EXPLANATIONS

1. If $\tan^{-1} x = \theta$, then $x = \tan\theta, -\frac{\pi}{2} < \theta \frac{\pi}{2}$

$\Rightarrow \sec^2\theta = 1 + \tan^2\theta = 1 + x^2$

$\Rightarrow \sec\theta = \sqrt{1+x^2}$

$\therefore f'(x) = \frac{d}{dx}(\sec(\tan^{-1} x))$

$= \frac{d}{dx}(\sqrt{1+x^2})$

2. $\frac{dy}{dz} = \frac{\frac{d}{dx}(\tan^{-1}x)}{\frac{d}{dx}(\cot^{-1}x)}$

$= \frac{\frac{1}{1+x^2}}{\frac{-1}{1+x^2}} = -1.$

3. $\int \frac{\log x^n}{x} dx = n \int \frac{\log x^n}{x} dx$

$= n \int (\log x)^1 \frac{1}{2x} dx$

$= \frac{n(\log x)^2}{2} + c$

4. $\int_1^e \frac{1+\log_x}{2x} dx = \frac{1}{2}\left[\log x + \frac{(\log x)^2}{2}\right]_1^e.$

5. Required limit $= \frac{d}{dx}(\sin^2 x)$

$= 2 \sin x \cos x.$

$\frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}$ is valid only

if $1 - x^2 > 0$

i.e., if $x^2 < 1$

i.e., if $|x| < 1.$

7. Required area $= \int_1^4 3\sqrt{x}\, dx = 3.\left[\frac{x^{3/2}}{3/2}\right]_1^4$

$= 2(4^{3/2} - 1) = 2(8 - 1) = 14.$

8. Since $\int e^x (f(x) + f'(x)) dx\, e^x = f'(x)$

$\therefore \int e^x\left(\log x + \frac{1}{x}\right) dx = e^x \log x.$

9. $f'(x) = \frac{d}{dx}(x \tan^{-1} x)$

$= \frac{x}{1+x^2} + \tan^{-1} x$

$\Rightarrow f(1) = \frac{1}{1+1} + \tan^{-1} 1 = \frac{1}{2} + \frac{\pi}{4}.$

10. Let $y = \sin^3 x$ and $z = \cos^3 x.$

then $\frac{dy}{dz} = \frac{dy}{dx} \Big/ \frac{dz}{dx}$

$= \frac{3\sin^2 x \cos x}{3\cos^2 x(-\sin x)}$

$= -\tan x.$

11. $\int_1^{\sqrt{3}} \frac{1}{1+x^2} dx = \left[\tan^{-1}x\right]_1^{\sqrt{3}}$

$= \tan^{-1}\sqrt{3} - \tan^{-1} 1$

$= \frac{\pi}{3} - \frac{\pi}{4} = \frac{\pi}{12}.$

12. Substitute $x^2 = t$ and integrate by parts taking t as the first function.

13. $\underset{x\to a^+}{\text{Lt}} \frac{|x-a|}{x-a} = \underset{x\to a^+}{\text{Lt}} \frac{x-a}{x-a} = -1$

$(\because x > a$, therefore $|x - a| = x - a)$

14. $\underset{x\to\infty}{\text{Lt}} \left(1+\frac{3}{x}\right)^x = \underset{t\to 0^+}{\text{Lt}} (1 + 3t)^{1/t}$

$= \underset{3t\to 0^+}{\text{Lt}} [(1 + 3t)^{1/3t}]^3 = e^3.$

15. If the scalar triple product of three non-zero vectors is zero, then the vectors are coplanar.

16. $\hat{i}.(\hat{j}\times\hat{k}) + \hat{j}.\hat{k}\times\hat{i} + \hat{k}.\hat{i}\times\hat{j} = 3[\hat{i}\ \hat{j}\ \hat{k}]$

$= 3(\hat{i}\times\hat{j}.\hat{k})$

$= 3(\hat{k}.\hat{k})$

$= 3.1 = 3$

17. Here $|PF_1| + |PF_2| = 10 > |F_1F_2|$, therefore, locus of P is on ellipse.

18. Length of chord $= 2\sqrt{r^2 - d^2}$

$= 2\sqrt{80 - d^2}$

where d = distance of given line from the centre of the circle.

149. Area of the parallelogram is

$$= \frac{1}{2}|(3\hat{i}+\hat{j}-2\hat{k}) \times (\hat{i}-3\hat{j}+4\hat{k})|.$$

Normals to two perpendicular planes are perpendicular. $\vec{a}\times\vec{b}$ is perpendicular to the plane of $\vec{a}$ and $\vec{b}$ and $\vec{c}\times\vec{d}$ is perpendicular to the plane of $\vec{c}$ and $\vec{d}$.

21. For point circle,

$$\left(\frac{-3}{2}\right)^2 + 2^2 - k = 0$$

(Divide the equation of the circle by 2)

22. Vertices of the triangle are (0, 0) (–2, –2), (–4, – 8).

∴ Required area

$$= \frac{1}{2} \text{ modulus of } \begin{vmatrix} 0 & 0 & 1 \\ -2 & -2 & 1 \\ -4 & -8 & 1 \end{vmatrix} = 4.$$

23. Required moment $= ((1-2)\hat{i} + (2-3)\hat{k}) \times \vec{F}$

$$= (-\hat{i} - \hat{k}) \times \vec{F}.$$

24. $\vec{a} = \vec{b}$ or $\vec{a} = -\vec{b}$.

25. Length of tangent to a circle s = 0, from a point (x_1, y_1) outside $s = \sqrt{S_1}$.

Here, it is $\sqrt{2^2 + (-3)^2 - \frac{1}{2}} = \sqrt{\frac{25}{2}} = \frac{5}{\sqrt{2}}$

26. Equation of common chord of circles $S_1 = 0$ and $S_2 = 0$ is $S_1 - S_2 = 0$.

27. $f(x) = \dfrac{x-3}{3-x} = -1$ for $x \neq 3$.

So, $f(x) = -1 \ \forall\ x \in D_f = R - \{3\}$.

28. Centre of the circles is (1, 2) and therefore every normal passes through (1, 2). Required line is x + y = 3.

29. If the centre is (h, k) then

$$k = h + 1, \text{ and } \sqrt{h^2 + k^2} = \frac{|h - k + 2|}{\sqrt{1^2 + 1^2}}.$$

Solving these equation, we get

$$h = -\frac{1}{2} \text{ and } k = \frac{1}{2}.$$

30. For D_f, $x^2 > 0$ and $\log_{16} x^2 \geq 0$ $x \neq 0$ and $x^2 \geq 16$

$\Rightarrow \quad x^2 \geq 1$

$\Rightarrow \quad |x| \geq 1.$

31. For the domain of the function in reference, we must have

$\sin^2 x > 0.$

$\Rightarrow \quad \sin^2 x \neq 0$

$\Rightarrow \quad \sin \neq 0$

$\Rightarrow \quad x \neq n\pi, n \in I.$

32. $\cos 5° - \sin 25° = \sin 85° - \sin 25°$

$= 2 \cos 55° \sin 30°.$

33. $\tan^2\theta = \sec^2\theta - 1 = \left(x + \frac{1}{4x}\right)^2 - 1$

$= \left(x - \frac{1}{4x}\right)^2$

$\Rightarrow \quad \tan\theta = \pm\left(x - \frac{1}{4x}\right)$

$\Rightarrow \quad \sec\theta + \tan\theta = x + \frac{1}{4x} \pm \left(x - \frac{1}{4x}\right)$

34. Since $[x] \leq x < [x] + 1,$

therefore, $[x] - [x] \leq x - [x] < [x] + 1 - [x]$

$\Rightarrow \quad 0 \leq x - [x] < 1.$

36. $\sec^2\theta + \cos^2\theta = \dfrac{1}{\cos^2\theta} + \cos^2\theta$

$= \left(\cos\theta - \frac{1}{\cos\theta}\right)^2 + 2 > 2.$

37. Only the first alternative is correct for all $z_1, z_2 \in C$

and $\arg z_1 z_2 = \arg z_2 z_1$

$|z_1 + z_2| \leq |z_1| + |z_2|$

and $|z_1 - z_2| \geq \big||z_1| - |z_2|\big|.$

38. Since, 2 is the only even prime, therefore, number of even number is 1.

39. $\cos^2\theta = \dfrac{1}{\sec^2\theta} = \dfrac{1}{1+\tan^2\theta}$

$= \dfrac{1}{1+\frac{9}{16}} = \dfrac{16}{15}$

$\Rightarrow \quad \cos\theta = \frac{4}{5}$ or $\frac{-4}{5}$.

40. $\tan \frac{\pi}{2}$ is not defined.

41. $(-1 + \sqrt{3})^2 + (-1-1\sqrt{-3})^2 = (2\omega)^2 + (2\omega^2)^2$
$= 4(\omega^2 + \omega^4)$
$= 4(\omega^2 + \omega)$
$= 4(-1)$.

42. in = i, –1, – i or i, as n is of any one of the the forms :
4k, 4k + 1, 4k + 2, 4k + 3, where $k \in I$.

43. Since $\tan(\pi + 2) = \tan x$ for all x, therefore, tan x is periodic with period π as π is the smallest positive number to satisfy the property.

44. Since, $\sin\alpha = \sin\beta$ and $\cos\alpha = \cos\beta$
Hence, both α and β lie in the same quadrant and differ by an integral multiple of 2π
i.e. $\alpha - \beta = 2n\pi,\ n \in I$.
$\Rightarrow$ $\alpha = 2n\pi + B$, where $n \in I$.

45. Given $7^{\log_7(x^2-4x+5)} = x - 1$
$\Rightarrow$ $x^2 - 4x + 5 = x - 1$
....$(\because a^{\log_a m} = m, m > 0)$
$\Rightarrow$ $x^2 - 5x + 6 = 0$
$\Rightarrow$ $x = 2, 3$

46. Voltmeter is a device used to measure potential difference and is connected in parallel in the circuit. Since minimum current passes through it, therefore we must connect a high resistance in series with the galvanometer.

47. Even, resistance of galvanometer, G = 100 Ω
Maximum current across the galvanometer, $I_g = 0.01$ A and
current range in ammeterm, I = 10A.
Shunt resistance that should be connected in parallel to convert the galvanometer into an ammeter (S),
$$= \left(\frac{I_g}{I - I_g}\right) \times G$$
$$= \left(\frac{0.01}{10 - 0.01}\right) \times 100$$
$= 0.1\ \Omega$.

48. In an open circuit, no current is drawn from the cell and the potential difference between two electrodes of a galvanic cell, in an open circuit, is called electromotive force of the cell.

49. Magnetic field at centre of circular loop,
$B_0 = 0.50 \times 10^{-4}$ T;
Radius of circular loop,
$r = 12$ cm $= 0.12$ m;
and distance of the point from centre,
$x = 5$ cm $= 0.05$ m.
$\therefore$ Magnetic field at the centre of a currentcarrying circular loop,
$$B_0 = \frac{\mu_0 i}{2r} \qquad ...(i)$$
Magnetic field at an axial point of a circular loop,
$$B = \frac{\mu_0 i r^2}{2(r^2 + x^2)^{3/2}} \qquad ...(ii)$$
Dividing equation (ii) by equation (i), we get
$$\frac{B}{B_0} = \frac{r^3}{(r^2 + x^2)^{3/2}}$$
or $$B = B_0 \times \frac{r^3}{(r^2 + x^2)^{3/2}}$$
$$= 0.50 \times 10^{-4} \times \frac{(0.12)^3}{[(0.12)^2(0.05)^2]^{3/2}}$$
$$= \frac{0.50 \times 10^{-4} \times (0.12)^3}{[0.0169]^{3/2}}$$
$$= 0.50 \times 10^{-4} \times \left(\frac{0.12}{0.13}\right)^3$$
$= 3.9 \times 10^{-5}$ T.

50. Geocentric theory was initially proposed by Ptolemy in which the earth stood still and all the celestial bodies revolved around it. This theory was disproved by Copernicus, who proposed his heliocentric theory in which the sun occupied a central position and is at rest. All the planets including earth revolve around it.

51. Current gain, $\alpha = 0.96$
emitter current, $I_e = 7.2$ mA
Now the current gain,
$$\alpha = 0.96 = \frac{I_c}{I_e} = \frac{I_c}{7.2}$$

or $I_c = 0.96 \times 7.2 = 6.91$ mA

∴ Base current

$$I_b = I_e - I_c = 7.2 - 6.91 = 0.29 \text{ mA.}$$

(where I_c = collector current).

52. Heavy water is rich in protons. When fast moving neutrons have head on collision with The protons of heavy water, they lose their energy and get slow down.

53. Original number of atoms, $N_0 = 2828$; half-life $(t)_{1/2} = 2$ days

and time of decay, t = 1 day.

Number of half-lives $(n) = \dfrac{t}{(t)_{1/2}} = \dfrac{1}{2}$

∴ Number of nuclei left after one day

$$= \left(\frac{1}{2}\right)^{t} \times \text{Original number of atoms}$$

$$= \left(\frac{1}{2}\right)^{1/2} \times 2828 = 2000$$

54. The unit of magnetic field is weber/(metre)^2

In S.I. system, the unit for magnetic field is called tesla

Mathematically, 1 tesla = weber/(metre)^2.

55. Planck's constant,

$$h = \frac{\text{Energy in each photon}}{\text{Frequency of radiation}}$$

∴ Dimensions of Planck's constant

$$= \frac{\text{Dimensions of energy}}{\text{Dimensions of frequency}}$$

$$= \frac{[ML^2T^{-2}]}{[M^0L^0T^{-1}]} = [ML^2T^{-1}].$$

56. Speed of boat in still water, $v_b = 5$ km/hr;

Width of the river = 1 km, and

time taken to cross the river along the shortest possible path = 15 min = $\frac{1}{4}$ hour.

∴ Resultant velocity of the boat = 4 km/hr.

Now, velocity of river $= \sqrt{(5)^2 - (4)^2}$

$$= \sqrt{25 - 16} = 3 \text{ km/hr}$$

57. In both the cases, the initial velocity in the vertical downward direction is zero. Therefore they will hit the ground simultaneously.

58. Separation between marks = d;

Distance between paper and observer,

$D = 50$ m;

Aperture of eye-lens,

$a = 2 \text{ mm} = 2 \times 10^{-3}$ m

and mean wavelength of light,

$\lambda = 5000\text{Å} = 5000 \times 10^{-10}$ m.

The least distance between the marks to be seen separate,

$$d = \frac{1.22\lambda}{\alpha} \times D$$

$$= \frac{1.22 \times (5000 \times 10^{-10})}{2 \times 10^{-3}} \times 50$$

$$= 15.25 \times 10^{-3} \text{ m}$$

$$= 15.25 \text{ cm.}$$

59. Angle of refraction, A = 60, and refractive index, $\mu = 1.5$.

When a ray of light is to emerge grazingly at the second surface of the prism, the angle of incidence at first surface would be limiting angle of incidence.

Also relation for the limiting angle of incidence $(i)_{lim}$, is

$$\sin(i)_{lim} = \sin A\sqrt{\mu^2 - 1} - \cos A$$

$$= \sin 60° \sqrt{1.5)^2 - 1} - \cos 60°$$

$$= \frac{\sqrt{3}}{2} \times 1.18 - \frac{1}{2}$$

$$= 0.4682$$

∴ $(i)_m = 28°$

60. The range of wavelengths of X-rays is 10^{-10} to 10^{-8} m, radio wave greater than 10^{-1}, UV rays 10^{-8} to 4×10^{-7} m and IR rays 7.8×10^{-7} to 10^{-3} m. Therefore radio waves have the maximum wavelength.

61. Curie temperature of iron is the temperature above which, the iron behaves like paramagnetic substance and below which it remains ferromagnetic.

62. Speed of cyclist, v = 4.9 m/s, and radius of circular path, r = 4m.

Coefficient of friction between the cycle tyres and road,

$$\mu = \frac{v^2}{rg} = \frac{(4.9)^2}{4 \times 9.8} = 0.61.$$

63. Mass of body, m = 5kg;

Radius of circle, r = 1 m

and angular velocity, ω = 2 rad/sec

$\therefore$ Centripetal force $= \frac{mv^2}{r} = m\omega^2 r$

$= 5 \times (2)^2 \times 1$

$= 20$ N (where $v = \omega r$)

64. Mass of bullet,

m = 25 g = 0.025 kg

Initial velocity of bullet,

u = 200 m/s;

Final velocity, v = 0 and

distance, s = 5 cm = 0.05 m.

Relation for the accleration,

$$v^2 = u^2 - 2as$$

or $0 = (200)^2 - 2a \times 0.05$

or $a = \frac{(200)^2}{2 \times 0.05}$

$= 400000$ m/sec².

$\therefore$ Average resistance offered by the target,

F = m . a

= 0.025 × 400000

= 10000 N = 10 kN.

65. Power, $P = \frac{\text{Work done}}{\text{Time taken}} = \frac{F.s}{t} = \frac{mas}{t}$

$= \frac{m}{t} \times \frac{v}{t} \times s$

$= \frac{m}{t^2} \times v \times s$

$= \frac{m}{t^2} \times \frac{s}{t} \times s$

$= \frac{ms^2}{t^3}$

Since P and m are constant, therefore $s^2 \propto t^3$

or $s \propto t^{3/2}$

where, s = distance moved by the body in time t.

66. Power of bulb, P = 100W; voltage of bulb, V = 200 V and supply voltage, V_s = 160 V.

Resistance of bulb,

$$R = \frac{V^2}{P} = \frac{(200)^2}{100} = 400\ \Omega$$

$\therefore$ Acutal power consumption,

$$P = \frac{(V_s)^2}{R} = \frac{(160)^2}{400} = 64\ W.$$

67. Capacitances C_1, C_3, C_4, C_5 = 4μF each and capacitance C_2 = 10 μF.

If a battery is connected across A and B, the points b and d are at the same potential (since $C_1 = C_4 = C_3 = C_5$ = 4μF).

Therefore no charge flows through C_2. Thus it has no role in the circuit.

We also know that C_1 and C_5 are in series. Therefore relation for their equivalent capacitance

$$(C') = \frac{C_1 \times C_5}{C_1 + C_5} = \frac{4 \times 4}{4 + 4} = 2\mu F.$$

Similarly C_4 and C_3 are in series. Therefore their equivalent capacitance

$$(C'') = \frac{C_3 \times C_4}{C_3 \times C_4} = \frac{4 \times 4}{4 + 4} = 2\mu F.$$

Now C' and C" are in parallel, therefore effective capacitance between A and B

= C' + C" = 2 + 2 = 4μF.

68. The energy stored in a capacitor is in the form of electrostatic energy. It is actually stored between the plates of the capacitor.

69. As current flows in the direction of flow of positive charge. Similarly electric field exists in the direction of flow of positive charge. Therefore electric field exists in the direction of the flow of current.

70. Initial radius of earth,

$$R_1 = R$$

and final radius of earth,

$$R_2 = R(1 - 0.01) = 0.99\ R.$$

Acceleration due to gravity,

$$g = \frac{GM}{R^2} \propto \frac{1}{R^2}$$

$$\therefore \quad \frac{g_1}{g_2} = \left(\frac{R_2}{R_1}\right)^2 = \left(\frac{0.99R}{R}\right)^2 = 0.98$$

$$\Rightarrow \quad g_2 = \frac{g_1}{0.98} = 1.02\, g_1.$$

Therefore change in gravitational acceleration $= g_2 - g_1 = 1.02\, g_1 - g_2 = 0.02\, g_1 = 2\%$. Positive sign indicates increase.

71. Acceleration due to gravity 'at the equator,

$$g' = g - R\omega^2.$$

Thus if the spinning speed or angular velocity (ω) of earth increases, the value g' will decrease. Therefore weight of the body will decrease.

72. The energy required to raise the satellite to a height h is

$$E_1 = -GMm\left[\frac{1}{R+h} - \frac{1}{R}\right]$$

$$= \frac{GMmh}{R(R+h)} = \frac{gR^2mh}{R(R+h)} = \frac{gmRh}{R+h} \quad \text{...(i)}$$

where, $GM = gR^2$

Since velocity required to put the satellite into the orbit,

$$v = \sqrt{\frac{gR^2}{R+h}}$$

Therefore kinetic energy required to put the satellite into the orbit

$$E_2 = \frac{1}{2}mv^2 = \frac{1}{2}m \times \frac{gR^2}{R+h} \quad \text{...(ii)}$$

Dividing equation (i) by equation (ii), we get

$$\frac{E_1}{E_2} = \frac{\dfrac{gmRh}{R+h}}{\dfrac{1}{2}m \times \dfrac{gR^2}{R+h}} = \frac{2h}{R}$$

or $\quad E_1 : E_2 = 2h : R.$

73. Moment of inertia of a rigid body about a given axis of rotation is the sum of the product of the masses of the various particles and squares of their perpendicular distances from the axis of rotation.

Mathematically, moment of inertia,

$$I = \sum_{i=1}^{n} mr^2$$

Therefore moment of inertia (I) of a body depends upon the distribution of mass from the axis of rotation.

74. Angular velocity of circular disc = ω.

As the man walks towards the centre of the disc, then its moment of inertia decreases. As a result of this, angular velocity of the disc will increase.

75. The first law of thermodynamics states that heat energy supplied to a system is equal to the sum of the increase in internal energy of the system and the external work done by it. Therefore it deals with conservation of energy.

76. Work done is equal to the product of the force and the displacement. Since displacement after one complete oscillation of a simple pendulum is zero, therefore work done is also zero.

77. Equation of sound wave,

$$y = 0.0015 \sin(62.4\, x + 316\, t)$$

The standard equation of the waves is,

$$y = a \sin 2\pi\left[\frac{x}{\lambda} + \frac{t}{T}\right]$$

Comparing the given equation with standard equation, we get

$$\frac{2\pi}{\lambda} = 62.4$$

or $$\lambda = \frac{2\pi}{62.4} = 0.1 \text{ unit.}$$

78. Sound waves are transmitted in the form of longitudinal waves, while light waves travel in the form of transverse waves.

Also, since only transverse waves can exhibit the property of polarisation, therefore sound waves do not exhibit the property of polarisation.

79. Time required for maximum displacement (t) = 0.17 sec. Time period of sinusoidal wave (T) = 4t = 4 × 0.17 = 0.68 sec.

$$\therefore \quad \text{Frequency, } f = \frac{1}{T} = \frac{1}{0.68} = 1.47 \text{ Hz.}$$

80. Equations of standing wave

$$y = a \sin(100t).\cos(0.01x).$$

The standard equation of standing wave

$$y = a \sin(\omega t).\cos(k\, x).$$

Comparing the given equation with standard equation, we get

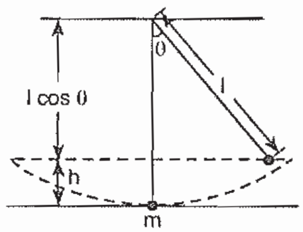
$$\omega = 100 \quad \text{and} \quad k = 0.01.$$

Therefore velocity of standing wave

$$v = \lambda \nu = \frac{2\pi}{k} \times \frac{\omega}{2\pi}$$

$$= \frac{\omega}{k} = \frac{100}{0.01} = 10^4 \text{ m/s.}$$

where, $\lambda = \frac{2\pi}{k}$ and $\nu = \frac{\omega}{2\pi}$

81. 

Length of pendulum = l;

Maximum angular displacement = θ

and mass of bob = m.

Since height of the bob at maximum angular displacement

$$h = l - l\cos\theta$$

$$= l(1 - \cos\theta)$$

At the end of displacement,

kinetic energy of the bob = Potential energy of the bob = mgh = $mgl(1 - \cos\theta)$.

82. Two mirrors on adjacent walls will give three images. And one mirror on the roof will give one image of the objective and three images of the earlier formed images. Therefore total,images will by 7.

83. Focal length of the convex lens,

$f_1 = +40$ cm

and focal length of the concave lens,

$f_2 = -25$ cm (Minus sign due to concave).

The relation for the focal length of the combination (F) is

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$= \frac{1}{40} - \frac{1}{25} = -\frac{3}{200}$$

or $$f = -\frac{200}{3} = -66.7 \text{ cm.}$$

∴ Power of the spectacles

$$P = \frac{100}{f} = \frac{100}{-66.7} = -1.5\text{D}$$

84. The velocity of an electron in an orbit of an atom is inversely proportional to the radius of orbit. Therefore velocity of electron in the innermost orbit of an atom is the highest.

85. Positron has the same mass (9.11×10^{-31} kg) as the electron. The magnitude of charge in both the electron and positron is 1.6×10^{-19} C.

86. $$\underset{\text{(Acetaldehyde)}}{CH_3CHO} + \frac{2[Ag(NH_3)_2]^+ + 3OH^-}{\text{(Tollen's reagent)}} \longrightarrow$$

$$\underset{\text{(Acetate ion)}}{CH_3COO^-} + \underset{\text{(Water)}}{2H_2O} + \underset{\text{(Silvr mirror)}}{2Ag} + \underset{\text{(Ammonia)}}{4NH_3}$$

Thus acetaldehyde reduces Tollen's reagent to silver mirror.

87. Bronsted base strength can be estimated from effective charge on oxygen. The effective charge of oxygen on ClO^-, ClO_2^-, ClO_3^-) and ClO_4^-; are $-1, -\frac{1}{2}, -\frac{1}{3}$ and $-\frac{1}{4}$ respectively.

Also that greater the effective charge, lower will be the stability and greater will be base strength. Since ClO^- has greater effective charge, therefore it is the strongest Bronsted base.

88. $$\underset{\text{(Aldehyde)}}{\text{R}(\text{H})C = O} + \underset{\text{(Hydroxyl amine)}}{H_2N - OH} \longrightarrow \underset{\text{(Aldoxime)}}{\text{R}(\text{H})C = N - OH} + \underset{\text{(Water)}}{H_2O.}$$

Thus in this reaction aldoxime is given out.

89. Half-life ($t_{1/2}$) = 140 days;

Initial quantity of the substance, $N_0 = 16$g

and decayed quantity of substance, $N_1 = 15$g.

We know that mass of the element left after n half-lives, N = 16 – 15 = 1g.

Relation for the number of half-lives (n) is

$$\frac{N_1}{N_0} = \left(\frac{1}{2}\right)^n$$

or $\frac{1}{16} = \left(\frac{1}{2}\right)^n$

or $\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$ or $n = 4$.

∴ Time taken in the disintegration of 15 g of the substance

$= t_{1/2} \times$ Number of half-lives

$= 140 \times 4$

$= 560$ days.

90. Charge of an electron,

$e = -1.6 \times 10^{-19}$ C.

Magnitude of charge of an electron is equal to that of a proton.

Since Li^+ one more proton than the number of electrons, therefore, the value of free charge on Li^+ ion is $+1.6 \times 10^{-19}$C.

91. Atomic number of element is 7. The electrons of element with of atomic number 7 are arranged in shell K, L as 2, 5. The electrons present in the outermost shell of an atom are known as valence electrons and it maximum decides valency of the atom. Since the outer shell (L) contains 5 electrons, therefore its maximum valency is 5.

92. $CaCO_3 \longrightarrow CaO + CO_2$

(Calcium carbonate) (Calcium oxide) (Carbon dioxide)

Molecular weight of $CaCO_3 = 40 + 12 + (3 \times 16)$

$= 100$

And molecular weight of $CaO = 40 + 16$

$= 56.$

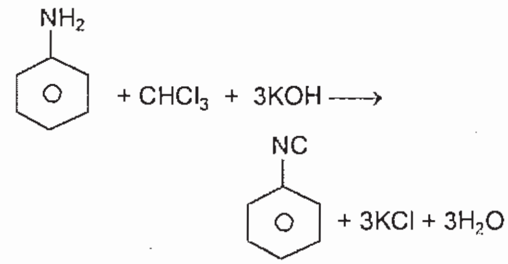
Therefore 100 g of $CaCO_3$ will give 56 g of CaO.

93. Chloramphenicol is an antibiotic, which is effective against a variety of diseases. This can be used for curing typhoid, acute fever, dysentery and certain urine infections.

94. The molecule of vitamin B_{12} has a complex structure with cobalt atom coordinated to 4 nitrogen atoms.

95. Terylene is very strong fibre. It is used for making sails, fabrics and seat belts.

96. When aniline is warmed with chloroform and an alcoholic solution of potassium hydroxide (KOH) it forms phenyl isocyanide, which gives very unpleasant smell. This reaction is called carbylamine reaction.



97. Nitrous oxide is poisonous in nature. When it is inhaled in small quantities, it produces hysterical laugher. That is why, nitrous oxide is known as **laughing gas.**

98. $ZnO + BaO \xrightarrow{1100°C} BaZnO_2$

(Zinc oxide) (Barium oxide) (Barium zincate)

In this reaction, the compound produced is barium zincate ($BaZnO_2$).

99. $2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$

(Zinc blend) (Oxygen) (Zinc oxide) (Sulphur dioxide) ...(i)

And $ZnO + C \longrightarrow Zn + CO$

(Zinc oxide) (Carbon) (Zinc) (Carbon monooxide)

Thus in the metallurgy of zinc, the zinc oxide (ZnO) obtained from roasting, when smelted with carbon C, it gives zinc (Zn) and evolved carbon monoxide (CO). Therefore zinc oxide is removed by the process of smelting.

100. $2CHCl_3 + O_2 \xrightarrow[\text{light}]{\text{Air}} 2COCl_2 + 2HCl$

(Chloroform) (Oxygen) (Carbonyl chloride) (Hydro chloric acid)

In this reaction carbonyl chloride ($COCl_2$) is formed. It is poisonous and commercially known as phosgene.

101. In an isobaric process, heat supplied to the system,

$dQ = nC_pdT.$

And work done by the system,

$dW = nRdT.$

Also, specific heat for diatomic gas at constant pressure,

$C_p = \frac{7}{2}R.$

Therefore ratio of heat supplied to the system and work done by the system

$$\left(\frac{dQ}{dW}\right) = \frac{nC_p dT}{nRdT} = \frac{C_p}{R}$$

$$= \frac{7R/2}{R} = \frac{7}{2}$$

or $dQ : dW = 7 : 2$.

102. Specific heat at constant volume,

$$C_v = \frac{n}{2} R.$$

And specific heat at constant pressure,

$$C_p = \left(1 + \frac{n}{2}\right) R.$$

Degree of freedom for monoatomic gas (n) = 3 and degree of freedom for diatomic gas (n) = 5.

Therefore specific heat of monatomic gas at constant pressure

$$C_{p_1} = \left(1 + \frac{n}{2}\right) R$$

$$= \left(1 + \frac{3}{2}\right) R = \frac{5}{2} R$$

and specific heat of diatomic gas at constant pressure

$$C_{p_2} = \left(1 + \frac{n}{2}\right) R$$

$$= \left(1 + \frac{5}{2}\right) R = \frac{7}{2} R.$$

Similarly, specific heat of monoatomic gas at constant volume,

$$C_{v_1} = \frac{n}{2} R = \frac{3}{2} R$$

and specific heat of diatomic gas constant volume,

$$C_{v_2} = \frac{n}{2} R = \frac{5}{2} R.$$

Since both the gases of equal volume are mixed at same temperature and pressure, therefore specific heat of mixture at constant pressure

$$C_p = C_{p_1} + C_{p_2}$$

$$= \frac{5R}{2} + \frac{7R}{2} = 6R.$$

Similarly specific heat of mixture at constant volume

$$C_v = C_{v_1} + C_{v_2}$$

$$= \frac{3R}{2} + \frac{5R}{2} = 4R.$$

Thus ratio of specific heats

$$= \frac{C_p}{C_v} = \frac{6R}{4R} = 1.5.$$

103. Rate of diffusion of $CH_4 (R_{CH_4}) = 2 \times$ Rate of diffusion of the gas X (R_x).

Graham's law of diffusion states that the rate of diffusion of a gas (R) is inversely proportional to square root of its molecular mass (M).

Also, molecular mass of

$$CH_4 (M_{CH_4}) = 12 + (1 \times 4) = 16.$$

$$\therefore \quad \frac{R_{CH_4}}{R_X} = \sqrt{\frac{M_X}{M_{CH_4}}}$$

or $$\frac{2}{1} = \sqrt{\frac{M_X}{16}} = \frac{\sqrt{M_X}}{4}$$

or $$\sqrt{M_X} = 4 \times 2 = 8$$

or $$M_X = 64.$$

104. Volume of water sample, $V_1 = 100$ ml;

Volume of HCl solution $V_2 = 5$ ml;

Normality of HCl solution $N_2 = 0.09$ N

and molecular weight of $Na_2CO_3 = 106$.

Normality or hardness of the water sample,

$$N_1 = \frac{N_2 \times V_2}{V_1}$$

$$= \frac{0.09 \times 5}{100}$$

$$= 4.5 \times 10^{-3}$$

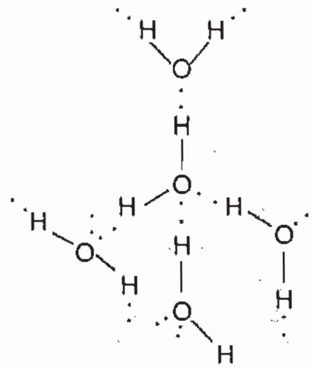
$$= 4.5 \times 10^{-3} \times 1000$$

$$= 4.50 \text{ mg-eq/ltr.}$$

105. The rate of chemical reaction is a function of time (t). When the concentration or pressure during a chemical reaction changes, the rate of chemical reaction also changes.

106. Graphite is the only substance among the given molecules, which has free electrons. That is why, it shows electrical conduction.

107.



Tetrahedral open cage like structure of Ice.

In liquid state, water molecules contain two hydrogen bonds, while in solid state (ice) it contains 4 hydrogen bonds in its one molecule. This happens due to spatial arrangement of atoms of liquid water and solid water viz. ice.

108. The homologue of a compound differ by unit of $-CH_2$ with its molecular formula. Since the given compound is ethylene (C_2H_4), therefore its homologue is $C_2H_4 + CH_2 = C_3H_6$

109. IA and IIA group metals have high oxidation potential due to which their chemical reduction is not possible. Therefore they are extracted by electrolytic reduction.

110. $SiO_2 + 2Mg \xrightarrow{\Delta} Si + 2MgO$

(Silicon oxide) (Magnesium) (Silicon) (Magnesium oxide)

In this reaction silicon is prepared by heating dry powdered silica or silicon oxide with magnesium in laboratory.

111. Element having atomic number 56 has the electronic configuration [Xe] $6s^2$. Thus it is placed in the 6th period of IIA group. And the element is Barium (Ba). As the IIA group elements are known alkaline earth metals, therefore barium (Ba) belongs to alkaline earth metal.

112. Azimuthal quantum number (l) = 3.

For a given value of l, the values of magnetic quantum number (m) are –l – – –, 0, – – + l.

Since the value of l is equal to 3, therefore the values of m will be 0, ±1, ± 2, ± 3.

113. Interatomic distance in hydrogen (H_2) molecule (l_{H_2}) = 74 pm and interatomic distance in chlorine (Cl_2 molecule (l_{Cl_2}) = 198 pm.

Atoms linked by one σ -bond, 2 covalent radius (r) = $\frac{\text{Interatomic distance}}{2}$

Therefore covalent radius of hydrogen,

$$r_H = \frac{l_{H_2}}{2} = \frac{74}{2} = 37 \text{ pm}$$

and that of chlorine $r_{Cl} = \frac{l_{Cl_2}}{2} = \frac{198}{2} = 99$ pm.

As $H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl(g)$

Therefore bond length of HCl molecule (L_{HCl})

$$= r_H + r_{CL}$$
$$= 37 + 99 = 136 \text{ pm}$$

114. The process of heating steel to bright redness and then suddenly cooling by plunging it in oil or water is known as hardening. This process is followed to obtain hard steel.

115. Manganese (Mn^{2+}) ion contains 23 electrons. Therefore its electronic configuration will be $[Ar]^{18}3d^5 4s^0$. Thus the electronic configuration of manganese (Mn^{2+}) ion in its ground state is $3d^5 4s^0$.

116. In ethylene (C_2H_4), carbon atom is sp^2 hybridised, and bond angle between two carbon atoms is 120°. Therefore its molecular shape is square planar.

117. The functional isomers have the same molecular formula but different functional group. The functional isomer of ethanol is dimethyl ether.

$CH_3 - CH_2 - OH$	CH_3-O-CH_3
(C_2H_6O)	(C_2H_6O)
Ethanol	Dimethyl ether

118. Starch gives a blue coloured complex with iodine and this colour serves as the analytical test for iodine. This reaction involves the insertion of iodine molecules in the channel provided by the water soluble portion of starch where they are held by van der Waal's forces. Therefore starch is used as an indicator in the titration of iodine against sodium thiosulphate.

$$I_2 + 2Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + 2NaI$$

119. $4Na + O_2 \xrightarrow{\Delta} 2Na_2O$. and
(Sodium) (Oxygen) (Sodium monoxide)

$2Na + O_2 \xrightarrow{\Delta} Na_2O_2$.
(Sodium) (Oxygen) (Sodium peroxide)

Thus in these reaction 4 moles of sodium forms sodium monoxide (Na_2O) while 2 moles of sodium forms sodium peroxide (Na_2O_2).

120. Diphenyl carbonium ($C_6H_5C\overset{+}{H}C_6H_5$) ion has maximum number of resonating structures. Therefore it is the most stable carbonium ion.

121. $2Cu + H_2O + CO_2 \longrightarrow CuCO_3 .Cu(OH)_2$.
(Copper) (Water) (Carbon dioxide) (Copper carbonate) Copper hydroxide)

In this reaction copper carbonate ($CuCO_3$) and copper hydroxide [$Cu(OH)_2$] are formed which provide green powdery/pasty coating.

122. Carborundum is silicon carbide (SiC). It is used as abrasive for polishing metallic surface.

123. In graphite, the carbon atoms are sp^2-hybridized and each carbon atom is joined to three other carbon atoms by covalent bond and forms flat hexagonal ring.

124. In an atom, the protons are positively charged particles. Since the protons are concentrated at the nucleus, therefore the positive charge of an atom is concentrated at the nucleus.

125. First carbon atom has two π-bonds and it is sp-hybridised. And second carbon atom has one π-bond and it is sp^2-hybridised. Therefore hybridisation of carbons of C—C single bond of $HC \equiv C—CH = CH_2$ is $sp - sp^2$.