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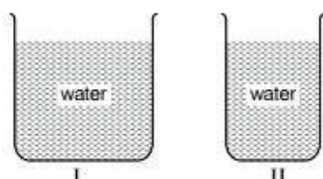
5. From the top of a tower, two stones whose masses are in the ratio 1 : 2 are thrown - one straight up with an initial speed u and the second straight down with the same speed u . Then, neglecting air resistance
- the heavier stone hits the ground with a higher speed
 - the lighter stone hits the ground with a higher speed
 - Both the stones will have the same speed when they hit the ground
 - the speed can't be determined with the given data

6. If M is the mass of the earth and R its radius, the ratio of the gravitational acceleration and the gravitational constant is

a. $\frac{R^2}{M}$ b. $\frac{M}{R^2}$ c. MR^2 d. $\frac{M}{R}$

7. A student unable to answer a question on Newton's laws of motion attempts to pull himself up by tugging on his hair. He will not succeed
- as the force exerted is small
 - the frictional force, while gripping is small
 - Newton's law of inertia is not applicable to living beings
 - as the force applied is internal to the system

8. From the adjacent figure, the correct observation is



- the pressure on the bottom of tank (I) is greater than at the bottom of (II)
- the pressure on the bottom of tank (I) is smaller than at the bottom of (II)
- the pressure depend on the shape of the container
- the pressure on the bottom of (I) and (II) is the same

9. Which one of the following is not a unit of Young's modulus?

a. Nm^{-1} b. Nm^{-2}
c. dyne cm^{-2} d. Mega pascal

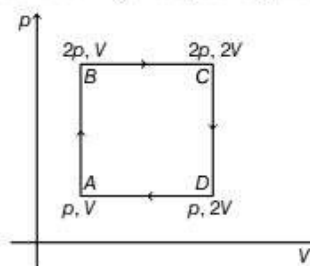
10. A piece of blue glass heated to a high temperature and a piece of red glass at room temperature are taken inside a dimly lit room. Then
- the blue piece will look blue and red will look as usual
 - red will look brighter red and blue will look ordinary blue

- blue will shine like brighter red compared to the red piece
- Both the pieces will look equally red

11. The wavelength of the radiation emitted by a body depends upon

- the nature of the surface
- the area of the surface
- the temperature of the surface
- All of the above

12. An ideal monoatomic gas is taken around the cycle $ABCD$ as shown in the p - V diagram. The work done during the cycle is given by



a. $\frac{1}{2} pV$ b. pV
c. $2 pV$ d. $4 pV$

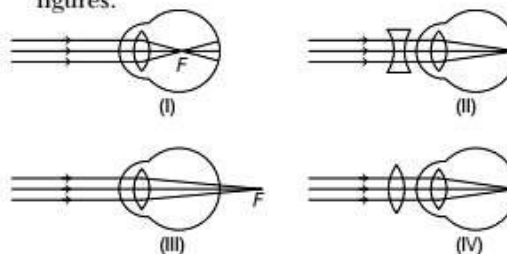
13. Which mirror is to be used to obtain a parallel beam of light from a small lamp?

- Plane mirror
- Convex mirror
- Concave mirror
- Any one of the above

14. Which of the following is a wrong statement?

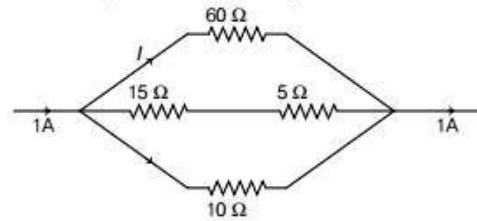
- $D = \frac{1}{f}$, where f is the focal length and D is called the refractive power of a lens.
- Power is called a dioptre when f is in metres.
- Power is called a dioptre and does not depend on the system of unit used to measure f .
- D is positive for convergent lens and negative for divergent lens.

15. Identify the wrong description of the below figures.



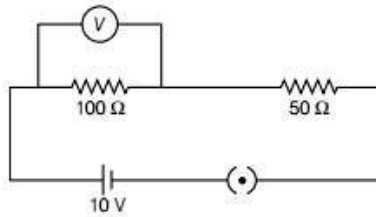
- a. I represents far - sightedness
 b. II correction for short-sightedness
 c. III represents far - sightedness
 d. IV correction for far - sightedness
16. Infrared radiation was discovered in 1800 by
 a. William Wollaston b. William Herschel
 c. Wilhelm Roentgen d. Thomas Young
17. A particle on the trough of a wave at any instant will come to the mean position after a time (T = time period)
 a. $\frac{T}{2}$ b. $\frac{T}{4}$ c. T d. $2T$
18. The disc of a siren containing 60 holes rotates at a constant speed of 360 rpm. The emitted sound is in unison with a tuning-fork of frequency
 a. 10 Hz b. 360 Hz
 c. 216 kHz d. 6 Hz
19. The ratio of velocity of sound in hydrogen and oxygen at STP is
 a. 16 : 1 b. 8 : 1
 c. 4 : 1 d. 2 : 1
20. In an experiment with sonometer a tuning fork of frequency 256 Hz resonates with a length of 25 cm and another tuning fork resonates with a length of 16 cm. Tension of the string remaining constant the frequency of the second tuning fork is
 a. 163.84 Hz b. 400 Hz
 c. 320 Hz d. 204.8 Hz
21. The apparent frequency of a note is 200 Hz. When a listener is moving with a velocity of 40 ms^{-1} towards a stationary source. When he moves away from the same source with the same speed, the apparent frequency of the same note is 160 Hz. The velocity of sound in air (in m/s) is
 a. 340 b. 330
 c. 360 d. 320
22. The wave theory of light, in its original form, was first postulated by
 a. Isaac Newton
 b. Christian Huygens
 c. Thomas Young
 d. Augustin Jean Fresnel
23. If a liquid does not wet glass, its angle of contact is
 a. zero b. acute
 c. obtuse d. right angle

24. The magnitude of I in ampere unit is

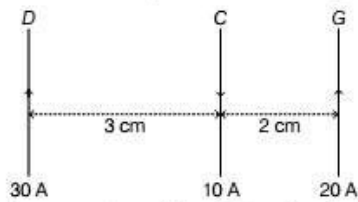


- a. 0.1 b. 0.3
 c. 0.6 d. None of these
25. Electron of mass m and charge q is travelling with a speed v along a circular path of radius r at right angles to a uniform magnetic field of intensity B . If the speed of the electron is doubled and the magnetic field is halved, then the resulting path would have a radius
 a. $2r$ b. $4r$ c. $\frac{r}{4}$ d. $\frac{r}{2}$
26. If the potential difference across the internal resistance r_1 is equal to the emf E of the battery, then
-
- a. $R = r_1 + r_2$ b. $R = \frac{r_1}{r_2}$ c. $R = r_1 - r_2$ d. $R = \frac{r_2}{r_1}$
27. By using only two resistance coils-singly, in series, or in parallel-one should be able to obtain resistances of 3, 4, 12 and 16 ohms. The separate resistances of the coil are
 a. 3 and 4 b. 4 and 12
 c. 12 and 16 d. 16 and 3
28. The electrons in the beam of a television tube move horizontally from South to North. The vertical component of the earth's magnetic field points down. The electron is deflected towards
 a. West b. no deflection
 c. East d. North to South
29. A tangent galvanometer has a reduction factor of 1 A and it is placed with the plane of its coil perpendicular to the magnetic meridian. The deflection produced when a current of 1 A is passed through it is
 a. 60° b. 45°
 c. 30° d. None of these

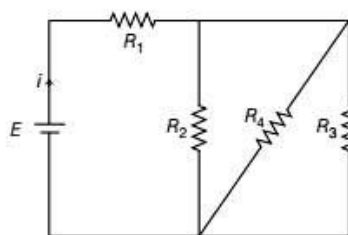
30. In the given circuit, the voltmeter records 5 V. The resistance of the voltmeter (in ohms) is



- a. 200
b. 100
c. 10
d. 50
31. Three long, straight and parallel wires, carrying current, are arranged as shown in figure.



- The force experienced by a 25 cm length of wire C is
- a. 10^{-3} N
b. 25×10^{-3} N
c. Zero
d. 15×10^{-3} N
32. A 5.0 A current is setup in an external circuit by a 6.0 V storage battery for 6.0 min. The chemical energy of the battery is reduced by
- a. 1.08×10^4 J
b. 1.08×10^4 V
c. 1.8×10^4 J
d. 1.8×10^4 V
33. The current in a simple series circuit is 5.0 A. When an additional resistance of 2.0Ω is inserted, the current drops to 4.0 A. The original resistance of the circuit (in Ω) is
- a. 1.25
b. 8
c. 10
d. 20
34. In the circuit given $E = 6.0$ V, $R_1 = 100\Omega$, $R_2 = R_3 = 50\Omega$ and $R_4 = 75\Omega$. The equivalent resistance of the circuit (in Ω) is



- a. 11.875
b. 26.31
c. 118.75
d. None of these

35. Two resistances are connected in two gaps of a meterbridge. The balance point is 20 cm from the zero end. A resistance of 15Ω is connected in series with the smaller of the two. The null point shifts to 40 cm. The value of the smaller resistance (in Ω) is
- a. 3
b. 6
c. 9
d. 12

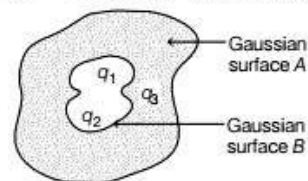
36. An electric field of 1500 V/m and a magnetic field of 0.40 Wb/m² act on a moving electron. The minimum uniform speed along a straight line the electron could have is
- a. 1.6×10^{15} m/s
b. 6×10^{-16} m/s
c. 3.75×10^3 m/s
d. 3.75×10^7 m/s

37. In an ammeter 10% of main current is passing through the galvanometer. If the resistance of the galvanometer is G , then the shunt resistance (in Ω) is
- a. $9G$
b. $\frac{G}{9}$
c. $90G$
d. $\frac{G}{90}$

38. Among the following properties describing diamagnetism identify the property that is wrongly stated.
- Diamagnetic material do not have permanent magnetic moment.
 - Diamagnetism is explained in terms of electromagnetic induction.
 - Diamagnetic materials have a small positive susceptibility.
 - The magnetic moment of individual electrons neutralise each other.
- a. I
b. II
c. III
d. IV

39. The induction coil works on the principle of
- a. self-induction
b. mutual induction
c. Ampere's rule
d. Fleming's right hand rule
40. The square root of the product of inductance and capacitance has the dimension of
- a. length
b. mass
c. time
d. no dimension

41. The electric flux for Gaussian surface A that enclose the charged particles in free space is (Given, $q_1 = -14$ nC, $q_2 = 78.85$ nC, $q_3 = -56$ nC)



- a. 10^3 N - m²C⁻¹
b. 10^3 CN⁻¹m⁻²
c. 6.32×10^3 N - m²C⁻¹
d. 6.32×10^3 CN⁻¹m⁻²

54. If the forward voltage in a diode is increased, then the width of the depletion region
 a. increases b. decreases
 c. fluctuates d. no change
55. Two nucleons are at a separation of one Fermi. Protons have a charge of $+1.6 \times 10^{-19}$ C. The net nuclear force between them is F_1 , if both are neutrons, F_2 if both are protons and F_3 if one is proton and the other is neutron. Then,
 a. $F_1 = F_2 > F_3$
 b. $F_1 = F_2 = F_3$
 c. $F_1 < F_2 < F_3$
 d. $F_1 > F_2 > F_3$
56. The energy that should be added to an electron to reduce its de-Broglie wavelength from 1 nm to 0.5 nm is
 a. four times the initial energy
 b. equal to the initial energy
 c. twice the initial energy
 d. thrice the initial energy
57. Mean life of a radioactive sample is 100 s. Then, its half-life (in min) is
 a. 0.693 b. 1
 c. 10^{-4} d. 1.155
58. Consider two nuclei of the same radioactive nuclide. One of the nuclei was created in a supernova explosion 5 billion years ago. The other was created in a nuclear reactor 5 min ago. The probability of decay during the next time is
 a. different for each nuclei
 b. nuclei created in explosion decays first
 c. nuclei created in the reactor decays first
 d. independent of the time of creation
59. Bohr's atom model assumes
 a. the nucleus is of infinite mass and is at rest
 b. electrons in a quantised orbit will not radiate energy
 c. mass of the electron remains constant
 d. All of the above
60. Identify the property which is not characteristic for a semi-conductor.
 a. At a very low temperatures it behaves like an insulator.
 b. At higher temperatures two types of charge carriers will cause conductivity.
 c. The charge carriers are electrons and holes in the valance band at higher temperatures.
 d. The semiconductor is electrically neutral.

CHEMISTRY

61. The correct order in which the first ionisation potential increases is
 a. Na, K, Be b. K, Na, Be
 c. K, Be, Na d. Be, Na, K
62. 10 cm³ of 0.1 N monobasic acid requires 15 cm³ of sodium hydroxide solution whose normality is
 a. 1.5 N b. 0.15 N
 c. 0.066 N d. 0.66 N
63. The IUPAC name for tertiary butyl iodide is
 a. 4-iodobutane
 b. 2-iodobutane
 c. 1-iodo, 3-methyl propane
 d. 2-iodo, 2-methyl propane
64. When sulphur dioxide is passed in an acidified $K_2Cr_2O_7$ solution, the oxidation state of sulphur is changed from
 a. + 4 to 0 b. + 4 to + 2
 c. + 4 to + 6 d. + 6 to + 4
65. Mass of 0.1 mole of methane is
 a. 1g b. 16 g c. 1.6 g d. 0.1 g
66. Methoxy methane and ethanol are
 a. position isomers
 b. chain isomers
 c. functional isomers
 d. optical isomers
67. When the azimuthal quantum number has the value of 2, the number of orbitals possible are
 a. 7 b. 5
 c. 3 d. 0
68. For the reaction,
 $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$, the volume of carbon monoxide required to reduce one mole of ferric oxide is
 a. 22.4 dm³ b. 44.8 dm³
 c. 67.2 dm³ d. 11.2 dm³
69. The monomers of buna-S rubber are
 a. vinyl chloride and sulphur
 b. butadiene
 c. styrene and butadiene
 d. isoprene and butadiene

70. An element with atomic number 21 is a
 a. halogen
 b. representative element
 c. transition element
 d. alkali metal
71. The maximum number of hydrogen bonds that a molecule of water can have is
 a. 1 b. 2 c. 3 d. 4
72. A gas deviates from ideal behaviour at a high pressure because its molecules
 a. attract one another
 b. show the Tyndall effect
 c. have kinetic energy
 d. are bound by covalent bonds
73. The reagent used to convert an alkyne to alkene is
 a. Zn/HCl b. Sn/HCl
 c. Zn-Hg/HCl d. Pd/H₂
74. When, compared to ΔG° for the formation of Al₂O₃, the ΔG° for the formation of Cr₂O₃ is
 a. higher b. lower
 c. same d. unpredicted
75. In order to increase the volume of a gas by 10%, the pressure of the gas should be
 a. increased by 10% b. increased by 1%
 c. decreased by 10% d. decreased by 1%
76. Catalytic dehydrogenation of a primary alcohol gives a/an
 a. secondary alcohol b. aldehyde
 c. ketone d. ester
77. Excess of PCl₅ reacts with conc. H₂SO₄ giving
 a. chlorosulphonic acid b. thionyl chloride
 c. sulphuryl chloride d. sulphurous acid
78. If one mole of ammonia and one mole of hydrogen chloride are mixed in a closed container to form ammonium chloride gas, then
 a. $\Delta H > \Delta U$
 b. $\Delta H = \Delta U$
 c. $\Delta H < \Delta U$
 d. there is no relationship
79. The compound on dehydrogenation gives a ketone. The original compound is
 a. primary alcohol b. secondary alcohol
 c. tertiary alcohol d. carboxylic acid
80. Which is the most easily liquefiable rare gas?
 a. Xe b. Kr c. Ar d. Ne
81. Mesomeric effect involves delocalisation of
 a. π -electrons b. σ -electrons
 c. protons d. None of these
82. Which of the following has the maximum number of unpaired *d*-electrons?
 a. Zn²⁺ b. Fe²⁺ c. Ni³⁺ d. Cu⁺
83. One mole of which of the following has the highest entropy?
 a. Liquid nitrogen b. Hydrogen gas
 c. Mercury d. Diamond
84. Which of the following species does not exert a resonance effect?
 a. C₆H₅NH₂ b. C₆H₅⁺NH₃⁺
 c. C₆H₅OH d. C₆H₅Cl
85. A complex compound in which the oxidation number of a metal is zero, is
 a. K₄[Fe(CN)₆] b. K₃[Fe(CN)₆]
 c. [Ni(CO)₄] d. [Pt(NH₃)₄]Cl₂
86. Three moles of PCl₅, three moles of PCl₃ and two moles of Cl₂ are taken in a closed vessel. If at equilibrium the vessel has 1.5 moles of PCl₅, the number of moles of PCl₃ present in it is
 a. 5 b. 3 c. 6 d. 4.5
87. How many optically active stereoisomers are possible for butan-2, 3-diol?
 a. 1 b. 2 c. 3 d. 4
88. An octahedral complex is formed when hybrid orbitals of the following type are involved
 a. sp³ b. d sp²
 c. d²sp³ d. sp²d²
89. For the reaction,
 2HI(g) \rightleftharpoons H₂(g) + I₂(g); -Q kJ, the equilibrium constant depends upon
 a. temperature b. pressure
 c. catalyst d. volume
90. The angle strain in cyclobutane is
 a. 24°44' b. 29°16'
 c. 19°22' d. 9°44'
91. The number of nodal planes present in σ^* -antibonding orbital is
 a. 1 b. 2 c. 0 d. 3
92. Which of the following electrolytic solution has the least specific conductance?
 a. 0.02 N b. 0.2 N
 c. 2 N d. 0.002 N
93. The overlapping of orbitals in benzene is of the type
 a. sp-sp b. p-p
 c. sp²-sp² d. sp³-sp³

- 113.** Amines behave as
 a. Lewis acids b. Lewis base
 c. aprotic acid d. neutral compound
- 114.** Dalda is prepared from oils by
 a. oxidation b. reduction
 c. hydrolysis d. distillation
- 115.** The chemical name of anisole is
 a. ethanoic acid b. methoxy benzene
 c. propanone d. acetone
- 116.** The number of disulphide linkages present in insulin are
 a. 1 b. 2 c. 3 d. 4
- 117.** 80 g of oxygen contains as many atoms as in
 a. 80 g of hydrogen b. 1 g of hydrogen
 c. 10 g of hydrogen d. 5 g of hydrogen

- 118.** Which metal has a greater tendency to form metal oxide?
 a. Cr b. Fe
 c. Al d. Ca
- 119.** Identify the reaction that does not take place in a blast furnace.
 a. $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$
 b. $\text{CaO} + \text{SiO}_2 \longrightarrow \text{CaSiO}_3$
 c. $2\text{Fe}_2\text{O}_3 + 3\text{C} \longrightarrow 4\text{Fe} + 3\text{CO}_2$
 d. $\text{CO}_2 + \text{C} \longrightarrow 2\text{CO}$
- 120.** Waxes are esters of
 a. glycerol
 b. long chain alcohols
 c. glycerol and fatty acid
 d. long chain alcohols and long chain fatty acids

MATHEMATICS

- 121.** Which of the following is an even function?
 a. \sqrt{x} b. $x^2 + \sin^2 x$
 c. $\sin^3 x$ d. None of these
- 122.** If $A = \{x : x^2 - x + 2 > 0\}$ and $B = \{x : x^2 - 4x + 3 \leq 0\}$, then $A \cap B$ is
 a. $[1, 3]$ b. $(-\infty, \infty)$
 c. $(1, 3)$ d. $(-\infty, 1) \cup (3, \infty)$

- 123.** If $*$ be a binary operation on a set A and e be the identity element w.r.t. $*$, then $b \in A$ is said to be inverse of $a \in A$ w.r.t. $*$, if
 a. $a * e = b * e$ b. $a = b$
 c. $a * a = b * b$ d. $a * b = b * a = e$

- 124.** If in a $\triangle ABC$, $\angle C = \frac{\pi}{2}$, then

$$\tan^{-1}\left(\frac{a}{b+c}\right) + \tan^{-1}\left(\frac{b}{c+a}\right) =$$

a. $\frac{\pi}{4}$ b. $\frac{\pi}{2}$
 c. $\frac{\pi}{3}$ d. None of these

- 125.** The sides a, b, c of a triangle are in AP. If $\cos \alpha = \frac{a}{b+c}$, $\cos \beta = \frac{b}{c+a}$, $\cos \gamma = \frac{c}{a+b}$

$$\text{then } \tan^2 \frac{\alpha}{2} + \tan^2 \frac{\gamma}{2} =$$

a. 1 b. $\frac{1}{2}$ c. $\frac{1}{3}$ d. $\frac{2}{3}$

- 126.** The value of $\cos(35^\circ + A) \cos(35^\circ - B) + \sin(35^\circ + A) \sin(35^\circ - B)$ is equal to
 a. $\sin(A + B)$ b. $\sin(A - B)$
 c. $\cos(A + B)$ d. $\cos(A - B)$
- 127.** The value of $2 \operatorname{cosec} 2x + \operatorname{cosec} x$ is equal to
 a. $\tan x \cdot \sec(x/2)$ b. $\sec x \cdot \cot(x/2)$
 c. $\sec x \cdot \tan(x/2)$ d. $\tan x \cdot \cot(x/2)$
- 128.** The value of $\cot 2x \cot x - \cot 3x \cot 2x - \cot 3x \cot x$ is equal to
 a. 3 b. 0 c. -1 d. 1
- 129.** The value of $\cos\left(\frac{\pi}{4} - x\right) \cos\left(\frac{\pi}{4} - y\right) - \sin\left(\frac{\pi}{4} - x\right) \sin\left(\frac{\pi}{4} - y\right)$ is equal to
 a. $\sin(x + y)$ b. $\sin(x - y)$
 c. $\cos(x + y)$ d. $\cos(x - y)$
- 130.** For all $n \in N$, $2 \cdot 4^{2n+1} + 3^{3n+1}$ is divisible by
 a. 2 b. 9
 c. 3 d. 11
- 131.** The statement $P(n): '1 \times 1! + 2 \times 2! + 3 \times 3! + \dots + n \times n! = (n+1)! - 1'$ is
 a. true for all $n > 1$ b. not true for any n
 c. true for all $n \in N$ d. None of these
- 132.** If $z = re^{i\theta}$, then $|e^{iz}| =$
 a. 1 b. $e^{2r \sin \theta}$
 c. $e^{r \sin \theta}$ d. $e^{-r \sin \theta}$

169. The value of $[a - b \quad b - c \quad c - a]$, where $|a| = 1$, $|b| = 5$, $|c| = 3$, is

- a. 0
b. 1
c. 6
d. None of these

170. If $A = \begin{bmatrix} 2 & -3 \\ 5 & -7 \end{bmatrix}$, then $A + A^{-1} =$

- a. $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
b. $\begin{bmatrix} -5 & 0 \\ 0 & -5 \end{bmatrix}$
c. $\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$
d. $\begin{bmatrix} 4 & 0 \\ 0 & -5 \end{bmatrix}$

171. If $A = \begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$, then minor and cofactor of a_{32} are

- a. 1, -1
b. 0, 1
c. -1, 0
d. 0, 0

172. An anti-aircraft gun can take a maximum of 4 shots at an enemy plane moving away from it. The probabilities of hitting the plane at the first, second, third and fourth shot are 0.4, 0.3, 0.2, 0.1 respectively. The probability that the gun hits the plane is

- a. 0.6972
b. 0.6875
c. 0.64
d. 0.6976

173. The negation of the statement "If I become a teacher, then I will open a school", is

- a. Neither I will become a teacher nor I will open a school.
b. I will not become a teacher or I will open a school.
c. I will become a teacher and I will not open a school.
d. Either I will not become a teacher or I will not open a school.

174. Maximize $Z = 7x_1 - 3x_2$ subject to,

$$x_1 + 2x_2 \leq 2, 2x_1 + 4x_2 \geq 8, x_1 \geq 0, x_2 \geq 0.$$

- a. Unique solution
b. Unbounded solution
c. Infeasible solution
d. Infinite number of solutions

175. Find the transformed equation of the straight line $xy - x - y + 1 = 0$, when the origin is shifted to the point (1, 1) after translation of axes.

- a. $xy = 5$
b. $xy = 2$

- c. $xy = 0$
d. $xy = 8$

176. If $\log_6 a + \log_6 b + \log_6 c = 6$, where a, b and c are positive integers that form an increasing GP and $b - a$ is a square of an integer, then $a + b + c =$

- a. 95
b. 99
c. 105
d. 111

177. A random variable X has the following probability distribution :

X	0	1	2	3
$P(X = x)$	0.5	0.2	0.18	0.12

Find the c.d.f. of X

a.

$X = x$	0	1	2	3
$F(x)$	0.12	0.18	0.2	0.5

b.

$X = x$	0	1	2	3
$F(x)$	0.5	0.88	1	0.7

c.

$X = x$	0	1	2	3
$F(x)$	0.5	0.7	0.88	1

d.

$X = x$	0	1	2	3
$F(x)$	1	0.5	0.88	0.7

178. From a lot of 20 items containing 4 defective items, 2 items are drawn at random. If X denotes the number of defective items, then find the mean of the probability distribution of X .

- a. $\frac{3}{8}$
b. $\frac{1}{95}$
c. $\frac{2}{5}$
d. $\frac{28}{57}$

179. The total number of subsets of a finite set A has 56 more elements than the total number of subsets of another finite set B . What is the number of elements in the set A ?

- a. 5
b. 6
c. 7
d. 8

180. If $\log_4 2 + \log_4 4 + \log_4 x + \log_4 16 = 6$, then the value of x is

- a. 64
b. 4
c. 8
d. 32

ANSWERS

Physics

1. (c)	2. (c)	3. (d)	4. (b)	5. (c)	6. (b)	7. (d)	8. (d)	9. (a)	10. (c)
11. (c)	12. (b)	13. (c)	14. (c)	15. (a)	16. (b)	17. (b)	18. (b)	19. (c)	20. (b)
21. (c)	22. (b)	23. (c)	24. (a)	25. (b)	26. (c)	27. (b)	28. (a)	29. (b)	30. (b)
31. (c)	32. (a)	33. (b)	34. (c)	35. (c)	36. (c)	37. (b)	38. (c)	39. (b)	40. (c)
41. (b)	42. (a)	43. (c)	44. (d)	45. (d)	46. (b)	47. (c)	48. (a)	49. (a)	50. (b)
51. (a)	52. (b)	53. (b)	54. (b)	55. (b)	56. (d)	57. (d)	58. (d)	59. (d)	60. (a)

Chemistry

61. (b)	62. (c)	63. (d)	64. (c)	65. (c)	66. (c)	67. (b)	68. (c)	69. (c)	70. (c)
71. (d)	72. (a)	73. (d)	74. (b)	75. (c)	76. (b)	77. (b)	78. (c)	79. (b)	80. (a)
81. (a)	82. (b)	83. (b)	84. (b)	85. (c)	86. (d)	87. (b)	88. (c)	89. (a)	90. (d)
91. (a)	92. (d)	93. (c)	94. (c)	95. (a)	96. (b)	97. (a)	98. (a)	99. (b)	100. (c)
101. (b)	102. (b)	103. (c)	104. (b)	105. (c)	106. (a)	107. (c)	108. (c)	109. (a)	110. (a)
111. (a)	112. (d)	113. (b)	114. (b)	115. (b)	116. (c)	117. (d)	118. (d)	119. (c)	120. (d)

Mathematics

121. (b)	122. (a)	123. (d)	124. (a)	125. (d)	126. (c)	127. (b)	128. (d)	129. (a)	130. (d)
131. (c)	132. (d)	133. (b)	134. (c)	135. (d)	136. (d)	137. (d)	138. (a)	139. (d)	140. (a)
141. (a)	142. (d)	143. (a)	144. (c)	145. (b)	146. (a)	147. (c)	148. (c)	149. (a)	150. (b)
151. (a)	152. (b)	153. (c)	154. (b)	155. (a)	156. (d)	157. (d)	158. (d)	159. (c)	160. (a)
161. (a)	162. (a)	163. (b)	164. (c)	165. (b)	166. (a)	167. (c)	168. (a)	169. (a)	170. (b)
171. (d)	172. (d)	173. (c)	174. (c)	175. (c)	176. (d)	177. (c)	178. (c)	179. (b)	180. (d)

HINTS & SOLUTIONS

Physics

1. (c) The air resistance on an object depends on its area, normal to air flow.

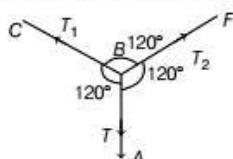
Since, area normal to air flow is maximum in case of disc.

So, air resistance on it is maximum. The air flow in case of cigar shaped is streamlined, so air resistance is minimum.

Hence, the correct order is

$$\text{III} < \text{II} < \text{I}$$

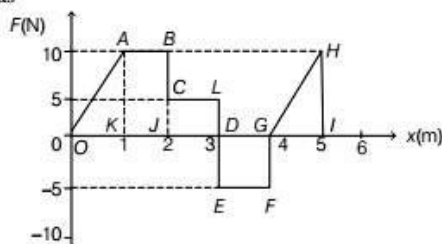
2. (c) Let tension in section BC is T and in section BF is T_2 , then according to Lami's theorem,



$$\frac{T_1}{\sin 120^\circ} = \frac{T_2}{\sin 120^\circ} = \frac{T}{\sin 120^\circ}$$

$$\Rightarrow T_1 = T_2 = T = 10 \text{ N}$$

3. (d) The velocity of light in vacuum is 3×10^8 m/s, which is a dimensional constant.
4. (b) The work done in a F - x graph is calculated by the area under the graph. The given graph can be shown as



\therefore Work done in displacing the object from $x = 1$ m to $x = 5$ m will be

$$\begin{aligned} W &= \text{area under } F\text{-}x \text{ graph} \\ &= \text{area } ABJK + \text{area } CLD \\ &\quad + \text{area } DCFE + \text{area } GHI \\ &= (10 \times 1) + (5 \times 1) + (-5 \times 1) + \left(\frac{1}{2} \times 1 \times 10\right) \\ &= 10 + 5 - 5 + 5 = 15 \text{ J} \end{aligned}$$

5. (c) The first stone move up to some height and then its velocity becomes zero. Now, it move downward and at the level of top of tower, it acquires the same initial velocity u and gravitational acceleration g in downward direction.

The second stone is moving with the same speed u and with downward acceleration g . So, both will have same

final velocity when they reach the bottom and hit the ground.

6. (b) The gravitational acceleration on earth is given by

$$g = \frac{F}{m} = \frac{GMm}{R^2 \times m} = \frac{GM}{R^2}$$

$$\therefore \frac{g}{G} = \frac{M}{R^2}$$

7. (d) According to Newton's law, the state of an object can be changed by applying external force on it. In given case the force applied is internal, so he will not succeed.

8. (d) The pressure applied at the bottom of a container by a liquid column of height h is given by

$$p = h\rho g$$

Here, in two cases, the liquid used is same (water), so ρ is same. Also, the height of liquid column is same on both. So, the pressure applied at the bottom is same for both.

9. (a) Young's modulus, $Y = \frac{\text{Stress}}{\text{Strain}}$

Here, strain is a dimensionless quantity and stress is measured in SI unit of Nm^{-2} , dyne cm^{-2} or pascal.

So, the Young's modulus has the same unit as stress.

$\therefore \text{Nm}^{-1}$ is not a unit of Young's modulus.

10. (c) When blue glass is heated to a high temperature, it absorbs all radiations of higher wavelength except red. So, when it is taken inside a dimly lit room, it emits all radiations and hence looks brighter red compared to the red piece. This happens according to Kirchhoff's law of radiation.

11. (c) According to Wien's law, the wavelength of radiation emitted by a body is

$$\lambda \propto \frac{1}{T}$$

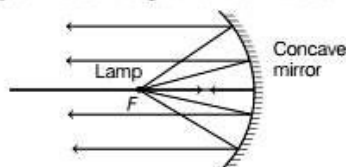
i.e., it depends on the temperature of the surface.

12. (b) Work done in a cyclic process is equal to the area enclosed by the cycle in p - V diagram.

$$\begin{aligned} \therefore W &= \text{Area } ABCD \\ &= AB \times AD \\ &= (2p - p) \times (2V - V) = p \times V = pV \end{aligned}$$

13. (c) A concave mirror is of converging type as the light parallel to principal axis converges at its focus.

So, when a lamp is placed at its focus, the ray of light falling on it becomes parallel beam as shown below.

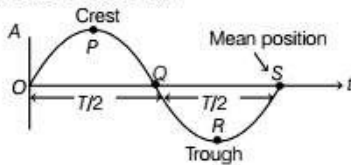


14. (c) The power of a lens is given by the reciprocal of its focal length,

$$P = \frac{1}{f}$$

When f is in metre, then power P is in dioptre. Thus, power depends on the system of unit used to measure f .

15. (a) In first figure, the parallel rays are converging at a point before the retina. So, the person is suffering from near-sightedness.
 16. (b) Infrared radiation was discovered in 1800 by William Herschel.
 17. (b) As total time period of a wave is T . The wave motion can be shown as



From figure, it can be seen that time taken by the particle to move from trough to its mean position i.e., from R to S is

$$T' = \frac{T/2}{2} = \frac{T}{4}$$

18. (b) The number of waves produced by the disc is equal to number of notes

i.e., $n = 60$
 Speed of rotation, $v = 360 \text{ rpm}$
 $= \frac{360}{60} = 6 \text{ rps}$

\therefore Frequency $= n \times v = 60 \times 6 = 360 \text{ Hz}$

19. (c) The velocity of sound in a gas is given by

$$v = \sqrt{\frac{\gamma RT}{M}}$$

At STP, both gases are at same temperature and as they are diatomic, so their specific heat ratio (γ) is also same.

$$\therefore \frac{v_H}{v_O} = \sqrt{\frac{M_O}{M_H}} = \sqrt{\frac{32}{2}} = 4 \text{ or } 4 : 1$$

20. (b) The wavelength of the sound is proportional to the length of wire. Also, the velocity of sound is same in both cases, so

$$\begin{aligned} \Rightarrow v_1 &= v_2 \\ \Rightarrow f_1 \lambda_1 &= f_2 \lambda_2 \\ \Rightarrow 256 \times 25 &= f_2 \times 16 \\ \Rightarrow f_2 &= \frac{256 \times 25}{16} = 400 \text{ Hz} \end{aligned}$$

21. (c) Let f_s be the frequency of source.

The apparent frequency heard when listener moves towards source is

$$f' = f_s \left(\frac{v_s + v_o}{v_s} \right)$$

$$\Rightarrow 200 = f_s \left(\frac{v_s + 40}{v_s} \right) \quad \dots(i)$$

The apparent frequency heard, when listener moves away from source is

$$f'' = f_s \left(\frac{v_s - v_o}{v_s} \right)$$

$$\Rightarrow 160 = f_s \left(\frac{v_s - 40}{v_s} \right) \quad \dots(ii)$$

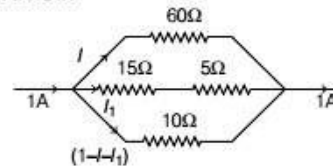
Dividing Eq. (i) by Eq. (ii), we get

$$\begin{aligned} \frac{200}{160} &= \frac{v_s + 40}{v_s - 40} \\ \Rightarrow \frac{5}{4} &= \frac{v_s + 40}{v_s - 40} \\ \Rightarrow 5v_s - 200 &= 4v_s + 160 \\ \Rightarrow v_s &= 360 \text{ m/s} \end{aligned}$$

22. (b) Christian Huygens believed that the light was made up of waves vibrating up and down perpendicular to the direction of propagation of wave. This is known as Huygens principle.

23. (c) If a liquid does not wet glass, it means that the liquid-liquid interaction (cohesion) is more than liquid-solid interaction (adhesion). So, the angle of contact is obtuse.

24. (a) Consider the diagram with current distribution as shown below.



As voltage is same in parallel combination, so

$$\begin{aligned} 60I &= (15 + 5)I_1 \\ 60I &= 20I_1 \text{ or } I_1 = 3I \quad \dots(i) \end{aligned}$$

Similarly, $(15 + 5)I_1 = 10(1 - I - I_1)$

$$\begin{aligned} \Rightarrow 20I_1 &= 10 - 10I - 10I_1 \\ \Rightarrow 30I_1 &= 10 - 10I \\ \Rightarrow 3(3I) &= 10 - 10I \quad [\text{Using Eq. (i)}] \\ \Rightarrow 10I &= 10 \\ \text{or } I &= \frac{10}{10} = 1 \text{ A} \end{aligned}$$

25. (b) We know that, radius of charge particle of mass m having charge q moving with speed v in magnetic field perpendicular to it,

$$r = mv / Bq \quad \dots(i)$$

For second case,

$$\begin{aligned} r' &= \frac{mv'}{qB'} = \frac{m(2v)}{q\left(\frac{B}{2}\right)} \left[\text{Since, } v' = 2v, B' = \frac{B}{2} \right] \\ &= 4 \frac{mv}{qB} = 4r \quad [\text{using Eq. (i)}] \end{aligned}$$

26. (c) Total emf of circuit, $E_T = E + E = 2E$
 Total resistance of circuit, $R_T = r_1 + r_2 + R$
 Current flowing through the circuit,

$$i = \frac{E_T}{R_T} = \frac{2E}{r_1 + r_2 + R} \quad \dots(i)$$

As per question $E = ir_1$

$$\Rightarrow i = \frac{E}{r_1} \quad \dots(ii)$$

From Eqs. (i) and (ii), we get

$$\frac{E}{r_1} = \frac{2E}{r_1 + r_2 + R}$$

$$\Rightarrow r_1 + r_2 + R = 2r_1$$

$$\Rightarrow R = r_1 - r_2$$

27. (b) The maximum and minimum resistances are 16Ω and 3Ω that are obtained by series and parallel combination of resistances. From given option only 4Ω and 12Ω resistors satisfies this condition.

28. (a) According to Fleming's right hand rule, for current in South-North direction, magnetic field in inward direction, the force on the electrons will be to the left or in West side.

29. (b) The deflection in a tangent galvanometer is given by

$$\tan \theta = \frac{I}{K}$$

where, K = reduction factor
 Here, $K = 1A$, $I = 1A$

$$\therefore \tan \theta = \frac{1}{1} = 1 \Rightarrow \theta = 45^\circ$$

30. (b) If R be the resistance of voltmeter, then the equivalent resistance of circuit is

$$R_{eq} = \frac{R \times 100}{100 + R} + 50$$

$$= \frac{150R + 5000}{R + 100}$$

Total current in circuit,

$$i = \frac{V}{R_{eq}} = \frac{10}{\frac{150R + 5000}{R + 100}}$$

$$= \frac{10(R + 100)}{150R + 5000}$$

Voltage across 100Ω resistor,

$$V = i \left(\frac{R \times 100}{R + 100} \right)$$

Given, $V = 5V$

$$\therefore 5 = \frac{10(R + 100)}{150R + 5000} \times \frac{R \times 100}{R + 100}$$

$$= \frac{1000R}{150R + 5000}$$

$$\Rightarrow 750R + 25000 = 1000R$$

$$\Rightarrow R = 100\Omega$$

31. (c) Force on 25 cm length of wire C due to wire D is

$$F_D = \frac{\mu_0}{4\pi} \frac{2I_1 I_2}{r} \times l$$

$$= 10^{-7} \times \frac{30 \times 10 \times 2}{3 \times 10^{-2}} \times 25 \times 10^{-2}$$

$$= 5 \times 10^{-4} \text{ N, towards right}$$

Force of 25 cm length of wire C due to wire G is

$$F_G = 10^{-7} \times \frac{2 \times 20 \times 10}{2 \times 10^{-2}} \times 25 \times 10^{-2}$$

$$= 5 \times 10^{-4} \text{ N, towards left}$$

\therefore Net force on wire C = $F_D - F_G = 0$

32. (a) Given, $I = 5A$, $V = 6V$, $t = 6 \text{ min} = 6 \times 60 = 360 \text{ s}$
 Heat produced in a circuit = Chemical energy reduced in the battery

$$\Rightarrow H = VIt$$

$$= 6 \times 5 \times 360$$

$$= 10800 = 1.08 \times 10^4 \text{ J}$$

33. (b) Given, $I_1 = 5A$, $R_2 = 2\Omega$, $I_2 = 4A$

Let initial resistance be R .

As voltage given is same in both cases, so

$$V_1 = V_2$$

$$\Rightarrow I_1 R = I_2 R' = I_2 (R + R_2)$$

$$\Rightarrow 5 \times R = 4 \times (R + 2) \Rightarrow R = 8\Omega$$

34. (c) Given, $R_1 = 100\Omega$, $R_2 = R_3 = 50\Omega$, $E = 6V$,

$$R_4 = 75\Omega$$

As R_2, R_3 and R_4 are in parallel combination, so their equivalent resistance be

$$\frac{1}{R'} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$= \frac{1}{50} + \frac{1}{50} + \frac{1}{75} = \frac{3 + 3 + 2}{150} = \frac{8}{150}$$

$$\text{or } R' = \frac{150}{8} \Omega$$

Now, R' is in series with R_1 , so

$$R_{net} = R_1 + R' = 100 + \frac{150}{8} = \frac{950}{8} = 118.75\Omega$$

35. (c) In first case, at balance point,

$$\frac{P}{Q} = \frac{l}{100 - l} = \frac{20}{100 - 20} = \frac{1}{4} \Rightarrow Q = 4P \quad \dots(i)$$

Let P be the smaller resistance, then in second case at balance point,

$$\frac{P + 15}{Q} = \frac{l'}{100 - l'} = \frac{40}{60} = \frac{2}{3}$$

$$\Rightarrow \frac{P + 15}{4P} = \frac{2}{3} \quad \text{[Using Eq. (i)]}$$

$$\Rightarrow 3P + 45 = 8P \Rightarrow P = 9\Omega$$

36. (c) Given, electric field, $E = 1500 \text{ V/m}$

Magnetic field, $B = 0.4 \text{ Wb/m}^2$

Charge on electron, $q = e = 1.6 \times 10^{-19} \text{ C}$

For minimum uniform speed of electron along a straight line is a region, where electric field E and magnetic field B , both are present is given as

$$v = \frac{E}{B} \quad \left[\begin{array}{l} \because qE = Bqv \\ \Rightarrow v = \frac{E}{B} \end{array} \right]$$

$$= \frac{1500}{0.4}$$

$$= 3750 \text{ m/s}$$

$$= 3.75 \times 10^3 \text{ m/s}$$

37. (b) If I be the main current, then current passing through galvanometer,

$$I_g = 10\% \text{ of } I = \frac{I}{10}$$

Resistance of galvanometer, $R_g = G$

$$\text{Shunt resistance, } R_s = \frac{I_g R_g}{I - I_g} = \frac{\frac{I}{10} \times G}{I - \frac{I}{10}} = \frac{G}{9}$$

38. (c) Magnetic susceptibility of diamagnetic materials is small and negative.
Diamagnetic material do not have permanent magnetic moment because the magnetic moment of individual electrons neutralise each other due randomly oriented.
39. (b) The induction coil works on the principle of mutual induction. In the phenomena of mutual induction, an emf is induced across the secondary coil if the magnetic flux due to primary coil linked with the secondary coil changes.
40. (c) We know that, in L - C - R series resonant circuit, resonance frequency,

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$\Rightarrow \sqrt{LC} = \frac{1}{2\pi f}$$

$$\Rightarrow \sqrt{LC} = \frac{1}{\omega} \quad [\omega = \text{angular frequency}]$$

$$\therefore \text{Dimension of } \sqrt{LC} = \frac{1}{\text{Dimension of } \omega}$$

$$\Rightarrow [\sqrt{LC}] = \frac{1}{[\omega]} = \frac{1}{[T^{-1}]} = [T]$$

Hence, square root of the product of inductance $[L]$ and capacitance $[C]$ has the dimension of time.

41. (b) Given, $q_1 = -14 \text{ nC} = -14 \times 10^{-9} \text{ C}$
 $q_2 = 78.85 \text{ nC} = 78.85 \times 10^{-9} \text{ C}$
 $q_3 = -56 \text{ nC} = -56 \times 10^{-9} \text{ C}$

According to Gauss's law

Net electric flux passing through closed surface A ,

$$\Phi_A = \frac{1}{\epsilon_0} (\text{total charged enclosed by closed surface } A)$$

$$= \frac{1}{\epsilon_0} (q_1 + q_2 + q_3)$$

$$= \frac{-14 \times 10^{-9} + 78.85 \times 10^{-9} - 56 \times 10^{-9}}{8.85 \times 10^{-12}}$$

$$= \frac{8.85}{8.85} \times 10^{-9+12} = 10^3 \text{ CN}^{-1} \text{ m}^{-2}$$

42. (a) In case of spherical metal conductor, the charges quickly spread over its entire surface uniformly because of which charges can stay for longer time on spherical conductor.

While in case of non-spherical surfaces, charge concentration is different at different points due to which the charges do not stay on the surfaces for longer time.

43. (c) When we give charge to a conductor, then its potential increases.

$$\text{Potential, } V = \frac{\text{Charge}(Q)}{\text{Capacitance}(C)}$$

$$\Rightarrow V = \frac{Q}{\epsilon_0 \frac{A}{d}} \quad \left[\because C = \frac{\epsilon_0 A}{d} \right]$$

$$\Rightarrow V = \frac{Qd}{\epsilon_0 A}$$

Hence, V also depends on d and A . Thus, potential of conductor depends on the amount of charge, area or geometry and size of the conductor.

44. (d) According to given situation of charges, electrostatic force works which is conservative in nature i.e., work done depends on initial and final position only. Here, initial and final position coincide, hence work done will be zero.

45. (d) Given, capacitance of air filled parallel plate capacitor,

$$C_0 = 2 \text{ pF}$$

$$= 2 \times 10^{-12} \text{ F}$$

$$\Rightarrow \frac{\epsilon_0 A}{d} = 2 \times 10^{-12} \text{ F} \quad \dots(i)$$

When the separation between the plates is doubled, i.e.,

$$d' = 2d$$

And wax of dielectric constant k is filled between the plates of capacitor, then,

$$C' = 6 \text{ pF}$$

$$\frac{\epsilon_0 k A}{d'} = 6 \times 10^{-12} \text{ F}$$

$$\Rightarrow \frac{\epsilon_0 k A}{2d} = 6 \times 10^{-12} \quad [\because d' = 2d]$$

$$\Rightarrow \frac{\epsilon_0 A}{d} \times \frac{k}{2} = 6 \times 10^{-12}$$

$$\Rightarrow 2 \times 10^{-12} \times \frac{k}{2} = 6 \times 10^{-12} \quad [\text{from Eq. (i)}]$$

$$\Rightarrow k = 6$$

46. (b) According to Coulomb's law, electrostatic force acts only between two charge particles. Neutron is a neutral particle, therefore Coulomb's law is applicable only for protons.

47. (c) Given, In first case,

Wavelength of violet light,
 $\lambda_1 = 400 \text{ nm}$

We know that, width of the diffraction pattern is given as

$$\begin{aligned} \beta &= y = \frac{2D\lambda_1}{d} \\ \Rightarrow y &= \frac{2D\lambda_1}{d} = \frac{2D \times 400}{d} \\ y &= \frac{800D}{d} \quad \dots(i) \end{aligned}$$

In the second case,

$$\begin{aligned} \lambda_2 &= 600 \text{ nm}, d' = \frac{d}{2} \\ \therefore y' &= \frac{2D\lambda'}{d'} = \frac{2D \times 600}{\frac{d}{2}} \\ &= 2400 \frac{D}{d} = 3 \times \frac{800D}{d} \\ &= 3y \quad \text{[from Eq. (i)]} \end{aligned}$$

48. (a) Diameter of objective,

$$D_1 = 1 \text{ m}, D_2 = 254 \text{ m}$$

$$\text{Resolving power, } R_p = \frac{D}{1.22\lambda}$$

Since, $R_p \propto D$ [For same value of λ]

$$\therefore \frac{R_{p_1}}{R_{p_2}} = \frac{D_1}{D_2} = \frac{1}{2.54}$$

$$\Rightarrow R_{p_2} = 2.54 \times R_{p_1}$$

49. (a) According to phenomena of polarisation by reflection, when unpolarised light beam is incident from air onto glass ($n = 1.5$) at the polarising angle (Brewster's angle), then reflected beam is polarised completely i.e. 100%.

50. (b) In Huygens principle, the wave theory was established by assuming that the waves were longitudinal. So, option (a) is not correct.

In Maxwell's theory of light, he stated that light is a transverse wave and conducted various experiments to prove so. Hence, option (b) is correct.

Thomas Young conducted his double slit experiment for determining fringe width and tried to prove the wave nature of light by providing that light undergoes interference which is a phenomenon showed by waves. He never proved the type of wave light is, i.e. transverse or longitudinal. Hence, option (c) is not correct.

These statements mostly highlight the wave nature of light. They do not comment on the particle nature of light or the dual nature of light established. Hence, they clearly do not answer the question "what is light" correctly. Hence, option (d) is not correct.

51. (a) Given, intensity of two coherent light beams,

$$I_1 = I \text{ and } I_2 = 4I$$

After superposition of two light beams,

\therefore Maximum intensity,

$$\begin{aligned} I_{\max} &= (\sqrt{I_1} + \sqrt{I_2})^2 \\ &= I_1 + I_2 + 2\sqrt{I_1 I_2} \\ &= I + 4I + 2\sqrt{I \cdot 4I} = 9I \end{aligned}$$

Minimum intensity,

$$\begin{aligned} I_{\min} &= (\sqrt{I_1} - \sqrt{I_2})^2 \\ &= I_1 + I_2 - 2\sqrt{I_1 I_2} \\ &= I + 4I - 2\sqrt{I \cdot 4I} = I \end{aligned}$$

52. (b) According to given figure, the graph between stopping potential and frequency is a straight line, therefore stopping potential (V_0) and hence maximum kinetic energy ($K_{\max} = eV_0$) of photoelectrons depends linearly on the frequency. Since, threshold frequency for Na is less than that of for Al, therefore work function for Na will be lesser than that of Al. Hence, Na is better photosensitive material than Al.

53. (b) Here, for hydrogen atom, $Z = 1$

We know that, time period of electron in n th orbit is given as

$$\begin{aligned} T_n &\propto n^3 \\ \therefore \frac{T_{n_1}}{T_{n_2}} &= \frac{n_1^3}{n_2^3} \end{aligned}$$

Since, $T_{n_1} = 8T_{n_2}$

$$\therefore \frac{8T_{n_2}}{T_{n_2}} = \frac{n_1^3}{n_2^3} \Rightarrow 2^3 = \left(\frac{n_1}{n_2}\right)^3$$

$$\Rightarrow n_1 = 2n_2$$

Hence, this condition satisfies only in option (b).

i.e., $n_1 = 4$ and $n_2 = 2$

54. (b) When forward voltage in a diode is increased, then it opposes the potential barrier. Due to it, the potential barrier is considerably reduced and hence depletion region decreases.

55. (b) Since, nuclear force is independent of charge of the nucleons. Thus, nuclear force is same for any pair of two nucleons which are at same distance apart.

Therefore, $F_1 = F_2 = F_3$

56. (d) Given, initial value of de-Broglie wavelength,

$$\lambda_1 = 1 \text{ nm} = 1 \times 10^{-9} \text{ m}$$

Final value of de-Broglie wavelength,

$$\lambda_2 = 0.5 \text{ nm} = 0.5 \times 10^{-9} \text{ m}$$

de-Broglie wavelength in terms of energy E is given as

$$\lambda = \frac{h}{\sqrt{2mE}}$$

$$\therefore \lambda \propto \frac{1}{\sqrt{E}}$$

$$\Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}}$$

where, E_1 and E_2 are initial and final energy,

$$\Rightarrow \frac{1 \times 10^{-9}}{0.5 \times 10^{-9}} = \sqrt{\frac{E_2}{E_1}}$$

$$\Rightarrow 2 = \sqrt{\frac{E_2}{E_1}}$$

$$\Rightarrow E_2 = 4E_1$$

\therefore Addition of energy = $E_2 - E_1 = 4E_1 - E_1 = 3E_1$
= thrice the initial energy

57. (d) Given, mean life of radioactive sample,

$$\tau = 100 \text{ s} = \frac{100}{60} \text{ min} = \frac{5}{3} \text{ min}$$

We know that,

$$\tau = 1.44T_{1/2}$$

$$\Rightarrow T_{1/2} = \frac{\tau}{1.44} = \frac{5/3}{1.44} = \frac{5}{3 \times 1.44} = 1.157 \text{ min}$$

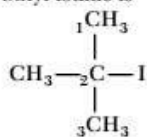
$$\approx 1.155 \text{ min}$$

Chemistry

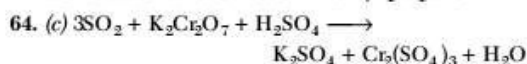
61. (b) The correct order in which first ionisation potential (IP) increases is K, Na, Be. On going down the group IP decreases while on going left to right IP increases.

62. (c) $V_1 = 10 \text{ cm}^3$
 $V_2 = 15 \text{ cm}^3$
 $N_1 = 0.1 \text{ N}$
 $N_2 = ?$
 $N_1V_1 = N_2V_2$
 $N_2 = \frac{0.1 \times 10}{15} = 0.066 \text{ N}$

63. (d) Tertiary butyl iodide is



It's IUPAC name is 2-iodo-2-methyl propane.



O.N. of S in SO_2 is
 $x + 2(-2) = 0$
 $\Rightarrow x = +4$
O.N. of S in K_2SO_4 is
 $2(1) + x + 2(-4) = 0$
 $x = +6$

\therefore O.N. changes from +4 to +6.

65. (c) Mass of 0.1 mole of methane = molar mass \times no. of moles
 $= 16 \times 0.1 = 1.6 \text{ g}$

66. (c) Methoxy methane and ethanol are functional group isomer as one is ether and other is alcohol group.

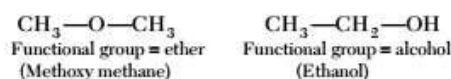
58. (d) The decay's constant (λ) and half-life period of radioactive nuclei remains constant and independent of time of creation of radioactive nuclei.

Hence, the probability of decay during the next time is independent of the time of creation.

59. (d) Bohr assumed one of the postulates of Rutherford's atomic model. That is the mass of the nucleus is very large compared to that of the electrons and hence assumed to be infinite. Electrons in quantised orbit does not radiate energy. Mass of electron remains constant.

60. (a) A semiconductor acts like an insulator only at absolute temperature i.e. 0°K . It is because the free electrons in the valence band of semiconductor will not carry enough thermal energy to overcome the forbidden energy gap at absolute zero.

Hence, option (a) is not correct.

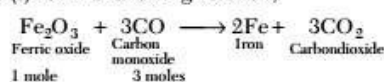


67. (b) The azimuthal quantum number has the value of 2 (i.e., $l = 2$) or (d -orbital).

$$\therefore \text{Magnetic quantum number } (m) \text{ can be } = 2l + 1$$

$$= 2 \times 2 + 1 = 5$$

68. (c) For the following reaction,

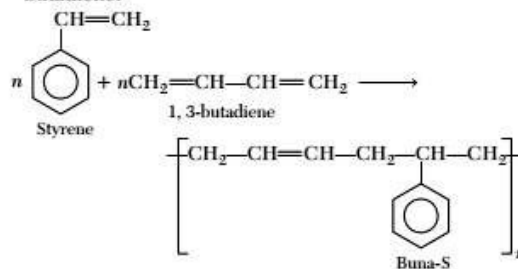


The volume of carbon monoxide require to reduce one mole of ferric oxide is

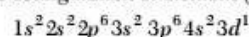
$$= 3 \times 22.4 \text{ dm}^3 = 67.2 \text{ dm}^3$$

\therefore Volume of CO required is 67.2 dm^3 .

69. (c) The monomers of Buna-S rubber are styrene and butadiene.

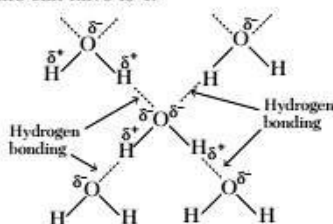


70. (c) Electronic configuration of element (21) is

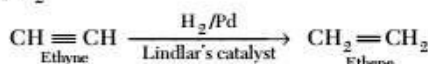


\therefore It is a transition element as its last electron enters in d -orbital.

71. (d) The maximum number of hydrogen bonds that a molecule can have is 4.



72. (a) A gas deviates from ideal behaviour at high pressure because its molecules attract one another as their intermolecular distance decreases.
73. (d) The reagent used to convert alkyne to alkene is Pd/H_2 .



74. (b) ΔG° for the formation of Al_2O_3 is higher than ΔG° for the formation of Cr_2O_3 .

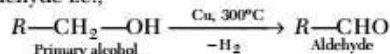
75. (c) According to ideal gas equation

$$pV = nRT$$

$$\therefore V \propto \frac{1}{p}$$

\therefore To increase the volume of gas by 10%, the pressure of gas should be decrease by 10%.

76. (b) Catalytic dehydration of a primary alcohol gives aldehyde i.e.,



77. (b) Excess of PCl_5 reacts with conc. H_2SO_4 to gives thionyl chloride (SO_2Cl_2), phosphorus oxychloride (POCl_3) and HCl .



78. (c) $\text{NH}_3(g) + \text{HCl}(g) \longrightarrow \text{NH}_4\text{Cl}(g)$
- Ammonical Hydrogen Ammonium
chloride chloride chloride

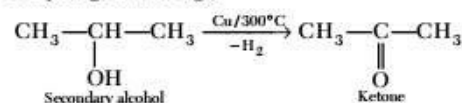
$$\Delta n_g = n_p - n_R = 1 - 2 = -1$$

$$\text{Also, } \Delta H = \Delta U + \Delta n_g RT$$

$$\therefore \Delta H - \Delta U = -ve \quad [:\Delta n_g = -ve]$$

$$\therefore \Delta H < \Delta U$$

79. (b) Secondary alcohols gives ketones on dehydrogenation e.g.,



80. (a) Xenon has largest size and thus has high van der Waals' force of attraction. So, it is easily liquefiable rare gas.

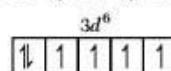
81. (a) Mesomeric effect involves delocalisation of π -electrons. It can show +M-effect and -M-effect. The electron donating functional group shows

+M-effect while electron withdrawing functional group shows -M-effect.

82. (b) The electronic configuration of

$$\text{Fe}(26) = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$$

$$\text{Fe}^{2+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^0$$



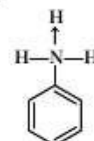
It has four unpaired electrons.

83. (b) The order of entropy is

$$S_{\text{gas}} > S_{\text{liq}} > S_{\text{gas}}$$

\therefore One mole of hydrogen gas has the highest entropy.

84. (b) $\text{C}_6\text{H}_5\text{NH}_2$ does not exert a resonance effect because all the electron pairs of nitrogen are involved in bond formation.



Hence, no lone pair is present on nitrogen for resonance.

85. (c) The oxidation number of Ni metal is zero in complex $\text{Ni}(\text{CO})_4$. As CO is a neutral ligand i.e., $\Rightarrow \text{Ni}(\text{CO})_4$

$$x + 4(0) = 0$$

$$x = 0$$

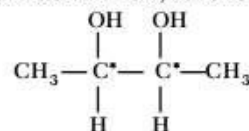
86. (d) $\text{PCl}_3 + \text{Cl}_2 \rightleftharpoons \text{PCl}_5$

Initially 3 moles 2 moles 3 moles
At equilibrium (3 + 1.5) moles 1.5 moles

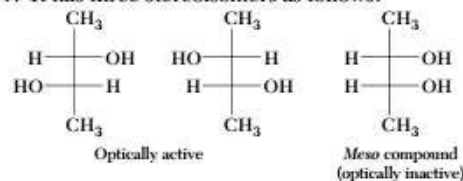
\therefore At equilibrium 1.5 moles of PCl_5 is converted into 4.5 moles of PCl_3 .

\therefore Total moles of PCl_3 at equilibrium is 4.5.

87. (b) The structure of butane-2, 3-diol is



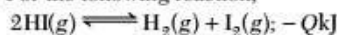
\therefore It has three stereoisomers as follows:



\therefore It has two optically active isomers.

88. (c) An octahedral complex is formed when hybrid orbital of sp^3d^2 (outer orbital) or d^2sp^3 (inner orbital) types are involved.

89. (a) For the following reaction,

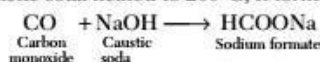


$$\Delta n = (n_p)_g - (n_R)_g = (1 + 1) - 2 = 0$$

attracting them towards the wall of oppositely charged precipitator.

Thus, lose their charge and coagulate colloidal particle.

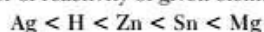
108. (c) When, carbon mono-oxide is passed over solid caustic soda heated to 200°C, it forms sodium formate.



109. (a) The given reaction, $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 + \text{Heat}$, is an exothermic reaction.

∴ According to Le-Chatelier's principle, on increase in temperature equilibrium is shifted to the left.

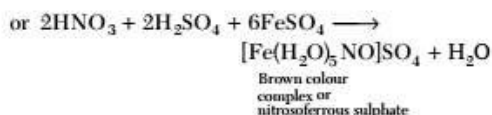
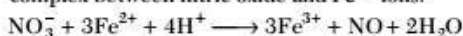
110. (a) The order of reactivity of given elements is



As, Ag is less reactive than hydrogen, it cannot replace hydrogen from HCl and H_2 gas is not liberated.

111. (a) The ionic compound formed is $\text{M}^+\text{X}^-(\text{s})$ as the gaseous ions $[\text{M}^+(\text{g})$ and $\text{Cl}^-(\text{g})]$ combines in the crystal lattice which is in solid state.

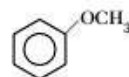
112. (d) The brown ring is due to the formation of a brown complex between nitric oxide and Fe^{2+} ions.



113. (b) Amines behaves as Lewis base as if donates its lone pairs in the chemical reaction.

114. (b) Oils reacts with hydrogen in presence of metal catalyst to give saturated glycerides. Thus, vegetable ghee (Dalda) is obtained by hydrogenation (reduction) of oils.

115. (b) Anisole is



Its chemical name is methoxy benzene.

116. (c) The number of disulphide linkages present in insulin are three. Two linkages are between two polypeptide chains containing 21 and 30 amino acid residues. In addition, the smaller polypeptide chain (21 amino acids) has also an internal disulphide linkage.

117. (d) Number of atoms = $\frac{\text{mass}}{\text{molecular mass}} \times N_A$

Number of atoms is oxygen = product of atoms in hydrogen

$$\frac{80}{16} \times N_A = \frac{W}{1} \times N_A$$

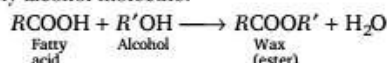
$$\therefore W = \frac{80}{16} = 5 \text{ g of hydrogen}$$

118. (d) Greater the stability of oxide, greater is the chance of its formation. Generally, ionic oxide are more stable, than covalent oxides and among the given metals only Ca form ionic oxide. Hence, Ca has greater tendency to form oxide.

119. (c) The reaction, $2\text{Fe}_2\text{O}_3 + 3\text{C} \longrightarrow 4\text{Fe} + 3\text{CO}_2$, do not occur in blast furnace. This reaction occurs at the end of the process.

120. (d) Wax is an ester of fatty acid and an alcohol.

They are formed by combining one fatty acid with one fatty alcohol molecule.



Mathematics

121. (b) : Let $f(x) = x^2 + \sin^2 x$, then $f(-x) = f(x)$
Therefore, $f(x) = x^2 + \sin^2 x$ is an even functions.

122. (a) Here, $A = \{x : x^2 - x + 2 > 0\} = R$

$$\left(\begin{array}{l} \because x^2 - x + 2 = x^2 - x + \frac{1}{4} + \frac{7}{4} \\ = \left(x - \frac{1}{2}\right)^2 + \frac{7}{4} \geq \frac{7}{4} \end{array} \right)$$

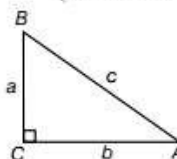
$$\begin{aligned} \text{and } B &= \{x : x^2 - 4x + 3 \leq 0\} \\ &= \{x : (x-1)(x-3) \leq 0\} = [1, 3] \\ \text{Hence, } A \cap B &= R \cap [1, 3] = [1, 3] \end{aligned}$$

123. (d) : $b \in A$ is said to be an inverse of a w.r.t. operation * if $a * b = b * a = e$. [by definition]

124. (a) Given, $\angle C = \frac{\pi}{2} \Rightarrow c^2 = a^2 + b^2$ {by pythagoras}

$$\text{Now, } \tan^{-1}\left(\frac{a}{b+c}\right) + \tan^{-1}\left(\frac{b}{c+a}\right)$$

$$\begin{aligned} &= \tan^{-1}\left[\frac{\frac{a}{b+c} + \frac{b}{c+a}}{1 - \left(\frac{a}{b+c}\right)\left(\frac{b}{c+a}\right)}\right] \\ &= \tan^{-1}\left(\frac{ac + a^2 + b^2 + bc}{bc + ba + c^2 + ca - ab}\right) \end{aligned}$$



$$\begin{aligned} &= \tan^{-1}\left(\frac{ac + c^2 + bc}{bc + c^2 + ca}\right) \\ &= \tan^{-1}(1) = \frac{\pi}{4} \end{aligned}$$

$$125. (d) \frac{\cos \alpha}{1} = \frac{a}{b+c} \Rightarrow \frac{1}{\cos \alpha} = \frac{b+c}{a}$$

By componendo and dividendo, we have

$$\begin{aligned} \frac{1-\cos \alpha}{1+\cos \alpha} &= \frac{b+c-a}{b+c+a} \\ \Rightarrow \tan^2 \frac{\alpha}{2} &= \frac{b+c-a}{3b} \left\{ \because a, b, c \text{ are in A.P.} \right\} \\ \Rightarrow \frac{1-\cos \gamma}{1+\cos \gamma} &= \frac{a+b-c}{a+b-c} \\ \Rightarrow \tan^2 \frac{\gamma}{2} &= \frac{a+b-c}{3b} \\ \therefore \tan^2 \frac{\alpha}{2} + \tan^2 \frac{\gamma}{2} &= \frac{2b}{3b} = \frac{2}{3} \end{aligned}$$

$$\begin{aligned} 126. (c) \cos(35^\circ + A) \cos(35^\circ - B) &+ \sin(35^\circ + A) \sin(35^\circ - B) \\ &= \cos [(35^\circ + A) - (35^\circ - B)] \\ &= \cos(A + B) \end{aligned}$$

$$\begin{aligned} 127. (b) 2 \operatorname{cosec} 2x + \operatorname{cosec} x &= \frac{2}{\sin 2x} + \frac{1}{\sin x} = \frac{2}{2 \sin x \cdot \cos x} + \frac{1}{\sin x} \\ &= \frac{1}{\sin x} \left[\frac{1}{\cos x} + 1 \right] = \frac{1}{\sin x} \cdot \frac{(1 + \cos x)}{\cos x} \\ &= \frac{1}{\cos x} \cdot \frac{2 \cos^2(x/2)}{2 \sin(x/2) \cdot \cos(x/2)} \\ &= \operatorname{sec} x \cdot \frac{\cos(x/2)}{\sin(x/2)} \left[\because \cos 2x = 2 \cos^2 x - 1 \right. \\ &\quad \left. \sin 2x = 2 \sin x \cos x \right] \\ &= \operatorname{sec} x \cdot \cot(x/2) \end{aligned}$$

$$\begin{aligned} 128. (d) \text{ We have, } \cot 3x &= \cot(2x + x) \\ \Rightarrow \cot 3x &= \frac{\cot 2x \cot x - 1}{\cot 2x + \cot x} \\ &\quad \left\{ \cot(A + B) = \frac{\cot A \cot B - 1}{\cot A + \cot B} \right\} \\ \Rightarrow \cot 3x \cot 2x + \cot 3x \cot x &= \cot 2x \cot x - 1 \\ \Rightarrow \cot 2x \cot x - \cot 3x \cot 2x - \cot 3x \cot x &= 1 \end{aligned}$$

$$\begin{aligned} 129. (a) \text{ We have } \cos A \cos B - \sin A \sin B &= \cos(A + B) = \cos \left[\left(\frac{\pi}{4} - x \right) + \left(\frac{\pi}{4} - y \right) \right] \\ \text{where, } A = \frac{\pi}{4} - x \text{ and } B = \frac{\pi}{4} - y & \\ \Rightarrow \cos \left[\frac{\pi}{2} - (x + y) \right] &= \sin(x + y) \end{aligned}$$

$$\begin{aligned} 130. (d) \text{ Let } P(n) &= 2 \cdot 4^{2n+1} + 3^{3n+1} \\ P(1) &= 128 + 81 = 209, \text{ which is divisible by 11 only.} \end{aligned}$$

$$\begin{aligned} 131. (c) P(1) : 1 \times 1! &= (1+1)! - 1' \text{ is true.} \\ \text{Let } P(k) : '1 \times 1! + 2 \times 2! + 3 \times 3! &+ \dots + k \times k! = (k+1)! - 1' \text{ is true.} \end{aligned}$$

$$\begin{aligned} \text{Now, } P(k+1) : 1 \times 1! + 2 \times 2! + \dots &+ k \times k! + (k+1) \times (k+1)! \\ &= (k+1)! - 1 + (k+1)(k+1)! \\ &= (k+1)! + (k+1) \times (k+1)! - 1 \\ &= (k+1)!(1+k+1) - 1 = (k+2)! - 1 \end{aligned}$$

i.e., $P(k)$ is true $\Rightarrow P(k+1)$ is true

$$\begin{aligned} 132. (d) \text{ We have, } z &= re^{i\theta} = r(\cos \theta + i \sin \theta) \\ \therefore iz &= ir(\cos \theta + i \sin \theta) \\ &= ir \cos \theta + i^2 r \sin \theta = -r \sin \theta + ir \cos \theta \\ |e^z| &= |e^{(-r \sin \theta + ir \cos \theta)}| \\ &= |e^{-r \sin \theta}| \cdot |ir \cos \theta| \\ &= e^{-r \sin \theta} \left[\sqrt{\cos^2(r \cos \theta) + \sin^2(r \cos \theta)} \right] \\ &= e^{-r \sin \theta} \times 1 = e^{-r \sin \theta} \end{aligned}$$

$$\begin{aligned} 133. (b) \text{ We have, } (\sqrt{5} + \sqrt{3}i)^{33} &= 2^{49} z \\ \text{Taking modulus on both sides, we get} & \\ 2^{49} |z| &= |\sqrt{5} + \sqrt{3}i|^{33} \\ \Rightarrow 2^{49} |z| &= (\sqrt{5} + 3)^{33} = (\sqrt{8})^{33} = 2^{33} 2^{33/2} \\ \Rightarrow |z| &= \frac{2^{33} 2^{33/2}}{2^{49}} = 2^{2^{33-16}} = 2^{1/2} = \sqrt{2} \end{aligned}$$

$$\begin{aligned} 134. (c) \left| \frac{1}{1 - \cos \theta + i \sin \theta} \right| &= \frac{1}{|1 - \cos \theta + i \sin \theta|} \\ &= \frac{1}{\sqrt{(1 - \cos \theta)^2 + \sin^2 \theta}} = \frac{1}{\sqrt{2 - 2 \cos \theta}} \\ &= \frac{1}{2 |\sin(\theta/2)|} = \frac{1}{2} \left| \operatorname{cosec} \frac{\theta}{2} \right| \end{aligned}$$

$$\begin{aligned} 135. (d) \text{ We have, } a + b\omega + c\omega^2 &= 0 \\ \Rightarrow a + b \left(-\frac{1}{2} + \frac{i\sqrt{3}}{2} \right) + c \left(-\frac{1}{2} - \frac{i\sqrt{3}}{2} \right) &= 0 \\ \Rightarrow \left(a - \frac{b}{2} - \frac{c}{2} \right) + i \left(\frac{\sqrt{3}b}{2} - \frac{\sqrt{3}c}{2} \right) &= 0 + 0i \\ \text{Real part } \Rightarrow a = \frac{b+c}{2} & \\ \text{Imaginary parts } \Rightarrow b = c & \\ \therefore a = b = c & \end{aligned}$$

$$\begin{aligned} 136. (d) \text{ We have, } (x-1)^3 &= -8 = (-2)^3 \\ \therefore x-1 &= -2 - 2\omega, -2\omega^2 \\ \Rightarrow x &= -1, 1 - 2\omega, 1 - 2\omega^2 \end{aligned}$$

$$\begin{aligned} 137. (d) \text{ We have, } a^3 x^2 + abcx + c^3 &= 0 \\ \Rightarrow x^2 + \frac{b}{a} \cdot \frac{c}{a} x + \left(\frac{c}{a} \right)^3 &= 0 \\ \Rightarrow x^2 - (\alpha + \beta) \alpha \beta x + \alpha^3 \beta^3 &= 0 \\ \Rightarrow x = \alpha^2 \beta, \alpha \beta^2 \Rightarrow \alpha^2 \beta &\text{ is one of the root.} \end{aligned}$$

138. (a) There are $4! = 24$ numbers. Each digit occurring $3! = 6$ times, in the unit's, ten's, hundred's and thousand's places. We note that $(2 + 4 + 6 + 8) = 120$. Thus in the over all sum there will be 120 units, 120 tens, 120 hundreds and 120 thousands.

The required sum

$$= 120(1 + 10 + 10^2 + 10^3) \\ = 120 \times 1111 = 133320$$

139. (d) Total number of discs are $4 + 3 + 2 = 9$.

Out of 9 discs, 4 are of the first kind (red) 3 are of the second kind (yellow) and 2 are of the third kind (green).

Therefore, the number of arrangements

$$= \frac{9!}{4!3!2!} = 1260$$

140. (a) There are 12 face cards and 4 are to be selected, out of these 12 cards. This can be done in ${}^{12}C_4$ ways.

Therefore, the required number of = $\frac{12!}{4!8!} = 495$

$$141. (a) \binom{2n}{3r-1} = \binom{2n}{r+1}$$

$$\left\{ \begin{array}{l} \because {}^nC_x = {}^nC_y \Rightarrow x + y = n \\ \text{or } n - x = y \end{array} \right.$$

$$\Rightarrow 2n = 3r - 1 + r + 1 \Rightarrow n = 2r$$

142. (d) H.M. = $\frac{2ab}{a+b}$; G.M. = \sqrt{ab} .

$$\text{Now, } \frac{\text{H.M.}}{\text{G.M.}} = \frac{2\sqrt{ab}}{a+b} = \frac{4}{5}$$

$$\Rightarrow 25ab = 4(a+b)^2 \\ \Rightarrow 4a^2 - 17ab + 4b^2 = 0 \\ \Rightarrow (4a-b)(a-4b) = 0 \\ \Rightarrow 4a = b \Rightarrow a : b = 1 : 4$$

143. (a) Let the numbers be a, ar, ar^2, ar^3 .

$$\Rightarrow a - 2, ar - 7, ar^2 - 9 \text{ are in A.P.}$$

$$\Rightarrow a - 2 + ar^2 - 9 = 2(ar - 7)$$

$$\Rightarrow a(r^2 + 1) - 11 = 2ar - 14$$

$$\Rightarrow r^2 + 1 = 2r - \frac{3}{a} \quad \dots (i)$$

$$\text{Further, } ar - 7 + ar^3 - 5 = 2(ar^2 - 9)$$

$$\Rightarrow ar(r^2 + 1) - 12 = 2ar^2 - 18$$

$$\Rightarrow r^2 + 1 = 2r - \frac{6}{ar} \quad \dots (ii)$$

Solving Eqs. (i) and (ii), we get $r = 2, a = -3$

The number are $-3, -6, -12, -24$

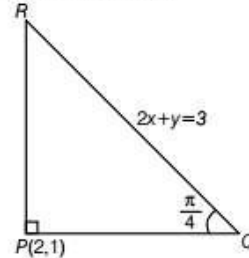
$$144. (c) n \text{th term} = \frac{n}{(2n+1)!}$$

$$= \frac{1}{2} \left[\frac{(2n+1) - 1}{(2n+1)!} \right] = \frac{1}{2} \left[\frac{1}{(2n)!} - \frac{1}{(2n+1)!} \right]$$

\therefore Sum of the series

$$= \frac{1}{2} \left[\frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!} + \frac{1}{6!} - \frac{1}{7!} + \dots \right] \\ = \frac{1}{2} e^{-1} = \frac{1}{2e}$$

145. (b) Let m be the slope of PQ .



Slope of QR is -2

$$\left| \frac{m+2}{1-2m} \right| = \tan \frac{\pi}{4} = 1$$

$$\Rightarrow m+2 = \pm(1-2m) \Rightarrow m = 3, -\frac{1}{3}$$

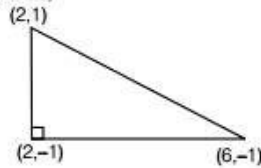
The lines PQ and PR are $\frac{y-1}{x-2} = 3, -\frac{1}{3}$

The combined equation is

$$(3x - y - 5)(x + 3y - 5) = 0$$

$$\text{or } 3x^2 - 3y^2 + 8xy - 20x - 10y + 25 = 0$$

146. (a) The vertices are $(2, -1), (6, -1), (2, 1)$ forming a right angled triangle. Circumcentre is the mid-point of the hypotenuse,



$$\text{i.e., } \left(\frac{6+2}{2}, \frac{1-1}{2} \right) = (4, 0)$$

147. (c) We have, $a = 3, b = 4$ and

$$c = \sqrt{a^2 + b^2} = \sqrt{9 + 16} = 5$$

Therefore, the coordinates of the foci are $(\pm 5, 0)$.

$$\text{Also, length of latusrectum} = \frac{2b^2}{a} = \frac{32}{3}$$

148. (c) The line $21x + 5y = 116$ is a tangent to $7x^2 - 5y^2 = 232$. If $P(x_1, y_1)$ is the point of contact, then $S_1 = 0$.

$$\Rightarrow 7x_1x - 5y_1y = 232 \text{ It is same as } 21x + 5y = 116$$

$$\therefore \frac{7x_1}{21} = -\frac{5y_1}{5} = \frac{232}{116} = 2$$

$$\therefore x_1 = 6, y_1 = -2. \text{ So, } P \text{ is } (6, -2).$$

149. (a) Let $P(x_1, y_1)$ be the mid-point of a chord of $x^2 + y^2 = r^2$.

Its equation is

$$S_1 = S_{11} \Rightarrow x_1x + y_1y = x_1^2 + y_1^2$$

$$\text{or } y = \left(-\frac{x_1}{y_1}\right)x + \frac{x_1^2 + y_1^2}{y_1}$$

The line $y = mx + c$ is a tangent to the hyperbola only if

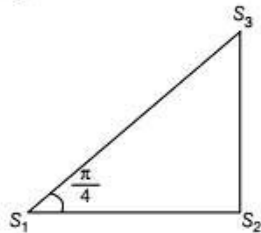
$$c^2 = a^2m^2 - b^2$$

$$\therefore \frac{(x_1^2 + y_1^2)^2}{y_1^2} = \frac{a^2x_1^2}{y_1^2} - b^2$$

\therefore The locus of P is

$$(x^2 + y^2)^2 = a^2x^2 - b^2y^2$$

150. (b) $\tan \frac{\pi}{4} = \frac{LS}{SS}$



$$= \frac{a(e^2 - 1)}{2ae}$$

$$\Rightarrow 1 = \frac{e^2 - 1}{2e}$$

$$\Rightarrow e^2 - 2e - 1 = 0$$

$$\text{Solving, } e = \sqrt{2} + 1$$

151. (a) Tangent with slope m is

$$y = mx \pm \sqrt{a^2m^2 - b^2}$$

It passes through $(0, 1)$.

$$\therefore 1 = \sqrt{\frac{m^2}{2} - 1} \quad \left[\text{Since, } a^2 = \frac{1}{2}, b^2 = 1 \right]$$

$$\Rightarrow 1 = \frac{m^2}{2} - 1$$

$$\Rightarrow m = \pm 2$$

$$\Rightarrow \tan \theta = \left| \frac{2 - (-2)}{1 - 4} \right| = \frac{4}{3}$$

152. (b) Let $P(3, 4, -1)$ and $Q(-1, 2, 3)$ be the end points of the diameter of a sphere.

\therefore Length of diameter = PQ

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

$$= \sqrt{16 + 4 + 16} = \sqrt{36} = 6 \text{ units}$$

$$\therefore \text{Radius} = \frac{6}{2} = 3 \text{ units}$$

153. (c) Let $y = \cos^{-1}\left(\frac{1-x}{1+x}\right)$

Put $x = \tan^2 \theta$

$$\Rightarrow \theta = \tan^{-1} \sqrt{x}$$

$$\therefore y = \cos^{-1}\left(\frac{1 - \tan^2 \theta}{1 + \tan^2 \theta}\right)$$

$$= \cos^{-1}(\cos 2\theta) = 2\theta = 2 \tan^{-1} \sqrt{x}$$

$$\therefore \frac{dy}{dx} = 2 \frac{d}{dx}(\tan^{-1} \sqrt{x})$$

$$= 2 \times \frac{1}{1+x} \times \frac{1}{2\sqrt{x}} = \frac{1}{\sqrt{x}(1+x)}$$

154. (b) $f(x) = \left(\frac{5}{x} + 7\right)$

$$\Rightarrow f'(x) = \frac{-5}{x^2} < 0 \text{ for all}$$

$x \in R$, where $x \neq 0$.

Hence, $f(x)$ is decreasing for $x \in R - \{0\}$.

155. (a) Let $f(x) = x^{1/4}$

$$\Rightarrow f'(x) = \frac{1}{4x^{3/4}}$$

Now, $a + h = 15 = 16 - 1$, where

$$a = 16, h = -1$$

We know, $f(a+h) = f(a) + hf'(a)$

$$\Rightarrow f(15) = f(16) - 1f'(16)$$

$$\Rightarrow (15)^{1/4} = (16)^{1/4} - \frac{1}{4(16)^{3/4}} = 2 - \frac{1}{32}$$

$$\Rightarrow (15)^{1/4} = 2 - 0.03125 = 1.9688$$

156. (d) Let the required point be $P(x_1, y_1)$

The given curve is $y = x^2$... (i)

Differentiating Eq. (i) w.r.t. x , we get

$$\frac{dy}{dx} = 2x \Rightarrow \text{Slope of tangent at } P(x_1, y_1) = 2x$$

But the slope of tangent at

$P(x_1, y_1) = x$ -coordinate of P

$$\Rightarrow 2x_1 = x_1 \Rightarrow 2x_1 - x_1 = 0$$

$$\Rightarrow x_1 = 0$$

As $P(x_1, y_1)$ lies on the curve, we get

$$y_1 = x_1^2 \Rightarrow y_1 = 0$$

Hence, the required point is $(0, 0)$.

157. (d) Given curve, $y = \frac{x^3}{4-x}$... (i)

is the given curve

Differentiating Eq. (i) w.r.t. x , we get

$$\frac{dy}{dx} = \frac{(4-x)(3x^2) - x^3(-1)}{(4-x)^2} = \frac{12x^2 - 2x^3}{(4-x)^2}$$

$$\Rightarrow \left(\frac{dy}{dx}\right)_{x=2} = \frac{12(2)^2 - 2(2)^3}{(4-2)^2} = \frac{32}{4} = 8$$

⇒ The slope of tangent at (2, 4) is 8.

∴ The equation of tangent is

$$y - 4 = 8(x - 2)$$

$$\Rightarrow 8x - y - 12 = 0 \Rightarrow \text{slope} = \frac{-8}{-1} = 8$$

Now the slope of normal at P(2, 4) is $-\frac{1}{8}$.

∴ The equation of normal is

$$y - 4 = -\frac{1}{8}(x - 2)$$

$$\Rightarrow x + 8y - 34 = 0$$

158. (d) We have,

$$y = \log_a x + \frac{\log a}{\log x} + 1 + 1 \quad [\because \log_x x = 1]$$

$$\Rightarrow \frac{dy}{dx} = \frac{1}{x} \log_a e - \log a \left(\frac{1}{\log x} \right)^2 \frac{1}{x} = \frac{1}{x \log a} - \frac{\log a}{x(\log x)^2}$$

159. (c) We have,

$$\begin{aligned} \int \frac{1}{\sin x + \sqrt{3} \cos x} dx &= \frac{1}{2} \int \frac{dx}{\frac{1}{2} \sin x + \frac{\sqrt{3}}{2} \cos x} \\ &= \frac{1}{2} \int \frac{1}{\sin \left(x + \frac{\pi}{3} \right)} dx \\ &= \frac{1}{2} \int \operatorname{cosec} \left(x + \frac{\pi}{3} \right) dx \\ &= \frac{1}{2} \log \left| \tan \left(\frac{x}{2} + \frac{\pi}{6} \right) \right| + C \end{aligned}$$

160. (a) $\int e^{2x} (2 \sin 3x + 3 \cos 3x) dx$

$$\begin{aligned} &= 2 \int e^{2x} \sin 3x dx + 3 \int e^{2x} \cos 3x dx \\ &= e^{2x} \sin 3x - 3 \int e^{2x} \cos 3x dx \\ &\quad + 3 \int e^{2x} \cos 3x dx + C \\ &= e^{2x} \sin 3x + C \end{aligned}$$

161. (a) $\int_1^2 \frac{dx}{x^2} = \left[\left(-\frac{1}{x} \right) \right]_1^2 = \frac{1}{2}$

162. (a) We have,

$$\begin{aligned} I &= \int_0^{\pi/2} \frac{\cos x}{\left(\cos \frac{x}{2} + \sin \frac{x}{2} \right)^3} dx = \int_0^{\pi/2} \frac{\cos \frac{x}{2} - \sin \frac{x}{2}}{\left(\cos \frac{x}{2} + \sin \frac{x}{2} \right)^3} dx \\ &= \int_0^{\pi/2} \frac{\cos \frac{x}{2} - \sin \frac{x}{2}}{\left(\cos \frac{x}{2} + \sin \frac{x}{2} \right)^2} dx \end{aligned}$$

Put $\cos \frac{x}{2} + \sin \frac{x}{2} = t$

$$\Rightarrow \frac{1}{2} \left(-\sin \frac{x}{2} + \cos \frac{x}{2} \right) dx = dt$$

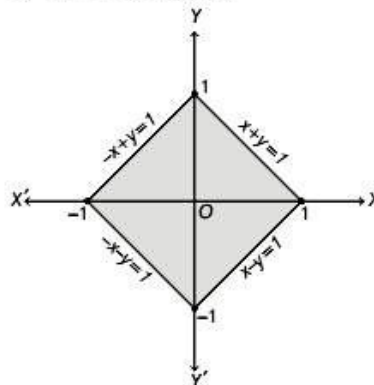
Also, when $x = 0 \Rightarrow t = 1$

When $x = \frac{\pi}{2} \Rightarrow t = \sqrt{2}$

$$\begin{aligned} \therefore I &= \int_1^{\sqrt{2}} \frac{2dt}{t^2} \\ &= 2 \left[-\frac{1}{t} \right]_1^{\sqrt{2}} = 2 \left[-\frac{1}{\sqrt{2}} + 1 \right] = (2 - \sqrt{2}) \end{aligned}$$

163. (b) We have,

$$\begin{aligned} x + y &= 1 \quad \forall x, y \geq 0 && \dots \text{(i)} \\ -x + y &= 1 \quad \forall x < 0, y \geq 0 && \dots \text{(ii)} \\ -x - y &= 1 \quad \forall x < 0, y < 0 && \dots \text{(iii)} \\ x - y &= 1 \quad \forall x \geq 0, y < 0 && \dots \text{(iv)} \end{aligned}$$



Required area is the area of shaded region

$$\begin{aligned} &= 4 \int_0^1 (1-x) dx \\ &= 4 \left[x - \frac{x^2}{2} \right]_0^1 = 4 \times \frac{1}{2} = 2 \text{ sq. units} \end{aligned}$$

164. (c) Let $I = \int \frac{dx}{\sqrt{x} + \sqrt[3]{x}}$

Put $x = t^6 \Rightarrow dx = 6t^5 dt$

$$\begin{aligned} \therefore I &= \int \frac{6t^5}{t^3 + t^2} dt = 6 \int \frac{t^3}{t+1} dt \\ &= 6 \int \left(t^2 - t + 1 - \frac{1}{t+1} \right) dt \\ &= 2t^3 - 3t^2 + 6t - 6 \log(t+1) + C \\ &= 2\sqrt[6]{x} - 3(\sqrt[3]{x}) + 6(\sqrt[6]{x}) - 6 \log(\sqrt[6]{x} + 1) + C \end{aligned}$$

165. (b) $\int_a^b \frac{x^n}{x^n + (16-x)^n} dx = 6 \dots \text{(i)}$

Let $a + b = 16$, then

Therefore, the equation of straight line in the new system is $xy = 0$

176. (d) We have, $\log_6 abc = 6 \Rightarrow abc = 6^6$... (i)

Let $b = ar, c = ar^2$

Eq. (i), $a^3 r^3 = 6^6 \Rightarrow b = ar = 36$

$b - a = 36 - a$ is square for $a = 35, 32, 27, 20, 11$

$c = \frac{b^2}{a} = \frac{36^2}{a}$ is an integer for $a = 27$

$\therefore a = 27, b = 36, c = 48$

$\Rightarrow a + b + c = 111$

177. (c) $F(x) = P(X < x)$

$F(0) = P(X \leq 0) = 0.5$

$F(1) = P(X \leq 1) = 0.5 + 0.2 = 0.7$

$F(2) = P(X \leq 2) = 0.5 + 0.2 + 0.18 = 0.88$

$F(3) = P(X \leq 3) = 0.5 + 0.2 + 0.18 + 0.12 = 1$

\therefore The c.d.f. of X is

$X = x$	0	1	2	3
$F(x)$	0.5	0.7	0.88	1

178. (c) X can take values 0, 1, 2.

The probability distribution of X .

Since there are 16 items are perfect and 4 are defective. Given that two items are drawn randomly.

$\therefore P(\text{no defective items are drawn}) = \frac{{}^{16}C_2}{{}^{20}C_2}$

$X = x$	0	1	2
$P(X = x)$	$\frac{{}^{16}C_2}{{}^{20}C_2} = \frac{12}{19}$	$\frac{{}^4C_1 \times {}^{16}C_1}{{}^{20}C_2} = \frac{32}{95}$	$\frac{{}^4C_2}{{}^{20}C_2} = \frac{3}{95}$

179. (b) Let sets A and B have m and n elements, respectively.

Then, $2^m - 2^n = 56 \Rightarrow 2^n (2^{m-n} - 1) = 56$

$\Rightarrow 2^n (2^{m-n} - 1) = 8 \times 7$

$\Rightarrow 2^n (2^{m-n} - 1) = 2^3 \times 7$

One comparing both sides, we get

$2^n = 2^3$ and $2^{m-n} - 1 = 7$

$\Rightarrow n = 3$ and $2^{m-n} = 8$

$\Rightarrow 2^{m-n} = 2^3$

$\Rightarrow m - n = 3$

$\Rightarrow m - 3 = 3$

$\Rightarrow m = 6$

Hence, number of the elements is set A is 6.

180. (d) $\because \log_4 2 + \log_4 4 + \log_4 x + \log_4 16 = 6$

$\Rightarrow \log_4 (2 \times 4 \times x \times 16) = 6$

$\Rightarrow 128x = 4^6$

$\therefore x = \frac{4^3}{2} = 32$