3S INSTITUTE
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08-April-2023 (Morning Batch) : JEE Main Paper

MATHEMATICS

Section - A (Single Correct Answer)

1. D
2. C
3. A
4. B
5. B
6. C
7. A
8. C
9. A
10. B
11. A
12. A
13. A
14. A
15. C
16. A
17. D
18. A
19. B
20. A

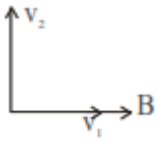
Section - B (Numerical Value)

21. 14
22. 1275
23. 11
24. 31
25. 5
26. 19
27. 2
28. 3
29. 9
30. 25

PHYSICS

Section - A (Single Correct Answer)

31. C

Sol. 

Due to component v_1,
magnetic force $F = qv_1 B \sin\theta = 0$
So v_1 remains unchanged but due to component v_2 magnetic force act towards centre i.e. moving it circular. So path is helical with the axis parallel to magnetic field B.

32. D

Sol. $R_1 = \frac{u_1^2 \sin 2\theta_1}{g}; R_2 = \frac{u_2^2 \sin 2\theta_2}{g}$

$$\frac{R_1}{R_2} = \frac{u_1^2 \sin 2\theta_1}{u_2^2 \sin 2\theta_2} = \frac{40^2 \sin(2\times 30^\circ)}{60^2 \sin(2\times 60^\circ)} = \frac{4}{9}$$

33. B

Sol. Due to motion of the coil eddy current develops thus bringing the coil to rest.

34. B

Sol. $h_T = 98\text{m}$, $h_R = 0$, $R = 6400\text{km}$

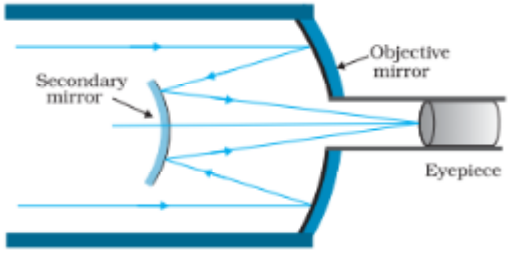
$$d = \sqrt{2h_T \cdot R} + \sqrt{2h_R \cdot R}$$

$$= \sqrt{2\times 98\times 6400\times 10^3} + 0 = \frac{112}{\sqrt{10}}\text{km}$$

So area $= \pi d^2$

$$= 3.14\times\frac{112^2}{10} = 3942\ \text{km}^2$$

35. D

Sol. 

It has advantage of a large focal length in a short telescope

36. D

Sol. **Statement I:** $\Delta Q > 0$

According to 1st law of thermodynamics

$\Delta Q = \Delta U + W$

If $\Delta Q > 0$, $\Delta U < 0$ and $W > 0$ is also possible.

Hence $\Delta T < 0$, so T decreases.

Statement I is false

Statement II: $W > 0$

$\therefore \int Pdv > 0$

Therefore volume of system must increase during positive work done by the system. Statement II is true

37. D

Sol. $W = mg = 400\ N$

At depth d, gravity $g' = g\left(1-\frac{d}{R}\right)$

For $d = \frac{R}{2}$ $g' = g\left(1-\frac{R}{2R}\right) = \frac{g}{2}$

$W' = mg' = \frac{mg}{2} = 200N$

38. A

Sol. $Y = 7 \times 10^{10}\ N/m^2$

$\text{Strain} = \frac{0.04}{100}$

$\text{Energy} = \frac{1}{2}\left(\frac{YA}{l}\right)\Delta x^2$

$\text{Energy} = \frac{1}{2}YA\left(\frac{\Delta x}{l}\right)^2 \times l$

$\frac{E}{V} = \frac{1}{2} \times Y \times \text{strain}^2$

$= \frac{1}{2} \times 7 \times 10^{10} \times \frac{0.04 \times 0.04}{10^4} = 56 \times 10^2$

39. A

Sol. $\vec{v} = 2t\hat{i} + 3t^2\hat{j}$

$\vec{a} = 2\hat{i} + 6t\hat{j}$

at t = 1, $\vec{a} = 2\hat{i} + 6\hat{j}$

$\vec{F} = m\vec{a} = 0.5\left(2\hat{i} + 6\hat{j}\right) = \hat{i} + 3\hat{j}$

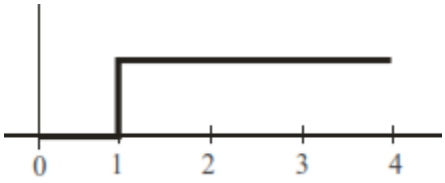
$\vec{F} = \hat{i} + x\hat{j}$ Hence x = 3

40. D

Sol.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

According to truth table, resultant graph is



41. A

Sol. Surface energy per nucleon $\propto \frac{r^2}{A} \propto \frac{A^{2/3}}{A} \propto \frac{1}{A^{1/3}}$

(Mass number $A \propto r^3 \Rightarrow r \propto A^{1/3}$).

A is incorrect

Contribution to binding energy by columbic forces is

$= \frac{-a_2 Z(Z-1)}{A^{1/3}}$

B is incorrect

Volume energy $\propto A$

C is correct

For (D), if we consider only surface energy contribution then option is correct.

For (E) only 3 interactions contribute to surface energy.

42. B

Sol. Energy of satellite in orbit $E = \frac{-GMm}{2R}$

PE of satellite in orbit $U = \frac{-GMm}{R} \Rightarrow U = 2E$

KE of satellite in orbit $K = E - U$

$$K = \frac{GMm}{2R} = (-E)$$

43. C

Sol. $$\frac{1}{\mu_0 \in_0} = c^2 \Rightarrow \left[\frac{1}{\mu_0 \in_0}\right] = \left[c^2\right] = \left[L^2T^{-2}\right]$$

44. B

Sol. At steady state, current in the circuit is

$$i = \frac{4V}{6+2+8} = \frac{1}{4}A$$

Voltage across C_1 is

$$V_1 = V_{AC} = i(6\Omega + 2\Omega) = \frac{1}{4} \times 8 = 2V$$

Voltage across C_2 is

$$V_2 = V_{BD} = i(2\Omega + 8\Omega) = \frac{1}{4} \times 10 = 2.5V$$

$$\Rightarrow \frac{V_1}{V_2} = \frac{2}{2.5} = \frac{4}{5}$$

45. A

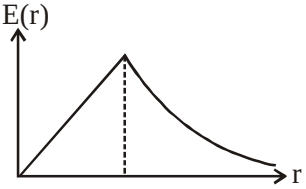
Sol. Electric field of solid sphere (uniformly charged)

$$E(r)\begin{cases} \frac{Q}{4\pi \in_0 r^2} & r \geq R \\ \frac{Qr}{4\pi \in_0 R^3} & r \leq R \end{cases}$$

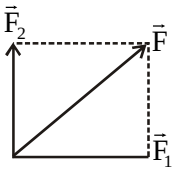
Graphically

$E(r) \propto r$ for $r \leq R$

$\propto \frac{1}{r^2}$ for $r \geq R$



46. D

Sol. 

$$\vec{F} = (\vec{F}_1 + \vec{F}_2)$$

$$|\vec{F}| = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos 90°}$$

$$= \sqrt{A^2 + \frac{A^2}{4}} = \frac{A\sqrt{5}}{2}$$

47. B

Sol. The relative velocity of a passenger with source of sound (engine) is 0. So there will be no doppler's effect. So frequency heard is 400 Hz.

48. A

Sol. $P = P_0 + \rho gh = 10^5$ Pa $+ 10^3 \times 10 \times 40 = 5 \times 10^5$ Pa

At T is constant

$PV = P_0V_0 = 5 \times 10^5$ Pa $\times$ 1 cm^3 $= 10^5$ Pa $\times V_0$

$\Rightarrow V_0 = 5$ cm^3

49. C

Sol. $$\rho = \frac{m}{\pi r^2 l} \Rightarrow \left|\frac{d\rho}{\rho}\right|_{max} = \left|\frac{dm}{m}\right| + 2\left|\frac{dr}{r}\right| + \left|\frac{dl}{l}\right|$$

$$= \frac{0.01}{0.4} + \frac{2(0.03)}{6} + \frac{0.04}{8}$$

$$\Rightarrow \%\text{ error in density} = \left(\frac{d\rho}{\rho}\right) \times 100\%$$

= (2.5 + 1 + 0.5) % = 4%

50. D

Sol. De Broglie wavelength is $\lambda = \frac{h}{mv}$

$$\lambda_p = \lambda_e \Rightarrow m_pv_p = m_ev_e \Rightarrow p_p = p_e$$

Section - B (Numerical Value)

51. 18

Sol. The work done in rotating the electric dipole =

ΔU

$= U_f - U_i$

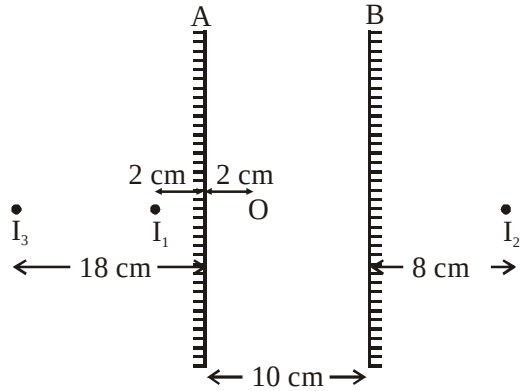
$= (-pE\cos(180°)) - (-pE\cos(0°))$

$= pE + pE = 2pE$

$= 2 \times 6 \times 10^{-6} \times 1.5 \times 10^3 = 18$ mJ

52. 18

Sol.



The desired image is 18 cm from A.

53. 125

Sol. Kinetic energy of body $= \frac{p^2}{2m}$

Initial kinetic energy $= \frac{p_i^2}{2m}$

Final kinetic energy $= \frac{p_f^2}{2m} = \frac{(1.5p_i)^2}{2m}$

$\_\_\_\_\_ = \frac{2.25p_i^2}{2m}$

% increase in KE

$$= \frac{2.25\frac{p_i^2}{2m} - \frac{p_i^2}{2m}}{\frac{p_i^2}{2m}} \times 100 = 125\%$$

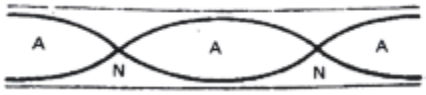
54. A

Sol. The moment of inertia of semicircular ring about axis passing through centre of ring and perpendicular to plane of ring is = MR^2

so x = 1

55. 900

Sol.



For second harmonic of open organ pipe

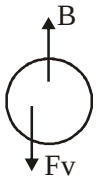
$L = \lambda$

So frequency of vibration is $f = \frac{V}{\lambda}$

$$f = \frac{V}{\lambda} = \frac{V}{L} = \frac{360}{\frac{40}{100}} = 900 \text{ Hz}$$

56. 10

Sol.



Since the bubble is moving at constant speed the force acting on it is zero.

$B = FV$

$$\frac{4}{3}\pi R^2 \rho g = 6\pi\eta Rv$$

$$\eta = \frac{2R^2\rho g}{9v} = \frac{2\times\left(3\times10^{-3}\right)^2\times1750\times10}{9\times0.35\times10^{-2}} = 10 \text{ Pas}$$

57. 9

Sol. Maximum energy stored in capacitor is same as maximum energy stored in inductor.

$$\frac{1}{2}Li_{max}^2 = \frac{1}{2}\frac{Q_{max}^2}{C}$$

$$i_{max} = \sqrt{\frac{1}{LC}}Q_{max}$$

$$= \frac{2.7\times10^{-6}}{\sqrt{75\times10^{-3}\times1.2\times10^{-6}}} = 9\text{mA}$$

58. 2

Sol. $H = \frac{B}{\mu_0} = \frac{\mu_0 ni}{\mu_0} = ni$

$$i = \frac{H}{n} = \frac{1.6\times10^{3}}{\left(\frac{8}{10^{-2}}\right)} = 2A$$

59. 25

Sol. Drift velocity $v_d = \frac{1}{neA}$

$$= \frac{2}{2\times10^{28}\times1.6\times10^{-19}\times25\times10^{-6}} = 25\times10^{-6}\,ms^{-1}$$

60. 121

Sol. Initial binding energy = 242 × 7.6 MeV

Final binding energy = 121 × 8.1 MeV + 121 × 8.1 MeV = 242×8.1 MeV

Total gain in binding energy = 242 (8.1 – 7.6) = 121 MeV

CHEMISTRY

Section - A (Single Correct Answer)

61. D

Sol. Number of atoms of iodine on reactant side = number of atoms of Iodine on product side

2 + x = 6 × 2

X = 10

$$2IO_3^- + 10I^- + 12H^+ \rightarrow 6I_2 + 6H_2O$$

62. B

Sol. Reference : NCERT

63. D

Sol. (A) Saccharin

(B) Aspartame

(C) Alitame

(D) Sucralose

II. First artificial sweetener

IV. Unstable at cooking temperature

I. High potency sweetener

III. Stable at cooking temperature

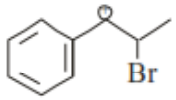
64. B

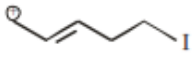
Sol. $\frac{x}{m} = k\,p^{1/n}$

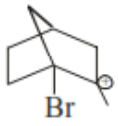
and $\log\frac{x}{m} = \log k + \frac{1}{n}\log P$

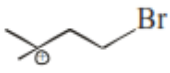
65. B

Sol. Stable is the carbocation, faster will be rate of SN1 reaction

(A)  (Benzylic carbocation)

(B)  (Allylic carbocation)

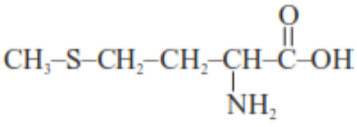
(C)  (Non bridgehead tertiary carbocation)

(D)  (Tertiary carbocation)

66. B

Sol. Sulphur containing amino acids

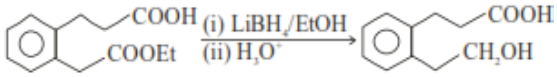
(b) cysteine  and

(d) methionine 

67. D

Sol. $CO + 2H_2 \xrightarrow{Co} CH_3OH$

68. C

Sol. 

$LiBH_4$ can reduce ester selectively but not carboxylic acids.

Hence correct answer is option C.

69. C

Sol. $Co^{+3} = t_2g^6eg^0$

CN^- -strong field ligand

All d-electrons should be paired (μ_s = 0)

Hence diamagnetic.

70. B

Sol. Anode : $\frac{1}{2}H_2(g) \rightleftharpoons H^+(aq) + e^-$

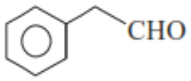
Cathode : $AgCl(s) + e^- \rightarrow Ag(s) + Cl^-(aq)$

71. D

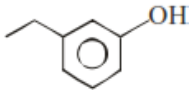
Sol.

A. Alkaline solution of copper sulphate and sodium citrate is known as Benedict's solution and it is used to test aliphatic aldehydes.

Hence it can be used to test compound (III) i.e.



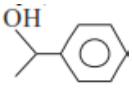
B. Neutral $FeCl_3$ solution is used to test phenolic compound (IV) i.e.



C. Alkaline chloroform solution is used to test primary amines (II) i.e.

D. $2KI + NaOCl + H_2O \rightarrow NaCl + I_2 + 2KOH$

Potassium iodide and sodium hypochlorite gives (I_2 + KOH) which is used to test those compounds which have $CH_3-\overset{O}{\overset{\|}{C}}-$ or $CH_3-\underset{OH}{\underset{|}{CH}}-$ group (iodoform test). Hence the compound is (I)



72. A

Sol. Butan-1-ol ($CH_3CH_2CH_2CH_2OH$) can undergo hydrogen bonding. Ethoxyethane ($CH_3CH_2-O-CH_2CH_3$) has no hydrogen (attached with F, O, N) which can undergo hydrogen bonding.

More is the extent of intermolecular H-bonding, more will be association of molecules. Thus leading to higher boiling point.

Hence both Assertion (A) & Reason(R) are true and (R) is the correct explanation of (A).

73. D

Sol. In CrO_2Cl_2 oxidation state of Cr is +6.

Cr (VI) = $[Ar]^{18}\ 3d^0$

Mn (VII) = $[Ar]^{18}\ 3d^0$

Fe (III) = $[Ar]^{18}\ 3d^5$

Ti (III) = $[Ar]^{18}\ 3d^1$

V (IV) = $[Ar]^{18}\ 3d^1$

Hence Cr (VI) and Mn (VII) have same d^0 configuration.

74. C

Sol. Factual

75. B

Sol.

		Unpaired e^-
$[Fe(CN)_6]^{3-}$	$Fe^{+3} \Rightarrow t_2g^5\ eg^0$,	1
$[Mn(CN)_6]^{3-}$	$Mn^{+3} \Rightarrow t_2g^4\ eg^0$,	2
$[CoF_6]^{3-}$	$Co^{+3} \Rightarrow t_2g^4\ eg^2$,	4
$[MnBr_4]^{2-}$	$Mn^{+2} \Rightarrow e^2\ t_2^3$,	5

Spin magnetic moment $\mu = \sqrt{n(n+2)}$B.M.

76. A

Sol. $2Cu^{2+} + 4I^- \rightarrow Cu_2I_2(s) + I_2$

77. D

Sol. Correct answer

A-III, B-IV, C-I, D-II

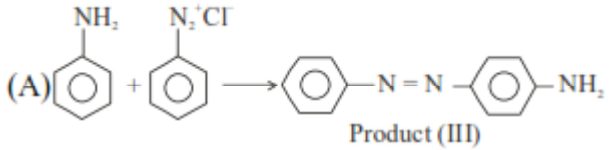
78. D

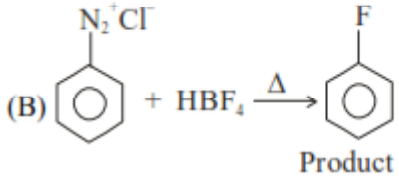
Sol.

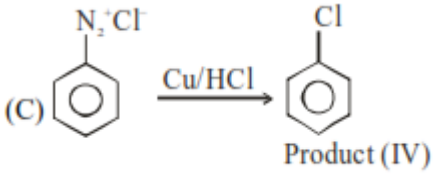
Atom	E.N.
Br	3.0
C	2.5
At	2.2
P	2.1

79. D

Sol.







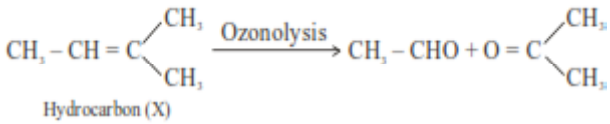
80. C

Sol. Li & Mg form oxide and order of size $Li^+ > Mg^{2+}$

Section - B (Numerical Value)

81. (70)

Sol.



Hence molar mass of hydrocarbon (X) is 70.

82. (3)

Sol. (a), (b) and (c) are factors which affect the percent covalent character of the ionic bond according to Fajan's rule.

83. (1200)

Sol. Power of heater = 60 W

= 60 J/sec

Total energy emitted

= 60 × 100 = 6000 J

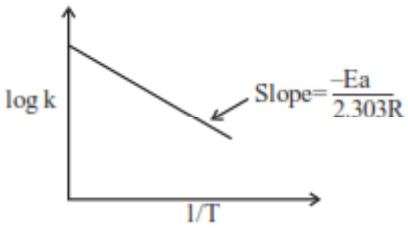
Heat capacity × temp. difference = 6000

$$\text{Heat capacity} = \frac{6000}{5} = 1200\ JK^{-1}$$

84. (2)

Sol. $k = A \cdot e^{-Ea/RT}$

$$\underset{y}{\log k} = \underset{c}{\log A} - \underbrace{\frac{Ea}{2.303R}}_{m} \cdot \underset{x}{\frac{1}{T}}$$



Higher is Ea, stronger is the temperature dependence of k (i.e. steeper the slope)

(B) $$\Rightarrow \frac{1}{k}\frac{dk}{dT} = \frac{Ea}{R}\frac{1}{T^2}$$

$$\Rightarrow \frac{dk}{dT} = A \times e^{-\frac{Ea}{R}} \cdot \frac{Ea}{RT^2}$$

85. (82)

Sol. Boiling point of solvent is 82°C

Boiling point of solution is 83°C

86. (11)

Sol. $XeF_4 + SbF_5 \rightarrow [XeF_3]^+[SbF_6]^-$

m = 3

n = 1

y = 6

z = 1

m + n + y + z = 11

87. (11)

Sol. Percentage of Carbon

$$= \frac{12}{44} \times \frac{\text{mass of } CO_2 \text{ formed}}{\text{mass of compound taken}} \times 100$$

$$60 = \frac{12}{44} \times \frac{\text{mass of } CO_2 \text{ formed}}{0.5} \times 100$$

$$\text{Mass of } CO_2 \text{ formed} = \frac{60 \times 44 \times 0.5}{12 \times 100} g$$

= 1.1 gram

$= 11 \times 10^{-1}$ gram

88. (2)

Sol. (B) $pk_{In} = -\log(4 \times 10^{-10}) = 9.4$

Indicator range

$\Rightarrow pk_{In} \pm 1$

i.e., 8.4 to 10.4

(D) In acidic medium, phenolphthalein is in unionized form and is colourless.

89. (3)

Sol. $P_T V_T = n_T RT$

For CH_4

$2 \times 2 = n_1 RT$

$$\Rightarrow n_1 = \frac{4}{RT}$$

For CO_2

$$\Rightarrow n_2 = \frac{12}{RT}$$

For Ne

$$\Rightarrow n_3 = \frac{12}{RT}$$

$$\Rightarrow n_T = \frac{1}{RT}[4+12+12] = \frac{28}{RT}$$

$$P_T = \frac{28}{RT}\frac{RT}{V_T}$$

$$P_T = \frac{28}{V_T} = 3.11$$

90. (1)

Sol. Statement (B) is incorrect.

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