is measured as a function of frequency, then :

(A) the plot between Q and frequency is linear

(B) the value of Q initially decreases with increase in frequency and afterwards increases with increase in frequency

(C) the value of Q initially increases with increase in frequency and afterwards decreases with increase in frequency

(D) the Q factor remains constant irrespective of the value of frequency

18. In a Millikan oil drop experiment, one of the drop falls at speed V without field and rises at speed 2 V with field E applied. If the field is made E/2, the drop will :

(A) fall with speed V/4

(B) rise with speed V/2

(C) rise with speed 3V/2

(D) remain steady

19. It is required to operate a proportional counter with a maximum radial field of $10^7$ $Vm^{-1}$. The applied voltage required if the radii of the wire and tube are 0.002 cm and 1 cm respectively is :

(A) $10^7$ Volts

(B) 1242 Volts

(C) $1242 \times 10^7$ Volts

(D) 12 Volts

20. A pressure sensor measures the systolic blood pressure of a human body which is 120 mm of Hg. It means :

(A) Pressure is only 120 mm of Hg

(B) Pressure is 120 mm of Hg above atmospheric pressure

(C) Pressure is 120 mm of Hg below atmospheric pressure

(D) It is noway related to atmospheric pressure

21. In an individual thermistor, the variation of resistance with temperature is :

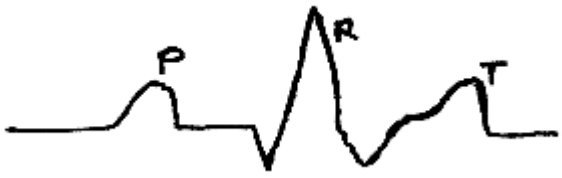
(A) Negative temperature coefficient and non-linear

(B) Negative temperature coefficient and linear

(C) Positive temperature coefficient and non-linear

(D) Positive temperature coefficient and linear

22. If a given signal consists of frequencies from 1 to 100 Hz. If the band limit frequencies for an amplifier are $F_1$ = 1 Hz, $F_2$ = 50 Hz




After amplification which of the portion of the signal is affected more.

(A) P

(B) T

(C) R

(D) All

23. Formula for decibel is given as :

$$\text{decibels} = 10 \log$$

If values of decibel is equal to zero then :

(A) Value of $P_2$ is zero

(B) Value of $P_2$ is greater than $P_1$

(C) Value of $P_1$ is ten times that of $P_2$

(D) Value of $P_1$ is equal to value of $P_2$

24. If a signal is averaged 'N' times the signal to noise ratio improves by :

(A) $N^2$ times

(B) N times

(C) $\sqrt{N}$ times

(D) $\frac{\sqrt{N}}{2}$ times

25. A cylindrical can filled with water to a height of 40 cm has on its side two small holes of equal area, one at height of 10 cm and the other at a height of 30 cm. At the initial time, what is the ratio of the mass of water flowing per second through the lower hole to that flowing through the upper hole ?

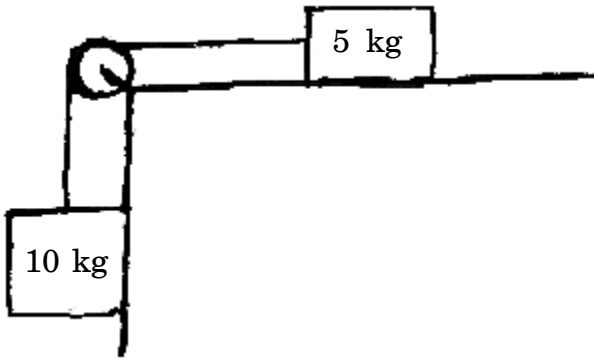
(A) 3

(B) $\sqrt{3}$

(C) $\sqrt{5}$

(D) 5

26. In the figure a frictionless, massless pulley is fixed to the edge of a frictionless table. The two blocks of mass 10 kg and 5 kg are connected by a weightless string passing over the pulley. Is the tension in the string :
(A) Greater than
(B) Less than
(C) Equal to
(D) Square of
the tension it would be if the 5 kg block was glued down.




27. A circular disc is rotating about its centre in the horizontal plane. A razor blade is balanced on edge in a grove along a radius of the wheel. If the blade is pulled along the radius toward the centre of the wheel, will it tend to fall :
(A) In the direction of rotation
(B) Opposite to the direction of rotation
(C) On both sides with equal probability
(D) In either in or opposite to the direction of rotation depending on the frictional force between the edge and the disc

28. Imagine the radius of the earth shrinking by 1%, its mass remaining the same. Then its kinetic energy of rotation :
(A) decreases by 2%
(B) increases by 2%
(C) increases by 1%
(D) decreases by 1%

29. A uniform thin rod of mass M and length L hangs from a frictionless pivot and is connected at the bottom by a spring to the wall as shown. The spring constant is K. Then the period of motion, is a function of :
(A) M and K
(B) K and L
(C) M and L
(D) M, K and L

30. What is the ratio of the mass of the sun to the mass of the earth to one significant figure ?

(A) $1 \times 10^9$

(B) $3 \times 10^5$

(C) $7 \times 10^7$

(D) $9 \times 10^{11}$

31. Two persons of equal weights are hanging by their hands from the ends of a rope hung over a frictionless pulley. They begin to climb. One person can climb twice the speed of the other (with respect to the rope). Who gets to the top first ?

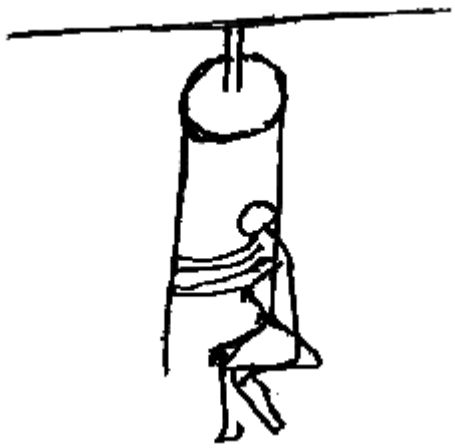
(A) faster climber

(B) slower climber

(C) get there together

(D) indeterminate

32. The man in the figure weighs 150 kg. He sits in a sling and pulls himself slowly up by means of a rope one a pulley. With what force he must pull ?



(A) $150g$
(B) $100g$
(C) $75g$
(D) $50g$

$g$ : constant acceleration due to gravity on earth surface.

33. A point charge $q$ is placed at the origin. The flux of the electric field that passes through a square described by the vertices (0, 0, 1), (1, 0, 1), (1, 1, 1) and (0, 1, 1) is :

(A) $\frac{q}{\epsilon_0}$

(B) $\frac{q}{3\epsilon_0}$

(C) $\frac{q}{6\epsilon_0}$

(D) $\frac{q}{24\epsilon_0}$

34. In a constant electric field $\bar{E}$, the electric displacement vector $\bar{D}$ in a certain dielectric medium is found to be given by $\bar{D} = 2.1 \in_0 \bar{E}$. This implies that the dielectric medium is :

(A) linear and isotropic

(B) linear and unisotropic

(C) non-linear and isotropic

(D) non-linear and unisotropic

35. The electric potential in a region of space is given by $V = V0e^{-bx^2}$, where $V_0$ and $b$ are constants. The volume charge density in this region is :

(A) 0

(B) $2b \in_0 xV$

(C) $-2b \in_0 xV$

(D) $2b \in_0 (1 - 2ax^2)V$

36. The Poynting vector

$$\bar{S} = \frac{1}{\mu_0}(\bar{E} \times \bar{B})$$

has the dimension of :

(A) energy

(B) energy/area

(C) power

(D) power/area

37. Which of the following equations implies that magnetic monopole does *not* exist ?

(A) $\nabla \times \bar{E} = \bar{0}$

(B) $\nabla \cdot \bar{B} = 0$

(C) $\nabla \times \bar{B} = \mu_0 \bar{J}$

(D) $\nabla \cdot \bar{J} + \frac{\partial \rho}{\partial t} = 0$

38. The energy stored by an inductor is in the form of :

(A) electric field

(B) magnetic field

(C) heat energy

(D) electrostatic potential energy

39. A constant current is flowing through a cylindrical wire. Then the Poynting vector at the surface of the cylindrical wire :

(A) is in the direction of the current

(B) is in the radially outward direction

(C) is in the radially inward direction

(D) has zero magnitude

40. A charged particle $q$ is kept at center of a mettalic spherical shell. The magnitudes of the electric fields inside the shell and outside the shell are given by :

(A) 0, $\frac{q}{4\pi \in_0 r^2}$ respectively

(B) $\frac{q}{4\pi \in_0 r^2}$, 0 respectively

(C) $\frac{q}{4\pi \in_0 r^2}$, $\frac{q}{4\pi \in_0 r^2}$ respectively

(D) $\frac{q}{4\pi \in_0 r}$, $\frac{q}{4\pi \in_0 r}$ respectively

($r$ denotes the distance from the center)

41. Considering Hydrogen ($H_2$) and Helium (He) as classical ideal Maxwell-Boltzmann gas, the ratio of root mean square speeds of $H_2$ molecules to that of He atoms at the same temperature T is :

(A) 2

(B) $\sqrt{2}$

(C) $\sqrt{\frac{1}{2}}$

(D) $\frac{1}{2}$

42. The molar specific heat of conduction electrons at 300 K is :

(A) $>> \frac{3}{2}R$

(B) $\frac{3}{2}R$

(C) $<< \frac{3}{2}R$

(D) R

Here R is the gas constant.

43. Two identical particles are to be distributed over 3 energy levels. Treating the particles as distinguishable Maxwell-Boltzmann particles, the number of ways in which the particles can be distributed is :

(A) 9

(B) 6

(C) 3

(D) 8

44. A system of N identical independent three dimensional harmonic oscillators vibrating with the same frequency $\omega$. The system is contact with a heat reservoir at temperature T. Treating the oscillators as classical, the molar specific heat of the system is :

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

(B) 3NK

(C) $\sqrt{\frac{3}{2}}R$

(D) 3R

45. A system has a relaxation time of the order of a millisecond. A quasistatic process on this system can be carried out on the time scale of the order of :

(A) 0.001 s

(B) 0.1 s

(C) 0.0001 s

(D) 1 $\mu$s

46. Let $\bar{E}$ be the mean kinetic energy and V be the volume of a classical ideal gas. The pressure of the gas is numerically equal to :

(A) $\frac{2}{3}\frac{\bar{E}}{V}$

(B) $\frac{1}{3}\frac{\bar{E}}{V}$

(C) $\frac{3}{2}\frac{\bar{E}}{V}$

(D) $\frac{1}{2}\frac{E}{V}$

47. In an adiabatic expansion of an ideal monatomic gas using Joule-Thompson effect :

(A) Cooling effect is produced

(B) Heating effect is produced

(C) Neither heating nor cooling effect is produced

(D) Supercooling effect is produced

48. Which of the following thermodynamic relations is *incorrect* ?

(A) $P = -\left(\frac{\partial F}{\partial V}\right)_T$

(B) $T = \left(\frac{\partial G}{\partial T}\right)_P$

(C) $S = -\left(\frac{\partial F}{\partial T}\right)_V$

(D) $P = -\left(\frac{\partial U}{\partial V}\right)_S$

Here P, V, T are the pressure, volume and temperature, and F, G, S, U are the Helmholtz Free energy, Gibbs' free energy, entropy and average energy respectively.

49. The equation of state of an ideal gas in the extreme relativistic approximation is given by :

(A) $PV = \frac{2}{3}U$

(B) $PV = \frac{5}{2}U$

(C) $PV = \frac{1}{3}U$

(D) $PV = \frac{2}{5}U$

50. The operator corresponding to $\vec{r} \cdot \vec{p} - \vec{p} \cdot \vec{r}$ in quantum mechanics is :

(A) $i\hbar$

(B) zero

(C) $3i\hbar$

(D) $(\partial/\partial x + \partial/\partial y + \partial/\partial z)$

**ROUGH WORK**

**ROUGH WORK**

Test Booklet No.
प्रश्नपत्रिका क्र. **F**

# Paper-II
# PHYSICS

**Signature and Name of Invigilator**

1. (Signature) .....

(Name) .....

2. (Signature) .....

(Name) .....

Seat No. | | | | | | |

(In figures as in Admit Card)

Seat No. .....

(In words)

OMR Sheet No. | | | | | | |

(To be filled by the Candidate)

## FEB - 32213

**Time Allowed : 1¼ Hours]** **[Maximum Marks : 100**

Number of Pages in this Booklet : **16** Number of Questions in this Booklet : **50**

**Instructions for the Candidates**

1. Write your Seat No. and OMR Sheet No. in the space provided on the top of this page.
2. This paper consists of **50** objective type questions. Each question will carry *two* marks. *All* questions of Paper-II will be compulsory, covering entire syllabus (including all electives, without options).
3. At the commencement of examination, the question booklet will be given to the student. In the first 5 minutes, you are requested to open the booklet and compulsorily examine it as follows :
   (*i*) To have access to the Question Booklet, tear off the paper seal on the edge of this cover page. Do not accept a booklet without sticker-seal or open booklet.
   (*ii*) **Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to missing pages/ questions or questions repeated or not in serial order or any other discrepancy should not be accepted and correct booklet should be obtained from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given. The same may please be noted.**
   (*iii*) After this verification is over, the OMR Sheet Number should be entered on this Test Booklet.
4. Each question has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
   **Example :** where (C) is the correct response.

   (A) (B) ● (D)

5. Your responses to the items are to be indicated in the **OMR Sheet given inside the Booklet only.** If you mark at any place other than in the circle in the OMR Sheet, it will not be evaluated.
6. Read instructions given inside carefully.
7. Rough Work is to be done at the end of this booklet.
8. If you write your Name, Seat Number, Phone Number or put any mark on any part of the OMR Sheet, except for the space allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair means, you will render yourself liable to disqualification.
9. You have to return original OMR Sheet to the invigilator at the end of the examination compulsorily and must not carry it with you outside the Examination Hall. You are, however, allowed to carry the Test Booklet and duplicate copy of OMR Sheet on conclusion of examination.
10. **Use only Blue/Black Ball point pen.**
11. **Use of any calculator or log table, etc., is prohibited.**
12. **There is no negative marking for incorrect answers.**

**विद्यार्थ्यांसाठी महत्त्वाच्या सूचना**

1. परिक्षार्थींनी आपला आसन क्रमांक या पृष्ठावरील वरच्या कोपऱ्यात लिहावा. तसेच आपणांस दिलेल्या उत्तरपत्रिकेचा क्रमांक त्याखाली लिहावा.
2. सदर प्रश्नपत्रिकेत **50** बहुपर्याय प्रश्न आहेत. प्रत्येक प्रश्नास **दोन** गुण आहेत. या प्रश्नपत्रिकेतील **सर्व** प्रश्न सोडविणे अनिवार्य आहे. सदरचे प्रश्न हे या विषयाच्या संपूर्ण अभ्यासक्रमावर आधारित आहेत.
3. परीक्षा सुरू झाल्यावर विद्यार्थ्याला प्रश्नपत्रिका दिली जाईल. सुरुवातीच्या 5 मिनीटांमध्ये आपण सदर प्रश्नपत्रिका उघडून खालील बाबी आवश्य तपासून पहाव्यात.
   (*i*) प्रश्नपत्रिका उघडण्यासाठी प्रश्नपत्रिकेवर लावलेले सील उघडावे. सील नसलेली किंवा सील उघडलेली प्रश्नपत्रिका स्विकारू नये.
   (*ii*) **पहिल्या पृष्ठावर नमूद केल्याप्रमाणे प्रश्नपत्रिकेची एकूण पृष्ठे तसेच प्रश्नपत्रिकेतील एकूण प्रश्नांची संख्या पडताळून पहावी. पृष्ठे कमी असलेली/कमी प्रश्न असलेली/प्रश्नांचा चूकीचा क्रम असलेली किंवा इतर त्रुटी असलेली सदोष प्रश्नपत्रिका सुरुवातीच्या 5 मिनिटातच पर्यवेक्षकाला परत देऊन दुसरी प्रश्नपत्रिका मागवून घ्यावी. त्यानंतर प्रश्नपत्रिका बदलून मिळणार नाही तसेच वेळही वाढवून मिळणार नाही याची कृपया विद्यार्थ्यांनी नोंद घ्यावी.**
   (*iii*) वरीलप्रमाणे सर्व पडताळून पहिल्यानंतरच प्रश्नपत्रिकेवर ओ.एम.आर. उत्तरपत्रिकेचा नंबर लिहावा.
4. प्रत्येक प्रश्नासाठी (A), (B), (C) आणि (D) अशी चार विकल्प उत्तरे दिली आहेत. त्यातील योग्य उत्तराचा रकाना खाली दर्शविल्याप्रमाणे ठळकपणे काळा/निळा करावा.
   **उदा. :** जर (C) हे योग्य उत्तर असेल तर.

   (A) (B) ● (D)

5. या प्रश्नपत्रिकेतील प्रश्नांची उत्तरे **ओ.एम.आर. उत्तरपत्रिकेतच दर्शवावीत.** इतर ठिकाणी लिहीलेली उत्तरे तपासली जाणार नाहीत.
6. आत दिलेल्या सूचना काळजीपूर्वक वाचाव्यात.
7. प्रश्नपत्रिकेच्या शेवटी जोडलेल्या कोऱ्या पानावरच कच्चे काम करावे.
8. जर आपण ओ.एम.आर. वर नमूद केलेल्या ठिकाणा व्यतिरीक्त इतर कोठेही नाव, आसन क्रमांक, फोन नंबर किंवा ओळख पटेल अशी कोणतीही खूण केलेली आढळून आल्यास अथवा असभ्य भाषेचा वापर किंवा इतर गैरमार्गाचा अवलंब केल्यास विद्यार्थ्याला परीक्षेस अपात्र ठरविण्यात येईल.
9. परीक्षा संपल्यानंतर विद्यार्थ्याने मूळ ओ.एम.आर. उत्तरपत्रिका पर्यवेक्षकांकडे परत करणे आवश्यक आहे. तथापी, प्रश्नपत्रिका व ओ.एम.आर. उत्तरपत्रिकेची द्वितीय प्रत आपल्याबरोबर नेण्यास विद्यार्थ्यांना परवानगी आहे.
10. **फक्त निळ्या किंवा काळ्या बॉल पेनचाच वापर करावा.**
11. **कॅलक्युलेटर किंवा लॉग टेबल वापरण्यास परवानगी नाही.**
12. **चुकीच्या उत्तरासाठी गुण कपात केली जाणार नाही.**