JELET-2024

Paper-I (For Engg./Tech., B.Sc., B. Voc., D. Voc. Candidates)

4091010805

(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 MCQ : 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 : Carries 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.
5. Use only **Black/Blue ink 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 Sheet**. Also fill appropriate bubbles.
7. Write your name (in block letter), name of the examination center and put your signature (as appeared in Admit Card) in appropriate boxes in the OMR Sheet.
8. The OMR Sheet 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 Sheet 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, bluetooth etc. inside the examination hall. Any candidate found with such prohibited items will be **reported against** and his/her candidature will be summarily cancelled.
10. Rough work must be done on the question booklet itself. Additional blank pages are given in the question booklet for rough work.
11. Hand over the OMR Sheet to the invigilator before leaving the Examination Hall.
12. Candidates are allowed to take the Question Booklet after Examination is over.

Signature of the Candidate : _____

(as in Admit Card)

Signature of the Invigilator : _____

SPACE FOR ROUGH WORK

MATHEMATICS

Category-I (Q 1 to 30)

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

1. If A and B are real orthogonal matrices of same order and $\det(A) + \det(B) = 0$, then A + B is

   (A) a singular matrix. (B) a symmetric matrix.

   (C) an orthogonal matrix. (D) $(A + B)^{-1}$ exists.

2. For the matrix $A = \begin{pmatrix} 1 & 0 & 3 \\ 4 & -1 & 5 \\ 2 & 0 & 6 \end{pmatrix}$, which of the following is correct ?

   (A) rank A = 0 (B) rank A = 1

   (C) rank A = 2 (D) rank A = 3

3. If $A = \begin{pmatrix} 3 & -4 \\ 1 & -1 \end{pmatrix}$, then A^K (where K is any positive integer) is

   (A) $\begin{pmatrix} 1+2K & -4K \\ K & 1-2K \end{pmatrix}$ (B) $\begin{pmatrix} 1+2K & -4K \\ K & 1-3K \end{pmatrix}$

   (C) $\begin{pmatrix} 1+K^2 & -4K^2 \\ K^2 & 1-3K^2 \end{pmatrix}$ (D) $\begin{pmatrix} K & 0 \\ 0 & K \end{pmatrix}$

4. If $p\lambda^4 + q\lambda^3 + r\lambda^2 + s\lambda + t = \begin{vmatrix} \lambda^2+3\lambda & \lambda-1 & \lambda+3 \\ \lambda+1 & 2-\lambda & \lambda-3 \\ \lambda-3 & \lambda+4 & 3\lambda \end{vmatrix}$, then t =

   (A) 33 (B) 22

   (C) 21 (D) –33

5. If $\Delta_1 = \begin{vmatrix} x & b & b \\ a & x & b \\ a & a & x \end{vmatrix}$ and $\Delta_2 = \begin{vmatrix} x & b \\ a & x \end{vmatrix}$ are the given determinants, then

(A) $\Delta_1 = 3(\Delta_2)^2$

(B) $\frac{d}{dx}(\Delta_1) = 3\Delta_2$

(C) $\frac{d}{dx}(\Delta_1) = 3(\Delta_2)^2$

(D) $\Delta_1 = 3(\Delta_2)^4$

6. If $\begin{vmatrix} a^2 & bc & ac+c^2 \\ a^2+ab & b^2 & ac \\ ab & b^2+bc & c^2 \end{vmatrix} = Ka^2b^2c^2$

Where a, b, c are real numbers, then K =

(A) 2

(B) 4

(C) 8

(D) 16

7. If $x = e^{i\theta}$ and $y = e^{i\varphi}$, then the value of $\frac{x^m}{y^n} + \frac{y^n}{x^m}$, where m, n are integers is

(A) $2\cos(m\phi - n\theta)$

(B) $2\cos(m\theta - n\phi)$

(C) $2\cos(m-n)\theta$

(D) $2\cos(m-n)\phi$

8. If the ratio $\frac{Z-i}{Z-1}$ where Z represents a complex number, is purely imaginary, then the point lies on

(A) an ellipse

(B) a circle

(C) a hyperbola

(D) a parabola

9. If the normal to the curve $xy = e^2$ at the point $\left(et_1, \frac{e}{t_1}\right)$ meets the curve again at the point $\left(et_2, \frac{e}{t_2}\right)$, then which of the following is true ?

(A) $(t_1 t_2)^2 + 1 = 0$

(B) $t_1^3 t_2 = -1$

(C) $t_1^3 t_2 = 1$

(D) $(t_1 t_2)^2 - 1 = 0$

10. The length of the tangent drawn from any point on the circle $x^2 + y^2 + 2gx + 2fy + c = 0$ to the circle $x^2 + y^2 + 2gx + 2fy + c' = 0$, is

(A) $(c - c')$ (B) $(c' - c)^{\frac{1}{2}}$

(C) $(c - c')^{\frac{1}{2}}$ (D) $(c^2 + c'^2 - 2cc')^{\frac{1}{2}}$

11. If $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$, then the angle between the vectors $\vec{A}$ and $\vec{B}$ is,

(A) π (B) $\frac{\pi}{2}$

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

12. Three vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ satisfy the condition $\vec{a} + \vec{b} + \vec{c} = \vec{0}$, where $|\vec{a}| = 3$, $|\vec{b}| = 4$, $|\vec{c}| = 2$, then the value of $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}$ is

(A) $\frac{28}{3}$ (B) $-\frac{29}{2}$

(C) $\frac{29}{2}$ (D) $\frac{26}{3}$

13. A particle acted on by constant forces $4\hat{i} + \hat{j} - 3\hat{k}$ and $3\hat{i} + \hat{j} - \hat{k}$ is displaced from the point $\hat{i} + 2\hat{j} + 3\hat{k}$ to the point $5\hat{i} + 4\hat{j} + \hat{k}$, then the work done by the forces is

(A) 36 units (B) 40 units

(C) 42 units (D) 60 units

14. The domain of the function $f(x) = \sin^{-1} \log_2 \left(\frac{x^2}{2}\right)$ is

(A) $[-2, -1] \cup [1, 2]$ (B) $[-\sqrt{2}, -1] \cup [1, 2]$

(C) $[-\sqrt{2}, -1] \cup [1, \sqrt{2}]$ (D) $[-2, -1] \cup [1, \sqrt{2}]$

15. If f'(a) exist then $\lim_{h \to 0} \frac{f(a+h) - f(a-h)}{h}$ is equal to

(A) f(a)
(B) f'(a)
(C) 2f'(a)
(D) f(a) + f'(a)

16. The value of f(π) for which $f(x) = \frac{1-\cos 7(x-\pi)}{x-\pi}$ is continuous is

(A) 7
(B) $\frac{7}{2}$
(C) −7
(D) 0

17. Let f : [a, b] ⟶ ℝ be a continuous function on [a, b] and f is differentiable on (a, b). If f'(x) = 0, for all $x \in (a, b)$, then which of the following is correct ?

(A) f(x) = kx, for some constant k and for all $x \in [a, b]$.
(B) f(x) = constant, for all $x \in [a, b]$.
(C) $f(x) = kx^2$, for some constant k and for all $x \in [a, b]$.
(D) None of the above

18. The function $f(x) = 2\log_e(x-2) - x^2 + 4x + 1$, increases in the interval.

(A) (1, 2)
(B) (2, 3)
(C) (1, 4)
(D) (2, 4)

19. The maximum value of xy subject to the condition 3x + 4y = 5, is

(A) $\frac{26}{48}$
(B) $\frac{25}{48}$
(C) $\frac{24}{48}$
(D) $\frac{23}{48}$

20. If $u = \tan^{-1}\frac{x^3+y^3}{x-y}$, then

(A) $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \sin 2u$
(B) $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \cos 2u$
(C) $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 2\tan u$
(D) $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 2\cot u$

21. If $u(x, y, z) = \log(x^3 + y^3 + z^3 - 3xyz)$, then $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z}$ is equal to

(A) 0

(B) $\frac{1}{x+y+z}$

(C) $\frac{3}{x+y+z}$

(D) $-\frac{3}{(x+y+z)^2}$

22. The value of $\int_{-1}^{1} (|x| + e^{|x|})dx$ is

(A) $2(e-1)$

(B) $2(e+1)$

(C) $2e-1$

(D) $2e+1$

23. If $\int \frac{\cos 4x + 1}{\cot x - \tan x} dx = k \cos 4x + c$, then $k =$

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

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

(C) $\frac{1}{4}$

(D) $-\frac{1}{8}$

24. The value of $\int_{0}^{\pi/2} \frac{dx}{1 + \tan^3 x}$ is

(A) 0

(B) 1

(C) $\frac{\pi}{2}$

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

25. The area in the first quadrant bounded by the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$, is

(A) 2π sq. unit

(B) 3π sq. unit

(C) 4π sq. unit

(D) 5π sq. unit

26. The equation of the curve passing through $\left(\frac{\pi}{2}, 1\right)$ and having slope $\frac{\sin x}{x^2} - \frac{2y}{x}$ at each point (x, y) with $x \neq 0$, is

(A) $-x^2y + \cos x = -\frac{\pi^2}{4}$

(B) $x^2y + \cos x = \frac{\pi^2}{4}$

(C) $x^2y - \sin x = \frac{\pi^2}{4} - 1$

(D) $x^2y + \sin x = \frac{\pi^2}{4} + 1$

27. The transformation $x = e^t$ reduces the differential equation $x^2\frac{d^2}{dx^2}y(x) - 2x\frac{d}{dx}y(x) + 2y(x) = x^3$ to $a\frac{d^2}{dt^2}y(t) + b\frac{d}{dt}y(t) + cy(t) = e^{3t}$, where a, b, c are

(A) $a = 1, b = -3, c = 2$

(B) $a = -1, b = 3, c = -2$

(C) $a = 1, b = 4, c = 3$

(D) $a = -1, b = -3, c = -2$

28. The solution of the differential equation $\frac{dy}{dx} = -\frac{x}{y}$, where $y(4) = 3$ is

(A) a circle

(B) a straight line

(C) an ellipse

(D) a parabola

29. A fair coin is tossed twice. The probability of getting at least one head is

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

(B) $\frac{1}{4}$

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

(D) 1

30. If $P(A) = P(B) = \frac{1}{2}$ and $P(A^c \cap B^c) = \frac{1}{3}$, then the value of $P(A^c \cup B^c)$ is

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

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

(C) 1

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

MATHEMATICS

Category-II (Q 31 to 40)

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

31. Consider two square matrices A and B such that $A^2 = A$ and $A + B = I$, where I is the identity matrix, then which of the following is/are true ?

(A) $B^2 = B$

(B) $AB = \theta$

(C) $BA = \theta$

(D) only (A) and (B) are correct but (C) is false.

Where θ is the null matrix.

32. If the elements of a 3×3 matrix A are polynomial of x and if for $x = a$, three rows become identical then.

(A) $(x - a)$ is a factor of det(A). (B) $(x - a)^2$ is a factor of det(A).

(C) $(x - a)^3$ is a factor of det(A). (D) $(x - a)$ is not a factor of det(A).

33. Suppose Z is a complex number and $\overline{Z}$ is the complex conjugate of Z. Then the values of $|Z|$ satisfying $iZ^2 - \overline{Z} = 0$ are

(A) 0 (B) 1

(C) 2 (D) 3 or 4

34. Which of the following is/are a rectangular hyperbola ?

(A) $xy = c^2$ (B) $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

(C) $\frac{x^2}{b^2} - \frac{y^2}{a^2} = 1$ (D) $x^2 - y^2 = c^2$

35. The value of $\left[\vec{a} \times \vec{b} \quad \vec{b} \times \vec{c} \quad \vec{c} \times \vec{a}\right]$ is

(A) $2\left[\vec{a} \ \vec{b} \ \vec{c}\right]$ (B) $2\left[\vec{a} \ \vec{b} \ \vec{c}\right]^2$

(C) $\left[\vec{a} \ \vec{b} \ \vec{c}\right]^2$ (D) 0 if $\vec{a}, \vec{b}, \vec{c}$ are coplanar.

36. For the function $f : \mathbb{R} \longrightarrow \mathbb{R}$ defined by $f(x) = |x - 1| + |x - 2|$, which of the following is/are correct ?

(A) $f(x)$ is continuous in $\mathbb{R}$.

(B) $f(x)$ is continuous in $\mathbb{R}$ but not derivable in $\mathbb{R}$.

(C) $f(x)$ is continuous in $\mathbb{R}$ but derivable in $\mathbb{R}$ except $x = 1$ and 2.

(D) $f(x)$ is not continuous at $x = 1$ and 2 but derivable in $\mathbb{R}$.

37. For the function $f : \mathbb{R} \longrightarrow \mathbb{R}$, given by $f(x) = x^3 - 6x^2 + 24x + 4$, which of the following is correct ?

(A) $f(x)$ attains only a maximum at $x = 2$.

(B) $f(x)$ attains only a minimum at $x = -1$.

(C) $f(x)$ attains both maximum and minimum at $x = -2$ and $x = -1$, respectively.

(D) $f(x)$ has neither a maximum nor a minimum for any $x \in \mathbb{R}$.

38. $\int_{-\pi}^{\pi} (a \cos x + bx + cx^2)dx$ depends on

(A) only a

(B) only b

(C) only c

(D) only a, c not b

39. The solution(s) of the differential equation $\frac{d^2y}{dx^2} + y = 0$ is (are)

(A) $y = \sin x$

(B) $y = \cos x$

(C) $y = 2 \cos x + 3 \sin x$

(D) $y = -\frac{7}{11} \sin x + \frac{9}{132} \cos x$

40. If A and B are two independent events such that $P(A' \cap B) = \frac{2}{15}$ and $P(A \cap B') = \frac{1}{6}$, then P(B) equal to

(A) $\frac{1}{5}$

(B) $\frac{1}{6}$

(C) $\frac{4}{5}$

(D) $\frac{5}{6}$

PHYSICS

Category-I (Q. 41 to 65)

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

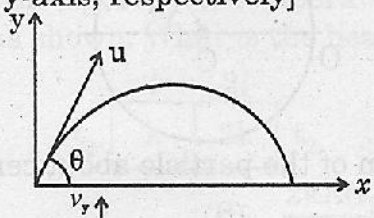
41. If velocity, time and force were chosen as basic quantities, then the dimension of mass will be

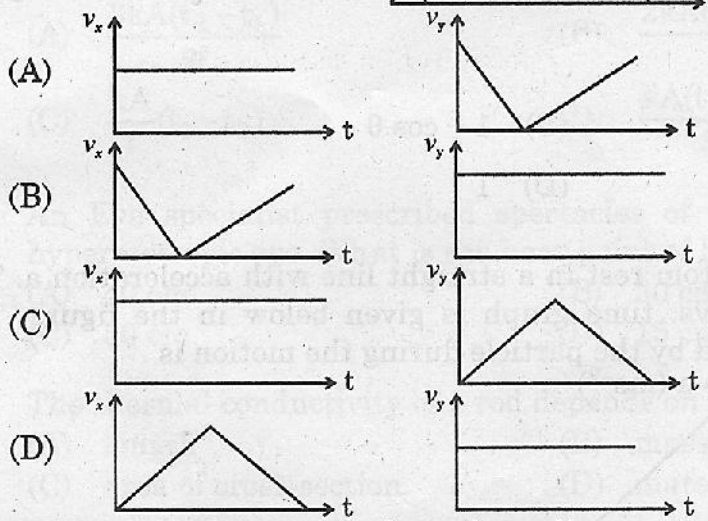
(A) FT^2V^{-2} (B) FTV^{-1}

(C) $F^2T^{-2}V^2$ (D) FTV

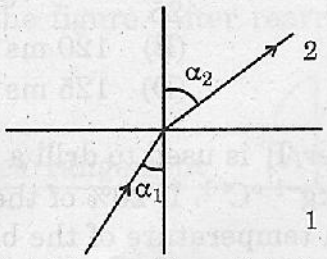
42. A particle is thrown with initial speed u at an angle θ with the horizontal line. It follows a parabolic path as shown in the figure.

Which of the following represents the speed-time graphs [v_x and v_y are the speed along x-axis, and y-axis, respectively]





43. A beam of light moving through medium 1 is refracted in another medium 2 as shown in figure.



If the wavelength of the light in medium 1 is λ_1 and in medium 2 is λ_2 then

(A) $\lambda_1 = \lambda_2$ (B) $\lambda_2 = \frac{\sin\alpha_2}{\sin\alpha_1}\lambda_1$

(C) $\lambda_2 = \frac{\sin\alpha_1}{\sin\alpha_2}\lambda_1$ (D) $\lambda_2 = \frac{\cos\alpha_2}{\cos\alpha_1}\lambda_1$

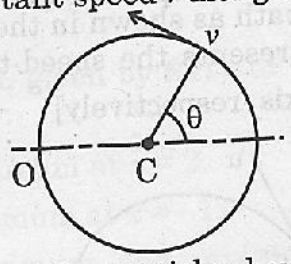
44. A load of 4 kg is suspended from a ceiling through a steel wire of radius 2 mm. The tensile stress developed in the wire when equilibrium is achieved will be

(A) $3.1 \times 10^6\ Nm^{-2}$ (B) $2.8 \times 10^4\ Nm^{-2}$

(C) $6.8 \times 10^8\ Nm^{-2}$ (D) $9.8 \times 10^3\ Nm^{-2}$

(Assume $g = 3.1\pi\ ms^{-2}$)

45. A particle moves with constant speed v along a circle of radius R.

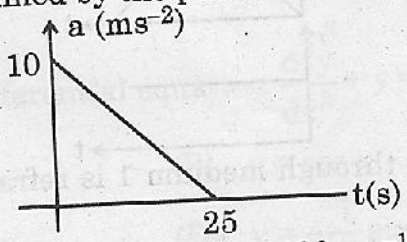


If the angular momentum of the particle about centre C is L_c and about point O is L_o, then $\frac{L_o}{L_c}$ is

(A) $\cos^2\theta$ (B) $1 + \cos\theta$

(C) $\cos^2\frac{\theta}{2}$ (D) 1

46. A particle starts moving from rest in a straight line with acceleration a. The variation of acceleration vs. time graph is given below in the figure. The maximum velocity attained by the particle during the motion is



(A) $225\ ms^{-1}$ (B) $120\ ms^{-1}$

(C) $100\ ms^{-1}$ (D) $125\ ms^{-1}$

47. A drilling machine of power 'P' is used to drill a hole in a metal block of mass 'M' and specific heat 's' J $kg^{-1}\ °C^{-1}$. If 20% of the power is lost due to heating of the machine, the rise in temperature of the block (in °C) in 't' seconds will be

(A) $\frac{0.4\,Pt}{Ms}$ (B) $\frac{0.8\,Pt}{Ms}$

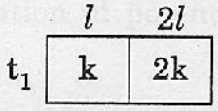
(C) $\frac{0.8\,P}{Ms\,t}$ (D) $\frac{0.2\,Pt}{Ms}$

48. Suppose same liquid is heated in two vessels A and B having coefficient of linear expansion α_A and α_B respectively. If co-efficient of apparent expansion of liquid in two vessels are γ_A^a and γ_B^a and if $\alpha_A > \alpha_B$ then

(A) $\gamma_A^a > \gamma_B^a$ (B) $\gamma_A^a < \gamma_B^a$

(C) $\gamma_A^a = \gamma_B^a$ (D) None of these

49. A metal rod consists of two parts of equal cross-section A, but length of one is l and that of the other is $2l$ and their thermal conductivities are respectively k and 2k, as shown in the figure. The temperatures at the two ends of the rod and t_1 and t_2 ($t_1 > t_2$) as shown. What is the heat current at the steady state ?



(A) $\frac{3kA(t_2 - t_1)}{2l}$ (B) $\frac{2kA(t_1 - t_2)}{l}$

(C) $\frac{kA}{l}(t_1 - t_2)$ (D) $\frac{kA(t_1 - t_2)}{3l}$

50. An Eye specialist prescribed spectacles of power +1.5 D to a patient of hypermetropic eye. What is the near point of his defective eye ?

(A) 40 cm (B) 30 cm

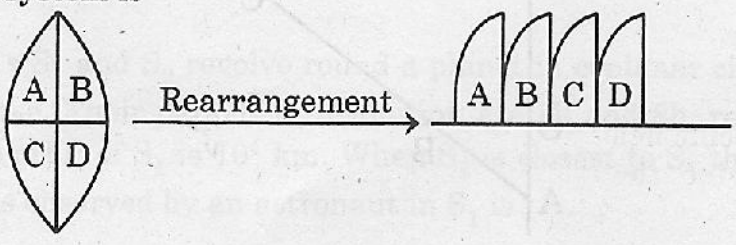
(C) 50 cm (D) 15 cm

51. The thermal conductivity of a rod depends on

(A) length (B) mass

(C) area of cross-section (D) material of the rod

52. An equiconvex lens of focal length f is broken into four parts and then re-arranged as shown in the figure. After rearrangement, the equivalent focal length lens system is



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

(C) $\frac{f}{4}$ (D) 4f

53. The first law of thermodynamics is a statement of

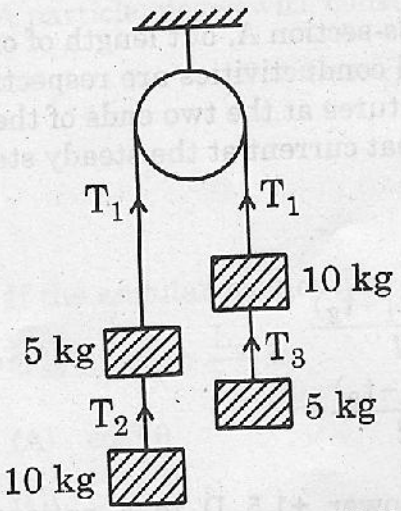
(A) conservation of heat

(B) conservation of work

(C) conservation of momentum

(D) conservation of energy

54.



In the above figure all the strings are massless and pulley is frictionless. Which of the following statement(s) is/are correct ?

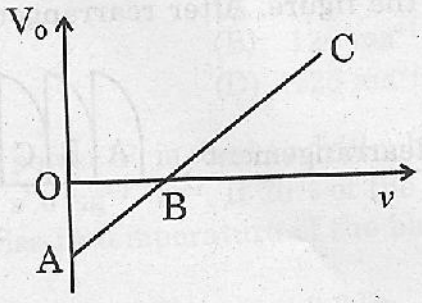
(A) $T_1 > T_2 > T_3$

(B) $T_1 < T_2 < T_3$

(C) $T_1 = T_3 = T_2$

(D) $T_2 > T_3 = T_1$

55. In an experiment on photoelectric effect the stopping potential V_o is plotted against the frequency (ν) of the light incident on a metal surface as shown in the figure. The work function of the surface of the metal is obtained from the



(A) slope of the line AC.

(B) product of the slope of the line AC and charge of the electron.

(C) product of the intercept OA and the charge of the electron.

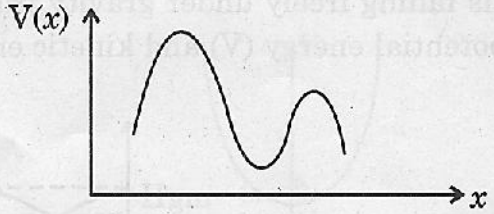
(D) intercept OA.

56. A solid cylinder of height H, radius R and density ρ, floats vertically on the surface of a liquid of density σ. The cylinder will be set into oscillatory motion by applying a small downward instantaneous force on it. The frequency of this small oscillation is

(A) $\omega = \sqrt{\frac{\sigma g}{\rho H}}$ (B) $\omega = \sqrt{\frac{\rho g}{\sigma H}}$

(C) $\omega = \sqrt{\frac{\sigma g}{\rho R}}$ (D) $\omega = \sqrt{\frac{\rho g}{\sigma R}}$

57. The figure shows the variation of potential energy $V(x)$ of a particle with distance x. The particle has



(A) Two equilibrium points, one stable and another unstable.

(B) Two equilibrium points, both stable.

(C) Three equilibrium points, one stable, two unstable.

(D) Three equilibrium points, two stable, one unstable.

58. The radius of the earth is approximately 6400 km. The height at which the acceleration due to gravity differs from g(acceleration due to gravity at the Earth's surface) by approximately 2% is

(A) 62.5 km (B) 63.9 km

(C) 64.2 km (D) 65.3 km

59. Two satellites S_1 and S_2 revolve round a planet in coplanar circular orbits in the same sense. Their periods of revolution are 1h and 8h, respectively. The radius of the orbit of S_1 is 10^4 km. When S_2 is closest to S_1 then the angular speed of S_2 as observed by an astronaut in S_1 is

(A) $\frac{\pi}{2}$ rad/h (B) $\frac{\pi}{4}$ rad h^{-1}

(C) $\frac{\pi}{3}$ rad h^{-1} (D) π rad h^{-1}

60. A man standing on a road has to hold his umbrella at 30° with the vertical to keep the rain away. He throws the umbrella and starts running at 10 km/h. He finds that rain drops are hitting his head vertically. The speed of rain drops with respect to the road (V_{rg}) and the moving man (V_{rm}) are respectively.

(A) $V_{rg} = 20$ km/h, $V_{rm} = 10\sqrt{3}$ km/h

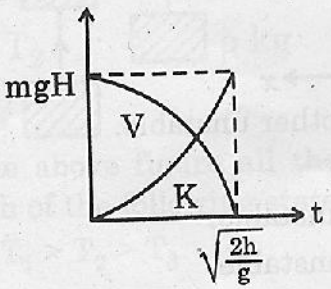
(B) $V_{rg} = 10$ km/h, $V_{rm} = 20$ km/h

(C) $V_{rg} = 10\sqrt{3}$ km/h, $V_{rm} = 20\sqrt{3}$ km/h

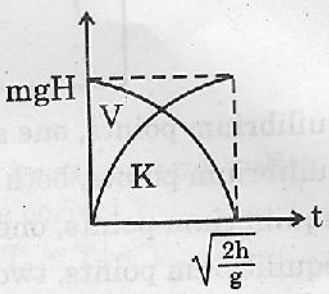
(D) $V_{rg} = 10$ km/h, $V_{rm} = 20\sqrt{3}$ km/h

61. A particle of mass m is falling freely under gravity from height H from rest. The variations of its potential energy (V) and kinetic energy (K) as a function of time (t) is

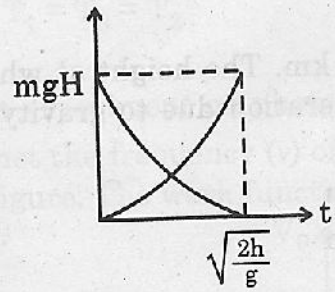
(A)



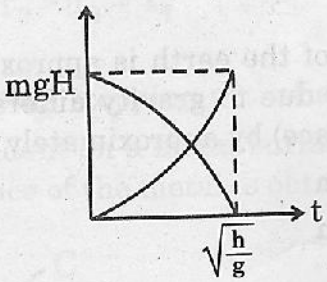
(B)



(C)



(D)



62. A particle is moving in a X-Y plane where X and Y coordinates are time dependent as follows :

$X(t) = At^4 + Bt$ and $Y(t) = Ct^3 + D$

(Here $A = 1.00$ m/s^4, $B = -2.00$ m/s, $C = 2.00$ m/s^3 and $D = 10$ m). The position of the particle at $t = 2$ sec is

(A) $(10\text{ m})\hat{i} + (12\text{ m})\hat{j}$

(B) $(-5\text{ m})\hat{i} + 15\text{ m}\hat{j}$

(C) $(-10\text{ m})\hat{i} + (15\text{ m})\hat{j}$

(D) $(12\text{ m})\hat{i} + (26\text{ m})\hat{j}$

63. A body of mass m is lifted up from the earth surface to a height R. The potential energy of the body with respect to the earth surface is [Assume acceleration due to gravity on earth surface is g_0]

(A) mg_0R (B) $\frac{mg_0R}{2}$

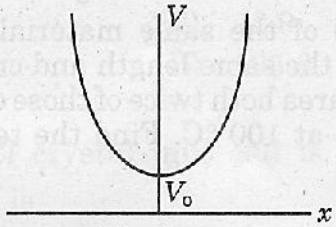
(C) $-\frac{mg_0R}{2}$ (D) $-mg_0R$

64. The mass of the bob of a simple pendulum (amplitude is small enough) is made doubled. Then the time period of the pendulum will be

(A) Doubled (B) Four times of the original one

(C) half of the original one (D) no change of time period

65. The dependence of the potential energy (V) of a particle on its displacement (x) is given in figure



The force (F) acting on the particle is

(A) $F = -kx$

(B) $F = +kx$

(C) $F = -kx^2$

(D) $F = -kx + F_0$, where F_0 is a constant depending on V_0.

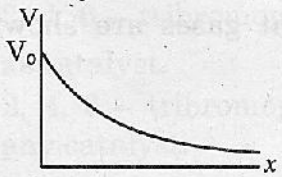
(k is a constant)

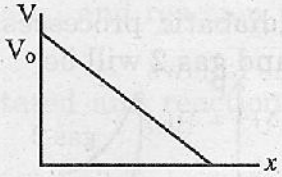
PHYSICS

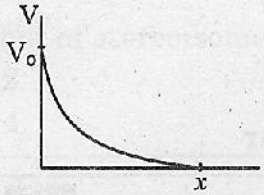
Category-II (Q 66 to 70)

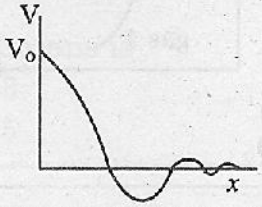
(Carry 2 mark each. One or more options are correct. No negative marks)

66. A particle of mass m is moving along x-axis in a medium where the retarding force is proportional to its velocity. If the particle starts with an initial velocity V_0, then velocity (V) versus displacement (x) curve will look like

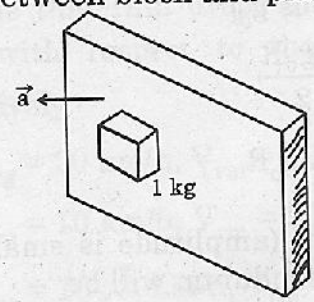
(A)


(B)


(C)


(D)


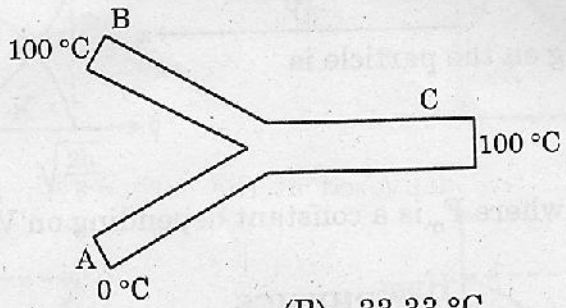
67. A block of mass 1 kg is held stationary against a rough vertical plate due to the acceleration ($\vec{a}$) of the plate, as shown in the figure. The coefficient of friction between block and plate will be



(A) $< \frac{g}{a}$ (B) $> \frac{g}{a}$

(C) $= \frac{g}{a}$ (D) $= \frac{a}{g}$

68. Three rods A, B, C made of the same material are joined as shown in the figure. Rods A and B have the same length and cross sectional area. Rod C has length and cross sectional area both twice of those of rod A. The end of A is kept at 0 °C and those of B and C at 100 °C. Find the temperature at the junction of three rods.



(A) 66.67 °C (B) 33.33 °C

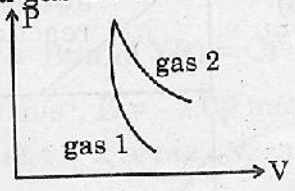
(C) 50 °C (D) 25 °C

69. Eight small water drops of equal radii combine to form a big drop. The ratio of final surface energy to the total initial surface energy is

(A) 1 : 64 (B) 1 : 8

(C) 1 : 2 (D) 1 : 4

70. PV plots of adiabatic processes for two different gases are shown in the figure. Gas 1 and gas 2 will be



(A) He and N_2 (B) N_2 and He

(C) CO_2 and O_2 (D) CO_2 and Ar

CHEMISTRY

Category-I (Q 71 to 85)

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

71. The number of atoms in 52 gm of 'He' are

(A) 78.299×10^{24} (B) 7.82×10^{23}

(C) 7.829×10^{24} (D) 7.829×10^{22}

72. Which of the following explains the sequence of filling the electrons in different shells ?

(A) Aufbau principle (B) Pauli's exclusion principle

(C) Hund's rule (D) All of these

73. Radius of 1st Bohr orbit of 'H' is 0.529 Å. The most probable radius (in pm) for finding the electron in He^+ is

(A) 0.0265 (B) 52.9

(C) 26.5 (D) 105.8

74. The edge length of NaCl crystal unit cell is 508 pm. If radius of Na^+ is 110 pm, the radius of Cl^- is

(A) 288 pm (B) 398 pm

(C) 144 pm (D) 618 pm

75. How many electrons are delivered at the cathode during electrolysis by a current of 1 A in 10 minutes. (charge of electron = 1.6×10^{-19} C)

(A) 3.75×10^{21} (B) 3.75×10^{20}

(C) 7.50×10^{21} (D) 6.0×10^{23}

76. Phenol is treated with Bromine water : Choose the correct statement.

(A) Ortho-bromophenol is produced as major product.

(B) Para-bromophenol is produced as major product.

(C) 2, 4, 6 – tribromophenol is precipitated and reaction requires $Fe/FeBr_3$ as catalyst.

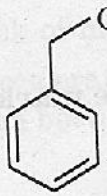
(D) 2, 4, 6 – tribromophenol is precipitated and reaction does not require any catalyst.

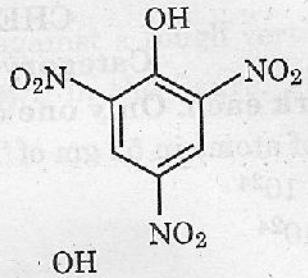
77. Number of stereoisomers of 2, 3-dibromobutane is

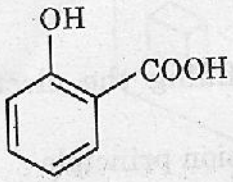
(A) 2 (B) 3

(C) 4 (D) 5

78. Chemical formula of carbolic acid is –

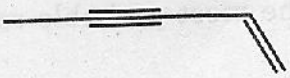
(A) 

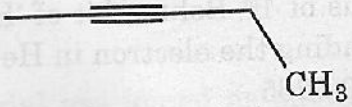
(B) 

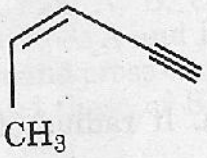
(C) 

(D) 

79. Which of the following compounds will give white precipitate when treated with ammoniacal silver nitrate solution ?

(A) 

(B) 

(C) 

(D) $H_3C - HC = C = CH - CH_3$

80. In the reaction sequence :

$$CaC_2 + H_2O \longrightarrow A \xrightarrow[\text{dil. } H_2SO_4]{HgSO_4} B \xrightarrow{H_2/Ni} C$$

'C' is –

(A) HCHO
(B) CH_3CHO
(C) CH_3OH
(D) C_2H_5OH

81. The solubility of $BaSO_4$ in water is 2.33×10^{-3} gram/litre. Its solubility product will be (Mol. wt. of $BaSO_4$ = 233)

(A) 5.43×10^{-6}
(B) 1×10^{-10}
(C) 1×10^{-5}
(D) 1×10^{-20}

82. What is the hybridization of S in SF_4 ?

(A) sp^3
(B) sp^3d
(C) sp^3d^2
(D) sp^2

83. Phenol is allowed to react with phthalic anhydride in presence of H_2SO_4 and finally the reaction mixture is made alkaline with NaOH. The product formed is –

(A) Alizarin
(B) Methyl orange
(C) Fluorescein
(D) Phenolphthalein

84. Which of the following molecules have one lone pair of electrons ?

(A) SO_2 (B) XeF_2

(C) SiF_4 (D) H_2S

85. Smallest internuclear distance is found in

(A) O_2 (B) O_2^+

(C) O_2^- (D) O_2^{2-}

CHEMISTRY

Category-II (Q 86 to 90)

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

86. Correct statement(s) w.r.t. H_3BO_3 is/are

(A) It is a monobasic acid.

(B) It is a tribasic acid.

(C) It is a strong acid.

(D) It is a strong acid in presence of glycerol.

87. Which of the following species have linear geometry ?

(A) O_3 (B) $N_3^{\ominus}$

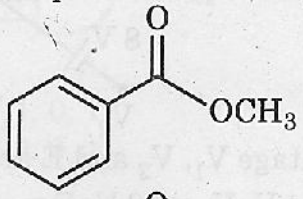
(C) $I_3^{\ominus}$ (D) CO_2

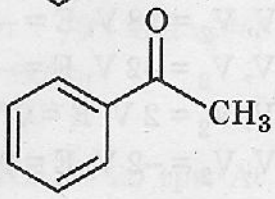
88. Which of the following compounds will liberate hydrogen gas, when reacted with sodium metal ?

(A) Dimethyl ether (B) Methanol

(C) Propanoic acid (D) Methyl propanoate

89. Which of the following compounds will give positive iodoform test ?

(A) CH_3OH (B) 

(C) CH_3CH_2OH (D) 

90. An organic saturated alcohol is optically active. Its IUPAC nomenclature may be

(A) 2-butanol (B) 2-methyl-2-butanol

(C) 3-methyl-2-butanol (D) 3-pentanol

Fundamentals of Electrical & Electronics Engineering

Category-I (Q 91 to 100)

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

91. The cross-sectional area of the coil of a PMMC instrument with a spring constant of 0.28×10^{-6} Nm/rad is 7.2×10^{-4} m^2. The air gap flux density is 3.6 m Wb/m^2. The number of turns required to produce a deflection of 60° when a current of 10 mA flows through the coil would be

(A) 136 (B) 44

(C) 22 (D) 11

92. The leakage flux in a transformer depends on

(A) applied voltage (B) load current

(C) frequency (D) mutual flux

93. A single phase IM with identical main and auxiliary windings can be made self-starting by connecting.

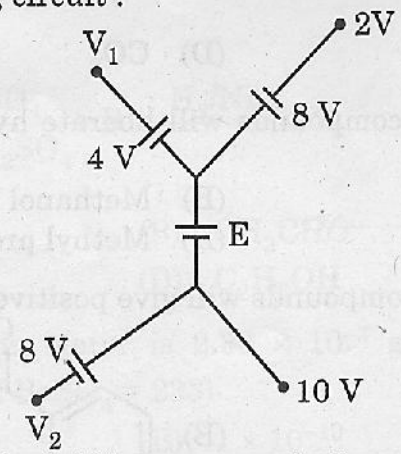
(A) a capacitor in series with the main winding.

(B) a capacitor in series with the auxiliary winding.

(C) a capacitor across the supply terminals.

(D) the main and auxiliary winding in series.

94. Consider the following circuit :



The node voltage V_1, V_2 and E are respectively :

(A) $V_1 = -14$ V, $V_2 = 18$ V, $E = -2$ V

(B) $V_1 = +14$ V, $V_2 = -2$ V, $E = -2$ V

(C) $V_1 = +14$ V, $V_2 = 2$ V, $E = 0$ V

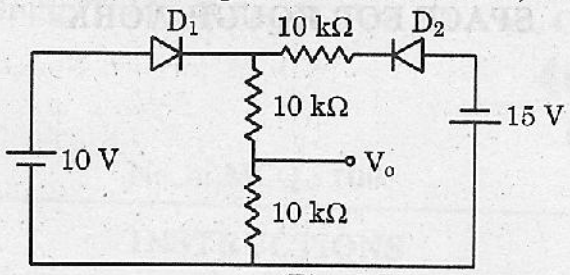
(D) $V_1 = -14$ V, $V_2 = -2$ V, $E = 0$ V

95. The voltage $V = 5 \cos(40\ t + 60°)$, is applied to a 0.5 H inductor. The steady state current through the inductor is

(A) $i(t) = 4 \sin(40\ t + 60°)$A (B) $i(t) = 0.25 \cos(40\ t + 30°)$A

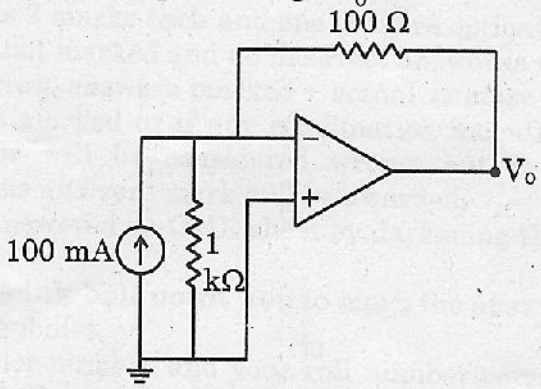
(C) $i(t) = 0.25 \cos(40\ t - 30°)$A (D) $i(t) = 0.25 \cos(wt + 60°)$A

96. Assuming that the diode in the given circuit is ideal, the voltage V_o is



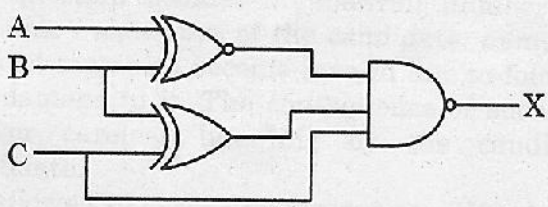
(A) 4 V
(B) 5 V
(C) 7.5 V
(D) 12.1 V

97. In the circuit shown, the output voltage V_o is



(A) −9 V
(B) −10 V
(C) +10 V
(D) +9 V

98. For the logic circuit shown, the required input condition (A, B, C) to make the output X = 0 is ?



(A) 1, 1, 1
(B) 1, 0, 1
(C) 0, 1, 1
(D) 0, 0, 1

99. The phase angle between $v_1 = -10 \cos (wt + 40°)$ and $v_2 = 8 \sin (wt - 20°)$ is

(A) 30°
(B) 60°
(C) −60°
(D) 20°

100. A DC motor develops a torque of 120 Nm at 20 rps. At 30 rps, the torque developed by the motor is

(A) 160 Nm
(B) 120 Nm
(C) 80 Nm
(D) 40 Nm

SPACE FOR ROUGH WORK