Question Booklet Series

A

JELET-2022

Paper – I (For Engg./Tech., BSc. Candidates)

2091013057

(Booklet Number)

Duration: **2** Hours | No. of MCQ : **100** | Full Marks: **120**

INSTRUCTIONS

1. **All** questions are of objective type having four answer options for each.
2. Category-I : Carry 1 mark each and only one option is correct. In case of incorrect answer or any combination of more than one answer, ¼ mark will be deducted.
3. Category-II : Carry 2 marks each and one or more option(s) is/are correct. If all correct answers are not marked and no incorrect answer is marked, then score = 2 × number of correct answers marked ÷ actual number of correct answers. If any wrong option is marked or if any combination including a wrong option is marked, the answer will be considered wrong, but there is **no negative marking** for the same and zero mark will be awarded.
4. Questions must be answered on OMR sheet by darkening the appropriate bubble marked A, B, C, or D. Question booklet series code (A, B, C, or D) must be properly marked on the OMR.
5. Use only **Black/Blue ball point pen** to mark the answer by complete filling up of the respective bubbles.
6. Write question booklet number and your roll number carefully in the specified locations of the **OMR**. Also fill appropriate bubbles.
7. Write your name (in block letter), name of the examination center and put your full signature in appropriate boxes in the OMR.
8. The OMR is liable to become invalid if there is any mistake in filling the correct bubbles for question booklet number/roll number or if there is any discrepancy in the name/ signature of the candidate, name of the examination center. The OMR may also become invalid due to folding or putting stray marks on it or any damage to it. The consequence of such invalidation due to incorrect marking or careless handling by the candidate will be sole responsibility of candidate.
9. Candidates are not allowed to carry any written or printed material, calculator, pen, log-table, wristwatch, any communication device like mobile phones etc. inside the examination hall. Any candidate found with such items will be **reported against** and his/her candidature will be summarily cancelled.
10. Rough work must be done on the question paper itself. Additional blank pages are given in the question paper for rough work.
11. Hand over the OMR to the invigilator before leaving the Examination Hall.

SPACE FOR ROUGH WORK

JELET-2022

MATHEMATICS

Category-I (Q1 to 30)

(Carry 1 mark each. Only one option is correct. Negative marks: $-\frac{1}{4}$)

1. Let $A=\begin{pmatrix}5 & 0 & 1\\ 0 & -2 & 0\\ 1 & 0 & 5\end{pmatrix}, Q=\begin{pmatrix}0 & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}}\\ -1 & 0 & 0\\ 0 & -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}}\end{pmatrix}$.

Then Q^TAQ is

(A) a diagonal matrix
(B) not a diagonal matrix
(C) an orthogonal matrix
(D) a null matrix

2. If $A=\begin{pmatrix}2 & -1\\ -1 & 2\end{pmatrix}$ and I is the unit matrix of order 2 then A^2 equal to

(A) $4A-3I$
(B) $3A-4I$
(C) $A-I$
(D) $A+I$

3. Let $A=\begin{pmatrix}1 & 2\\ 3 & 2\end{pmatrix}$

(A) A is non-diagonalizable
(B) A is singular matrix
(C) A is diagonalizable
(D) $A^TA=I_2$

4. Let $A=\begin{pmatrix}1 & 0 & 0\\ 1 & 0 & 1\\ 0 & 1 & 0\end{pmatrix}$, then $A^3-A^2-A+I_3$ (I_3 is the identity matrix of order 3) is

(A) Identity matrix of order 3
(B) null matrix of order 3
(C) non-null matrix of order 3
(D) $\begin{pmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 0\end{pmatrix}$

5. Let $\Delta = \begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix}$, then

(A) $\frac{BC-F^2}{a} = \Delta^2$ (B) $\frac{BC-F^2}{a} = \Delta$

(C) $\frac{BC-F^2}{a} = \frac{\Delta}{2}$ (D) $\frac{BC-F^2}{a^2} = \Delta$

Where B, C, F are respectively the co-factors of b, c, f to Δ.

6. If $\begin{vmatrix} a^2 & -ab & -ac \\ -ab & b^2 & -bc \\ ca & bc & -c^2 \end{vmatrix} = Ka^2b^2c^2$, then K =

(A) 1 (B) 2

(C) 3 (D) 4

7. Let $z = 1 + i \tan \frac{3\pi}{5}$, Then

(A) $|z| = \sec\frac{3\pi}{5}$, $\arg z = \frac{3\pi}{5}$ (B) $|z| = -\sec\frac{3\pi}{5}$, $\arg z = -\frac{7\pi}{5}$

(C) $|z| = -\sec\frac{3\pi}{5}$, $\arg z = \frac{2\pi}{5}$ (D) $|z| = \sec\frac{3\pi}{5}$, $\arg z = \frac{4\pi}{5}$

8. If $iz^3 + z^2 - z + i = 0$, then $|z| =$

(A) 1 (B) $\frac{1}{2}$

(C) 2 (D) $\frac{1}{3}$

9. The locus of the point which moves in such a way that the difference of its distance from the point (3, 0) and (9, 0) is 4 units in a conic section whose eccentricity is

(A) 2 (B) $\frac{5}{2}$

(C) $\frac{3}{2}$ (D) $\frac{4}{3}$

10. A triangle ABC of area Δ is inscribed in the parabola $y^2 = 4ax$ $(a > 0)$ such that the vertex of the parabola is at A, and the base BC is a focal chord. The differences of ordinates of B and C is

(A) $\frac{\Delta}{a}$ (B) $\frac{2\Delta}{a}$

(C) $\frac{\Delta}{2a}$ (D) $\frac{3\Delta}{2a}$

11. Consider a branch of the hyperbola $x^2 - 2y^2 - 2\sqrt{2}\,x - 4\sqrt{2}\,y - 6 = 0$ with vertex A. Let B be one of the end points of its latus rectum. If c is the focus of the hyperbola, nearer to A, then, the area of the triangle ABC is

(A) $1-\sqrt{\frac{2}{3}}$ sq. unit (B) $\sqrt{\frac{3}{2}}-1$ sq. unit

(C) $1+\sqrt{\frac{2}{3}}$ sq. unit (D) $\sqrt{\frac{3}{2}}+1$ sq. unit

12. If $\vec{\alpha}=\hat{i}+2\hat{j}+2\hat{k}$, $|\vec{\beta}|=5$ and the angle between $\vec{\alpha}$ and $\vec{\beta}$ is $\frac{\pi}{6}$, then, the area of the triangle formed by $\vec{\alpha}$ and $\vec{\beta}$ as two sides is

(A) $\frac{15}{4}$ sq. unit (B) 15 sq. unit

(C) $\frac{15\sqrt{3}}{4}$ sq. unit (D) $15\sqrt{3}$ sq. unit

13. A force of magnitude $\sqrt{6}$ acting along the line joining the points A (2, –1, 1) and B (3, 1, 2) displaces a particle from A to B. The work done by the force is

(A) $\sqrt{6}$ unit (B) 6 unit

(C) $6\sqrt{6}$ unit (D) 36 unit

14. Let f (x) be twice differentiable function such that $f''(x) = -f(x)$ and $f'(x) = g(x)$, $h(x) = [f(x)]^2 + [g(x)]^2$. If h (5) = 11, then h (10) is equal to

(A) 22 (B) 0

(C) 11 (D) 4

15. The equation $10^x + 5^x = 8^x + 7^x$ has

(A) no solution in $\mathbb{R}$.
(B) only solution at x = 0
(C) has non-zero integral solution
(D) all positive integers as solution

16. $\lim_{x \to 0} \left(e^x + x\right)^{1/x}$

(A) does not exists
(B) is 0
(C) is e^2
(D) is $e^{1/2}$

17. Consider the function $f(x) = |x|, x \in \mathbb{R}$. Then

(A) Rolle's theorem is always applicable to f in [a, b] ($\subset \mathbb{R}$)
(B) Rolle's theorem is applicable to f in [a, b] when $0 < a < b$
(C) Rolle's theorem is applicable to f in [a, b] if $a < b < 0$
(D) Rolle's theorem is never applicable to f in [a, b]

18. On the curve $y = x^3$, consider the chord joining A (–1, –1) and B (2, 8). Then

(A) $\exists$ a point on the curve at which the tg (tangent) is parallel to chord AB.
(B) $\exists$ no point satisfying the stipulation mentioned in (A).
(C) $\exists$ two points on the curve at which the tgs are parallel to chord AB.
(D) tgs at every point on the curve is perpendicular to AB.

19. A rectangle is inscribed in a right-angle triangle so as to have one angle coincident with the right angle. Then

(A) the area is maximum when the opposite corner bisects the hypotenuse.
(B) the area is maximum when the opposite corner intersects the hypotenuse in the ratio 2:1.
(C) the area is maximum when the opposite corner coincides with centroid of the triangle.
(D) area is not maximum anywhere.

20. The tangent at any point P to the parabola $y^2 = 4ax$ meets the directrix at the point K. Then the angle which KP subtends at the focus is

(A) 30°
(B) 45°
(C) 60°
(D) 90°

21. A man of 2 m height walks at a uniform speed of 6 km/h, away from a lamp post of 6 m high. The rate at which the length of his shadow increases is

(A) 2 km/h (B) 1 km/h

(C) 6 km/h (D) 3 km/h

22. If $u = \frac{x}{a} + f(ay - bx)$, then $a\frac{\partial u}{\partial x} + b\frac{\partial u}{\partial y}$ is

(A) a (B) 1

(C) b (D) a/b

23. Let $v(x, y) = \sin^{-1}\left(\sqrt{x^2 + y^2}\right)$. Then $x\frac{\partial v}{\partial x} + y\frac{\partial v}{\partial y}$

(A) does not exist (B) exists and is 0

(C) exists and is tan v (D) exists and is cot v

24. If $\int \frac{dx}{x^n(1+x^n)^{1/n}} = K\left(\frac{x^n+1}{x^n}\right)^{\frac{n-1}{n}} + C$, where C is an arbitrary constant, then K =

(A) $\frac{1}{n}$ (B) $-\frac{1}{n}$

(C) $\frac{1}{n-1}$ (D) $-\frac{1}{n-1}$

25. If $f(x) = |x^2 - x| + |x - 2|$, then $\int_0^3 f(x)\,dx =$

(A) $\frac{21}{4}$ (B) $\frac{19}{3}$

(C) $\frac{26}{3}$ (D) $\frac{22}{3}$

26. $I=\int \frac{dx}{\left(1+\sqrt{x}\right)\left(\sqrt{x-x^2}\right)}$, then I =

(A) $\frac{\sqrt{x}+1}{\sqrt{x}-1}+c$

(B) $\frac{1-\sqrt{x}}{1+\sqrt{x}}+c$

(C) $\frac{2\left(\sqrt{x}-1\right)}{\sqrt{(1-x)}}+c$

(D) $\frac{2\left(\sqrt{1+x}\right)}{\sqrt{(1-x)}}+c$

27. The equation of curve passing through the point $\left(1,\frac{\pi}{4}\right)$ and having slope at tangent at any point (x, y) as $\frac{y}{x}-\cos^2\left(\frac{y}{x}\right)$ is

(A) $x = e^{1+\tan\left(\frac{y}{x}\right)}$

(B) $x = e^{1-\tan\left(\frac{y}{x}\right)}$

(C) $x = e^{1+\tan\left(\frac{x}{y}\right)}$

(D) $x = e^{1-\tan\left(\frac{x}{y}\right)}$

28. $\frac{d^2y}{dx^2}+2\frac{dy}{dx}+y=2e^{2x}$, then

(A) $y = c_1e^x + c_2e^{-x} + e^{2x}$

(B) $y = (A + Bx)\, e^{-x} + \frac{1}{9}e^{2x}$

(C) $y = (A + Bx)\, e^{-x} + \frac{2}{9}e^{2x}$

(D) $y = A\cos x + B\sin x + \frac{e^{2x}}{9}$

29. The digits 1, 2, 3, ... , 9 are written in random order to form a nine digit number. The probability that this number is divisible by 36 is

(A) $\frac{2}{9}$

(B) $\frac{1}{9}$

(C) $\frac{1}{3}$

(D) $\frac{4}{9}$

30. The probability that at least one of A and B occurs is 0.6. If A and B occurs simultaneously with probability 0.3, then P (A') + P (B') is

(A) 0.9

(B) 0.15

(C) 1.1

(D) 1.2

MATHEMATICS

Category-II (Q 31 to 40)

(Carry 2 marks each. One or more options are correct. No negative marks.)

31. Let $A = \begin{pmatrix} \lambda & 1 & 0 \\ 3 & \lambda-2 & 1 \\ 3(\lambda+1) & 0 & \lambda+1 \end{pmatrix}$. Rank of A is

(A) 2 for $\lambda = 0$

(B) 3 for $\lambda \neq 0, 2, -1$

(C) 3 for $\lambda = 2$

(D) 3 for $\lambda = -1$

32. Under which of the following conditions the system of equations $ax + by + cz = 0$, $bx + cy + az = 0$, $cx + ay + bz = 0$ have a non-zero solution ?

(A) $a + b + c = 0$

(B) $a = b = c$

(C) $abc = 1$

(D) $a^2 + b^2 + c^2 = 0$

33. If $2\cos\theta = x + \frac{1}{x}$ and $2\cos\phi = y + \frac{1}{y}$, then

(A) $\frac{x}{y} + \frac{y}{x} = 2\cos(\theta - \phi)$

(B) $\frac{x}{y} + \frac{y}{x} = \cos(\theta + \phi)$

(C) $xy + \frac{1}{xy} = 2\cos(\theta + \phi)$

(D) $xy + \frac{1}{xy} = 2\cos(\theta - \phi)$

34. If the latus rectum of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ subtend a right angle at the centre of the hyperbola, then eccentricity of the ellipse is

(A) $\frac{\sqrt{5}+1}{2}$

(B) $\frac{\sqrt{5}+2}{2}$

(C) less than 2

(D) greater than 2

35. The vector $\vec{a} \times (\vec{b} \times \vec{c})$ is

(A) coplanar with $\vec{a}$ and $\vec{b}$

(B) coplanar with $\vec{b}$ and $\vec{c}$

(C) perpendicular to $\vec{a}$

(D) perpendicular to $\vec{c}$

36. If $x + |y| = 2y$, then y as a function of x is

(A) defined for all real x

(B) continuous at $x = 0$

(C) differentiable for all x

(D) such that $\frac{dy}{dx} = \frac{1}{3}$ for $x < 0$

37. The equation (s) of the tangents to the ellipse $\frac{x^2}{16} + \frac{y}{9} = 1$ parallel to the line $y = x$ is (are)

(A) $y = x + 5$

(B) $y = x + 3$

(C) $y = x - 3$

(D) $y = x - 5$

38. Let $f(x, y) = \begin{cases} \frac{xy^2 + x^2y}{x^2 + y^2}, x^2 + y^2 \neq 0 \\ 0, x^2 + y^2 = 0 \end{cases}$

(A) neither f_x nor f_y exists at (0, 0) but f is continuous at (0, 0)

(B) $f_x(0, 0) = 1$ but f_y does not exist at (0, 0)

(C) f is continuou at (0, 0)

(D) f_x, f_y exist at (0, 0) and both are 0

39. If $\int \frac{\sin x + \cos x}{\sqrt{\sin x \cos x}} dx = f(x) + c$, then $f(x)$ equals

(A) $\sqrt{2}\ \sin^{-1}(\sin x - \cos x)$

(B) $-\sqrt{2}\ \cos^{-1}(\sin x - \cos x)$

(C) $\sin^{-1}(\sin x - \cos x)$

(D) $\cos^{-1}(\sin x - \cos x)$

40. If $xdy = y(dx + ydy)$, $y(1) = 1$, then $y(-3)$ is

(A) 3

(B) 2

(C) –1

(D) 4

PHYSICS

Category-I (Q 41 to 65)

(Carry 1 mark each. Only one option is correct. Negative marks : $-\frac{1}{4}$)

41. The equation of a wave is given by $y = A \sin \omega \left(\frac{p}{v} - q\pi\right)$ where the symbols A, ω and v have their usual meanings. The dimension of p and q are respectively,

(A) L, T^{-1} (B) L^{-1}, T

(C) L, T (D) dimensionless, T^{-1}

42. The length, breadth and thickness of a strip are given by L = (10.0 ± 0.1) cm, h = (1.00 ± 0.01) cm, t = (0.1 ± 0.001) cm. The most probable error in volume will be

(A) 0.03 cm^3 (B) 0.111 cm^3

(C) 0.012 cm^3 (D) 0.12 cm^3

43. The area of the triangle having vertices at P (1, 3, 2), Q (2, –1, 1) and R (–1, 2, 3) will be

(A) $\sqrt{107}$ sq.unit (B) $2\sqrt{107}$ sq.unit

(C) $37\sqrt{2}$ sq.unit (D) $\frac{1}{2}\sqrt{107}$ sq.unit

44. The kinetic energy of a particle moving along a circle of radius R is αx where α is a constant and x is the distance covered. The force acting in the radial direction is proportional to

(A) x (B) x^2

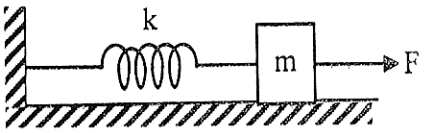
(C) $\frac{1}{x}$ (D) independent of x

45. The trajectory of a point particle in a projectile motion is given by the equation $Y = 2x - 5x^2$, where Y is height and x is horizontal distance. With what velocity was the particle projected? ($g=10\ m/s^2$)

(A) $\hat{i}+\hat{j}\ m/s$ (B) $2\hat{i}+\hat{j}\ m/s$

(C) $\hat{i}+2\hat{j}\ m/s$ (D) $3\hat{i}+\hat{j}\ m/s$

46. A constant force F is applied to the block of mass m connected to the spring of spring constant k as shown in figure. Initially (t = 0), the block is at rest. The amplitude of oscillation of m will be $\left(\text{consider } \omega = \sqrt{\frac{k}{m}}\right)$



(A) $\frac{F}{m\omega}$

(B) $\frac{F}{m\omega^2}$

(C) $\frac{F}{m}$

(D) $\frac{F\omega^2}{m}$

47. A block of mass 1.0 kg moving on a smooth horizontal surface with speed 2 m/s enters a rough surface. The retarding force (F_r) on the block is given by

$$F_r = \begin{cases} -\frac{k}{x} & ; 10\,m < x < 100\,m \\ 0 & ; x < 10\,m \text{ and } x > 100\,m \end{cases}$$, Where k = 0.5 J.

The kinetic energy of the block at x=100 m will be (given, ln 10=2.3)

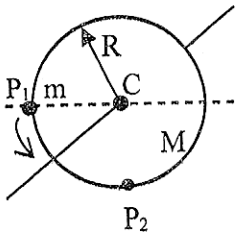
(A) 2 J

(B) 0

(C) 1.15 J

(D) 0.85 J

48. A uniform disc of mass M and radius R can rotate in vertical plane about its horizontal axis. A point mass m is glued to the disc at point P_1 as shown in figure. If the system is released from rest, the angular velocity of the disc when the point mass reaches the bottom most point P_2 is



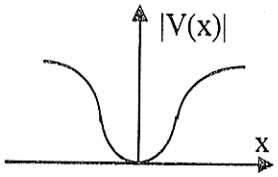
(A) $\frac{2mg}{(m+M)R}$ rad/sec

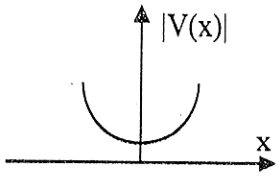
(B) $\frac{4mg}{(2M+m)}$ rad/sec

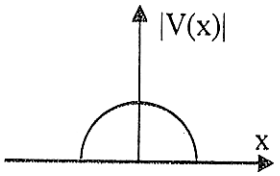
(C) $\frac{4mg}{(M+m)R}$ rad/sec

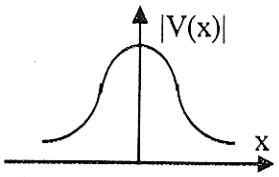
(D) $\frac{4mg}{(2m+M)R}$ rad/sec

49. Two identical point masses are placed on y axis at y = a and y = –a. The variation of the magnitude of the gravitational potential |V(x)| as a function of x is given by

(A) 

(B) 

(C) 

(D) 

50. If the change in volume is 0.4 % due to a change in length is 1% when a stress is applied along the length of the rod, the Poisson ratio of the material is

(A) 0.3 (B) 0.6

(C) 0.8 (D) cannot be determined

51. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth 2y from the top. The quantities of water flowing out per second from both holes are the same. Then R/L is equal to

(A) $\frac{1}{\sqrt{2}\,\pi}$ (B) $\frac{1}{2^{\frac{1}{4}}\sqrt{\pi}}$ (C) $\frac{1}{2^{\frac{1}{4}}\,\pi}$ (D) $\frac{1}{2\pi}$

52. A small sphere falls from rest in a viscous liquid. Heat is produced during its fall due to friction with the liquid. If R be the radius of the sphere, then the rate of production of heat at terminal velocity is

(A) proportional to R^2 (B) proportional to R^5

(C) proportional to R^3 (D) independent of R

53. A well lagged wire of length L and cross-sectional area S has its ends maintained at temperatures T_1 and T_2. The thermal conductivity of the wire is given by $K = \beta + \gamma T$ where T is the temperature and β and γ are constants. Then the rate of flow of heat along the wire is equal to

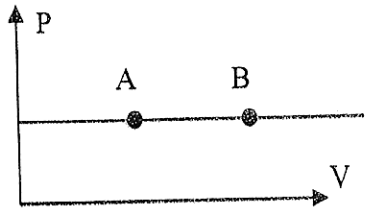
(A) $\frac{S\beta}{L}(T_1 - T_2)$ if $\gamma = 0$ (B) $\frac{S\gamma}{2L}(T_1^2 + T_2^2)$ if $\beta = 0$

(C) $\frac{S}{L}(T_1 - T_2)$ if $\gamma = 0, \beta = 0$ (D) $\frac{S\beta}{L}(T_1^2 - T_2^2)$ if $\gamma = \frac{\beta}{2}$

54. A one litre glass flask contains some mercury. It is found that at different temperatures, the volume of air in the empty space in the flask remains the same. What is the volume of mercury in the flask ? (The co-efficient of linear expansion of glass is $9 \times 10^{-6}\ ^\circ C^{-1}$ and the volume expansion of mercury is $1.8 \times 10^{-4}\ ^\circ C^{-1}$)

(A) 50 cm^3 (B) 150 cm^3 (C) 450 cm^3 (D) 400 cm^3

55. Consider an isobaric process of a monoatomic gas as shown in figure. The ratio of work done by the gas to the heat absorbed by it, when it undergoes a change from state A to state B is

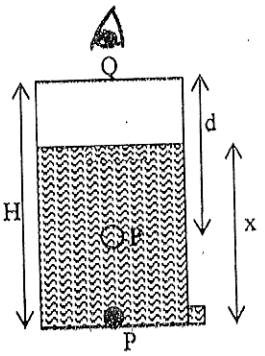


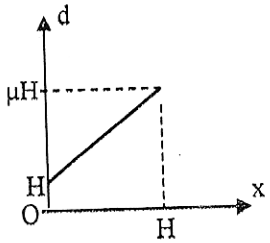
(A) $\frac{2}{3}$ (B) $\frac{1}{3}$ (C) $\frac{2}{7}$ (D) $\frac{2}{5}$

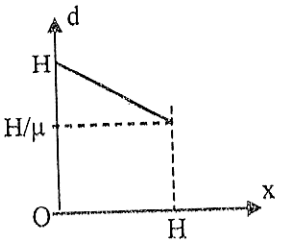
56. The angle of prism and refractive index of its material are A and $\cot\frac{A}{2}$ respectively. Then $\cos\delta_m$ is (δ_m : angle of minimum deviation) ($A < \pi/2$)

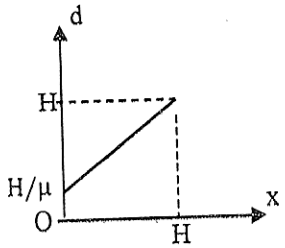
(A) $\sin 2A$ (B) $\cos 2A$ (C) $-\cos 2A$ (D) $\sin A$

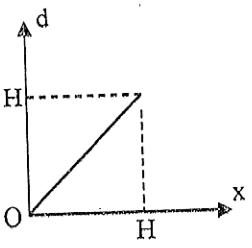
57. A vessel of height H contains a liquid of refractive index 'μ'. A spot P at the bottom of the vessel creates an image P' at a distance 'd' from the top of the vessel when viewed from the top. The liquid gradually drains out from a hole at the bottom. If 'x' represents the height of the water from the bottom at any instant, then the graph d versus x will be like,



(A)


(B)


(C)


(D)


58. A point source of monochromatic light S is kept at the centre of the bottom of a cylinder of radius 15 cm. The cylinder contains liquid of refractive index μ to a height of 7.0 cm. If the area of liquid surface through which the light emerges in air is 200 cm^2, then μ^2 equal to

(A) 0.23
(B) 1.77
(C) 1.33
(D) 1.5

59. A thin biconvex lens of radius 10 cm and index $\frac{3}{2}$ is placed on a horizontal plane mirror. The space between the lens and the mirror is filled with a liquid of refractive index μ. If the system has a focal length of 25 cm, then μ equals to

(A) 1.0
(B) 1.5
(C) 1.6
(D) 1.3

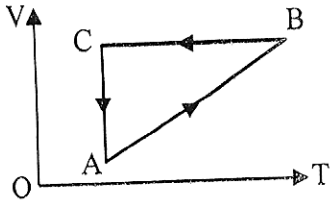
60. Given that a photon of light of wavelength 10,000 A° has an energy equal to 1.243 eV. When light of wavelength 5000 A° and intensity I_0 falls on a photo electric cell, the surface current is 0.4 μA and the stopping potential is 1.36 V. Then the work function is approximately

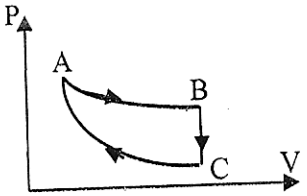
(A) 0.43 eV
(B) 1.54 eV
(C) 0.57 eV
(D) 1.12 eV

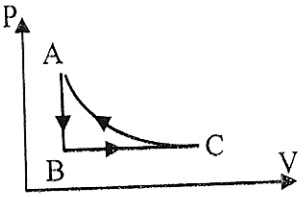
61. A and B are two identical balls. Ball A moving with a speed of 6 m/s along the positive x axis collides with ball B at rest. After collision each ball moves making a direction 30° with x axis. Then,

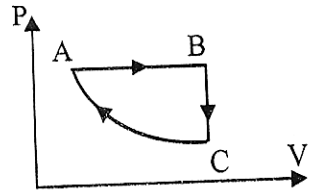
(A) Speed of ball A after collision is $\sqrt{3}$ m/s
(B) Speed of ball B after collision is $\sqrt{3}$ m/s
(C) Collision is not perfectly elastic
(D) Kinetic energy is conserved in collision

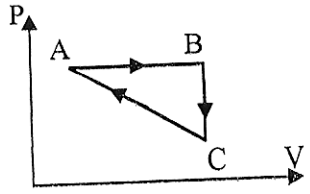
62. A cyclic process ABCA, shown in V-T diagram, is performed with a constant mass of an ideal gas. Which of the following graphs represents the corresponding prosses on a P-V diagram ?



(A)


(B)


(C)


(D)


63. A piece of ice floats in a liquid of density ρ_L. Density of water is ρw and $\rho_L \neq \rho_W$. When the ice melts completely, the level of liquid

(A) will rise if $\rho_L < \rho_W$

(B) will rise if $\rho_L > \rho_W$

(C) will fall if $\rho_L > \rho_W$

(D) level remains unchanged

64. Two spherical planets P and Q have masses M_P and M_Q, surface areas A and 4A respectively and same uniform density ρ. A spherical planet W also has uniform density ρ and its mass is $(M_P + M_Q)$. The escape velocities from the planets P, Q and W are V_P, V_Q and V_W respectively. Then

(A) $V_W < V_Q = V_P$

(B) $V_W > V_Q = V_P$

(C) $V_W > V_Q > V_P$

(D) $V_Q > V_W > V_P$

65. A rod of length 1000 mm and co-efficient of linear expansion $\alpha = 10^{-4}\ °C^{-1}$ is placed symmetrically between fixed walls separated by 1001 mm. The Young's modulus of the rod is 10^{11} N/ m^2. If the temperature is increased by 30°C, then the stress developed in the rod is

(A) 10^8 Pa

(B) 2×10^8 Pa

(C) 3×10^8 Pa

(D) 4×10^8 Pa

Category-II (Q 66 to 70)

(Carry 2 marks each. One or more options are correct. No negative marks)

66. A closed container of fixed volume has a mixture of one mole of hydrogen and one mole of helium in equilibrium at temperature T. Assume the gases are ideal. Which of the following statement (s) is/are true ?

(A) $\gamma\left(=\frac{C_P}{C_V}\right)$ of the mixture is $\frac{3}{2}$

(B) Average energy per mole of the gas mixture is 2RT

(C) Degree of freedom of the gas mixture is 5

(D) The ratio of rms speed of the Helium molecules to that of hydrogen molecules is $1 : \sqrt{2}$

67. A particle of mass 'm' moves rectilinearly under the force $F = A - Bx$ where $A > 0$, $B > 0$ and 'x' is the distance from the point where the particle was initially at rest. If 'd' is the distance travelled by the particle till it comes to rest, then which of the following statement(s) is/are true ?

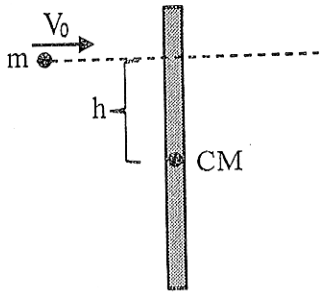
(A) $d = \frac{2A}{B}$

(B) acceleration of the particle at d is $-\frac{A}{m}$

(C) Speed of the particle at a distance $x = \frac{A}{B}$ is $B\sqrt{\frac{m}{A}}$

(D) acceleration vs x graph is a straight line with slope A/B

68. A stone of mass 'm' travels with a uniform speed v_0 perpendicular to a stick of mass 'm' and length L at rest. The stone collides elastically with the stick at a distance 'h' from its centre of mass. The stone and the stick move with equal speed after collision. Assume that stone moves in the same direction after collision. Then which of the following statement(s) is/are true ?



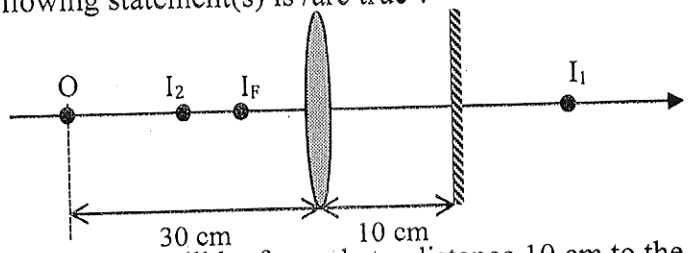
(A) The speed of the stick after collision is $\frac{v_0}{2}$

(B) The angular velocity of the stick is $\frac{\sqrt{6}\, v_0}{L}$

(C) Angular momentum is not conserved in this process

(D) $h = \frac{L}{\sqrt{6}}$

69. A biconvex lens of focal length 15 cm is placed 10 cm in front of a plane mirror. A small object O is kept at a distance of 30 cm in front of the lens as shown in the figure. Then which of the following statement(s) is /are true ?



(A) The second image I_2 will be formed at a distance 10 cm to the left of the lens.

(B) The final image at I_F is at a distance 16 cm from mirror.

(C) The first image I_1 will behave as a virtual object for mirror.

(D) The final image is real.

70. Two monochromatic radiations, blue and violet of same intensity are incident on a photosensitive surface and cause photoelectric emission. If n_b and n_v represent frequencies of blue light and violet light respectively then

(A) $n_b > n_v$

(B) Number of electrons emitted per second by the blue light will be more than that by the violet light.

(C) Maximum kinetic energy of ejected electrons will be more for blue light.

(D) Work function of the material is different for blue and violet light.

CHEMISTRY

Category-I (Q 71 to 85)

(Carry 1 mark each. Only one option is correct. Negative marks : $-\frac{1}{4}$)

71. Let x ml of a solution of a substance A reacts with y ml of a solution of a substance B according to the reaction 2A + 3B $\rightarrow$ products. If molar concentrations of the solutions of A and B are (M_1) and (M_2) respectively, then

(A) $2xM_1 = 3yM_2$ (B) $3xM_1 = 2yM_2$

(C) $2xM_2 = 3yM_1$ (D) $3xM_2 = 2yM_1$

72. If the density of a solution of a substance is z gcm^{-3} and gram molecular mass of the substance is y g, then the molality of the x (M) solution is

(A) $\frac{x}{z - 0.001xy}$ (B) $\frac{x}{z - xy}$

(C) $\frac{x}{1000z - xy}$ (D) $\frac{0.01x}{1000z - xy}$

73. If an electron is passed through a potential difference of V volts, then de Broglie wavelength of the moving electron is [h = Planck's constant, m = mass of electron, e = charge of an electron]

(A) $\frac{h}{\sqrt{2meV}}$ (B) $\frac{h}{\sqrt{meV}}$ (C) $\frac{h}{m\sqrt{eV}}$ (D) $\frac{heV}{\sqrt{m}}$

74. Electronic configuration of Cu^+ is (Atomic number of Cu is 29)

(A) $[Ar]3d^8\,4s^2$ (B) $[Ar]3d^9\,4s^1$

(C) $[Ar]3d^{10}$ (D) $1s^2\,2s^2\,2p^6\,3s^1\,3p^6\,3d^{10}\,4s^1$

75. A strong electrolyte $M_{\nu+}A_{\nu-}$ yielding the ions M^{z+} and A^{z-} in solution, the relation between equivalent conductivity (Λ_{eq}) and molar conductivity (Λ_m) is

(A) $\Lambda_{eq} = \frac{\Lambda_m}{\nu_+ z_+}$ (B) $\Lambda_{eq} = \frac{\Lambda_m}{\nu_+}$ (C) $\Lambda_m = \frac{\Lambda_{eq}}{\nu_+ z_+}$ (D) $\Lambda_m = \frac{\Lambda_{eq}}{\nu_+}$

76. At a definite temperature the molar concentrations of two monobasic acids HA and HA' in their individual solutions are same. At that temperature if ionization constants of the acids HA and HA' are κ_a and $\kappa_{a'}$ respectively and degrees of ionization of HA and HA' are α and α' respectively, then

(A) $\frac{\alpha}{\alpha'} = \sqrt{\frac{\kappa_a}{\kappa_{a'}}}$ (B) $\frac{\alpha}{\alpha'} = \sqrt{\kappa_a \kappa_{a'}}$ (C) $\frac{\alpha}{\alpha'} = \sqrt{\frac{\kappa_{a'}}{\kappa_a}}$ (D) $\frac{\alpha'}{\alpha} = \sqrt{\kappa_a \kappa_{a'}}$

77. To which of the following ions, Bohr model is applicable ?

(A) H^+ (B) Li^+ (C) Li^{2+} (D) He^{2+}

78. The metal hydroxide that dissolves both in aqueous KOH and ammonia, is :

(A) $Be(OH)_2$ (B) $Mg(OH)_2$ (C) $Al(OH)_3$ (D) $Zn(OH)_2$

79. Thiosulphuric acid is :

(A) $H_2S_2O_3$ (B) H_2SO_3 (C) $H_2S_2O_6$ (D) H_2SO_4

80. The correct order of the acidity is :

(A) $HClO_4 > HClO_3 > HClO_2 > HClO$ (B) $HClO > HClO_2 > HClO_3 > HClO_4$

(C) $HClO_3 > HClO_4 > HClO_2 > HClO$ (D) $HClO_2 > HClO > HClO_3 > HClO_4$

81. The shape of the NH_3 molecules is :

(A) pyramidal (B) tetrahedral

(C) triangular planar (D) see-saw

82. How many isomers are possible with molecular formula C_4H_9Cl ?

(A) 3 (B) 4 (C) 2 (D) 5

83. Which of the following oxides is used as a white pigment ?

(A) ZnO (B) HgO (C) CuO (D) NiO

84. If heat absorbed by a system and work done by the system are 120 J and 30 J respectively by a process, then change of internal energy of the system is

(A) 150 J (B) 90 J (C) –150 J (D) –90 J

85. The element of the following that reacts with N_2 to form a nitride is :

(A) Na (B) K (C) Cs (D) Li

CHEMISTRY

Category-II (Q 86 to 90)

(Carry 2 marks each. One or more options are correct. No negative marks)

86. Which of the following aqueous solutions of metal chlorides is neutral ?

(A) $AlCl_3$ (B) $BeCl_2$ (C) $BaCl_2$ (D) RbCl

87. Which of the chemical conversion(s) as given below show(s) the highest degree of redox change ?

(A) Phosphoric acid to phosphine.
(B) Nitric acid to molecular nitrogen.
(C) Sulphuric acid to elemental sulphur.
(D) Borax to diborane

88. A chemical change will be spontaneous at constant pressure and temperature under the set(s) of conditions

(A) $\Delta H = -ve, \Delta S = -ve, |\Delta H| > |T\Delta S|$

(B) $\Delta H = +ve, \Delta S = +ve, |\Delta H| < |T\Delta S|$

(C) $\Delta H = -ve, \Delta S = -ve, |\Delta H| = |T\Delta S|$

(D) $\Delta H = +ve, \Delta S = +ve, |\Delta H| > |T\Delta S|$

89. Which of the following statement (s) is / are true ?

(A) K_p of a chemical reaction increases with increase in temperature for an exothermic reaction.

(B) K_p of a chemical reaction increases with decrease in temperature for an endothermic reaction.

(C) K_p of a chemical reaction increases with decrease in temperature for an exothermic reaction.

(D) K_p of a chemical reaction decrease with decrease in temperature for an endothermic reaction.

90. Which of the following compounds have covalent bonds ?

(A) NaCl (B) H_2O (C) CH_4 (D) $CaCO_3$

Fundamentals of Electrical & Electronics Engineering

Category-I (Q 91 to 100)

(Carry 1 mark each. Only one option is correct. Negative marks: ¼)

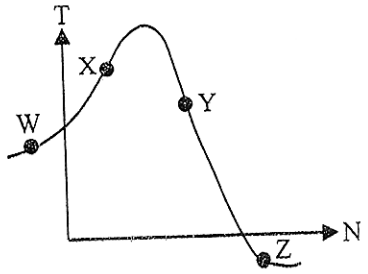
91. A voltage $v(t) = V_m \sin\omega t$ is connected to a moving Iron instrument. The reading of the instrument will be

(A) V_m (B) $\frac{V_m}{\sqrt{2}}$ (C) $\frac{V_m}{\pi}$ (D) $\frac{2V_m}{\pi}$

92. A 25 KVA transformer is constructed to a turn ratio of $N_1/N_2 = 10$. The impedance of the primary winding is $2 + j5\ \Omega$ and of the secondary windings is $0.5 + j0.8\ \Omega$. What will be the impedance when referred to primary?

(A) 52+j85 Ω (B) 2.5+j5.8 Ω (C) 50+j80 Ω (D) 0.025+J0.508 Ω

93. On the Torque -Speed curve of the Induction motor shown in the figure, four points of operation are marked, as W, X, Y and Z. Which one represents the operation at a slip greater than 1 ?



(A) W (B) X (C) Y (D) Z

94. A series circuit consists of two elements has the following current and applied voltage $i = 4 \cos(2000t + 11.32°)$ A and $v = 200 \sin(2000t + 50°)$ V. The circuit elements are

(A) Resistance and Capacitance (B) Capacitance and Inductance

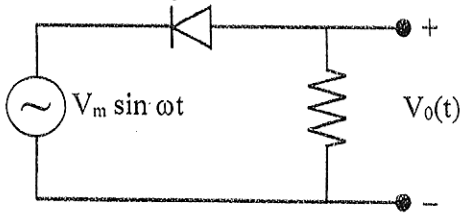
(C) Inductance and Resistance (D) Both resistances

95. Two incandescent light bulbs of 40W and 60 W rating are connected in series across the mains. Then

(A) the bulbs together consume 100 W (B) the bulbs together consume 50 W

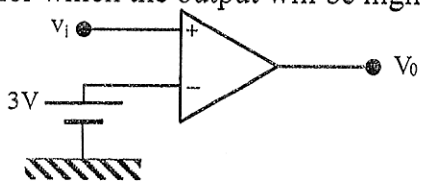
(C) the 60 W bulb glows brighter (D) the 40 W bulb glows brighter

96. The average value of $v_0(t)$ in the given circuit will be



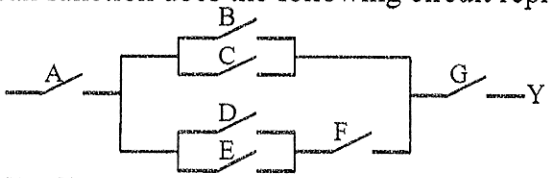
(A) 0 (B) $\frac{-V_m}{\pi}$ (C) $\frac{-V_m}{\sqrt{2}}$ (D) $-V_m$

97. In the comparator shown, v_i is a sinusoidal input of peak value 6V. The period (in degrees) for which the output will be high is



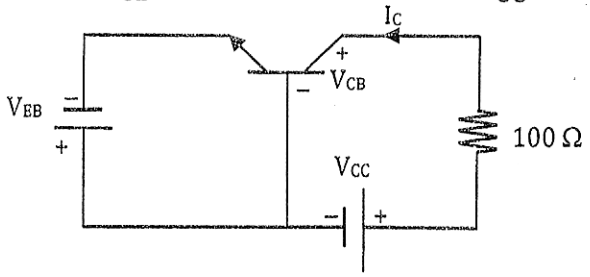
(A) 180° (B) 60° (C) 120° (D) 150°

98. What Boolean function does the following circuit represents ?



(A) A[F+(B+C).(D+E)]G (B) A+BC+DEF+G
(C) A[(B+C)+F(D+E)]G (D) ABG+ABC+F(D+E)

99. If I_C = 15 mA and V_{CB} = 3 V, then the value of V_{CC} required is



(A) 4 V (B) 4.5 V (C) 3.15 V (D) 18 V

100. A DC shunt motor is started with an open circuited field. Then

(A) The motor picks up fast and acquires full speed while drawing large current.
(B) Motor does not pick up speed but draws a large current.
(C) The motor does not pick up speed but draws only a small current.
(D) The motor picks up speed fast and acquires full speed while drawing only a small current.

SPACE FOR ROUGH WORK