\[ \begin{align*}
\{u\} &= M^{-1}L^{-2}T^4A^2 \\
\{e\} &= AT; \quad \{a^0\} = L; \quad \{a\} = ML^2T^{-1}; \quad \{c\} = LT^{-1} \\
\{w\} &= \{a^0\} \{a\} \{b\} \{f\} \{c\}\] \\
M^{-1}L^{-2}T^4A^2 &= [AT]^a \{b\} [ML^2T^{-1}]^c \{LT^{-1}\}^d \\
&= Me^cL^{b+2c+d}T^{a-c-d}A^d
\end{align*} \]

Thus, \( u = \frac{e^2a_0}{hc} \)

\[ \begin{align*}
\text{Step 2} \quad & \frac{dp}{p} = 3 \frac{da}{a} x 100 + 2 \frac{db}{b} x 100 + 3 \frac{dc}{c} x 100 + 4 \frac{dd}{d} x 100 \\
& = 3 \times (1) + 2 \times (2) + 3 \times 4 \\
& = 3 + 4 + 3 + 4 = 14 \%
\end{align*} \]

\[ \begin{align*}
\text{Step 3} \quad & \text{We know} \ a = \frac{vdv}{dx}, \ \ \ b \ v^2 = 12x - 3x^2 \\
& \Rightarrow a = 6 - \frac{9x^2}{2} \ \
& 2vdv = 12 - 9x^2 \\
& \text{When} \ a = 1.5 \ \\n& c = 1 \\
& \Rightarrow v^2 = (12)(1) - 3(1)^2 = 9 \\
& \Rightarrow v = 3 \text{ m/s}
\end{align*} \]
4. A constant speed body will experience a centripetal acceleration

\[ a_c = \frac{v^2}{r} \]

5. \[ \mathbf{A} \cdot \mathbf{B} = 0 \Rightarrow \cos \theta = 0 \Rightarrow \theta = 90^\circ \]

6. \[ R = \frac{u^2 \sin 2\theta}{g} \Rightarrow 5\sqrt{3} = \frac{(10)^2 \sin (2\theta)}{10} \]

\[ \sin 2\theta = \frac{\sqrt{3}}{2} \Rightarrow \theta = 30^\circ \text{ or } 60^\circ \]

Now, time of flight in each case will be,

\[ t_1 = \frac{2u \sin 30^\circ}{g} \quad \text{and} \quad t_2 = \frac{2u \sin 60^\circ}{g} \]

\[ \therefore t_2 - t_1 = 2(\sin 60^\circ - \sin 30^\circ) = (\sqrt{3} - 1) \text{ sec} \]

7. \[ \mathbf{a}' = \frac{(-3i + 4j)}{5} \]

\[ \mathbf{v}' = \mathbf{u} + \mathbf{a} \cdot t = (6i - 12j) + \left( \frac{-3i + 4j}{5} \right) t \]

\[ \mathbf{v}' = \left( \frac{30 - 3t}{5} \right)i - \left( \frac{60 - 4t}{5} \right)j \]

We want velocity only along y-axis.

\[ \frac{30 - 3t}{5} = 0 \Rightarrow t = 10 \text{ sec} \]
\[ 150 \times \sin 45^\circ = 50 \cos 45^\circ + f_r \]
\[ f_r = \frac{100}{\sqrt{2}} \, N \]
\[ N = 150 \cos 45^\circ + 50 \sin 45^\circ = \frac{200}{\sqrt{2}} \]
\[ \mu = \frac{f_r}{N} = \frac{1}{2} \]

Total work done in one minute = \((0.5') 72 = 36 \text{ joule} \]

Power = \(\frac{W}{t} = \frac{36}{60} = 0.6 \, \text{W} \)

given \( m_A = m, \quad m_B = 2m \)
\( u_A = u_i, \quad u_B = u_f \)

After collision, from momentum conservation
\[ m(u_i) + 2m(u_f) = 3m \bar{v} \]
\[ \bar{v} = \frac{u_i}{3} + \frac{2}{3} u_f \]

Loss in K.E.
\[ = \frac{1}{2} m v^2 + \frac{1}{2} (2m) v^2 - \frac{1}{2} (3m) \left( \frac{u_i}{3} + \frac{2}{3} u_f \right)^2 \]
\[ = \frac{3}{2} m v^2 - \frac{3}{2} \left( \frac{u_i}{3} + \frac{2}{3} u_f \right)^2 \]
\[ = \frac{2}{3} m v^2 \]
11. Take geometrical centre as origin

\[ c \cdot m = \frac{m \left( \frac{2\pi}{m} \right) - 3m \left( \frac{2\pi}{m} \right)}{m + 3m} \]

Distance = \( \frac{r}{n} \) 

12. From both axes \( xy \) and \( x'y' \), the moment of inertia of disc should be \( I \).

Hence, using perpendicular axis theorem,

\[ I_p = I + I = 2I \]
Using angular momentum conservation

\[ \sum I_1 \omega_1 + \sum I_2 \omega_2 = (\sum I_1 + \sum I_2) \omega \]

\[ \omega = \frac{\sum I_1 \omega_1 + \sum I_2 \omega_2}{\sum I_1 + \sum I_2} \]

The new rotational k.e.

\[ = \frac{1}{2} (\sum I_1 + \sum I_2) \omega^2 = \frac{\left(\sum I_1 \omega_1 + \sum I_2 \omega_2\right)^2}{2 (\sum I_1 + \sum I_2)} \]

Given

\[ \phi \sqrt{A^2 - x^2} = \omega x \]

\[ \omega^2 x^2 = A^2 - x^2 \Rightarrow \omega^2 = \left(\frac{A}{x}\right)^2 - 1 \]

\[ \Rightarrow \omega^2 = 2^2 - 1 \Rightarrow \omega = \sqrt{3} \]

\[ \Rightarrow f = \omega = \frac{\sqrt{3}}{2 \pi} \]

From Kepler's 2nd law \( L_1 = L_2 \)

& since \( r_2 < r_1 \Rightarrow v_2 > v_1 \)

thus, \( K_2 > K_1 \)

At any time only one ribbon will apply the restoring force.

\[ T = 2\pi \sqrt{\frac{m}{k}} \]
17. Using Bernoulli's principle
\[ P_x + \frac{1}{2} \rho v_x^2 = P_y + \frac{1}{2} \rho v_y^2 \]
\[ (P_x - P_y) = \frac{1}{2} \rho (v_y^2 - v_x^2) \]
\[ \frac{\rho g h}{2} = \frac{1}{2} \rho (v_y^2 + v_x^2) \]
\[ v_y^2 = v_x^2 + 2gh = 4 + 2 \times 1000 \times 0.51 \]
\[ v_y = 32 \text{ cm/sec} \]

18. Change in Surface Energy
\[ \Delta T \left( \frac{4\pi}{6} \right) \left( r^2 - r^2 \right) \]
\[ = 24 \pi r^2 T \]

19. \[ P^2 V = \text{Constant} \]
From \[ PV = nRT \]
\[ T^2 V^{-1} = \text{Constant} \]
\[ T_0^2 V_0^{-1} = T^2 (3V_0)^{-1} \Rightarrow T = \sqrt{3} T_0 \]

20. \[ \Delta U = \frac{\sigma}{2} \left( 2xS + \frac{4}{2} x \cdot 3RT \right) - \frac{4}{2} \left( \frac{S}{2} RT \right) \]
\[ = 11RT - 10RT = RT \]
\[ \Delta Q = \Delta U = RT \]
(21) \[ DL = L_1 \alpha_1 \Delta T + L_2 \alpha_2 \Delta T = (L_1 + L_2) \alpha_{eff} \Delta T \]
\[ \alpha_{eff} = \frac{L_1 \alpha_1 + L_2 \alpha_2}{L_1 + L_2} \]

(22) Wood would just sink when

\[ S_{\text{wood}} = S_{\text{benzene}} \]
\[ \frac{880}{(1 + 12 \times 10^{-4} \Delta T)} = \frac{980}{(1 + 15 \times 10^{-4} (T-0))} \]
\[ 880 (1 + 15 \times 10^{-4} T) = 980 (1 + 12 \times 10^{-4} T) \]

\[ T = \frac{250}{3} \degree C \]

(23) \[ P = e \sigma AT^4 \]
Since \( P_1 = P_2 \)
\[ A_1 T_1^4 = A_2 T_2^4 \]
\[ \Rightarrow \frac{A_1}{A_2} = \left( \frac{T_2}{T_1} \right)^4 \]
for spherical surface \( A = 4\pi r^2 \)
\[ \left( \frac{r_1}{r_2} \right)^2 = \left( \frac{T_2}{T_1} \right)^4 \]
\[ \Rightarrow \frac{r_1}{r_2} = \left( \frac{T_2}{T_1} \right)^2 \]

(24) \[ P_t = mL_f \]
\[ L_f = \frac{P_t}{m} \]
\[ R' = \frac{4/3}{f'} = \frac{2(\frac{3}{2} - \frac{4}{3})}{R} \Rightarrow \frac{4}{3f'} = \frac{1}{3R} \Rightarrow f' = \frac{3}{4}R \]

\[ f' = \frac{3}{4}f \]

26. \[ a \quad y \]

27. \[ 2f = f \left( \frac{V + V_c}{V - V_c} \right) \Rightarrow V_c = \frac{V}{3} \]

28. \[ R_{eq} = \frac{0.5 \text{ mV}}{0.1 \text{ mA}} = 5 \Omega \]

We want 0.1 mA current for each volt potential

\[ (0.1) \frac{\text{mA}}{V} = \frac{1}{R_T} \]

\[ R_T = 10000 \]

\[ R_S + R_{eq} = 10000 \Omega \Rightarrow R_S = 9995 \Omega \]
\[ M = \frac{C}{A} \quad \Rightarrow \quad B = \frac{C}{A} (0.6) \quad \text{(i)} \]

From (i) and (ii)
\[ \frac{M}{A} = \frac{4}{2} \times \frac{(0.2)}{(0.6)} \quad \Rightarrow \quad M = \frac{2}{3} \text{A/m} \]

\[ d = 1 \text{ mm} \quad D = 1 \text{ m} \quad \lambda = 500 \text{ nm} \]

Fringe width for central maxima of single slit
\[ \frac{DA}{\lambda} = \frac{1 \times 500 \times 10^{-9}}{1 \times 10^{-3}} = 0.5 \text{ mm} \]

\[ 5 \text{ mm} - \frac{2A}{a} \quad \Rightarrow \quad a = \frac{2A}{5(\text{mm})} = \frac{2 \times 500 \times 10^{-9}}{5 \times 10^{-3}} \]

\[ a = 0.2 \text{ mm} \]

\[ \frac{R}{2} = \frac{X}{100 - x} \quad \text{and} \quad \frac{1}{R} = \frac{X + 2x}{60 - x} \quad \text{(ii)} \]

From (i) and (ii)
\[ x (x + 2x) = (100 - x) (60 - x) \quad \Rightarrow \quad x = 40 \]

\[ \frac{R}{2} = \frac{40}{60} \quad \Rightarrow \quad R = 3 \text{ cm} \]

\[ PV = \frac{P_1 (4V)}{V} \quad \Rightarrow \quad P_1 = \frac{P}{4} \]

\[ PV = \text{Constant} \quad \Rightarrow \quad P_1 V_1^{3/2} = \frac{P_2}{4} (16V)^{3/2} \]

\[ \Rightarrow \quad \frac{P}{4} (4V)^{3/2} = \frac{P_2}{2} (16V)^{3/2} \]

\[ \Rightarrow \quad P_2 = \frac{1}{4} \left( \frac{1}{4} \right)^{3/2} P = \frac{1}{32} P \]
No current through E to B.

\[ V_A - V_D = -4 + 9 = 5 \text{ V} \]

Charge on \( C_2 = \frac{C}{3} V \)

Charge on \( C_4 = 4C V \)

\[ \left[ \frac{q_2}{q_4} = \frac{1}{12} \right] \]
\[ \phi = \frac{Q_{\text{enc}}}{\varepsilon_0} = \frac{\sigma \pi (R^2 - x^2)}{\varepsilon_0} \]

\[ B = \frac{\mu_0 I}{4\pi} \left[ \frac{1}{3} - \frac{1}{2x} + \frac{1}{8} \right] = \frac{\mu_0 I}{4\pi} \left( \frac{2 - 3 + 6}{6x} \right) \]

\[ = \frac{5 \mu_0 I}{24\pi x} \]

\[ \text{Emf} = -\frac{d\phi}{dt} = -\frac{d}{dt} (BA) \]

\[ = -B \frac{d}{dt} (\pi x^2) \]

\[ = -2B\pi x \frac{dx}{dt} = 2 \times (0.025)\pi \times 2 \times 10^{-2} \times 1 \times 10^{-3} \]

\[ \text{Emf} = 11 \times 10^{-6} \text{ V} = 11 \mu \text{V} \]

\[ \text{At resonance } I_0 = \frac{100}{1 \times 10^3} = 0.1 \text{ Amp} \]

Resonance frequency: \[ \omega^2 = 200 \text{ rad/s} \]

\[ X_C = \frac{1}{\omega C} = 2500 \]

\[ V_C = 250 \text{ V} \]

at Resonance: \[ V_C = V_L = 250 \text{ V} \]
\[ \frac{1}{2} L i^2 = \frac{q^2}{2c} \quad i = q \cos \omega t \]

then \[ i' = \omega q \sin \omega t \]

\[ \Rightarrow \quad \frac{1}{2} L (\omega q \sin \omega t)^2 = \left(\frac{q \cos \omega t}{2c}\right)^2 \]

\[ \Rightarrow \quad \omega^2 \tan(\omega t) = \frac{1}{Lc} \quad \therefore \quad \omega = \frac{1}{\sqrt{Lc}} \]

\[ \Rightarrow \quad \tan \omega t = 1 \Rightarrow \omega t = \frac{\pi}{4} \Rightarrow t = \frac{\pi}{4} \sqrt{Lc} \]

\[ \text{given:} \quad \frac{hc}{\lambda_1} - \phi = eV \quad - (i) \]

\[ \frac{hc}{\lambda_2} - \phi = e(3V) \quad - (ii) \]

from the above 2 eqns.

\[ \frac{hc}{\lambda_2} - \phi = 3 \left(\frac{hc}{\lambda_1} - \phi\right) \]

\[ \Rightarrow \quad \phi = \frac{1}{2} \left[ \frac{3hc}{\lambda_1} - \frac{hc}{\lambda_2} \right] \]

for the \[ \lambda_3 \]

\[ eV' = \frac{hc}{\lambda_3} - \phi \]

\[ V' = \frac{hc}{e} \left[ \frac{1}{\lambda_3} - \frac{3}{2\lambda_1} + \frac{1}{2\lambda_2} \right] \]

\[ \text{or} \quad V' = \frac{hc}{e} \left[ \frac{1}{\lambda_3} + \frac{1}{2\lambda_2} - \frac{3}{2\lambda_1} \right] \]
41. The equation \[ N_A = \frac{N_0}{(2)^{80/20}} = \frac{N_0}{16} \]
and \[ N_B = \frac{N_0}{(2)^{80/40}} = \frac{N_0}{4} \]
for delayed nuclei of \( A = \frac{N_0 - N_0}{16} = \frac{15N_0}{16} \)
and \( B = \frac{N_0 - N_0}{4} = \frac{3N_0}{4} \)
their ratio is \[ \frac{15N_0/16}{3N_0/4} = 5/4 \]

42. Energy of light: \( \frac{hc}{\lambda} = \frac{12398}{5800} \approx 2.12 \text{ eV} \)
Only 2nd diode has less energy gap than 2.06 eV
Hence only D2 will be able to detect the light.

43. a) atmosphere absorb some of sun radiation and release in night
b) if a charged particle oscillates with frequency \( f \), then it produces EM wave of same frequency \( f \).

44. Source \rightarrow Transmitter \rightarrow Channel \rightarrow Receiver \rightarrow User
46. Gold has higher reduction potential than iron. Hence, Fe is easily oxidised to Fe^{2+}.

47. Fluoro group causes negative inductive effect increasing ionisation thus 0.1 M difluoroacetic acid has highest electrical conductivity.

\[ \text{F} \quad \text{O} \]
\[ \text{H} \rightarrow \text{C} \rightarrow \text{O} \rightarrow \text{H} \]
\[ \text{F} \]
48. The safest and most common alternative of sugar is aspartame.

49. Plexiglass is commercial name of polymethyl methacrylate. It is used as substitute of glass and making decorative material.

50. Action of alcoholic caustic potash on chloroform and aniline forms a bad smelling compound phenyl isocyanide.

\[ \text{C}_6\text{H}_5\text{NH} + \text{CHCl}_3 + 3\text{KOH} \rightarrow \text{C}_6\text{H}_5\text{NC} + 3\text{KCl} + 3\text{H}_2\text{O} \]

This reaction is called carbamylamine reaction.

51. Addition of HCN is nucleophilic addition. Greater the electron deficiency of carbonyl group higher the rate of reaction. Hence, the order is as

\[ \text{Ph} - \text{C} - \text{Ph} < \text{Ph} - \text{C} - \text{CH}_3 < \text{CH}_3 - \text{C} - \text{CH}_3 < \text{H} - \text{C} - \text{H} \]

52. During dehydration of alcohols to alkenes by heating with conc. H₂SO₄ the initiation step is protonation of alcohol molecule.

53. 3\text{C}_2\text{H}_2 \xrightarrow{\text{Polymerisation}} \text{C}_6\text{H}_6

\[ \Delta H = \text{enthalpy of product} \]
\[ - \text{enthalpy of reactant} \]
\[ = 85 - 3(230) \]
\[ = 85 - 690 \]
\[ = -605 \text{kJ mol}^{-1} \]

54. The correct order of bond angle is as:

\[ \text{H}_2\text{S} < \text{NH}_3 < \text{SiH}_4 < \text{BF}_3 \]
92.6° 107° 109.5° 28° 120°

55. On passing 96500 C silver deposited = 108 g
On passing 9650 C silver will deposit

\[ = \frac{108}{96500} \times 9650 \]
\[ = 10.8 \text{ g} \]

56. rms velocity

\[ \sqrt{\frac{3 \text{RT}}{\text{M}}} \]

\[ \left( \sqrt{\frac{3 \text{RT}}{\text{M}_1}} \right) \text{Al}_2 \]

\[ \frac{303}{32} = \frac{T}{64} \]

\[ T = \frac{303 \times 64}{32} = 606 \text{ K} \]

57. When the number of unpaired electrons is increased, the magnetic moment increases due to the superposition of the magnetic moments of the unpaired electrons.
67. \[ X \xrightarrow{a} Y + Z \]
   \[ a \quad a \quad a \]
   \[ a - x \quad x \quad x \]

   \[ \frac{P}{7} = \frac{P}{(a-x)(a+x)} = \frac{P}{7} \]
   \[ 7a - 7x = a + x \]
   \[ 6a = 8x \]
   \[ x = \frac{6a}{8} = \frac{3a}{4} \]

   \[ K_P = \frac{x^2}{(a-x)(a+x)} \]
   \[ \frac{(3a)^2}{4} \times \frac{P}{(a-3a)(a+3a)} \]
   \[ = \frac{9a^2 \times 4 \times 4 \times P}{16 \times a \times 7a} \]

   \[ K_P = \frac{9P}{7} \]

68. The enthalpy of neutralization of weak acid with strong base is always less than the strong acid with strong base. Therefore, the enthalpy of neutralization of NaOH with CH₃COOH is 55 KJ and with HCl is 57.1 KJ. This is due to that weak acid is not completely dissociated. Hence, some of heat is utilised for complete ionisation of weak acid, i.e. CH₃COOH.

69. The order of a reaction is not a theoretical concept. It is the sum of the powers to which the concentration terms are raised in the rate law expression as observed experimentally.

70. \[ 2-(3-oxobutyl)cyclohexan-1-one \]

71. Common salt and sugar both are soluble in water but common salt dissolves in water but not in alcohol. Hence, alcohol is preferred over water for crystallization of sugar.

72. Molecular solids have low melting points and are poor conductor of heat and electricity.

73. \[ V_a \frac{1}{\sqrt{r}} \quad V_h \alpha \frac{1}{\sqrt{r}} \quad V_n \alpha \frac{1}{\sqrt{r}} \]
   \[ \frac{V_A}{V_B} = 2 \]

   \[ t_A \quad t_B \]
   \[ \frac{2x^2}{2x^2} \quad \frac{1}{4} \quad \frac{1}{8} \]

   \[ t_A = \frac{1}{8} \]

74. Only HF has H-bonding [F – H – F⁻] rest all the molecules have co-ordinate bonds;

75. Isotonic solutions have same molar concentrations

6 g urea/litre = 0.1 M

34.2 g sucrose/litre = 0.1 M

76. \[ 1 \text{MH}_2\text{SO}_4 = 2\text{NH}_2\text{SO}_4 \]

   \[ N_1V_1 = N_2V_2 \]

   \[ 2 \times V_1 = 10 \times 1 \]

   \[ V_1 = \frac{10}{2} = 5 \text{ ml} \]

77. \[ \text{Zn} \quad \rightarrow \quad 2\text{Zn}^{2+} + 2e^- \quad E^* = +0.76V \]

   \[ \text{Ag}_2\text{O} + \text{H}_2\text{O} + 2e^- \quad \rightarrow \quad 2\text{Ag} + 2\text{OH}^- \quad E^* = +0.34V \]

Adding, \[ E^*_{cell} = 0.76 + 0.34 \]

   \[ = 1.10 \text{ V} \]

78. CaCl₂ and MgCl₂ are deliquescent salts and absorb moisture from air to impart hygroscopic nature to crude common salt.

79. Anhydride cannot be used to dry organic matter since it being a strong oxidising agent causes explosions.
80. A mixture of Al powder and Al(NO₃)₃ is known as ‘Ammonal’. It is used in bombs.

81. Since the electronegativity of X in NX₄ decreases from F to I hence, the tendency of N to donate its lone pair of electrons increases and therefore N₂ is the most basic trihalide of nitrogen.

82. In etching of glass, HF reacts with Na₂SiO₃ and CaSiO₃ present in glass to give Na₂SiF₆ and CaSiF₆

{\[
\text{Na}_2\text{SiO}_3 + 6\text{HF} \rightarrow \text{Na}_2\text{SiF}_6 + 3\text{H}_2\text{O}
\]

CaSiO₃ + 6HF \rightarrow CaSiF₆ + 3H₂O

83. PCl₅ is stored in a well stoppered bottle because it reacts with moisture of air.

PCl₅ + 3H₂O \rightarrow H₃PO₃ + 3HCl

84.

\begin{align*}
\text{CH}_3 & \\
\text{CH} - & \text{C} - \text{H} - \\
\text{H} & \text{C} - \text{H} - \\
\text{Cl} & \quad \text{2-Chloro-4,4-dimethylhexane}
\end{align*}

85. 1, 1-Dichloro-1-pentene does not show geometrical isomerism since it has two identical atoms of chlorine on C₁.

86. P – NO₂-C₂H₅-C₂H₅ is the most stable carbocation since electron withdrawing –NO₂ group stabilizes the carbocation by dispersal of the negative charge.

87. Symmetrical alkene i.e. CH₃CH = CHCH₃ gives the same product obeying Markovnikov’s rule and peroxide effect.

88.

\begin{align*}
\text{1,2 - Hydride Shift} & \\
\text{CH}_3 & \\
\text{H} & \quad \text{3-phenylbut-1-ene} \\
\text{CH}_3 & \\
\text{C} - & \text{CH} - \text{CH} - \\
\text{CH} & \quad \text{2-Phenybutan-2-ol}
\end{align*}

89. The order of increasing boiling point is

\begin{align*}
\text{CH₃COCl} < \text{CH₃COOH} < (\text{CH₃CO})₂O < \text{CH₃CONH}₂
\end{align*}
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