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Section-I

1. a
2. a
3. c
4. d. The phenomenon of beats can take place for both longitudinal and transverse waves
5. d. In a cyclic process, the system returns to its initial state. Since internal energy is a state variable, ΔU = 0, for a cyclic process.
6. C
7. d. Linear momentum is not conserved
8. b. The purpose of a waterproofing agent is to alter the surface of a solid such that it starts repelling water. Initially, the surface was getting wet by water as water tends to spread on the surface, because contact angle is acute. If the solid surface (e.g., clothes) are sprayed with a waterproofing agent , then it changes the angle of contact from acute to obtuse. Hence, water tends to be repelled from the surface and beads up on the surface and does not easily penetrate the clothing.
9. b. $\lambda = \hbar\ p = \hbar\ mv$ If the velocity of the electron increases, de Broglie wavelength decreases.
10. c As, $\varepsilon = L\frac{dI}{dt}$

    When $\frac{dI}{dt}$= 1, ε = L
11. b According to Wein's law,

    $\lambda_m T$ = constant

    $\lambda_m \propto T^{-1}$
12. c Change in momentum, $p = pf - pi = -mv - mv = -2mv$ Momentum changes by 2mv in magnitude but kinetic energy remains same.
13. c When Young's double slit experiment is repeated in water,

    instead of air $\lambda' = \frac{\lambda}{\mu}$, i.e., wavelength decreases. $\beta = \frac{\lambda' D}{d}$,

    i.e., fringe width decreases.Therefore, fringe becomes narrower.
14. a. Angular momentum, $L = \frac{nh}{2\pi}$

    As $\frac{n}{2\pi}$ is just a number, thus dimensions of Planck's constant is the same as that of angular momentum.
15. c $[X] = [Force] \times [Density] = [MLT^{-2}] \times [ML^{-3}] = [M^2L^{-2}T^{-2}]$
16. d. $\sigma = \frac{Q}{A} = \frac{1.6\times10-19}{2\times10-6}$= 8 × 10−14
17. d When the total external force acting on the system is zero, the velocity of the centre of mass remains constant.
18. b. $\lim_{x\to\frac{3\pi}{4}} \frac{(1+tanx)}{\frac{1-tan^2x}{1+tan^2x}} = \lim_{x\to 3\pi\ 4} \frac{(1+tan^2x)}{1-tan\ x} = \frac{1+tan^2\frac{3\pi}{4}}{1-tan^2\frac{3\pi}{4}} = 1$
19. B
20. d Angle between lines is π/2. Since, they are line; one horizontal and other is vertical
21. We observe that the possible values of prime numbers when two digits on the dice are added are 2, 3, 5, 7, and 11.

We observe that 2 occurs only once, 3 occurs 2 times, 5 occurs 4 times, 7 occurs 6 times and 11 occurs 2 times.

The number of favourable outcomes is the sum of occurrences of all the favourable outcomes. So, the number of favourable outcomes =1+2+4+6+2=15

We know that the number of possible outcomes is 36. Thus, the probability of getting the sum of two numbers as prime numbers is = 15/36 = 5/12

+	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

22. B
23. C
24. B $A - B = \{x: x \in A \text{ and } x \notin B\} = A \cap B^C$
25. B From the end, $a = 86$, $d = -4$

$T_{19} = a + 18d = 86 - 72 = 14$

26. d Let r be the radius and V be the volume of the sphere.

Then, $V = \frac{4}{3}\pi r^3$

$\frac{dV}{dt} = 4\pi r^2 \frac{dr}{dt}$

$\frac{dr}{dt} = 4\pi r^2 \frac{dr}{dt}$ [$\frac{dV}{dt} = \frac{dr}{dt}$(given)]

$4\pi r^2 = 1$

$r = \frac{1}{2\sqrt{\pi}}$

27. d $f'(x) = 2 - \sin x$

We know, $-1 \le \sin x \le 1$

$f'(x) = 2 - \sin x > 0 \ \forall \ x \in R \Rightarrow f(x)$ is an increasing function for all $x \in$ R

28. . b The two diameters intersect at (8, -2) which is the centre of circle. The circle passes through (6, 2).

∴ Radius = √(8 − 6) 2 + (−2 − 2) 2 = √20

29. c $\lim_{n\to\infty} \frac{1^3+2^3+\cdots+n^3}{n^4} = \lim_{n\to\infty} \frac{\{\frac{n(n+1)}{2}\}^2}{n^4} = \lim_{n\to\infty} \frac{(n+1)^2}{4n^2} = \frac{1}{4}$
30. b Total number of functions from A to B = 2^3 = 8
31. a
32. c Put $y = \tan^{-1} x \Rightarrow dy = \frac{1}{1+x^2} dx$

$I = \int e\ y\ dy = e\ y + c = e^{\tan^{-1} x}$ + c

33. b
34. d We have,

$4 sin 2x - 8 \sin x + 3 \leq 0$

$(2 \sin x - 1)(2 \sin x - 3) < 0$

$2 \sin x - 1 \geq 0$ [∵ $2 \sin x - 3 \leq 0$ for all x]

$\sin x \geq 1\ 2$

$x \in [\pi/6, 5\pi/6]$

35. a We have,

$y = Ax + A^3\ dy\ dx = A$

On eliminating A,

we get, $y = x\ dy.\ dx + (\frac{dy}{dx})^3$

Clearly, it is a differential equation of degree 3.

36. d We have,

$\vec{a} = 8\vec{b}$ and $\vec{c} = -7\vec{b}$

$\vec{a} = -\frac{8}{7}\vec{c}$

$\vec{a}$ and $\vec{c}$ are unlike parallel vectors. Angle between $\vec{a}$ and $\vec{c}$ is π.

37. a
38. b $A^2 - A + 2I = 0$

$A - A^2 = 2I$

$A(I - A) = 2I$

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

$A^{-1} = \frac{1}{2}(I - A)$

39. b CH3COOK is a salt of strong base and weak acid. Its aqueous solution will be basic and pH value will be >7 ≈ 8.8.

Na2CO3 is a salt of strong base and weak acid. Its aqueous solution is also basic and pH value will be >10.

NH4Cl is a salt of weak base and strong acid. So, its aqueous solution will be acidic and pH value will be less than 7.

NaNO3 is the salt of strong acid and strong base. So, its aqueous solution is neutral and pH value will be equal to 7

40. b
41. a Carbon monoxide has a triple covalent bond in which two are normal covalent bonds and one is a dative bond.
42. d Inert gases do not support combustion
43. d Excess of sodium hydroxide reacts with zinc to form sodium zincate along with liberation of hydrogen. 2 NaOH + Zn → $Na_2ZnO_2 + H_2$
44. d In a face-centred cubic (FCC) arrangement, the number of atoms per unit cell is 8.
45. d Normality = Basicity × Molarity = 2 × 0.3 = 0.6 N
46. a
47. b
48. d On warming with silver powder, chloroform is converted into acetylene.

49. A
50. A
51. D
52. D
53. B
54. A
55. C
56. B
57. D
58. A
59. B
60. B

Section-II[2 marks]

61. C
62. D
63. D
64. B
65.) b The given cell is:
    Fe | Fe2+ // Fe3+ | Fe2+
    E 0 = E 0 Fe3+/Fe2+− $E^0_{Fe2+/Fe}$ = 0.771 − (−0.441) = 1.212 V 68)
66. c CaC_2 +H_2O → HC ≡ CH hot iron tube → C_6H_6 CH_3Cl,$AlCl_3$ → $C_6H_5CH_3$ Acetylene Benzene Toluene
67. d Normality = Gram equivalents Volume (in mL) × 1000 Gram equivalents of HCl = 0.1×100 1000 = 0.01
68. No. of gram equivalents of metal carbonate = No. of gram equivalents of HCl ∴ Gram equivalents of metal carbonate = 0.01 Weight Equivalent weight = 0.01 Equivalent weight = 2 0.01 = 200
69. a $\frac{rCH4}{rX}$= 2 = $\sqrt{\frac{MX}{MCH4}}$= $\sqrt{\frac{MX}{16}}$
    $\frac{MX}{16}$ = 4
    MX = 64

70.c
71a

Configuration	Group
$[Ne]3s^2 3p$	IV
$[Ne]3s^2 3p^2$	V
$[Ar]3d^{10} 4s^2 4p^3$	IV
$[Ne]3s^2 3p^1$	III

72. d $C6H5NO2$ $Reduction \rightarrow$ $C6H5NH2$ $CHCl3, alc.KOH \rightarrow$ $C6H5NC$ $H2/catalyst \rightarrow$ $C6H5NHCH3$

73. C

74. B

75. c. $\log x^{y} = \log e^{(x-y)}$

$y \log x = (x - y) \log e$

$y = \frac{logx}{(1=logx)}$

$y \log x - x + y = 0$

$\frac{dy}{dx} = \frac{logx}{(1=logx)^2}$

76. C. S.D. = $\sqrt{\frac{\sum(X-\bar{X})^2}{n}} = \sqrt{\frac{10}{5}} = \sqrt{2}$

77. c Area (A) = 2 ($\frac{1}{2}$. 1.1) = 1 sq. units

78.) b $4\alpha\ 2 + p\alpha - 12 = 0$ --- (i)

$\frac{4\alpha\ 2+3p\alpha-4=0}{\alpha(p-3p)-8=0} \Rightarrow \alpha = -\frac{4}{p}$

From (i), we get, $p = \pm 2$

79.c $\int\ dx = (\tan x - \sec x)\ {}_{0}^{\frac{\pi}{4}} = (1 - \sqrt{2}) - (0 - 1) = 2 - \sqrt{2}$

80.a. Let $y = x(1 - x)^2 = x(1 - 2x + x\ 2\ ) = (x - 2x^2 + {}^{x\,3}\ )$

$y' = 1 - 4x + 3x^2$ and $y'' = -4 + 6x$

For extreme values, $y' = 0 \Rightarrow 3x^2 - 4x + 1 = 0$ $x = 1, 1\ 3$

For $x = 1$,

$y'' = -4 + 6 = 2 > 0$

For $x = 1\ 3$,

$y'' = -4 + 6 \times 1\ 3 = -2 < 0$ (Max) And $x = 1\ 3 \in [0, 2]$ $\therefore$ $y_{max} = 1\ 3\ (1 - 1\ 3\ )^2 = \frac{4}{27}$

81. b

82. a Solving $y = x$ and $y = x + \sin x$,

we have, $x = x + \sin x$

$\sin x = 0$

$x = 0, \pi$

Area = $\int (y1 - y2\ )dx$=2 sq. unts

83. d $|a + \vec{b}\ | = 1$

Squaring: $a\ 2 + 2a\ .\ \vec{b} + b\ 2 = 1$

$2a\ .\ \vec{b} = -1$

Now, $|a - \vec{b}\ |\ 2 = (a - \vec{b}\ )\ 2 = a\ 2 + b\ 2 - 2a\ .\ \vec{b} = 1 + 1 - 2(-1) = 3$ $|a - \vec{b}\ | = \sqrt{3}$

84. d For $2x + 3y = 1$

$y = -\frac{2x}{3} + \frac{1}{3}$

$m = -\frac{2}{3}$ & $c = \frac{1}{3}$

Line touches parabola: $c = \frac{a}{m}$ $\quad a = -\frac{2}{9}$

Length of L.R. = $4a$ = 8/9

85.a $\frac{dx}{dy}$= a cos mx . $m - b$ sin mx . m = $m(a$ cos $mx - b$ sin $mx)$ $\frac{d^2y}{dx^2}$ = m^2 ($-a$ sin $mx - b$ cos mx)

= $-m^2$y

86. c Sum 7 : {(1, 6), (6, 1), (2, 5), (5, 2), (3, 4), (4, 3)} = 6 ways

Sum 11 : {(5, 6), (6, 5)} = 2 ways

Favorable cases = 6 + 2 = 8

Total cases = 6 × 6 = 36 $P(E)$ = $\frac{8}{36}$=$\frac{2}{29}$

87. b $|\vec{a} + \vec{b}|^2 < |\vec{a} - \vec{b}|^2$

$4\vec{a}.\vec{b} < 0$

ab cos θ < 0

cos θ < 0

θ > 90° i.e. obtuse angle.

88. a. Current gain, α = $\frac{Power\ gain}{Voltage\ gain}$= $\frac{800}{840}$= 20 21

β =$\frac{\alpha}{1-\alpha}$ = $\frac{\frac{20}{21}}{1-\frac{20}{21}}$= 20 As, β =$\frac{IC}{IB}$

$IC = \beta IB$ = 20 × 1.2 = 24 mA

89.) d If m is the mass of ice melted,

then Heat spent in melting = Heat supplied by the ball

$mL = Ms\Delta T$

m × 80 = (80 × 1000) × 0.2 × 100 m = 2 × 10^4 g

90.) d Here, n = 25 turns, r = 12 cm,B = 0.5 T

Since the coil is placed in a uniform magnetic field normal to the plane of the coil, the angle between magnetic moment and magnetic field direction is zero i.e., θ = 0°

∴ $\tau = MB$ sin θ = MB sin 0° = 0

91.c Breaking force = Breaking stress × Area of cross section

For a given material of the wire, breaking stress is constant.

∴ $\frac{F1}{A1}$= $\frac{F2}{A2}$

$F2 = F1$ ($A1/4\ A1$) = $F\frac{1}{4}$= $\frac{W}{4}$ [∵ $A = \pi r$ 2]

92.d Here,

Surface tension (S) = 2.5 × 10−2 Nm−1

r = 6 mm = 6 × 10−3 m

Excess pressure inside the soap bubble, P = $\frac{4S}{r}$ = 16.7 Pa

93.) b As reflected light is completely polarized,

therefore, ip = 60°

μ = tan ip = tan 60° = √3

As, μ = $c\ v\ v = c$ μ = 3×108 √3 = √3 × 108 m/s

94.a I =$\frac{E}{R+r}$

For the maximum current from the battery, R = 0 i.e., I = $\frac{E}{r}$ = $\frac{24}{0.8}$ = 30 A

95.) b Here, m = 0.2 kg, v = 5 m/s, h = length of elevator = 5 m

As relative velocity of the bolt w.r.t. elevator is zero, therefore, in the impact, only potential energy of the bolt is converted into heat energy.

Amount of heat produced = Potential energy lost by the bolt = mgh = 0.2 × 10 × 5 = 10 J

96. c

97.) a When a charged capacitor of capacitance C1 is connected in parallel to an uncharged capacitor of capacitance C2, the charge is shared between them till both attain the common potential which is given by:

$V' = \frac{q1+q2}{C1+C2} = \frac{C1V}{C1+C2}$

98.a Applying Kirchhoff's first law at the junction P

$6 = i1 + i2$ --- (1)

Applying Kirchhoff's second law to the closed loop PQRP,

$-2i1 - 2i1 + 2i2 = 0$

$4i1 - 2i2 = 0$ --- (2)

Solving (1) and (2), we get $i1 = 2A$, $i2$ = 4A

99.) d The given transverse harmonic wave equation is:

$y = 3 \sin(36t + 0.018x + \pi/4)$ --- (i)

As there is positive sign between t and x terms, therefore the given wave is travelling in the negative x-direction.

The standard transverse harmonic wave equation is: $y = a \sin(\omega t + kx + \phi)$ --- (ii) Comparing (i) and (ii), we get, $a = 3\ cm$, $\omega = 36\ rad\ s^{-1}$, $k = 0.018\ rad\ cm^{-1}$ Amplitude of the wave, $a = 3$

Frequency of the wave, $= \frac{18}{\pi}$

Velocity of the wave, v =20m/s

100.d Since ranges are same so shell have been fired at complementary angles. Let, they be θ and $90^\circ - \theta$.

$t_1 = \frac{2u \sin\theta}{g}$ and $t_2 = \frac{2u \sin(90-\theta)}{g}$

$t_1 t_2 = 2\ g\ .\ \frac{2u^2 \sin\theta \cos\theta}{g} = \frac{2R}{g}$

..