

Geophysics

11P/204/31

Question Booklet No.....778.....

(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 10 minutes of the issue of the Question Booklet, check the Question Booklet to ensure that it contains all the pages in correct sequence and that 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. Only the Answer Sheet will be evaluated.*
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 also 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. Each question in this Booklet is followed by four alternative answers. *For each question, 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 ball-point pen as mentioned in the guidelines given on the first page of the Answer Sheet.*
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 mark).
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 *only the OMR Answer Sheet* 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.

No. of Questions/प्रश्नों की संख्या : 150

Time/समय : 2½ Hours/घण्टे

Full Marks/पूर्णांक : 450

Note/नोट : (1) Attempt as many questions as you can. Each question carries **3** marks. **One** mark will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question.

अधिकाधिक प्रश्नों को हल करने का प्रयत्न करें। प्रत्येक प्रश्न **3** अंक का है। प्रत्येक गलत उत्तर के लिए एक अंक काटा जाएगा। प्रत्येक अनुत्तरित प्रश्न का प्राप्तांक शून्य होगा।

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

यदि एकाधिक वैकल्पिक उत्तर सही उत्तर के निकट प्रतीत हों, तो निकटतम सही उत्तर दें।

1. If $|x| < 1$, the sum of the infinite series

$$\sum_{r=1}^{\infty} \frac{x^{r-1}}{(1+x^r)(1+x^{r+1})}$$

is

(1) $\frac{1}{1+x}$

(2) $\frac{1}{1-x}$

(3) $\frac{1}{1-x^2}$

(4) $\frac{1}{1+x^2}$

2. The partial fractions of $\frac{(x+1)^3 - x^3}{(3x+1)(x-2)}$ are

(1) $\frac{1}{7(3x+1)} - \frac{19}{7(x-2)}$ (2) $1 - \frac{19}{7(x-2)} + \frac{1}{7(3x+1)}$

(3) $\frac{19}{7(x-2)} - \frac{1}{7(3x+1)}$ (4) $1 + \frac{19}{7(x-2)} - \frac{1}{7(3x+1)}$

3. If $x \in (-2, 7)$, the maximum value of $(7-x)^4 (2+x)^5$ is

(1) 800000 (2) 80000 (3) 640000 (4) $7^4 \times 2^5$

4. $(6+x)^3 (1-x)^4$ is maximum, where $x \in (-6, 1)$, when x is equal to

(1) 3 (2) -3 (3) -6 (4) 1

5. If the roots of the equation $x^n - 1 = 0$ are $1, \alpha_1, \alpha_2, \dots, \alpha_{n-1}$, then the value of $(1-\alpha_1)(1-\alpha_2)\dots(1-\alpha_{n-1})$ is

(1) 0 (2) 1 (3) n^2 (4) n

6. If α, β, γ are the roots of the equation $ax^3 + bx^2 + cx + d = 0$, then the value of $(\beta + \alpha)(\gamma + \alpha)(\alpha + \beta)$ is

(1) $\frac{bc - ad}{a^2}$ (2) $\frac{ad - bc}{a^2}$ (3) $\frac{ac - bd}{a^2}$ (4) $\frac{bd - ac}{a^2}$

7. If A is an $n \times n$ matrix such that $A^2 + A + I = 0$, then A^{100} is equal to

(1) A (2) $-A$ (3) A^2 (4) $-A^2$

8. If A is an $n \times n$ matrix, then $\det (\text{Adj Adj } A)$ is equal to
 (1) $(\det A)^{n(n-1)}$ (2) $(\det A)^{n^2}$ (3) $(\det A)^{(n-1)^2}$ (4) $(\det A)^{n-1}$
9. If $x = cy + bz$, $y = az + cx$, $z = bx + ay$ and x, y, z are not all zero, then the value of $a^2 + b^2 + c^2 + 2abc$ is
 (1) -1 (2) 1 (3) 0 (4) 2
10. The system of equations $x - 2y + 2z = 4$, $3x + y + 4z = 6$, $x + y + z = 1$ has
 (1) no solution (2) unique solution
 (3) infinitely many solutions (4) zero solution
11. If $z = \cos \frac{2\pi}{3} + i \sin \frac{2\pi}{3}$, then the value of $1 + z^n + z^{2n}$, where n is not multiple of 3 is
 (1) 3 (2) $1 + z$ (3) $1 + z^2$ (4) 0
12. If $i^{A+iB} = A + iB$, then $\log_e (A^2 + B^2)$ is equal to
 (1) $-\pi A$ (2) $-\pi B$ (3) πB (4) πA
13. If $|r| < 1$, the expansion of $\frac{r \sin \theta}{1 - 2r \cos \theta + r^2}$ is
 (1) $\sum_{n=1}^{\infty} r^n \sin n\theta$ (2) $1 + \sum_{n=1}^{\infty} r^n \sin n\theta$
 (3) $1 + \sum_{n=1}^{\infty} r^n \cos n\theta$ (4) $\sum_{n=1}^{\infty} r^n \cos n\theta$

14. The sum of the infinite series $\frac{1}{1 \cdot 3} + \frac{1}{5 \cdot 7} + \frac{1}{9 \cdot 11} + \dots$ is

- (1) $\frac{\pi^2}{6}$ (2) $\frac{\pi^2}{4}$ (3) $\frac{\pi}{8}$ (4) $\frac{\pi}{4}$

15. The principal value of $\log_e \frac{(1+i)(1+i\sqrt{3})}{\sqrt{3}+i}$ is

- (1) $\frac{1}{2} \log_e 2 + \frac{7\pi i}{12}$ (2) $\log_e 2 + \frac{5\pi i}{12}$ (3) $\frac{1}{2} \log_e 2 + \frac{\pi i}{12}$ (4) $\frac{1}{2} \log_e 2 + \frac{5\pi i}{12}$

16. The modulus and argument of $\frac{3-i}{2+i} + \frac{3+i}{2-i}$ are respectively

- (1) $2, \frac{\pi}{2}$ (2) 2, 0 (3) 1, 0 (4) $1, \frac{\pi}{2}$

17. If n is an integer, the value of $i^{n-1} + i^n + i^{n+1} + i^{n+2}$ is equal to

- (1) 4 (2) 1 (3) -1 (4) 0

18. The value of $\cos(\log_e i^i)$ is

- (1) 0 (2) $-i$ (3) 1 (4) -1

19. If $y = \sqrt{2x - x^2}$, then $y^3 \frac{d^2y}{dx^2}$ is equal to

- (1) 0 (2) 1 (3) -1 (4) $2x$

20. If $D^n \tan^{-1} \frac{x}{a} = (-1)^{n-1} (n-1)! \sin^n \phi \sin n\phi$, then ϕ is equal to

(1) $\tan^{-1} \frac{x}{a}$

(2) $\tan^{-1} \frac{a}{x}$

(3) $\tan^{-1}(ax)$

(4) $\tan^{-1}\left(\frac{1}{ax}\right)$

21. If $y = \sin^{-1} x$, then the value of $\left(\frac{d^3y}{dx^3}\right)_{x=0}$ is

(1) 1

(2) -1

(3) 0

(4) 2

22. The points of intersection of the curve $x^2y^2 - x^2 + xy - y^2 = 0$ and its asymptotes lie on the curve

(1) $x^2 + y^2 = 1$

(2) $xy + 1 = 0$

(3) $x^2 - xy + y^2 = 0$

(4) $xy - 1 = 0$

23. All the asymptotes of the curve $\frac{a^2}{x^2} + \frac{b^2}{y^2} = 1$ are

(1) $(x^2 - a^2)(y^2 - b^2) = 0$

(2) $(x^2 - b^2)(y^2 - a^2) = 0$

(3) $x^2y^2 - a^2b^2 = 0$

(4) None of these

24. The correct formula for the radius of curvature of a curve is

(1) $\rho = p - \frac{d^2p}{d\psi^2}$

(2) $\rho = r \frac{dp}{dr}$

(3) $\rho = \frac{-\frac{dy}{ds}}{\frac{d^2x}{ds^2}}$

(4) $\rho = \sqrt{\left(\frac{d^2x}{ds^2}\right)^2 + \left(\frac{d^2y}{ds^2}\right)^2}$

25. The radius of curvature at any point of the curve $r = a(1 - \cos \theta)$ is
(1) $\sqrt{2ar}$ (2) $\frac{2}{3}\sqrt{2ar}$ (3) $\frac{1}{3}\sqrt{2ar}$ (4) $2\sqrt{ar}$
26. The length of chord of curvature through the pole of the curve $r = ae^\theta$ is
(1) $4r$ (2) $3r$ (3) $2r$ (4) r
27. The curve $r = a \cos 6\theta$ has
(1) 6 loops (2) 3 loops (3) 24 loops (4) 12 loops
28. In the curve $y^2 = (x-2)^2(x-5)$, the point (2, 0) is
(1) single point (2) cusp (3) node (4) conjugate point
29. The maximum value of $\sin x(1 + \cos x)$ is
(1) $\frac{3\sqrt{3}}{4}$ (2) $\frac{3\sqrt{3}}{2}$ (3) $\frac{\sqrt{3}}{2}$ (4) $\sqrt{3}$
30. $\frac{\log_e x}{x}$ is maximum when x is equal to
(1) $\frac{1}{e}$ (2) e (3) 1 (4) e^2
31. If $u = \sin^{-1} \frac{x}{y} + \tan^{-1} \frac{y}{x}$, then $\frac{\partial u}{\partial x} / \frac{\partial u}{\partial y}$ is equal to
(1) $-\frac{y}{x}$ (2) $\frac{y}{x}$ (3) $\frac{x}{y}$ (4) $-\frac{x}{y}$

32. If $u = t^n e^{-r^2/4t}$ satisfies the equation

$$\frac{\partial}{\partial r} \left(r^2 \frac{\partial u}{\partial r} \right) = r^2 \frac{\partial u}{\partial t}$$

then n is equal to

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

33. If $x = r \cos \theta$, $y = r \sin \theta$, then

$$\frac{\partial x}{\partial r} \frac{\partial y}{\partial \theta} - \frac{\partial x}{\partial \theta} \frac{\partial y}{\partial r}$$

is equal to

- (1) $-r$ (2) $-r \cos 2\theta$ (3) r (4) $r \cos 2\theta$

34. If $u = \log_e (x^3 + y^3 - x^2y - xy^2)$, then $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y}$ is equal to

- (1) $\frac{1}{x+y}$ (2) $\frac{2}{x+y}$ (3) $\frac{2}{x-y}$ (4) $\frac{1}{x-y}$

35. $\lim_{x \rightarrow 0} \frac{2 - x^2 - 2 \cos x}{x^4}$ is equal to

- (1) $\frac{1}{24}$ (2) $-\frac{1}{24}$ (3) $\frac{1}{12}$ (4) $-\frac{1}{12}$

36. $\int_a^b \frac{f(x) dx}{f(x) + f(a+b-x)}$ is equal to

- (1) $\frac{1}{2}(b-a)$ (2) $\frac{1}{2}(b+a)$ (3) $\frac{f(a)}{f(a)+f(b)}$ (4) $\frac{f(b)}{f(a)+f(b)}$

37. The area, bounded by the curve $y = \log_e x$, x -axis and the ordinates $x = 1$, $x = 2$ is

- (1) $\log_e 4$ (2) $\log_e \left(\frac{2}{e}\right)$ (3) $(\log_e 2)^2$ (4) $\log_e \left(\frac{4}{e}\right)$

38. $\int x (\log x^2)^2 dx$ is equal to

- (1) $x^2 \left(\log_e x^2 \log_e \left(\frac{x}{e}\right) - 1 \right) + c$ (2) $x^2 \left(\log_e x^2 \log_e \left(\frac{x}{e}\right) + 1 \right) + c$
 (3) $x^2 \left(1 - \log_e x^2 \log_e \frac{x}{e} \right) + c$ (4) $x^2 \log_e x^2 \log_e \left(\frac{x}{e}\right) + c$

39. The volume of the solid generated by revolving $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ about x -axis is

- (1) $\frac{4}{3} \pi (a^3 + b^3)$ (2) $\frac{2}{3} \pi (a^3 + b^3)$
 (3) $\frac{4}{3} \pi ab^2$ (4) $\frac{4}{3} \pi a^2 b$

40. The whole length of the curve $r = a(1 - \cos \theta)$ is

- (1) $8a$ (2) $6a$ (3) $4a$ (4) $2a$

41. The asymptotes of the hyperbola $x^2 + 3xy + 2y^2 + 2x + 3y = 0$ are given by

- (1) $x^2 + 3xy + 2y^2 + 2x + 3y + 1 = 0$ (2) $x^2 + 3xy + 2y^2 + 2x + 3y - 1 = 0$
 (3) $x^2 + 3xy + 2y^2 = 0$ (4) $x^2 + 3xy + xy^2 + x + 2y = 0$

42. The condition that the line $\frac{l}{r} = A \cos \theta + B \sin \theta$ may touch the conic $\frac{l}{r} = 1 + e \cos \theta$ is

(1) $A^2 + B^2 = 1$ (2) $(A - e)^2 + B^2 = 1$

(3) $(A + e)^2 + B^2 = 1$ (4) $A^2 + (B - e)^2 = 1$

43. The equation of the parabola, which touches the conic $x^2 + xy + y^2 - 2(x + y) + 1 = 0$ at the points, where it is cut by the line $x + y + 1 = 0$, is

(1) $(x - y)^2 = 7(x + y) - 1$ (2) $(x + y)^2 = 7(x - y) - 1$

(3) $(x - y)^2 = 14(x + y) + 1$ (4) $(x - y)^2 = 14(x + y) - 1$

44. The equation of the conic confocal with $x^2 + 2y^2 = 2$ and passing through the point $(0, \sqrt{2})$ is

(1) $2x^2 + 3y^2 = 1$ (2) $2x^2 + 3y^2 = 6$

(3) $x^2 + 2y^2 = 4$ (4) $2x^2 + y^2 = 2$

45. The distance of the point $(1, 2, 3)$ from the line through $(2, 3, 4)$ and $(-1, 2, 5)$ is

(1) $\sqrt{\frac{6}{11}}$ (2) $2\sqrt{6}$ (3) $2\sqrt{\frac{6}{11}}$ (4) $\sqrt{6}$

46. The equation of the plane through $(2, 3, -4)$ and $(1, -1, 3)$ and parallel to the x -axis is

(1) $4x - y - 5 = 0$ (2) $7x + 4y - 5 = 0$

(3) $7y + 4z - 5 = 0$ (4) $7x + z - 10 = 0$

47. The radius of the circle $x^2 + y^2 + z^2 - x + z - 2 = 0$, $x + 2y - z = 4$ is

(1) 1 (2) 2 (3) $\frac{1}{2}$ (4) 4

48. The vertical angle of a right circular cone having three mutually perpendicular generators is

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

49. The maximum number of normals which can be drawn from a point to a central conicoid is

- (1) 6 (2) 5 (3) 4 (4) 3

50. The radius of the right circular cylinder, whose guiding curve is $x^2 + y^2 + z^2 = 9$, $x - y + z = 3$ is

- (1) $2\sqrt{6}$ (2) $\sqrt{6}$ (3) $3\sqrt{2}$ (4) $\sqrt{3}$

51. The line $\frac{x-3}{2} = \frac{y-4}{3} = \frac{z-5}{3}$ lies on the plane

- (1) $4x + 4y - 5z - 3 = 0$ (2) $x + y - z - 2 = 0$
 (3) $x + y - z - 1 = 0$ (4) $4x + 4y + 5z - 3 = 0$

52. The angle between the planes $x + y + z + 1 = 0$ and $2x - 2y + 4z + 2 = 0$ is

- (1) $\cos^{-1} \left(\frac{\sqrt{3}}{2} \right)$ (2) $\cos^{-1} \left(\frac{1}{\sqrt{6}} \right)$ (3) $\cos^{-1} \left(\frac{\sqrt{2}}{3} \right)$ (4) $\cos^{-1} \left(\frac{\sqrt{2}}{\sqrt{3}} \right)$

53. The general equation of orthogonal trajectory of family of curves $r^n = a^n \cos n\theta$, where a is the parameter, is

- (1) $r^n = b^n \cos n\theta$ (2) $r^n = b^n \sin n\theta$
 (3) $r^n \cos n\theta = b$ (4) $r^n \sin n\theta = b$

54. The solution of the differential equation $\frac{d^2y}{dx^2} - y = e^x$, given that $y = 0, \frac{dy}{dx} = \frac{1}{2}$ when $x = 0$ is

(1) $y = xe^x$ (2) $y = e^x$

(3) $y = \frac{1}{2} xe^x$ (4) $y = \frac{1}{2} e^x$

55. The particular integral of the differential equation $\frac{d^2y}{dx^2} + 4y = \sin 2x$ is

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

56. If $y = e^{2x} + e^{-3x}$ satisfies the differential equation $\frac{d^2y}{dx^2} + A \frac{dy}{dx} + By = 0$, then A, B are respectively equal to

(1) 2, -3 (2) -2, 3 (3) 1, -6 (4) -6, 1

57. The solution of the differential equation

$$y \frac{d^2y}{dx^2} + 2 \left(\frac{dy}{dx} \right)^2 = 0$$

is

(1) $y^3 = ax + b$ (2) $y^2 = ax + b$ (3) $y^3 = ax^2 + bx$ (4) $y^2 = ax^2 + bx$

58. If $\mathcal{L}(F(t)) = f(s)$, then $\mathcal{L} \left\{ \frac{d^2 F(t)}{dt^2} \right\}$ is equal to

(1) $s^2 f(s) - s f'(0) - f(0)$ (2) $s^2 f(s) - s F'(0) - F(0)$

(3) $s^2 f(s) - s f(0) - f'(0)$ (4) $s^2 f(s) - s F(0) - F'(0)$

59. $\mathcal{L}^{-1}\left\{\frac{4s+12}{s^2+8s+16}\right\}$ is equal to

- (1) $4(1+t)e^{-4t}$ (2) $4(1-t)e^{-4t}$ (3) $4te^{-4t}$ (4) $4e^{-4t}$

60. If $\mathcal{L}(F(t)) = f(s)$, then $\mathcal{L}^{-1}\left\{\frac{d^n f(s)}{ds^n}\right\}$ is equal to

- (1) $(-1)^n F(t)$ (2) $t^n F(t)$ (3) $(-1)^n t^n F(t)$ (4) $(-1)^n t^{n-1} F(t)$

61. If $\vec{u} = u_1 \hat{i} + u_2 \hat{j} + u_3 \hat{k}$, then $\text{div curl } \vec{u}$ is equal to

- (1) $\text{curl curl } \vec{u} + \nabla^2 \vec{u}$ (2) $u_2 \frac{\partial^2 u_3}{\partial x^2} + u_3 \frac{\partial^2 u_1}{\partial y^2} + u_1 \frac{\partial^2 u_2}{\partial z^2}$
 (3) $\frac{\partial^2 u_1}{\partial x^2} + \frac{\partial^2 u_2}{\partial y^2} + \frac{\partial^2 u_3}{\partial z^2}$ (4) 0

62. $\text{div grad } r^m$, where $r = |\vec{r}|$ is equal to

- (1) $m(m+1)r^{m-2}$ (2) $m(m-1)r^{m+1}$
 (3) $m(m-1)r^{m-2}$ (4) $m(m+1)r^{m-1}$

63. If S is any closed surface enclosing a volume V and $\vec{F} = ax \hat{i} + by \hat{j} + cz \hat{k}$, then

$\int_S \vec{F} \cdot \hat{n} dS$ is equal to

- (1) $\frac{1}{3}(a+b+c)V$ (2) $(a+b+c)V$ (3) $\frac{1}{2}(a+b+c)V$ (4) $2(a+b+c)V$

64. The value of $\int_S \vec{r} \cdot \hat{n} dS$, where S is the part of the sphere $x^2 + y^2 + z^2 = 1$ above xy -plane, is

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

65. $\text{div} (r^m \vec{r})$, where $r = |\vec{r}|$ is equal to

- (1) $(m+2)r^m$ (2) $(m+3)r^{m+1}$ (3) $(m+3)r^m$ (4) $(m+2)r^{m+1}$

66. The forces P, Q, R acting along the sides BC, CA and AB respectively are such that $P \cos A + Q \cos B + R \cos C = 0$, then their resultant passes through the

- (1) incentre (2) circumcentre (3) orthocentre (4) centroid

67. Forces equal to $3P, 5P$ and $7P$ act along the sides BC, CA and AB respectively of an equilateral triangle ABC , the magnitude of their resultant is

- (1) $3P$ (2) $2\sqrt{7}P$ (3) $2\sqrt{3}P$ (4) $15P$

68. Four equal heavy uniform rods each of weight W are freely jointed so as to form a rhombus which is suspended from an angular point and kept in shape by connecting the middle points of upper two rods by a light rod. If the angle of rhombus at the point of suspension is 2α , the thrust in the rod is

- (1) $4W \sin \alpha$ (2) $2W \tan \alpha$ (3) $2W \cos \alpha$ (4) $4W \tan \alpha$

69. If a uniform heavy string of length l is suspended between two points in the same horizontal line distant a apart, then the parameter c of the catenary is given by

- (1) $l = 2c \sinh \frac{a}{2c}$ (2) $l = c \sinh \frac{a}{c}$ (3) $l = 2c \sinh \frac{a}{c}$ (4) $l = c \sinh \frac{a}{2c}$

70. The distance of the centre of gravity of a thin hemispherical shell of radius r from its centre is

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

71. A uniform ladder rests in limiting equilibrium with its lower end resting on a rough horizontal plane and its upper end against a smooth vertical wall. If μ is the coefficient of friction, the inclination of the ladder with the vertical is given by

- (1) $\cot^{-1}(2\mu)$ (2) $\tan^{-1}(2\mu)$ (3) $\tan^{-1}\mu$ (4) $\cot^{-1}\mu$

72. A particle executing SHM with time period T when moves from the position of maximum displacement to one in which the displacement is half the amplitude takes the time

- (1) $\frac{1}{6}T$ (2) $\frac{1}{4}T$ (3) $\frac{1}{3}T$ (4) $\frac{1}{2}T$

73. If a particle is projected from a point A with a given velocity u so as to pass through another point B , the product of the two times of flight is

- (1) $\frac{\sqrt{2}}{g} AB$ (2) $\frac{4}{g} AB$ (3) $\frac{3}{g} AB$ (4) $\frac{2}{g} AB$

74. A heavy particle of mass m is suspended by a string of length a and hangs vertically. It is then projected with velocity u so that it just makes a complete revolution, then

- (1) $u^2 = (2 + \sqrt{3}) ag$ (2) $u^2 = 5ag$
 (3) $u^2 = 4ag$ (4) $u^2 = 6ag$

75. If W and w are the weights of a body in vacuum and water respectively, the weight of the body in air of specific gravity σ is

- (1) $w + \sigma(W - w)$ (2) $W + \sigma(W - w)$ (3) $W - \sigma(W - w)$ (4) $w - \sigma(W - w)$

- 76.** Two electrons are moving in opposite directions with speeds $0.8c$ and $0.4c$ respectively, where c is the velocity of light. Their relative speed is about
- (1) $0.4c$ (2) $0.6c$ (3) $0.9c$ (4) $1.2c$
- 77.** If c is the velocity of light, then the speed at which a body should move for its mass to become twice its rest mass is
- (1) $\frac{2}{5}c$ (2) $\frac{3}{5}c$ (3) $\frac{\sqrt{3}}{2}c$ (4) $\frac{2}{\sqrt{3}}c$
- 78.** If sun radiates energy at the rate of 4×10^{26} joules/sec, the rate at which its mass is decreasing, is
- (1) 4.44×10^9 kg (2) 2.44×10^6 kg
 (3) 6.44×10^{16} kg (4) 8.44×10^{12} kg
- 79.** The percentage contraction produced in length of a rod moving with a speed of $0.80c$, where c is the velocity of light, in a direction parallel to its length is about
- (1) 50 (2) 60 (3) 80 (4) 40
- 80.** The acceleration due to gravity on the moon is just one-sixth that of the earth. If the moon and earth were assumed to have the same average composition, the ratio of moon's radius to that of the earth is
- (1) 1:6 (2) 1:3 (3) 2:5 (4) 3:5
- 81.** A satellite is orbiting just above the surface of a planet of average density d with a period T . If G is the universal constant of gravitation, the quantity $T^2 d$ is equal to
- (1) $\frac{1}{G}$ (2) $\frac{3\pi}{G}$ (3) $\frac{4\pi^2}{G}$ (4) $4\pi^2 G$

82. For a geosynchronous orbit, the period of rotation of the satellite should be approximately

- (1) 23 hours, 56 minutes (2) 12 hours, 34 minutes
 (3) 10 hours, 56 minutes (4) 18 hours, 30 minutes

83. A satellite is orbiting the earth. Its speeds at perihelion and aphelion are related to the distances from the perihelion and aphelion as

- (1) $\frac{v_p}{v_a} = \frac{r_a}{r_p}$ (2) $\frac{v_a}{v_p} = \frac{r_a}{r_p}$ (3) $\frac{v_p}{v_a} = \frac{1}{r_p}$ (4) $\frac{v_p}{v_a} = \frac{1}{r_a}$

84. Which of the following forces is conservative?

- (1) $F = 2xyz \hat{k}$ (2) $F = yz \hat{i} + zx \hat{j} + xy \hat{k}$
 (3) $F = x^2z \hat{i} + y^2z \hat{j} + z^2 \hat{k}$ (4) $F = x^2yz \hat{i} - xyz^2 \hat{k}$

85. An ice skater spins with arms outstretched at 1.9 revolutions/sec. Her moment of inertia at this time is 1.44 kg m^2 . She pulls in her arms to increase her rate of spin. If her moment of inertia is 0.48 kg m^2 after she pulls in her arms, her new rate of rotation is

- (1) 4.2 rev/s (2) 6.4 rev/s (3) 5.7 rev/s (4) 3.6 rev/s

86. A boy stands on a freely rotating platform. With his arms extended, his rotation speed is 0.25 revolutions/sec. But when he draws them in, his speed increases to 0.8 rev/sec. Then the ratio of the initial and final moments of inertia is

- (1) 3.2 (2) 6.2 (3) 7.2 (4) 2.4

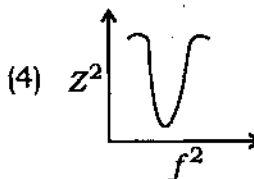
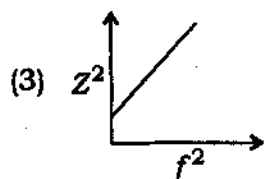
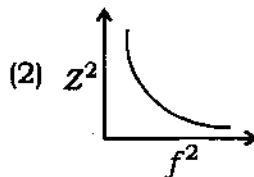
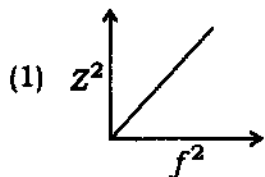
91. Two tuning forks A and B produce 6 beats per second when sounded together. When B is slightly loaded with wax, the beats reduce to 4 per sec. If the frequency of A is 512 vib/sec the frequency of b is

- (1) 514 vib/sec (2) 516 vib/sec (3) 518 vib/sec (4) 520 vib/sec

92. In a series $L-C-R$ circuit, $R = 100 \Omega$, $X_L = 300 \Omega$ and $X_C = 200 \Omega$. Then the phase angle ϕ of the circuit is

- (1) 0° (2) 90° (3) 45° (4) 60°

93. In an a.c. circuit which consists of an inductance and a resistance connected in series, the variation of impedance with frequency is shown by



94. If the capacitance of a series $L-C-R$ circuit is reduced to one-fourths its previous value while keeping the inductance a constant, its resonance frequency is

- (1) twice its previous value (2) thrice its previous value
 (3) four times its previous value (4) one-fourths of its previous value

95. A series $L-C-R$ circuit has a resonant frequency of 2 MHz and a Q -factor of 100. Its bandwidth is
- (1) 20 kHz (2) 2 kHz (3) 4 kHz (4) 40 kHz
96. When a capacitor is added in series in an $L-C-R$ circuit, the impedance of the circuit
- (1) decreases
(2) increases
(3) remains constant
(4) depends on frequency of the a.c. mains
97. For a series $L-C-R$ circuit under resonance condition, the power factor is
- (1) infinity (2) zero (3) 0.5 (4) unity
98. For the harmonic wave $\psi(x, t) = A \sin(kx \pm \omega t)$, the wave number and wave length are related as
- (1) $k = \frac{2\pi}{\lambda}$ (2) $k = \frac{4\pi}{\lambda^2}$ (3) $k = \frac{\lambda^2}{4\pi}$ (4) $k = \frac{\lambda}{2\pi}$
99. A wave is represented as $\psi(x, t) = 10^3 \sin \pi(3 \times 10^6 x - 9 \times 10^{14} t)$. Then its wave velocity is
- (1) $v = 3 \times 10^6$ m/s (2) $v = 9 \times 10^8$ m/s
(3) $v = 3 \times 10^8$ m/s (4) $v = 9 \times 10^6$ m/s

- 100.** A wavefront is a surface over which the following is a constant
 (1) Amplitude (2) Frequency (3) Phase (4) Wave number
- 101.** A certain radio station transmits at a frequency of 900 kHz. The number of wave crests that pass a point each second if the point is 50 km from the station, is
 (1) 9.00×10^5 (2) 3.00×10^8
 (3) 9.00×10^8 (4) 3.00×10^5
- 102.** A radio station transmits at a frequency of 900 kHz. The wavelength of its waves is
 (1) 256 m (2) 640 m (3) 720 m (4) 333 m
- 103.** A radar system sends out pulses of extremely short radio waves. How many microseconds after a pulse transmitted will an echo from an airplane 30000 m away from the radar station be received?
 (1) 300 μ s (2) 200 μ s (3) 400 μ s (4) 100 μ s
- 104.** For a linearly polarised electromagnetic plane wave whose electric field is of the form $\vec{E} = E_x(z, t) \hat{i}$, its magnetic component is given by
 (1) $\vec{B} = B_x(y, t) \hat{i}$ (2) $\vec{B} = B_y(z, t) \hat{j}$
 (3) $\vec{B} = B_z(x, t) \hat{k}$ (4) $\vec{B} = B_x(z, t) \hat{k}$
- 105.** Television frequencies are of the order of 100 MHz while radio broadcast frequencies are of the order of 1 MHz. The ratio of e.m.f.s generated in a loop antenna by a television wave to that generated by a radio wave if both have equal electric field intensities, is
 (1) 50:1 (2) 60:1 (3) 100:1 (4) 200:1

- 106.** A laser emits a 2 mm diameter beam of highly collimated light at a power level or radiant flux of 100 mW. Neglecting any divergence of the beam, its irradiance is
- (1) 31.8 kW/m² (2) 63.6 kW/m² (3) 15.9 kW/m² (4) 42.8 kW/m²
- 107.** A certain laser beam has a cross-sectional area of 2.0 mm² and a power of 0.80 mW. The intensity of the beam is
- (1) 800 mW (2) 1600 mW (3) 560 mW (4) 400 mW
- 108.** The average energy flux density delivered by sunlight to the surface of the earth on a clear day is $\langle S \rangle = 1.0 \text{ kW/m}^2$. Then the momentum density for sunlight $\langle p_m \rangle$ is
- (1) $1.1 \times 10^{14} \text{ kg m/s m}^3$ (2) $2.4 \times 10^{-13} \text{ kg m/s m}^3$
 (3) $3.6 \times 10^{16} \text{ kg m/s m}^3$ (4) $4.2 \times 10^{18} \text{ kg m/s m}^3$
- 109.** The following waves do not exist in a waveguide
- (1) TM waves (2) TE waves (3) TEM waves (4) TE and TM waves
- 110.** When a wave travelling in air enters a waveguide
- (1) the phase velocity will increase
 (2) the group velocity will increase
 (3) the phase velocity will decrease
 (4) both phase velocity and group velocity will decrease

111. When a transmission line is terminated by its characteristics impedance

- (1) it behaves as an infinite line
- (2) standing wave pattern is obtained
- (3) zero power reaches the load
- (4) power gets reflected to the source

112. For TEM mode propagation in a transmission line

- (1) \vec{E} is entirely transverse to direction of propagation and \vec{H} has a component in the direction of propagation
- (2) \vec{H} is entirely transverse to direction of propagation and \vec{E} has a component in the direction of propagation
- (3) both \vec{E} and \vec{H} have components in the direction of propagation
- (4) both \vec{E} and \vec{H} are entirely transverse to the direction of propagation

113. In semiconductors like silicon, the unit cell is

- (1) simple cubic
- (2) body-centred cubic
- (3) face-centred cubic
- (4) hexagonal

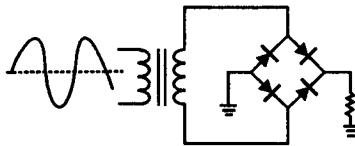
114. The electronic distributions of electrons in the various orbits of a silicon atom are

- (1) 2, 10, 2
- (2) 2, 7, 5
- (3) 2, 8, 4
- (4) 2, 4, 8

115. Conduction electrons have more mobility than holes because they

- (1) are lighter
- (2) experience collisions less frequently
- (3) have negative charge
- (4) need less energy to move them

- 116.** Major part of current in an intrinsic semiconductor is due to
- (1) conduction-band electrons (2) valence-band electrons
 (3) holes in the valence band (4) thermally generated electrons
- 117.** The leakage current of a *P-N* junction diode is caused by
- (1) chemical potential (2) barrier voltage
 (3) heat energy (4) dopant
- 118.** A transistor has $\alpha = 0.98$, $I_B = 100 \mu\text{A}$ and $I_{CO} = 6 \mu\text{A}$. Its collector current I_C is
- (1) 5.2 mA (2) 4.6 mA (3) 7.2 mA (4) 9.6 mA
- 119.** The emitter of a transistor is generally doped the heaviest because it
- (1) has to dissipate maximum power
 (2) has to supply the charge carriers
 (3) is the first region of the transistor
 (4) must possess low resistance
- 120.** In the rectifier circuit shown below, the AC signal voltage is $E = 5 \sin(2\pi 50t)$. Then the ripple frequency of the output voltage is



- (1) 25 Hz (2) 50 Hz (3) 100 Hz (4) 200 Hz

121. A bridge rectifier is preferred over an ordinary full-wave rectifier, because

- (1) it uses four diodes
- (2) its transformer has no centre tap
- (3) it needs much smaller transformer for the same output
- (4) it has higher efficiency

122. In a CE class A voltage amplifier, the worst case condition occurs when

- (1) zero signal input
- (2) maximum signal input
- (3) high load resistance
- (4) transformer coupling

123. When two laser lights having wavelengths λ and λ' incident independently on a pair of slits, they produce interference patterns having fringe widths $\Delta x = 6.3$ mm and $\Delta x' = 7.6$ mm respectively. If $\lambda = 630$ nm, λ' is

- (1) 760 nm
- (2) 660 nm
- (3) 560 nm
- (4) 860 nm

124. When the movable mirror of a Michelson's interferometer illuminated by monochromatic light is shifted by 0.015 mm, a shift of 50 fringes is observed. Then the wavelength of light used is

- (1) 400 nm
- (2) 500 nm
- (3) 600 nm
- (4) 800 nm

125. In a Newton's ring experiment, the diameter of the n th dark ring changes from 1.2 cm to 1 cm when the air space between the lens and plate is replaced by a transparent liquid. The refractive index of the liquid is

- (1) 1.33
- (2) 1.44
- (3) 1.5
- (4) 2.33

126. Newton's rings are formed by a light of 400 nm wavelength. Between the third and sixth bright fringe, the change in thickness of the air film is
- (1) 600 nm (2) 800 nm (3) 300 nm (4) 900 nm
127. When one leg of a Michelson's interferometer is lengthened by a distance, say x , 150 dark fringes sweep through the field of view. If the wavelength of light used is 480 nm, the value of x is
- (1) 12000 nm (2) 24000 nm (3) 48000 nm (4) 36000 nm
128. Two wavelengths of light λ_1 and λ_2 are sent through a Young's double slit apparatus simultaneously. If the third order λ_1 bright fringe is to coincide with fourth order λ_2 bright fringe, then the wavelengths are related as
- (1) $\lambda_2 = \frac{3}{4} \lambda_1$ (2) $\lambda_2 = \frac{2}{5} \lambda_1$ (3) $\lambda_2 = \frac{4}{3} \lambda_1$ (4) $\lambda_2 = \frac{5}{3} \lambda_1$
129. A diffraction grating is illuminated by a laser of wavelength 500 nm. If a second order spectral line is observed at 30° , the number of lines per centimetre of the grating is
- (1) 6000 (2) 5000 (3) 4000 (4) 2000
130. If a beam of polarised light has one-fourths of the initial intensity after passing through an analyzer, the angle between the axis of the analyzer and the initial amplitude of the beam is
- (1) 30° (2) 45° (3) 60° (4) 90°
131. Ordinary light incident on one Polaroid sheet falls on a second Polaroid whose plane of vibration makes an angle of 60° with that of the first Polaroid. If the Polaroids are assumed to be ideal, the fraction of the original light transmitted through both the Polaroids is
- (1) $\frac{1}{8}$ (2) $\frac{2}{8}$ (3) $\frac{3}{8}$ (4) $\frac{5}{8}$

132. Linearly polarised light is incident at Brewster's angle on the surface of a medium. If the incident beam is polarised parallel to the plane of incidence, then

- (1) no light is reflected at all
- (2) no light is refracted at all
- (3) some of the light is reflected and some refracted
- (4) neither the light is reflected nor refracted

133. Plane polarised light is incident on a quartz crystal at an angle 30° . The quartz crystal is cut with faces parallel to the axis. If the wavelength of light is 500 nm, refractive index for ordinary ray is 1.54 and that for extraordinary ray is 1.553, the ratio of intensities of the extraordinary ray and ordinary ray is

- (1) 3:1
- (2) 1:2
- (3) 2:3
- (4) 3:2

134. The tube in a Laurent's half shade polarimeter is 20 cm long. It is filled with a solution of cane sugar formed by dissolving 10 gm of sugar in 40 c.c. of distilled water. If the rotation of the plane of polarisation is 34° , the specific rotation of cane sugar is

- (1) 54°
- (2) 68°
- (3) 72°
- (4) 84°

135. The rotation of the plane of polarised light for the green mercury line produced by 1 mm of quartz cut perpendicular to the optic axis is 20° . If this quartz plate is placed between two parallel Nicol prisms, then the intensity of transmitted light is zero for a thickness of the quartz plate equal to

- (1) 2.5 mm
- (2) 3.5 mm
- (3) 5 mm
- (4) 4.5 mm

136. The total number of lines on a grating to just resolve 4000 \AA and 4001 \AA wavelength lines in the first order spectrum is

- (1) 4000 (2) 4200 (3) 5400 (4) 6400

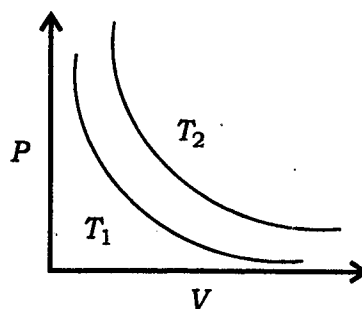
137. Green light of wavelength 500 nm illuminates a pair of narrow slits 1 mm apart. The separation of the bright bands in the interference pattern on a screen 2 m away is

- (1) 0.1 mm (2) 0.25 mm (3) 1.0 mm (4) 0.4 mm

138. A reversible heat engine converts $1/6$ th heat which it absorbs from source into useful work. When the temperature of the sink is reduced by $62 \text{ }^\circ\text{C}$, its efficiency is doubled. Then the temperature of the source is

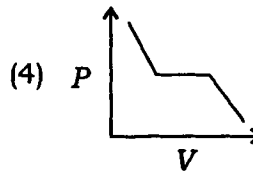
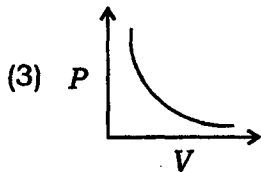
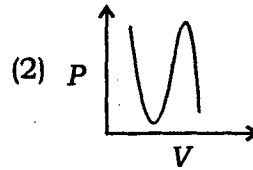
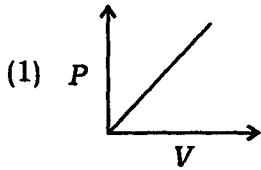
- (1) 262 K (2) 172 K (3) 272 K (4) 372 K

139. For a certain mass of gas the isothermal curve between P and V at temperatures T_1 and T_2 is shown in the figure below. Then



- (1) $T_1 > T_2$ (2) $T_1 < T_2$
 (3) $T_1 = T_2$ (4) Nothing can be predicted

140. For a certain mass of gas above its critical temperature the graph that best represents the pressure and volume variations is



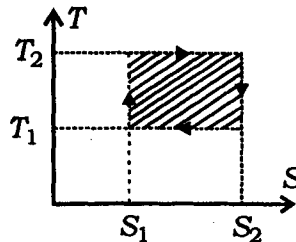
141. The total gain in the entropy of a working substance in a Carnot engine is

- (1) negative (2) positive (3) zero (4) oscillatory

142. 540 gm of ice at 0 °C is mixed with 540 gm of water at 80 °C. The resultant temperature of the mixture is

- (1) 0 °C (2) 40 °C (3) -20 °C (4) 80 °C

143. In the S-T diagram given below, the shaded area shows



- (1) a net outflow of heat (2) a net inflow of heat
 (3) work done on the system (4) work done by the system

- 144.** When a certain amount of heat is given to a gas under isothermal conditions, it will result in
- (1) external work being done
 - (2) a rise in temperature
 - (3) both external work and rise in temperature
 - (4) an increase in internal energy of the gas
- 145.** The ratio of adiabatic to isochoric pressure coefficient of expansion $\frac{\beta_s}{\beta_v}$ is
- (1) $\frac{\gamma}{\gamma-1}$
 - (2) $\frac{1}{\gamma-1}$
 - (3) $\frac{\gamma-1}{\gamma}$
 - (4) γ
- 146.** In photoelectric experiment the wavelength of incident radiation is decreased from 6000 Å to 4500 Å, then
- (1) the stopping potential will increase
 - (2) the stopping potential will decrease
 - (3) the photoelectric current will increase
 - (4) the photoelectric current may stop
- 147.** Radiation from the Big Bang has been Doppler shifted to longer wavelengths by the expansion of the universe and today has a spectrum corresponding to a black body at 2.898 K. The wavelength at which the energy density of this radiation is a maximum, is
- (1) 1.0 mm
 - (2) 2.4 mm
 - (3) 3.6 mm
 - (4) 4.8 mm

- 148.** It is impossible for pair production to occur in empty space because
- (1) it is impossible for pair production to conserve energy in empty space
 - (2) it is impossible for pair production to conserve momentum in empty space
 - (3) it is impossible for pair production to conserve both energy and momentum in empty space
 - (4) of relativistic speed of the particles
- 149.** For Compton scattering at 90° , the effective shift in wavelength is
- (1) 0.242 \AA (2) 2.42 \AA (3) 0.0242 \AA (4) 0.00242 \AA
- 150.** Raman effect is due to
- | | |
|----------------------------|---------------------------|
| (1) coherent scattering | (2) incoherent scattering |
| (3) electronic translation | (4) refraction |

अभ्यर्थियों के लिए निर्देश

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

1. प्रश्न पुस्तिका मिलने के 10 मिनट के अन्दर ही देख लें कि प्रश्नपत्र में सभी पृष्ठ मौजूद हैं और कोई प्रश्न 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 में न लायें।
3. उत्तर-पत्र अलग से दिया गया है। इसे न तो मोड़ें और न ही विकृत करें। दूसरा उत्तर-पत्र नहीं दिया जायेगा, केवल उत्तर-पत्र का ही मूल्यांकन किया जायेगा।
4. अपना 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. ओ० एम० आर० पत्र पर अनुक्रमांक संख्या, प्रश्न-पुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्न-पुस्तिका पर अनुक्रमांक सं० और ओ० एम० आर० पत्र सं० की प्रविष्टियों में उपरिलेखन की अनुमति नहीं है।
7. उपर्युक्त प्रविष्टियों में कोई भी परिवर्तन कक्ष निरीक्षक द्वारा प्रमाणित होना चाहिये अन्यथा यह एक अनुचित साधन का प्रयोग माना जायेगा।
8. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं। प्रत्येक प्रश्न के वैकल्पिक उत्तर के लिये आपको 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 लिये केवल एक ही वृत्त को गाढ़ा करें। एक से अधिक वृत्तों को गाढ़ा करने पर अथवा एक वृत्त को अपूर्ण भरने पर वह उत्तर गलत माना जायेगा।
10. ध्यान दें कि एक बार स्याही द्वारा अंकित उत्तर बदला नहीं जा सकता है। यदि आप किसी प्रश्न का उत्तर नहीं देना चाहते हैं, तो सम्बन्धित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर शून्य अंक दिये जायेंगे।
11. रफ़ कार्य के लिये प्रश्न-पुस्तिका के मुखपृष्ठ के अन्दर वाले पृष्ठ तथा अंतिम पृष्ठ का प्रयोग करें।
12. परीक्षा के उपरान्त केवल ओ०एम०आर० 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 दंड का/की, भागी होगा/होगी।