JEE Main 2024 Solution April 9 Shift 2 (B.E./B.Tech)

JEE Main Physics Questions

Ques 1. Dimensional formula of Plank's constant is:
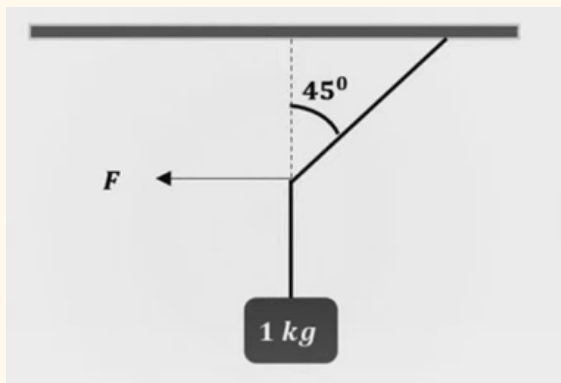
    A. $[M^2L^2T^{-1}]$
    B. $[M^1L^2T^{-1}]$
    C. $[M^2L^2T^{-2}]$
    D. $[ML^2T^{-3}]$

Ans. B

Solu. E = hv

$$[h] = \frac{ML^2T^{-2}}{T^{-1}}$$

Ques 2. Find the magnitude of force F, if the given system is in equilibrium

    A. 10 N

B. 10√2 N
C. 0 N
D. 1 / 10√2 N

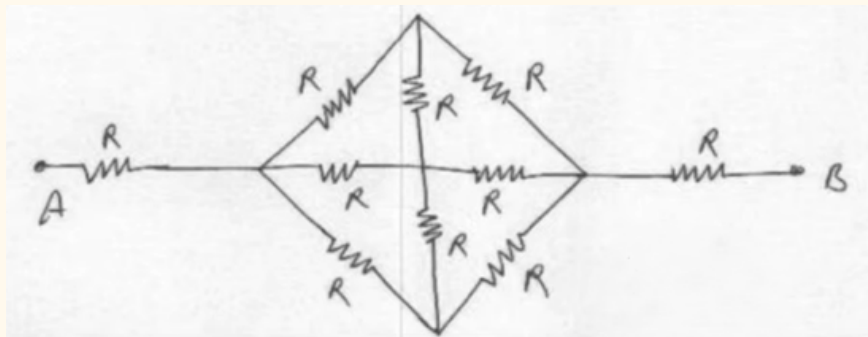**Ans.** A
Solu. T = 10 N;
Tsin45 = F
F= 10/√2 N

Ques 3. The equivalent resistance between terminal A and B in the network shown

A. 4R/3
B. 8R/3
C. 3R
D. 5R/2

Ans. B
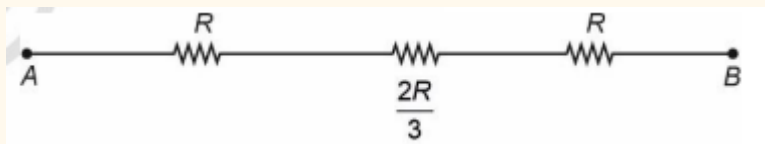
Solu.
R_{AB} = 8R/3

Ques 4. The nuclei at rest breaks into two parts with mass ratio 1 : 2. The ratio of their velocity and direction is

A. Opposite Direction 2 : 1

B. Same Direction 1 : 2

C. Opposite Direction 1:1

D. Same Direction 1 : 1

Ans. A

Solu. By conservation of momentum

m1v1 = m2v2

v1/v2 = m1/m2 =2/1

Ques 5. Two cars A and B are moving towards each other with speed 20 m/s each. When 300 m apart, they both apply breaks which causes deceleration of 2 m/s². The distance between them when they stop will be:

A. 100 m

B. 50 m

C. 150 m

D. 200 m

Ans. A

Solu. → v_{AB} =40 îm/s

→ a_{AB} =-4 î m/s

$v^2 = u^2 + 2as$

0 = 1600 - 8s

s = 200m

Ques 6. For a wire, the original resistance was 50 Ω at the initial temperature of 27° C. When the temperature is increased, its resistance becomes 62 Ω. If the thermal coefficient of resistivity of the wire is 2.4 x 10⁻² K⁻¹, find the final temperature.

A. 45° C

B. 37°C
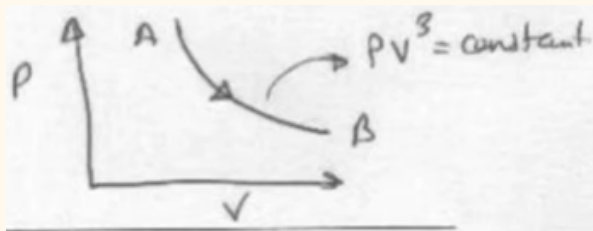
C. 48°C

D. 32° C

Ans. B
Solu. $R = R_0(1 + \alpha\Delta T)$
$62 = 50(1 + 2.4 \times 10^{-2} \Delta T)$
$1.24 = 1 + 2.4 \times 10^{-2} \Delta T$
$\Delta T = 10$
$T = 37°C$

Ques 7. Find the work done by a monoatomic gas from A and B. Here the temperature of gas (1 mol) changes from 300 K to 330 K.

   A. 125 J
   B. 250 J
   C. 500 J
   D. 6250 J

Ans. A

Solu.
$$w = \frac{\mu R \Delta T}{1 - \alpha} = \frac{25}{3} \times \frac{30}{2} = 125 \text{ J}$$

Ques 8. Two bubbles having radii rA and rB are having excess pressure PA and PB in them. If PA = 3PB, find rA/rB

   A. 9: 1
   B. 1:9
   C. 1:3
   D. 3 : 1

Ans. C
Solu. $\Delta P = 4T/r$

$P_A/P_B = R_B/R_A$

$R_A/R_B = \frac{1}{3}$

Ques 9. In the given ray diagram, find the distance (in cm) between the two convex lenses.

$f = 10$ $f = 15 cm$

Ans. 25
Solu. $f_1 + f_2 = L = 25$ cm

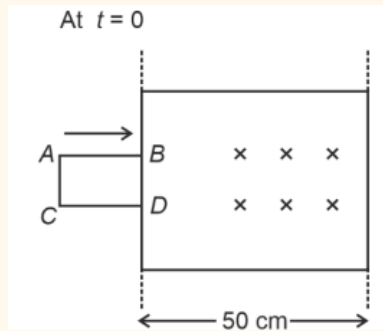**Ques 10. Find the work done (in J) by force $F = 3x^2 + 2x - 5$ in moving a particle $x = 2$ to $x = 4$.**

Ans. 58

$$W = \int_{2}^{4} F \cdot dx$$

$$= \left[x^3 + x^2 - 5x \right]_{2}^{4}$$

$$= 58 \text{ J}$$

Solu.

Ques 11. Find the induced emf in the square loop of side 15 cm moving with 2 cm/s after 10 seconds.

At $t = 0$

← 50 cm →

A. 0

B. 0.3V

C. 3V

D. 9V

Ans. A

Solu. At t = 10 seconds, Ø = Constant

dØ/ dt =0

Ques 12. A proton and deuteron, having same kinetic energy, enters a transverse uniform magnetic field. Radius of circular paths for proton and deuteron are in ratio of

A. $\sqrt{2}$

B. $1/2\sqrt{2}$

C. $1/\sqrt{2}$

D. $2\sqrt{2}$

Ans. C

Solu.

$$r = \frac{\sqrt{2mk}}{qB}$$

$$\frac{r_p}{r_d} = \sqrt{\frac{m_p}{m_d}}$$

$$\frac{q_d}{q_p} = \frac{1}{\sqrt{2}}.$$

Ques 1. Correct order of bond angle of following compounds is:
BF_3, PF_3, ClF_3

    A. $BF_3 > PF_3 > ClF_3$
    B. $PF_3 > ClF_3 > BF_3$
    C. $ClF_3 > PF_3 > BF_3$
    D. $BF_3 > ClF_3 > PF_3$

Ans. A
Solu. $BF_3 \Rightarrow sp^2 \Rightarrow$ Bond angle = 120°
$PF_3 \Rightarrow sp^3 \Rightarrow$ Bond angle = 109°28'
$ClF_3 \Rightarrow sp^3d \Rightarrow$ Bond angle = 90°

Ques 2. Identify the correct electronic configuration of Einsteinium is

    A. $[Rn]5f^{14}6d^{17}s^2$
    B. $[Rn]5f^{11}7s^2$
    C. $[Rn]5f^{10}6d^17s^2$
    D. $[Rn]5f^{11}6d^17s1$

Ans. B
Solu. Es (Z = 99) $\Rightarrow$ [Rn] $5f^17s$ 2

Ques 3. Ca^{2+} makes which type of complex with EDTA

    A. Trigonal bipyramidal
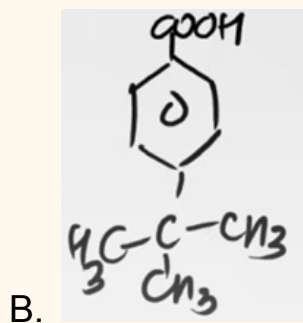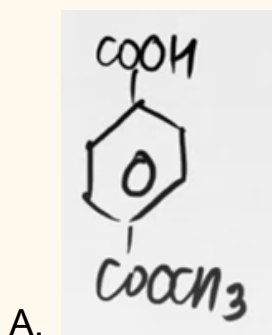   B. Square Planer
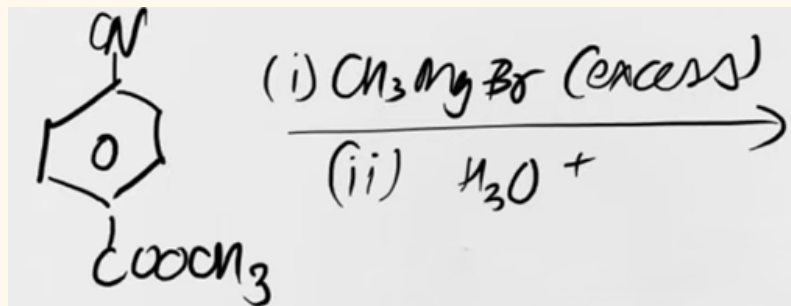   C. Tetrahedral
    D. Octahedral

Ans. D
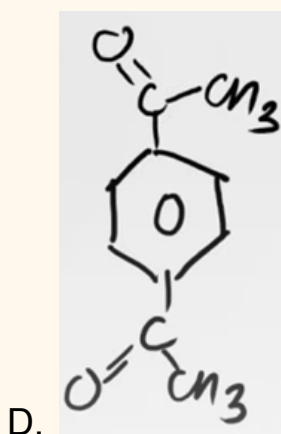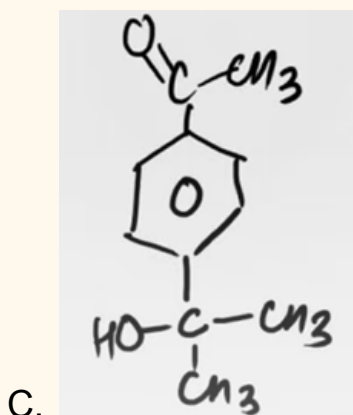
Solu. Co-ordination number of Ca^{2+} with EDTA is 6

Hybridisation = sp^3d^2

Shape = Octahedral

Ques 4. The product obtained in the following reaction is:

A.

B.

C.

D.

Ans. C
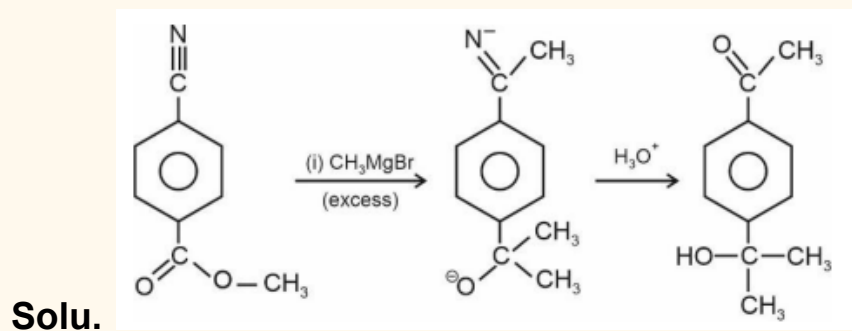
Solu.
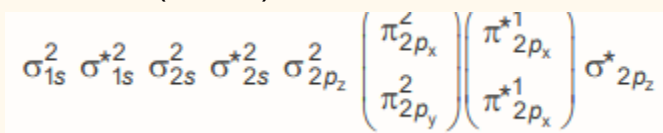
Ques 5. Fuming sulphuric acid has how many oxygen atoms?

Ans. 7

Solu. . Fuming sulphuric acid is oleum ($H_2S_2O_7$)

7 O-atoms are present in fuming sulphuric acid.

Ques 6. Total sum of number of electrons in π* orbitals of O_2, O_2^+ and O_2^- is:

Ans. 6

Solu. O_2 (16e–) :

$$\sigma_{1s}^2 \ \sigma_{1s}^{*2} \ \sigma_{2s}^2 \ \sigma_{2s}^{*2} \ \sigma_{2p_z}^2 \begin{pmatrix} \pi_{2p_x}^2 \\ \pi_{2p_y}^2 \end{pmatrix} \begin{pmatrix} \pi_{2p_x}^{*1} \\ \pi_{2p_x}^{*1} \end{pmatrix} \sigma_{2p_z}^*$$

Total number of e⁻ in π* orbitals of O_2, O_2^+ and O_2^- = 2 + 1 + 3 = 6

Ques 7. Which one of the following statements regarding glucose is incorrect?
   A. Glucose is one of the monosaccharides of sucrose
   B. Glucose dissolves in water because it has aldehyde group.
   C. Glucose has six carbon atoms in its structure
   D. Glucose is an aldose

Ans. B

Solu. Glucose is an aldohexose having molecular formula $C_6H_{12}O_6$. It is soluble in water due to number of hydroxyl groups which can form H-bonds with water. α(D) Glucose condenses with β(D) fructose to form sucrose.
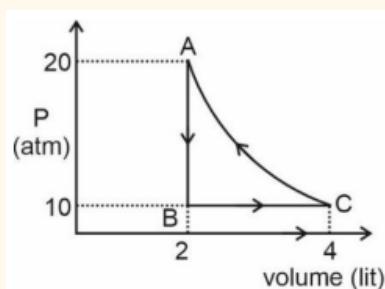
Ques 8.
What is the work done on the gas in cyclic process ABCA
   A. +773.7 J
   B. –773.7 J
   C. +4762.3 J
   D. –4762.3 J

Ans. A
Solu. $W_{AB} = 0$
$W_{BC} = -10 (4 - 2) = -20$ atm. Lit
$W_{CA} = 2.303(40) \log 2 = 27.636$ atm. Lit
$W_{total} = 7.636$ atm. Lit $= 773.7$ Joule

Ques 9. Which of the following compounds does not give Tollen's test?
  A. Formaldehyde
  B. Formic acid
  C. Benzaldehyde
  D. Acetone

Ans. D
Solu. Aldehyde and Formic acid can give Tollen's test with ammoniacal silver nitrate solution.

Ques 10. What is the correct order of C – C bond length of ethane, ethene and ethyne?
  A. Ethane > Ethene > Ethyne
  B. Ethene > Ethane > Ethyne
  C. Ethyne > Ethene > Ethane
  D. Ethyne > Ethane > Ethene

Ans. A
Solu. Correct order of C – C bond length is
Ethane > Ethene > Ethyne
$C - C > C = C > C \equiv C$

Ques 11. Among the elements – Sc, Ti, V, Cr, Mn find magnetic moment of element which have highest ionization enthalpy in +2 oxidation state. [Nearest integer]
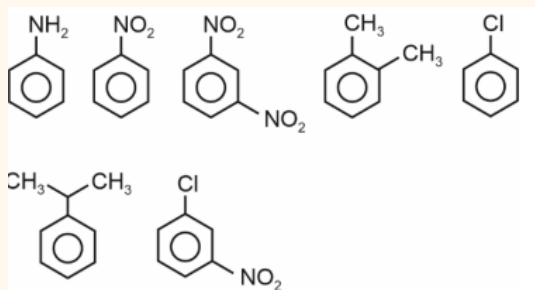
Ans. 6

Solu. Sc^{+2} Ti^{+2} V^{+2} Cr^{+2} Mn^{+2}

Mn+2 will have highest I.E. due to its stable half filled configuration.

$Mn \rightarrow [Ar]\ 4s^2\ 3d^5 \rightarrow 5$ unpaired $e^{\ominus}$

$\mu_{spin} = \sqrt{5(5+2)}\ BM = \sqrt{35} = 6$

Ques 12. How many of the following compounds will give Friedel Craft's reaction?

Ans. 3

Solu. . Friedel Craft's reaction is not given by those aromatic compounds which have strong deactivating groups like –NO2 group. Even aniline does not give Friedel Crafts reaction because the Lewis acid AlCl3 will from co-coordinate bond with –NH2 group thus converting it into strongly deactivating group, Friedel Crafts reaction is given by
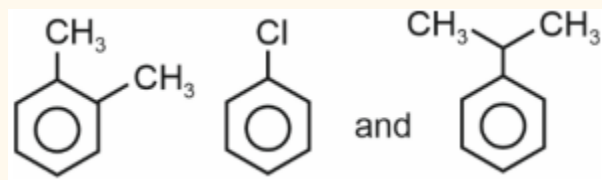
Ques 1. If (z-2i)/(z+2i) is purely imaginary, then maximum value of |z + 8 + 6i| is equal to

    A. 6
    B. 8
    C. 10
    D. 12

Ans. D

Solu. $\left(\dfrac{x+(y-2)i}{x+(y+2)i}\right)\dfrac{(x-(y+2)i)}{(x-(y+2)i)}$ = purely imaginary.

$\Rightarrow x^2 + (y-2)(y+2) = 0 \Rightarrow x^2 + y^2 = 4$

Maximum value = 10 + 2 = 12

Ques 2. $\displaystyle\int_{\frac{1}{4}}^{\frac{3}{4}} \cos\left(2\cot^{-1}\sqrt{\dfrac{1-x}{1+x}}\right) dx =$

    A. -¼
    B. 3/2
    C. 1/16
    D. -4/3

Ans. A

$$\int_{\frac{1}{4}}^{\frac{3}{4}} \cos\left(2\cot^{-1}\left(\sqrt{\frac{1-x}{1+x}}\right)\right) dx$$

$$x = \cos 2\theta \qquad \Rightarrow \quad dx = (-\sin 2\theta \, d\theta)2$$

$$-2\int_{\alpha}^{\beta} \cos\left(2\cot^{-1}|\tan\theta|\right)\sin 2\theta \, d\theta$$

$$= -2\int_{\alpha}^{\beta} -\cos 2\theta \cdot \sin 2\theta \, d\theta$$

Solu.

Ques 3. $\lim\limits_{x\to 0}\dfrac{e-(1+2x)^{\frac{1}{2x}}}{x}$

    A. e

    B. e/4

    C. e/8

    D. 11e/24

Ans. A

Solu. Using Expression:

$$\lim_{x\to 0}\frac{e-e\left[1-\dfrac{2x}{2}+\dfrac{11\times 4x^2}{24}+\cdots\right]}{x}$$

$$\lim_{x\to 0} e - \frac{11x}{24}e \ldots$$

$$= e$$

Ques 4. In the given data

x_f	f_i
C	2
$2C$	1
$3C$	1
$4C$	1
$5C$	1
$6C$	1

If $\sigma^2 = 160$. Find the value of $|C|$.

    A. 7

    B. 5

    C. 6

    D. 4

Ans. A

x_i	$f(x_i)$	$xf(x)$	$x^2f(x)$
C	2	$2C$	$2C^2$
$2C$	1	$2C$	$4C^2$
$3C$	1	$3C$	$9C^2$
$4C$	1	$4C$	$16C^2$
$5C$	1	$5C$	$25C^2$
$6C$	1	$6C$	$36C^2$

$\sigma^2 = E(x^2) - [E(x)]^2, \qquad \Sigma f(x_i) = 7$

$\qquad E(x) = \Sigma xf(x) = 22C$

$\qquad E(x^2) = \Sigma x^2 f(x) = 92C^2$

$\sigma^2 = 160 = \dfrac{92C^2}{7} - \left(\dfrac{22C}{7}\right)^2$

$\Rightarrow \quad C = \pm 7$

Ques 5.
$$\int_{-1}^{2} \log(x + \sqrt{x^2 + 1})dx$$

A. $\log[(2 + \sqrt{5})^2 * (\sqrt{2} - 1)] - \sqrt{5} + \sqrt{2}$

B. $\log[(2 + \sqrt{5})^2 * (\sqrt{2} - 1)] + \sqrt{5} - \sqrt{2}$

C. $\log[(2 + \sqrt{5})^2 * (\sqrt{2} - 1)] + \sqrt{5} + \sqrt{2}$

D. $\log(2 + \sqrt{5})^2 + \sqrt{5} + \sqrt{2}$

Ans. A

$$\int_{-1}^{2} \underset{II}{1} \cdot \underset{I}{\log(x + \sqrt{x^2 + 1})}dx$$

$$= x\log(x + \sqrt{x^2 + 1}) - \int_{-1}^{2} \left(\frac{1 + \frac{x}{\sqrt{x^2 + 1}}}{x + \sqrt{x^2 + 1}} \right) x \, dx$$

$$= x\log(x + \sqrt{x^2 + 1}) - \int_{-1}^{2} \frac{x}{\sqrt{x^2 + 1}}dx$$

$$= x\log(x + \sqrt{x^2 + 1}) - \sqrt{x^2 + 1}\Big]_{-1}^{2}$$

$$= [2\log(2 + \sqrt{5}) - \sqrt{5}] - [-\log(\sqrt{2} - 1) - \sqrt{2}]$$

$$= \log[(2 + \sqrt{5})^2(\sqrt{2} - 1)] - \sqrt{5} + \sqrt{2}$$

Solu.

Ques 6. Dice is thrown 3 times, then find the probability that x1 < x2 < x3. (here x1, x2, x3 ∈ [1, 6]) (where x1, x2, x3 are outcomes on dice)

A. 7/54

B. 5/54

C. 11/54

D. 17/54

Ans. 2

Solu. . Given condition is x1 < x2 < x3 So,

$n(E) = {}^6C_3$

$n(s) = 6^3 = 216$

Then required probability $= {}^6C_3/216$

$= 20/216 = 5/54$

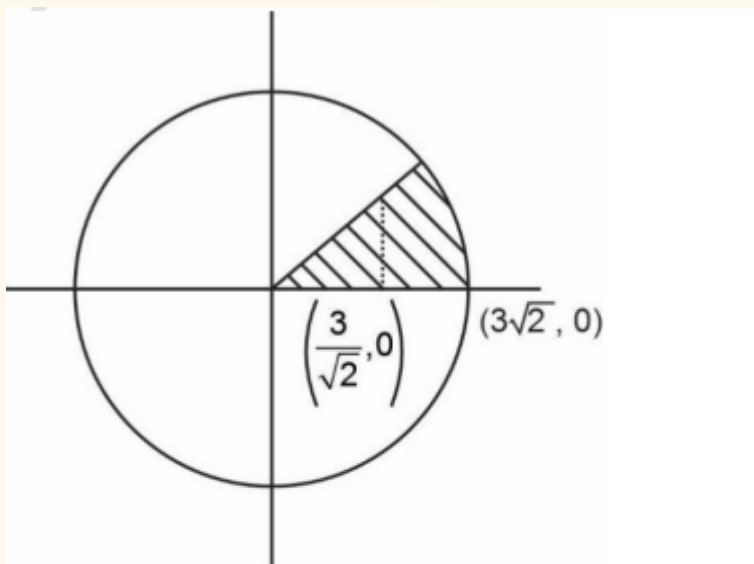**Ques 7. Find the area bounded by ellipse $x^2 + 3y^2 = 18$ below the line y = x is (in first quadrant)**

    A. $3\pi + 1$
    B. $\sqrt{3} * \pi$
    C. $3\pi - \frac{3}{4}$
    D. $3\pi + \frac{1}{4}$

Ans. B

$$\text{Area} = \int_{0}^{\frac{3}{\sqrt{2}}} x\,dx + \int_{\frac{3}{\sqrt{2}}}^{3\sqrt{2}} \sqrt{\frac{18-x^2}{3}}\,dx$$

$$= \frac{1}{2}\left(x^2\right)_{0}^{\frac{3}{\sqrt{2}}} + \frac{1}{\sqrt{3}}\left[\frac{x}{2}\sqrt{18-x^2} + 9\sin^{-1}\left(\frac{x}{3\sqrt{2}}\right)\right]_{\frac{3}{\sqrt{2}}}^{3\sqrt{2}}$$

Solu.

Ques 8. Sum of infinite terms of a, ar, ar^2... and a^{3}r^3, a^{3}r^6, a^{3}r^9.... is 57 and 9747 respectively, then a + 18r is

Ans. 31

a, ar, ar², ...

$$\frac{a}{1-r} = 57 \qquad ...(1)$$

a^3r^3, a^3r^6, a^3r^9 ....

$$\frac{a^3}{1-r^3} = 9747 \qquad ...(2)$$

Equation $\dfrac{(1)^3}{(2)}$ given,

$$\frac{\dfrac{a^3}{(1-r)^3}}{\dfrac{a^3}{1-r^3}} = \frac{57^3}{9747}$$

$$\Rightarrow \frac{1-r^3}{(1-r)^3} = 19$$

$$\frac{(1-r)(1+r^2+r)}{(1-r)^3} = 19 \qquad (r \neq 1)$$

$1 + r^2 + r = 19 + 19r^2 - 38r$

$18r^2 - 39r + 18 = 0$

$$\Rightarrow r = \frac{2}{3} \text{ and } \left(\frac{3}{2}\right) \text{ rejected}$$

$$\therefore r = \frac{2}{3} \text{ and } a = 19$$

Now $a + 18r = 19 + 12 = 31$

Solu.

Ques 9. The number of numbers between 100 to 1000 such that sum of their digits is 14, is

Ans. 70.00
Solu. Number in this range will be 3-digit number.
N abc = such that a + b + c = 14
Also, a ≥1 a, b, c ∈ {1, , , 0,1, 2, ...9}
Case I
All 3-digit same ⇒ 3a = 14 not possible
Case II
Exactly 2 digit same:
⇒ 2a + c = 14
(a,c) ∈ {(3, 8) , (4, 6), (5, 4), (6, 2), (7, 0) }
⇒ 3! / 2! ways ⇒ 5 × 3 − 1 = 15 − 1 = 14
Case III
All digits are distinct a + b + c = 14
without losing generality a > b > c

$$(a, b, c) \in \begin{cases} (9, 5, 0), (9, 4, 1), (9, 3, 2) \\ (8, 6, 0), (8, 5, 1), (8, 4, 2) \\ (7, 6, 1), (7, 5, 2), (7, 4, 3) \\ (6, 5, 3) \end{cases}$$

⇒ 8 * 3! + 2(3! - 2!) = 48 + 8 = 56
= 0 + 14 + 56 = 70

Ques 10. Find the number of solutions of 3sin⁻1x + 2cos⁻¹x = 2π/5 .

Ans. 0
Solu. $\sin^{-1}x = 2\pi/5 - \pi = -3\pi/5$
-3π/5 = -π/2
∴ No real solution

Ques 11. If f(x) = 2(2 – p)x – (p² – 6p + 8) cos4x + 7, then for what values of p, does f(x) not have a vertical point?

Ans. 4

Solu. f'(x) = 2(2 - p) + 4sin 4x(p - 2)(p - 4)

= (p - 2)((4sin 4x)(p - 4) - 2), p≠ 2

4sin 4x(p - 4) -2 ≠ 0

⇒ sin4x (p - 4) ≠1/2

sin 4x ≠1/(2(p - 4))

1/(2(p - 4)) > 1

1/(2(p - 4)) - 1 >0 ⇒ y in(4, 9/2)

1/(2(p - 4)) <-1 ⇒ p in(7 2 ,4)

p ∈φ .

p = 4 is the only required value