1. **(b)**

$$(\vec{v}_{bc})_x = (\vec{v}_b)_x - (\vec{v}_c)_x$$
$$20\cos 60^\circ = (\vec{v}_b)_x - 30$$
$$(\vec{v}_b)_x = 40; (\vec{v}_{bc})_y = (\vec{v}_b)_y - (\vec{v}_c)_y$$
$$20\sin 60^\circ = (\vec{v}_b)_y - 0$$
$$(\vec{v}_b)_y = 10\sqrt{3}; \tan\theta = \frac{(\vec{v}_b)_y}{(\vec{v}_b)_x} = \frac{10\sqrt{3}}{40} = \frac{\sqrt{3}}{4}$$

2. **(b)**

3. **(d)**

4. **(c)** $T = 2\pi\sqrt{\frac{ML^3}{3Yq}}$, writing dimensions of both the sides, we get $[T] = \left[\frac{ML^3}{ML^{-1}T^{-2}q}\right]^{1/2}$ or $q = [L^4]$

5. **(b)** When the mass increases by a factor of 4 the acceleration must decrease by a factor of four if the same force is applied. The question asks about position so we need to relate acceleration and time to position. We can do this by the equation : $x_f - x_i = v_{xi}t + 1/2a_xt^2$ We want the change in position to stay the same. The initial velocity is zero so in order for the change in position to remain constant the term ($1/2$) at ^{2} must remain the same. If the acceleration is reduced by a factor of 4 you can see that the time must be increased by a factor of 2 in order for the term to remain the same.

6. **(d)** For equilibrium of all 3 masses,

$$a = \frac{T_3}{m_1 + m_2 + m_3}$$

For equilibrium of m_1 & m_2

$$T_2 = (m_1 + m_2)\cdot a \text{ or, } T_2 = \frac{(m_1 + m_2)T_3}{m_1 + m_2 + m_3}$$

Given $m_1 = 10$ kg, $m_2 = 6$ kg, $m_3 = 4$ kg,

$$T_3 = 40\text{ N}$$
$$\therefore T_2 = \frac{(10+6)\cdot 40}{10+6+4} = 32\text{ N}$$

7. **(b)**

8. **(a)** $I = \frac{\tau}{\alpha} = \frac{31.4}{4\pi} = \frac{31.4}{4\times 3.14} = 2.5\text{ kg m}^2$.

9. **(a)** Change in force of gravity

$$= \frac{GMm}{R^2} - \frac{G\frac{M}{3}m}{R^2}$$

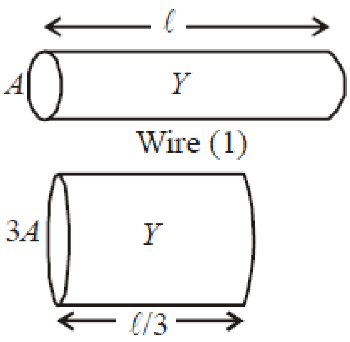
(only due to mass $M/3$ due to shell gravitational field is zero (inside the shell))

$$= \frac{2GMm}{3R^2}$$

10. **(c)** Geo-stationary satellites are also called synchronous satellite. They always remain about the same path on equater, i.e., it has a period of exactly one day (86400sec) So orbit radius $\left(T = 2\pi\sqrt{\frac{r^3}{GM}}\right)$ comes out to be

42400 km, which is nearly equal to the circumference of earth. So height of Geostationary satellite from the earth surface is 42,400 − 6400 = 36,000 km.

11. (c)



Wire (1)

Wire (2)

As shown in the figure, the wires will have the same Young's modulus (same material) and the length of the wire of area of cross section 3A will be $\ell/3$ (same volume as wire 1).

For wire 1, $Y = \frac{F/A}{\Delta x/\ell}$

For wire 2, $Y = \frac{F'/3A}{\Delta x/(\ell/3)}$

From (i) and (ii), $\frac{F}{A} \times \frac{\ell}{\Delta x} = \frac{F'}{3A} \times \frac{\ell}{3\Delta x} \Rightarrow F' = 9F$

12. (c)

$$Y = \frac{F/A}{\Delta\ell/\ell} = \frac{\frac{250\times9.8}{50\times10^{-6}}}{\frac{0.5\times10^{-3}}{2}}$$

$$= \frac{250\times9.8}{50\times10^{-6}} \times \frac{2}{0.5\times10^{-3}} \Rightarrow 19.6 \times 10^{10}\ N/m^2$$

13. (b)

14. (c)

15. (b) By Newton's law of cooling,

$$\frac{\theta_1 - \theta_2}{t} = -k\left[\frac{\theta_1 + \theta_2}{2} - \theta_0\right]$$

A sphere cools from 62°C to 50°C in 10 min.

$$\frac{62 - 50}{10} = -k\left[\frac{62 + 50}{2} - \theta_0\right]$$

Now, sphere cools from 50°C to 42°C in next 10 min.

$$\frac{50 - 42}{10} = -k\left[\frac{50 + 42}{2} - \theta_0\right]$$

Dividing eq ^{n}. (2) by (3) we get,

$$\frac{56 - \theta_0}{46 - \theta_0} = \frac{1.2}{0.8} \text{ or } 0.4\theta_0 = 10.4$$

Hence $\theta_0 = 26°C$

16. (d) As the bubble rises the pressure gets reduced for constant temperature, if P is the standard atmospheric pressure, then $(P+\rho gh)V_0 = PV$

or $V = V_0\left(1+\frac{\rho gh}{P}\right)$

17. (a)

$$\frac{c_2}{c_1} = \sqrt{\frac{400}{300}} = \frac{2}{\sqrt{3}}$$

$$\Rightarrow c_2 = \frac{2}{\sqrt{3}} \times 200 = \frac{400}{\sqrt{3}}\ \mathrm{ms^{-1}}$$

18. (d) In linear S.H.M., the restoring force acting on particle should always be proportional to the displacement of the particle and directed towards the equilibrium position. i.e., $F \propto x$

19. (d) When the spring undergoes displacement in the downward direction it completes one half oscillation while it completes another half oscillation in the upward direction. The total time period is:

$$T = \pi\sqrt{\frac{m}{k}} + \pi\sqrt{\frac{m}{2k}}$$

20. (a) For open pipe, $n = \frac{v}{2\ell}$, where n_0 is the fundamental frequency of open pipe.

$$\therefore\ \ell = \frac{v}{2n} = \frac{330}{2 \times 300} = \frac{11}{20}$$

As freq. of 1 st overtone of open pipe = freq. of 1 st overtone of closed pipe

$$\therefore\ 2\frac{v}{2\ell} = 3\frac{v}{4\ell'} \Rightarrow \ell' = \frac{3\ell}{4} = \frac{3}{4} \times \frac{11}{20}$$
$$= 41.25\ \mathrm{cm}$$

21. (c) Electric field inside the uniformly charged sphere varies linearly, $E = \frac{kQ}{R^3}\cdot r, (r \le R)$, while outside the sphere, it varies as inverse square of distance, $E = \frac{kQ}{r^2}; (r \ge R)$ which is correctly represented in option (c).

22. (c)

23. (b) Potential at any point inside the sphere = potential at the surface of the sphere = 10 V.

24. (c) Capacitance of capacitor (C) $= 6\mu F = 6 \times 10^{-6}$ F; Initial potential $(V_1) = 10$ V and final potential $(V_2) = 20$ V.

The increase in energy (ΔU)

$$= \frac{1}{2}C(V_2^2 - V_1^2)$$
$$= \frac{1}{2} \times (6 \times 10^{-6}) \times [(20)^2 - (10)^2]$$
$$= (3 \times 10^{-6}) \times 300 = 9 \times 10^{-4}\ \mathrm{J}.$$

25. (c) Equivalent resistance

$$= (5 + 10 + 15) \parallel (10 + 20 + 30)$$
$$\text{So, } R_{eq} = \frac{30 \times 60}{30 + 60} = 20\Omega$$

26. (c) By symmetry, the magnetic field at the centre P is zero.

27. (c) Torque, $\tau = \vec{M} \times \vec{B}$

28. (c) Given: $\ell = 1\ \mathrm{m}, B = 5 \times 10^{-3}\ \mathrm{Wb/m^2}$

$$f = \frac{1800}{60} = 30 \text{ rotations /sec}$$

In one rotation, the moving rod of the metal traces a circle of radius $r = \ell$
$\therefore$ Area swept in one rotation $= \pi r^2$

$$\frac{d\phi}{dt} = \frac{d}{dt}(BA) = B.\frac{dA}{dt} = \frac{B\pi r^2}{T}$$
$$= Bf\pi r^2 = (5 \times 10^{-3}) \times 3.14 \times 30 \times 1 = 0.471 \text{ V}$$

29. (c) $Z = \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$

30. (a) Energy density

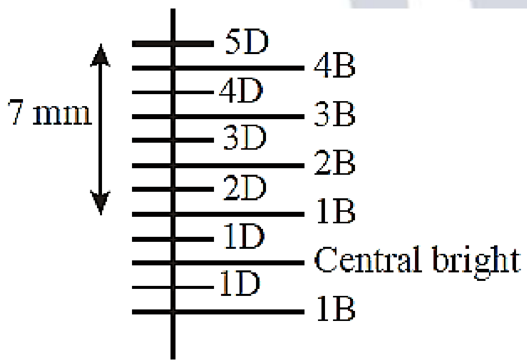
$$= \varepsilon_0 E_{rms}^2 = \varepsilon_0 \left(\frac{E_0}{\sqrt{2}}\right)^2 = \frac{1}{2}\varepsilon_0 E_0^2$$

31. (b)

$$\frac{P_a}{P_1} = \frac{\left(\frac{\mu_g}{\mu_a} - 1\right)}{\left(\frac{\mu_g}{\mu_1} - 1\right)} = \frac{+5}{-100/100} = -5$$
$$-5\left(\frac{\mu_g}{\mu_1} - 1\right) = \frac{\mu_g}{\mu_a} - 1$$
$$\frac{1.5}{\mu_1} - 1 = \frac{-1}{5}(1.5 - 1) = -0.1;$$
$$\mu_1 = \frac{1.5}{0.9} = \frac{5}{3}$$

32. (b) $h' = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} = d\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$

33. (d) There are three and a half fringes from first maxima to fifth minima as shown.



$$\Rightarrow \beta = \frac{7 \text{ mm}}{3.5} = 2 \text{ mm} \Rightarrow \lambda = \frac{\beta D}{d} = 600 \text{ nm}$$

34. (d) Momentum of a photon $\propto \frac{E}{c} = 5.33 \times 10^{-27}$ kg ms^{-1}

35. (d)

36. (a)

37. (b) $\overline{(A+B)}$ = NOR gate

When both inputs of NAND gate are connected, it behaves as NOT gate OR + NOT = NOR.

38. (c)

39. (a) $E_n = -3.4\text{eV}$

The kinetic energy is equal to the magnitude of total energy in this case.

$\therefore$ K.E. $= +3.4\text{eV}$

The de Broglie wavelength of electron

$$\lambda = \frac{h}{\sqrt{2mK}} = \frac{6.64 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 3.4 \times 1.6 \times 10^{-19}}} \text{eV}$$
$$= 0.66 \times 10^{-9} \text{ m}$$

40. (b) If $v_{\max}$ is the speed of the fastest electron emitted from the metal surface, then

$$\frac{hc}{\lambda} = W_0 + \frac{1}{2} m v_{\max}^2 \frac{(6.63 \times 10^{-34}) \times (3 \times 10^8)}{(180 \times 10^{-9})}$$
$$= 2 \times (1.6 \times 10^{-19}) + \frac{1}{2}(9.1 \times 10^{-31}) v_{\max}^2$$
$$v = 1.31 \times 10^6 \text{ m/s}$$

The radius of the electron is given by

$$r = \frac{mv}{qB} = \frac{(9.1 \times 10^{-31}) \times (1.31 \times 10^6)}{(1.6 \times 10^{-19}) \times (5 \times 10^{-9})} = 0.149 \text{ m}$$

41. (d) According to Dulong and Pettit's law

Atomic weight × Specific heat = 6.4 (approx)

This law is applicable only to solid elements but it fails to explain very high specific heat of diamond.

42. (d) Let E be the equivalent weight of the metal

So, $\frac{E+17}{E+8} = \frac{1.52}{0.995}$

[17 is equivalent weight of OH and 8 is equivalent weight of oxygen]

$$\Rightarrow 0.995\text{E} + 17 \times 0.995 = \text{E} \times 1.52 + 8 \times 1.52$$
$$\Rightarrow 0.525\text{E} = 16.915 - 12.16 = 4.755$$
$$\therefore E = \frac{4.755}{0.525} = 9$$

43. (b) Effective nuclear charge (i,e. Z/e ratio) decreases from F^- to N^{3-} hence the radii follows the order: $F^- < O^{2-} < N^{3-}$. Z/e for $F^- = 9/10 = 0.9$, for $O^{2-} = 8/10 = .8$, for $N^{3-} = 0.7$

44. (c) The valency of beryllium is +2 while that of aluminium is +3

45. (d) $SO_2 >$ $P_2O_3 >$ $SiO_2 >$ Al_2O_3

Acidic Weak acidic Amphoteric

46. (b) For T-shape geometry the molecule must have 3 bonded pair and 2 lone pair of electrons.

47. (c) O_2^+ ion - Total number of electrons $(16 - 1) = 15$.

E.C.:

$$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2$$
$$\pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y$$
$$\text{Bond order} = \frac{N_b - N_a}{2} = \frac{10 - 5}{2} = \frac{5}{2} = 2\frac{1}{2}$$

O_2^- (Super oxide ion): Total number of electrons $(16 + 1) = 17$.

E.C.:

$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2$
$\pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^1$

Bond order $= \frac{(N_b - N_a)}{2} = \frac{10-7}{2} = \frac{3}{2} = 1\frac{1}{2}$
O_2^{2+} ion: Total number of electrons

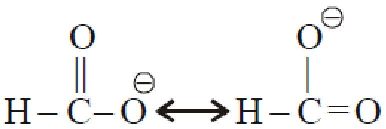
$= (16 - 2) = 14$

E.C.:
$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$
Bond order $= \frac{(N_b - N_a)}{2} = \frac{10-4}{2} = \frac{6}{2} = 3$
So bond order: $O_2^- < O_2^+ < O_2^{2+}$

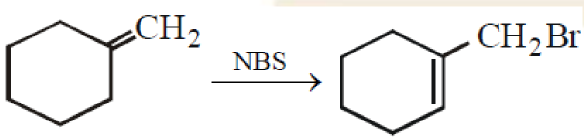
48. **(d)** Condition of equilibrium, hence $\Delta G = 0$.
49. **(a)** IV^{th} group needs higher S^{2-} ion concentration. In presence of HCl, the dissociation of H_2S decreases hence produces less amount of sulphide ions due to common ion effect, thus HCl decreases the solubility of H_2S which is sufficient to precipitate II^{nd} group radicals.
50. **(c)** $pH = 3. \therefore [H^+] = 10^{-3}; pH = 6,$
$\therefore [H^+] = 10^{-6}$. Hence $[H^+]$is reduced by 10^{-3} times.
51. **(a)** The more the reduction potential, the more the oxidising power.
52. **(b)** It is hygroscopic and deliquescent and hence absorbs moisture and CO_2 to form Na_2CO_3 $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$
53. **(a)** None of the carbon atoms in $DCH_2CH_2CH_2Cl$ is chiral i.e., each carbon atom is achiral (symmetric).
54. **(b)**
55. **(c)** Nucleophilicity increases with the decrease in electronegativity of the central atom. Since electronegativity follows the order: $F > O > N > C$; nucleophilicity of the concerned group will follow the reverse order i.e.,

$CH_3^- > NH_2^- > OH^- > F^-$

56. **(b)**



57. **(c)**



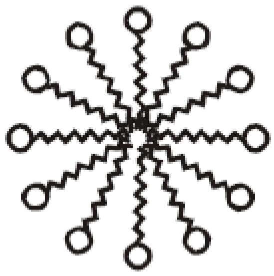
58. **(d)** Number of atoms per unit cell = 1
Atoms touch each other along edges.
Hence $r = \frac{a}{2}$
(r = radius of atom and a = edge length)
Therefore % fraction $= \frac{\frac{4}{3}\pi r^3}{(2r)^3} = \frac{\pi}{6}$
59. **(c)** $\Delta T_f = K_f m = 5.12 \times \frac{1}{250} \times \frac{1000}{51.2} = 0.4\ K$
60. **(a)**

$$\text{Amt. deposited } = \frac{\text{E. wt } \times \text{Q}}{96500}$$

$$107.870 = \frac{107.870}{96500} \times \text{Q}; \ \therefore \text{Q} = 96500\text{C}$$

61. (d) In case of (II) and (III) Keeping concentration of [A] constant, when the concentration of $[B]$ is doubled, the rate quadruples. Hence it is second order with respect to B. In case of I & IV Keeping the concentration of [B] constant, when the concentration of [A] is increased four times, rate also increases four times. Hence, the order with respect to A is one. Hence Rate = $k[\text{A}][\text{B}]^2$

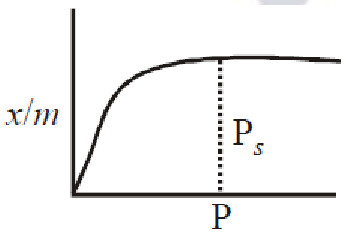
62. (a)



o- Polarhead
n - Non-polar tail
(micelle)

63. (d) According to Freundlich adsorption isotherm, at intermediate pressure, extent of adsorption

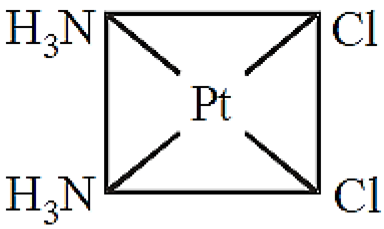
$$\frac{x}{m} = k\text{P}^{1/n} \text{ or } \log\frac{x}{m} = \log k + \frac{1}{n}\log \text{P};$$



plot of $\log\frac{x}{m}$ vs $\log \text{P}$ is linear with slope

$$= \frac{1}{n}$$

64. (b) Calcination is used for removal of volatile impurities and decompose carbonates.
65. (b) Red P does not react with NaOH to give PH_3.
66. (a) F_2 is strongest oxidising agent. $F^-$is not oxidised by MnO_2
67. (c) $\text{Ac}(89) = [\text{Rn}][6d^1][7s^2]$
68. (c) Due to lanthanide contraction, the size of Zr and Hf (atom and ions) become nearly similar.
69. (a) The structural formula of cis-platin is



Since no carbon is involved it is not a organometallic compound.

70. (b) A more basic ligand forms stable bond with metal ion, Cl^- is most basic amongst all.

71. (c)

$$\underset{(A)}{Me_3CCl} \xrightarrow{KOH} \underset{\text{tert. alcohol}}{Me_3COH}$$

$$\xrightarrow{Cu/300^\circ} CH_3-\underset{\displaystyle CH_3}{\underset{|}{C}H}=CH_2 + H_2O$$

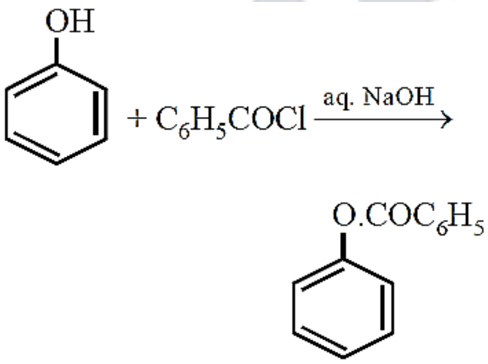
or

$$\underset{(C)}{Me_2C=CH_2}$$

72. (d) Williamson synthesis is one of the best methods for the preparation of symmetrical and unsymmetrical ethers. In this method, an alkyl halide is allowed to react with sodium alkoxide.

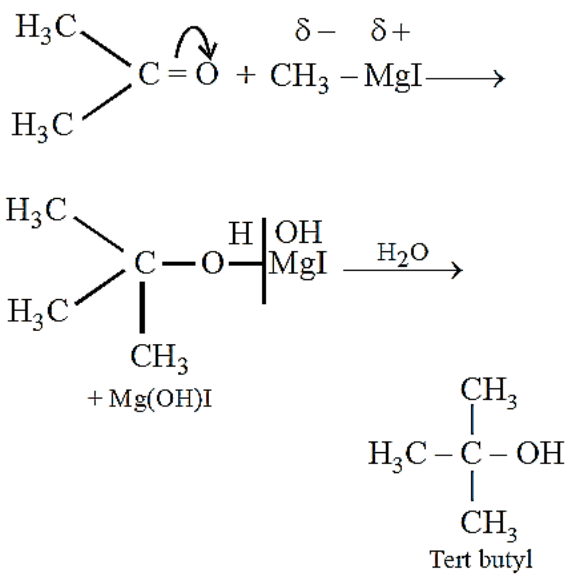
73. (b) Claisen condensation is given by esters having two α-hydrogen atoms.

74. (a)



phenyl benzoate

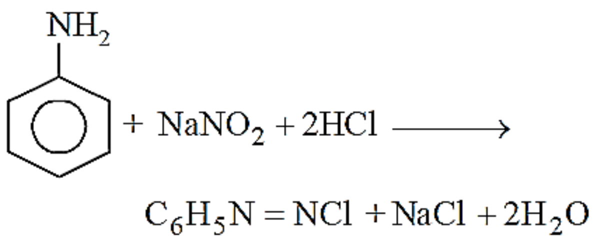
75. (d)



Tert butyl alcohol

76. (d) I_2 and NaOH react with acetophenone ($C_6H_5COCH_3$) to give yellow ppt. of CHI_3 but benzophenone ($C_6H_5COC_6H_5$) does not give haloform test.

77. (d) When aniline is treated with nitrous acid in the presence of HCl, then benzene diazonium chloride is obtained.



(Benzene diazonium chloride)

78. (d) Proline contains imino (secondary amino), $\geq$ NH group.

79. (a) There is no reaction between I^- and Fe^{3+}.

80. (c) Acetaldehyde is easily oxidised to acetic acid by a mild oxidising agent like Fehling solution. Acetone is not easily oxidised. Both acetone and acetaldehyde give iodoform test. Other two conditions are not relevant to aldehydes and ketones.

81. (c) $f(x) = 0 \forall x \in R \Rightarrow f(3) - f(2) = 0$

82. (c)

$$\tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A \tan B} = \frac{\frac{1}{2} + \frac{1}{3}}{1 - \frac{1}{2} \cdot \frac{1}{3}} = 1$$

$$\therefore A + B = 45^\circ = \frac{\pi}{4}$$

83. (c) We shall first consider values of θ between 0

and $2\pi \sin\theta = -\frac{1}{2} = -\sin\frac{\pi}{6} = \sin\left(\pi + \frac{\pi}{6}\right)$

or $\sin(2\pi - \pi/6)$

$\therefore \theta = 7\pi/6; 11\pi/6$

$\tan\theta = 1/\sqrt{3} = \tan(\pi/6)$ or $\tan(\pi + \pi/6)$

$\therefore \theta = \pi/6, 7\pi/6$

The value of θ which satisfies both the equations is $7\pi/6$
Hence the general value of θ is $2n\pi + 7\pi/6$ where $n \in I$

84. (b)

$$\frac{\cos\theta}{1-\tan\theta} + \frac{\sin\theta}{1-\cot\theta} = \frac{\cos\theta}{1-\frac{\sin\theta}{\cos\theta}} + \frac{\sin\theta}{1-\frac{\cos\theta}{\sin\theta}}$$
$$= \frac{\cos^2\theta}{\cos\theta-\sin\theta} - \frac{\sin^2\theta}{\cos\theta-\sin\theta} = \cos\theta + \sin\theta$$

85. (c) For $n = 1$, we have;

$x^{n+1} + (x+1)^{2n-1} = x^2 + (x+1) = x^2 + x + 1,$

which is divisible by $x^2 + x + 1$
For $n = 2$, we have; $x^{n+1} + (x+1)^{2n-1}$

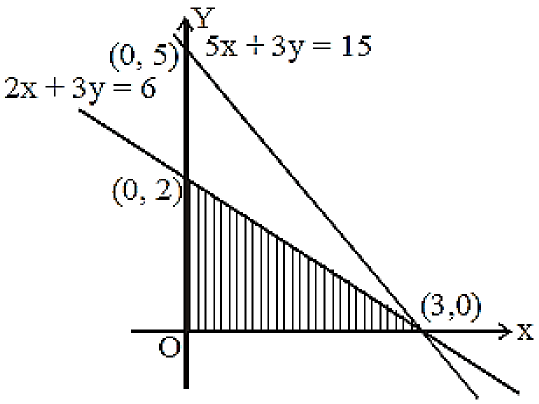
$= x^3 + (x+1)^3 = (2x+1)(x^2+x+1),$

which is divisible by $x^2 + x + 1$.

86. (d) The second equation can be rewritten as $a\left(\frac{x}{x+1}\right)^2 + b\left(\frac{x}{x+1}\right) + c = 0$ and hence its roots correspond to $\frac{x}{x+1} = \alpha$ and $\frac{x}{x+1} = \beta$.
Hence $x = \frac{\alpha}{1-\alpha}$ and $\frac{\beta}{1-\beta}$.

87. (d) Putting $z = a + 2i$ in the given equation and comparing imaginary parts, we get $a^2 + 4 = a^2$, which is not possible.

88. (d) Here (0,2), (0,0) and (3,0) all are vertices of feasible region.



89. (b)

$$^{20}C_r = {}^{20}C_{r-10} \Rightarrow r + (r-10) = 20 \Rightarrow r = 15$$
$$\therefore\ {}^{18}C_r = {}^{18}C_{15} = {}^{18}C_3 = \frac{18.17.16}{1.2.3} = 816$$

90. (d)

$$T_{r+1} = {}^{18}C_r(9x)^{18-r}\left(-\frac{1}{3\sqrt{x}}\right)^r$$
$$= (-r)^r\,{}^{18}C_r 9^{18-\frac{3r}{2}} x^{18-\frac{3r}{2}}$$

is independent of x provided r = 12 and then a = 1.

91. (b) $T_{r+1} = {}^nC_r a^{n-r} \cdot b^r$ where $a = 2^{1/3}$ and $b = 3^{-1/3}$

$$T_7 \text{ from beginning } = {}^nC_6 a^{n-6} b^6 \text{ and}$$
$$T_7 \text{ from end } = {}^nC_6 b^{n-6} a^6$$
$$\Rightarrow \frac{a^{n-12}}{b^{n-12}} = \frac{1}{6} \Rightarrow 2^{\frac{n-12}{3}} \cdot 3^{\frac{n-12}{3}} = 6^{-1}$$
$$\Rightarrow n - 12 = -3 \Rightarrow n = 9$$

92. (b)

$$\text{Let H. P. be } \frac{1}{a} + \frac{1}{a+d} + \frac{1}{a+2d} + \cdots \ldots.$$
$$\therefore u = \frac{1}{a+(p-1)d}, v = \frac{1}{a+(q-1)d},$$
$$w = \frac{1}{a+(r-1)d} \Rightarrow a + (p-1)d = \frac{1}{u}$$
$$a + (q-1)d = \frac{1}{v}, a + (r-1)d = \frac{1}{w}$$
$$\Rightarrow (q-r)\{a+(p-1)d\} + (r-p)\{a+(q-1)d\} + \cdots \ldots.$$
$$= \frac{1}{u}(q-r) + \frac{1}{v}(r-p) + \cdots . \Rightarrow (q-r)vw + \cdots .. = 0$$

93. (c) Given,

$$\frac{2n}{2}\{2.2 + (2n-1)3\} = \frac{n}{2}\{2.57 + (n-1)2\}$$
$$\text{or } 2(6n+1) = 112 + 2n \text{ or } 10n = 110, \therefore n = 11$$

94. (d) The given line is $12(x+6) = 5(y-2)$

$$\Rightarrow 12x + 72 = 5y - 10$$
$$\text{or } 12x - 5y + 72 + 10 = 0 \ \Rightarrow 12x - 5y + 82 = 0$$

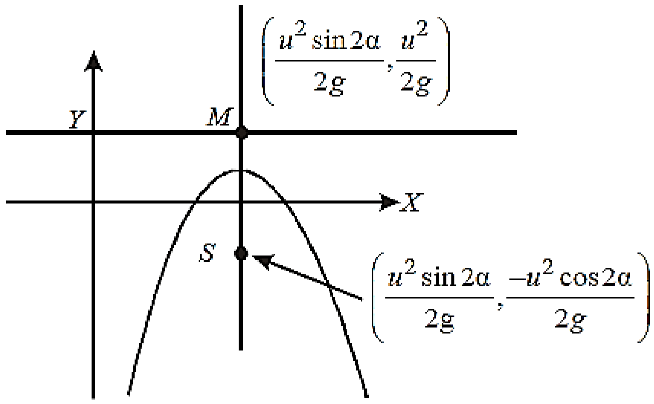
The perpendicular distance from (x_1, y_1) to the line $ax + by + c = 0$ is $\frac{(ax_1+by_1+c)}{\sqrt{a^2+b^2}}$. The point (x_1, y_1) is $(-1,1)$, therefore, perpendicular distance from $(-1,1)$ to the line $12x - 5y + 82 = 0$ is

$$= \frac{|-12 - 5 + 82|}{\sqrt{12^2 + (-5)^2}} = \frac{65}{\sqrt{144+25}} = \frac{65}{\sqrt{169}} = 5$$

95. (a) Rewriting the equation
$(2x + y + 2)a + (3x - y - 4)b = 0$ and for all a, b the straight lines pass through the intersection of $2x + y + 2 = 0$ and $3x - y - 4 = 0$ i.e., the point $\left(\frac{2}{5}, -\frac{14}{5}\right)$.

96. (d) According to the figure, the length of latus rectum is

$$2(SM) = 2 \times \frac{u^2}{2g}(1 + \cos 2\alpha) = \frac{2u^2\cos^2\alpha}{g}.$$



97. (b) We have $ae = 5$[Since focus is $(\pm ae, 0)$]

and $\frac{a}{e} = \frac{36}{5}$ since directrix is $x = \pm \frac{a}{e}$]

On solving we get $a = 6$

and $e = \frac{5}{6} \Rightarrow b^2 = a^2(1 - e^2) = 36\left(1 - \frac{25}{36}\right) = 11$

Thus, the required equation of the ellipse is

$$\frac{x^2}{36} + \frac{y^2}{11} = 1$$

98. (b) Let the two circles be $x^2 + y^2 + 2g_1x + 2f_1y + c_1 = 0$ and $x^2 + y^2 + 2g_2x + 2f_2y + c_2 = 0$ where $g_1 = 5/2, f_1 = 3/2, c_1 = 7, g_2 = 4, f_2 = 3$ and $c_2 = k$

If the two circles intersects orthogonally, then

$$2(g_1 g_2 + f_1 f_2) = c_1 + c_2 \Rightarrow 2\left(-10 + \frac{9}{2}\right) = 7 + k$$
$$\Rightarrow 11 = 7 + k \Rightarrow k = -18$$

99. (b) The diameter of the circle is perpendicular distance between the parallel lines (tangents) $3x - 4y + 4 = 0$ and $3x - 4y - \frac{7}{2} = 0$ and so it is equal to

$\frac{4}{\sqrt{9+16}} + \frac{7/2}{\sqrt{9+16}} = \frac{3}{2}$. Hence radius is $\frac{3}{4}$

100. (c)

$$\lim_{x \to 0} \frac{\sqrt{1 + \sin 3x} - 1}{\ln(1 + \tan 2x)}$$
$$= \lim_{x \to 0} \frac{(1 + \sin 3x) - 1}{\{\sqrt{1 + \sin 3x} + 1\} \ln(1 + \tan 2x)}$$
$$= \lim_{x \to 0} \frac{1}{(\sqrt{1 + \sin 3x} + 1)} \cdot \frac{\sin 3x}{\ln(1 + \tan 2x)^{\frac{1}{\tan 2x}}}$$
$$\times \frac{1}{\tan 2x}$$
$$= \lim_{x \to 0} \frac{1}{(\sqrt{1 + \sin 3x} + 1)} \cdot \left(\frac{\sin 3x}{3x}\right)\left(\frac{2x}{\tan 2x}\right)$$
$$\times \frac{3}{2} \cdot \frac{1}{\ln(1 + \tan 2x)^{\frac{1}{\tan 2x}}}$$
$$= \left(\frac{1}{1 + 1}\right)(1)(1)\left(\frac{3}{2}\right)\frac{1}{\ln e} = \frac{3}{4}.$$

101. **(b)** Let p: Paris is in France, q: London is in England

$\therefore$ we have $p \wedge q$

Its negation is $\sim(p \wedge q) = \sim p \vee \sim q$

i.e., Paris is not in France or London is not in England.

102. **(a)** First ten odd numbers are 1,3,5,7,11,13, 15,17,19 respectively. So A.M.

$$(\bar{x}) = \frac{1+3+5+7+9+11+13+15+17+19}{10}$$

$$= \frac{100}{10} = 10$$

103. **(c)** For mutually exclusive events

$$P(A \cup B) = P(A) + P(B) \Rightarrow P(A) = \frac{2}{7}$$

104. **(d)**

$$P(i) = \frac{k}{i} \Rightarrow 1 = \sum_{i=1}^{6} P(i) = k\sum_{i=1}^{6} \frac{1}{i} = k\frac{49}{20}$$

$$\Rightarrow k = \frac{20}{49} \cdot P(3) = \frac{20}{147}$$

105. **(b)**

$$\text{fof}\,(x) = \begin{cases} f(x);\ \text{when } f(x) \text{ is rational} \\ 1 - f(x);\ \text{when } f(x) \text{ is irrational} \end{cases}$$

$$= \begin{cases} x;\ \text{when } x \text{ is rational} \\ 1-(1-x);\ \text{when } x \text{ is irrational} \end{cases} = x$$

106. **(b)**

$$\text{Let } f(x) = y. \text{Then } \frac{1-x}{1+x} = y$$

$$\Rightarrow x = \frac{1-y}{1+y} \Rightarrow f^{-1}(y) = \frac{1-y}{1+y}$$

$$\text{Thus, } f^{-1}(x) = \frac{1-x}{1+x}$$

Clearly, $f^{-1}(x)$ is defined for $1 + x \neq 0$.

Hence, domain of $f^{-1}(x)$ is $R - \{-1\}$

107. **(d)**

$$\sin\left(4\tan^{-1}\frac{1}{3}\right)$$

$$= 2\sin\left(2\tan^{-1}\frac{1}{3}\right)\cos\left(2\tan^{-1}\frac{1}{3}\right)$$

$$= 2\sin\left(\tan^{-1}\frac{3}{4}\right) = \cos\left(\tan^{-1}\frac{3}{4}\right) = 2 \cdot \frac{3}{5} \cdot \frac{4}{5} = \frac{24}{25}$$

$$\cos\left(2\tan^{-1}\frac{1}{7}\right) = \cos\left(\tan^{-1}\frac{7}{24}\right) = \frac{24}{25}.$$

The given expression = 0

108. **(a)**

$$A^2 + 4A - 5I = A \times A + 4A - 5I$$
$$= \begin{bmatrix} 1 & 2 \\ 4 & -3 \end{bmatrix} \times \begin{bmatrix} 1 & 2 \\ 4 & -3 \end{bmatrix} + 4\begin{bmatrix} 1 & 2 \\ 4 & -3 \end{bmatrix} - 5\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$
$$= \begin{bmatrix} 9 & -4 \\ -8 & 17 \end{bmatrix} + \begin{bmatrix} 4 & 8 \\ 16 & -12 \end{bmatrix} - \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$$
$$= \begin{bmatrix} 9+4-5 & -4+8-0 \\ -8+16-0 & 17-12-5 \end{bmatrix} = \begin{bmatrix} 8 & 4 \\ 8 & 0 \end{bmatrix}$$
$$= 4\begin{bmatrix} 2 & 1 \\ 2 & 0 \end{bmatrix}$$

109. **(b)**

$$|A| = \begin{bmatrix} 2 & 0 & 0 \\ 2 & 2 & 0 \\ 2 & 2 & 2 \end{bmatrix} = (2)(2)(2) = 8$$

Now $\operatorname{adj}(\operatorname{adj} A) = |A|^{3-2}$ A

$$= 8\begin{bmatrix} 2 & 0 & 0 \\ 2 & 2 & 0 \\ 2 & 2 & 2 \end{bmatrix} = 16\begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

110. **(d)** Consider $y = x^{x^2} \Rightarrow \ln y = x^2 \ln x$

$$\frac{1}{y}\frac{dy}{dx} = 2x\ln x + x^2 \cdot \frac{1}{x} = x(1 + 2\ln x)$$
$$\frac{dy}{dx} = x^{x^2} \cdot x(1 + 2\ln x) = x^{x^2+1}(1 + 2\ln x)$$

111. **(c)** Continuous as well as differentiable,

so $f'(1) = 0$

112. **(b)** Let $f(x) = \sin x - kx - c$ where k and c are constants. $f'(x) = \cos x - k \therefore$ f decreases if $\cos x \leq k$

Thus, $f(x) = \sin x - kx - c$ decrease always when $k > 1$.

113. **(a)** Let $y = \sin^4 x + \cos^4 x$

$$\frac{dy}{dx} = 4\sin^3 x\cos x + 4\cos^3 x(-\sin x)$$
$$= 4\sin x \cos x(\sin^2 x - \cos^2 x)$$
$$= (2\sin 2x)(-\cos 2x) = -\sin 4x$$
$$\therefore \frac{dy}{dx} = 0 \Rightarrow \sin 4x = 0 \Rightarrow 4x = 0, \pi, 2\pi, 3\pi$$
$$\text{or } x = 0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \ldots\ldots\ldots\ldots, \Rightarrow x = \frac{\pi}{4}$$

114. **(c)**

$$y - e^{xy} + x = 0$$

$$\therefore \frac{dy}{dx} - e^{xy}\left(y + x\frac{dy}{dx}\right) + 1 = 0$$

$$\text{i.e.,} \ \frac{dy}{dx} - y(x+y) - x(x+y)\frac{dy}{dx} + 1 = 0$$

$$\text{i.e.,} \ [1 - x(x+y)]\frac{dy}{dx} = y(x+y) - 1$$

for the vertical tangents

$$1 - x(x+y) = 0 \text{ i.e., } y = \frac{1-x^2}{x}$$

$$\therefore x = 1 \text{ and } y = 0$$

115. (c)

$$f(x) = 2x^3 - 3x^2 - 12x + 4$$

$$\Rightarrow f'(x) = 6x^2 - 6x - 12 = 6(x^2 - x - 2)$$

$$= 6(x-2)(x+1)$$

For maxima and minima $f'(x) = 0$

$\therefore \ 6(x-2)(x+1) = 0 \Rightarrow x = 2, -1$

Now, $f''(x) = 12x - 6$
At $x = 2; f''(x) = 24 - 6 = 18 > 0$
$\therefore \ x = 2$, local min. point
At $x = -1; f''(x) = 12(-1) - 6 = -18 < 0$
$\therefore x = -1$ local max. point

116. (c)

$$\text{Given integral } I = \int \left(1 + \frac{1}{x^2-1}\right) dx$$

$$= \int dx + \int \frac{dx}{(x-1)(x+1)}$$

$$= x + \frac{1}{2}\int \left(\frac{1}{x-1} - \frac{1}{x+1}\right) dx = x + \frac{1}{2}\log\left(\frac{x-1}{x+1}\right) + c$$

117. (a) We know that $|\sin x|$ is a periodic function of π Hence $\int_0^{4\pi} |\sin x| dx = 4\int_0^{\pi} |\sin x| dx = 4\int_0^{\pi} \sin x dx$

$= 4[-\cos x]_0^{\pi} = 8$

118. (b)

$$\text{If } I_1 = \int_1^2 \frac{dx}{\sqrt{1+x^2}}, I_2 = \int_1^2 \frac{dx}{x}$$

$$I_1 = \ln\left(\frac{2+\sqrt{5}}{1+\sqrt{2}}\right), \ I_2 = \ln 2 \Rightarrow I_1 < I_2$$

119. (b)

Required area $= \int_0^{\frac{\pi}{4}} \tan x dx$

$= \ln|\sec 1|_0^{\frac{\pi}{4}} = \ln\sqrt{2} = \dfrac{\ln 2}{2}$

120. **(b)**

$$\left(\frac{d^3y}{dx^3}\right)^{2/3} + 4 - 3\frac{d^2y}{dx^2} + 5\frac{dy}{dx} = 0$$

$$\Rightarrow \left(\frac{d^3y}{dx^3}\right)^2 = \left[3\frac{d^2y}{dx^2} - 5\frac{dy}{dx} - 4\right]^3$$

It is a differential equation of degree 2 .

121. **(b)**

$\vec{A} + \vec{B}| = |\vec{A} - \vec{B}\,|$

$\Rightarrow \sqrt{A^2 + B^2 + 2AB\cos\theta} = \sqrt{A^2 + B^2 - 2AB\cos\theta}$

Squaring both the sides, we get

$\vec{A}^2 + \vec{B}^2 + 2\vec{A}\vec{B}\cos\theta = \vec{A}^2 + \vec{B}^2 - 2\vec{A}\vec{B}\cos\theta$

or $4\vec{A}\vec{B}\cos\theta = 0$ or $\cos\theta = 0$ (since the scalar or dot product is zero). Therefore, angle between $\vec{A}$ to $\vec{B}$ is $90°$

122. **(b)** Since $3(1) + 2(-2) + (-1)(-1) = 3 - 4 + 1 = 0$

$\therefore$ Given line is $\perp$ to the normal to the planei.e., given line is parallel to the given plane.

Also, $(1, -1, 3)$ lies on the plane $x - 2y - z = 0$ if $1 - 2(-1) - 3 = 0$ i.e., $1 + 2 - 3 = 0$

which is true $\therefore$ L lies in plane π.

123. **(b)** Length of ladder $= \frac{6\sqrt{3}}{\sin 60°} = 12$ m

124. **(b)**

We have $\Delta = \dfrac{\sqrt{3}}{4}a^2, s = \dfrac{3a}{2}$

$\therefore r = \dfrac{\Delta}{s} = \dfrac{a}{2\sqrt{3}}, R = \dfrac{abc}{4\Delta} = \dfrac{a^3}{\sqrt{3}a^2} = \dfrac{a}{\sqrt{3}}$

and $r_1 = \dfrac{\Delta}{s-a} = \dfrac{\sqrt{3}/4a^2}{a/2} = \dfrac{\sqrt{3}}{2}a$

Hence, $r : R : r_1 = \dfrac{a}{2\sqrt{3}} : \dfrac{a}{\sqrt{3}} : \dfrac{\sqrt{3}}{2}a = 1 : 2 : 3$

125. **(d)** Clearly point $(2000, 0)$ is outside.

126. **(c)** Sentence I, accusations were leveled against him not at him. Sentence II, despite is not followed by of.

127. **(c)** Sentence I: I deem it a privilege not as a privilege.

Sentence II: achieved through practice not with practice.

128. **(c)** Commotion means an disorderly outburst or tumult. Its most close to tubulence which means unstable flow of a liquid or gas. Turbulence also refers to a state of disturbance.

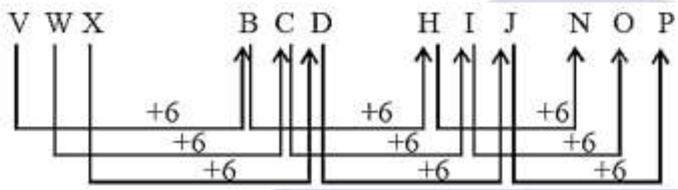
129. **(c)** Other synonyms are prorogue, put off, set back, shelve.

130. **(a)** An adage is a proverb or byword.

131. **(d)**
132. **(d)**
133. **(a)**
134. **(d)** Sticking-extending out above a surface or boundary contrary-very opposite in nature or character or purpose.
135. **(c)** Evocative-recreate strong feelings, memory etc.
Mesmerizing-attract strongly.
136. **(c)**
137. **(b)**
138. **(b)**
139. **(c)**
140. **(c)**
141. **(c)** The number should be 140.

$\times 1+5, \times 2+5, \times 3+5 \ldots \ldots$

142. **(b)** The pattern is:



143. **(a)**

T	A	R	G	E	T
↓	↓	↓	↓	↓	↓
20	1	18	7	5	20

Similarly,

W	I	L	L	I	U	M
↓	↓	↓	↓	↓	↓	↓
23	9	12	12	9	21	13

144. **(c)** From the question we get,
Rakesh > Sanjay > Suresh
Binit > Rakesh > Harish
So, Binit is the tallest among them.
145. **(a)** No. of Persons between Rahul and Nitesh $=(36+29)-62-2=65-62-2=1$
146. **(a)**
147. **(d)**
148. **(b)**
149. **(b)**
150. **(c)**