SECTION : PHYSICS

This section contains **15 Multiple Choice Questions**. Each question has four choices (1), (2), (3) and (4) out of which **ONLY ONE** is correct.

1. Rain falls vertically at 12 km/h. A man walks at 5 km/h on a horizontal road. The speed of the rain relative to the man is:
(1) 7 km/h
(2) 17 km/h
(3) 13 km/h
(4) 12 km/h

2. The coefficient of friction between a car's tyres and a flat road is 0.9. The maximum speed with which the car can safely turn on a circular path of radius 100 m is:
(1) 20 m/s
(2) 15 m/s
(3) 45 m/s
(4) 30 m/s

3. A force F = 6t N acts on a 3 kg body initially at rest. The work done in the first 2 s is:
(1) 12 J
(2) 24 J
(3) 36 J
(4) 48 J

4. A uniform rod of mass M and length L, pivoted at one end, is released from the horizontal position. Its angular acceleration just after release is:
(1) g/L
(2) 3g/2L
(3) 2g/3L
(4) 3g/L

5. The work needed to raise a 100 kg mass from the Earth's surface to a height equal to Earth's radius R = 6400 km is:
(1) 3.2×10^9 J
(2) 6.4×10^9 J
(3) 1.6×10^9 J
(4) 6.4×10^8 J

6. A Carnot engine works between 500 K and 300 K. If it absorbs 1000 J from the source, the work done per cycle is:
(1) 300 J
(2) 600 J
(3) 400 J
(4) 500 J

7. The length of a simple pendulum is increased by 2%. The time period:
(1) increases by about 1%
(2) increases by about 2%
(3) increases by about 4%
(4) decreases by about 1%

8. Charges +4 μC and +1 μC are 3 m apart. The point on the line joining them where the net field is zero is at a distance from the 4 μC charge of:
(1) 1 m
(2) 1.5 m
(3) 2 m

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(4) 2.4 m

9. A wire of resistance 4 Ω is bent into a circle. The resistance between two diametrically opposite points is:
(1) 2 Ω
(2) 1 Ω
(3) 4 Ω
(4) 0.5 Ω

10. A 2 μF capacitor charged to 100 V is disconnected and connected across an uncharged 3 μF capacitor. The common potential is:
(1) 60 V
(2) 40 V
(3) 50 V
(4) 100 V

11. A 6 Ω and a 3 Ω resistor in parallel are connected in series with a 4 Ω resistor. The equivalent resistance is:
(1) 13 Ω
(2) 9 Ω
(3) 4.5 Ω
(4) 6 Ω

12. Two long parallel wires 0.1 m apart carry 10 A and 5 A in the same direction. The force per unit length between them is:
(1) 10^{-4} N/m
(2) 10^{-5} N/m
(3) 2×10^{-4} N/m
(4) 10^{-3} N/m

13. The current through a 2 H inductor changes from 5 A to 1 A in 0.2 s. The magnitude of the induced emf is:
(1) 10 V
(2) 40 V
(3) 20 V
(4) 80 V

14. A coin lies at the bottom of a 12 cm deep water tank (μ = 4/3). Viewed from directly above, it appears at a depth of:
(1) 9 cm
(2) 16 cm
(3) 12 cm
(4) 8 cm

15. A radioactive sample has a half-life of 10 days. The time taken for 87.5% of it to decay is:
(1) 20 days
(2) 40 days
(3) 30 days
(4) 70 days

SECTION : CHEMISTRY

This section contains **15 Multiple Choice Questions**. Each question has four choices (1), (2), (3) and (4) out of which **ONLY ONE** is correct.

16. 10 g of $CaCO_3$ is treated with 100 mL of 1 M HCl. The volume of CO_2 produced at STP (in mL) is: (Ca = 40, C = 12, O = 16)

(1) 1120
(2) 2240
(3) 560
(4) 1680

17. The ratio of the de Broglie wavelengths of an electron accelerated through 100 V and a proton accelerated through the same potential is

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approximately: (mass of proton ≈ 1836 × mass of electron)

(1) 1836 : 1
(2) 43 : 1
(3) 1 : 43
(4) 1 : 1836

18. Which of the following correctly represents the order of second ionisation enthalpy?

(1) Na > Mg > Al
(2) Mg > Na > Al
(3) Na > Al > Mg
(4) Al > Mg > Na

19. Which of the following species has the highest bond order and is also diamagnetic?

(1) O_2^{2-}
(2) N_2
(3) O_2^{+}
(4) B_2

20. A gas deviates most from ideal behaviour at:

(1) High temperature and low pressure
(2) Low temperature and high pressure
(3) High temperature and high pressure
(4) Low temperature and low pressure

21. For a reaction, $\Delta H = +40$ kJ mol^{-1} and $\Delta S = +100$ J K^{-1} mol^{-1}. The reaction becomes spontaneous above approximately:

(1) 300 K
(2) 400 K
(3) 500 K
(4) 4000 K

22. 50 mL of 0.2 M CH_3COOH is mixed with 25 mL of 0.2 M NaOH. If pKa of acetic acid is 4.76, the pH of the resulting solution is:

(1) 4.46
(2) 4.76
(3) 5.06
(4) 9.24

23. In the reaction of $KMnO_4$ with oxalic acid in acidic medium, the number of moles of $KMnO_4$ required to oxidise 1 mole of oxalic acid ($H_2C_2O_4$) is:

(1) 5/2
(2) 2/5
(3) 1/5
(4) 5

24. Propene reacts with HBr in the presence of benzoyl peroxide to give mainly X, whereas without peroxide it gives Y. Which statement is correct?

(1) X is 2-bromopropane via a free radical mechanism
(2) X is 1-bromopropane via a free radical mechanism
(3) Y is 1-bromopropane via an electrophilic mechanism
(4) X and Y are the same product

25. 0.1 m aqueous solution of $K_4[Fe(CN)_6]$ is assumed to dissociate completely. If Kf of water = 1.86 K kg mol^{-1}, the freezing point of the solution is approximately:

(1) −0.186 °C
(2) −0.930 °C
(3) −0.744 °C
(4) −0.372 °C

26. The standard EMF of a cell involving a two-electron

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transfer is 0.46 V at 298 K. The value of ΔG° for the reaction is closest to: ($F = 96500\ C\ mol^{-1}$)

(1) $-44.4\ kJ\ mol^{-1}$
(2) $-88.8\ kJ\ mol^{-1}$
(3) $-22.2\ kJ\ mol^{-1}$
(4) $+88.8\ kJ\ mol^{-1}$

27. A first-order reaction is 75% complete in 40 minutes. The time required for 87.5% completion is:

(1) 50 min
(2) 60 min
(3) 80 min
(4) 120 min

28. The complex $[Co(NH_3)_5Cl]Cl_2$ and its isomer $[Co(NH_3)_5Cl_2]$... Consider the compound $[Co(en)_2Cl_2]^+$. Which statement is correct?

(1) It shows only geometrical isomerism
(2) It shows both geometrical and optical isomerism
(3) It shows only optical isomerism
(4) It shows no isomerism

29. Which of the following alkyl halides will undergo hydrolysis with aqueous KOH fastest by the SN1 mechanism?

(1) CH_3CH_2Br
(2) $(CH_3)_3CBr$
(3) C_6H_5Br
(4) $CH_2=CH-Br$

30. Aniline is treated with $NaNO_2/HCl$ at 0–5 °C to form X, which on treatment with CuCN gives Y. Hydrolysis of Y gives Z. The compound Z is:

(1) Benzamide
(2) Benzoic acid
(3) Phenylacetic acid
(4) Benzylamine

SECTION : MATHEMATICS

This section contains **20 Multiple Choice Questions**. Each question has four choices (1), (2), (3) and (4) out of which **ONLY ONE** is correct.

31. The number of onto functions from the set {1, 2, 3, 4} to the set {a, b, c} is
(1) 24
(2) 36
(3) 72
(4) 81

32. If $z = (\sqrt{3} + i)/2$, then z^{102} is equal to
(1) i
(2) 1
(3) −i
(4) −1

33. If α and β are the roots of $x^2 - x - 1 = 0$, then $\alpha^6 + \beta^6$ is equal to
(1) 11
(2) 18
(3) 29
(4) 7

34. Let A be a 3×3 matrix with $|A| = 2$. Then $|adj(adj\ A)|$ is equal to
(1) 4
(2) 8
(3) 16
(4) 32

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35. The value of the determinant $\begin{vmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 4 & 9 \end{vmatrix}$ is
(1) 2
(2) 0
(3) 1
(4) 6

36. The number of 4-digit numbers that can be formed using the digits 1, 2, 3, 4, 5 without repetition and which are divisible by 4 is
(1) 20
(2) 36
(3) 24
(4) 48

37. The coefficient of x^5 in the expansion of $(1 + x)^{21} + (1 + x)^{22} + \ldots + (1 + x)^{30}$ is
(1) ${}^{30}C_6 - {}^{20}C_6$
(2) ${}^{31}C_6 - {}^{21}C_6$
(3) ${}^{31}C_5 - {}^{21}C_5$
(4) ${}^{30}C_5 - {}^{20}C_5$

38. Evaluate the sum of the infinite series:
$$\sum_{n=1}^{\infty} \frac{1}{n(n+1)(n+2)}$$
(1) 1/2
(2) 1/3
(3) 1/6
(4) 1/4

39. Evaluate the limit:
$\lim_{x \to 0} \frac{e^{x^2} - \cos x}{x^2}$
(1) 3/2
(2) 1
(3) 1/2
(4) 2

40. The number of points in R at which $f(x) = |x - 1| + |x - 2| + |x - 3|$ is not differentiable is
(1) 1
(2) 2
(3) 4
(4) 3

41. Evaluate:
$\int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x}\, dx$
(1) $\pi/2$
(2) $\pi/4$
(3) $\pi/3$
(4) 1

42. The area (in square units) of the region bounded by the curves $y = x$ and $y = x^2$ is
(1) 1/3
(2) 1/2
(3) 1/6
(4) 2/3

43. If $y(x)$ is the solution of $dy/dx + y = x$ with $y(0) = 0$, then $y(1)$ is equal to
(1) 0
(2) 1/e
(3) e
(4) $1 - 1/e$

44. The equation of the ellipse with foci at $(\pm 2, 0)$ and eccentricity 1/2 is
(1) $x^2/16 + y^2/12 = 1$
(2) $x^2/12 + y^2/16 = 1$
(3) $x^2/16 + y^2/4 = 1$
(4) $x^2/8 + y^2/4 = 1$

45. The equation of the tangent to the circle $x^2 + y^2 = 25$ at the point (3, 4) is
(1) $3x + 4y = 25$
(2) $4x + 3y = 25$
(3) $3x - 4y = 25$
(4) $3x + 4y = 5$

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46. The distance of the point (1, 2, 3) from the plane $x + 2y + 2z = 3$ is
(1) 3
(2) 11/3
(3) 8/3
(4) 4

47. If $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = 2\hat{i} - \hat{j} + \hat{k}$, then $|\vec{a} \times \vec{b}|$ is equal to
(1) 14
(2) $\sqrt{18}$
(3) $2\sqrt{3}$
(4) $\sqrt{14}$

48. Bag I contains 3 red and 2 blue balls; Bag II contains 2 red and 3 blue balls. A bag is chosen at random and a ball is drawn from it. If the ball is red, the probability that it came from Bag I is
(1) 2/5
(2) 3/5
(3) 1/2
(4) 3/4

49. The variance of the first 10 natural numbers 1, 2, …, 10 is
(1) 9.17
(2) 7.5
(3) 8.5
(4) 8.25

50. The value of $\tan^{-1}(1/2) + \tan^{-1}(1/3)$ is
(1) $\pi/6$
(2) $\pi/3$
(3) $\pi/4$
(4) $\pi/2$

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