MATRIX

JEE MAIN 2026

Memory Based-Questions and Analysis of 4th April (Shift-1)

PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Radius of a soap bubble is increased from 1 cm to 2 cm. Work done in process is (S is surface tension)

(1) $\pi S \times 10^{-2}$ (2) $1.2\ \pi S$ J

(3) $2.4\ \pi \times 10^{-3}$ J (4) $\pi S \times 10^{-3}$ J

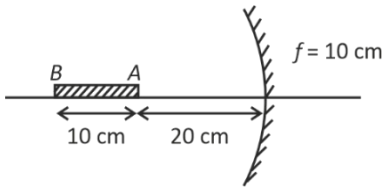
Answer (3)

Sol. $W = \Delta U = 2 \cdot S\left(4\pi\left\{\left(\frac{2}{100}\right)^2 - \left(\frac{1}{100}\right)^2\right\}\right.$

$= \frac{2 \times 4\pi S \times 3}{10^4}$

$= 2 \cdot 4\ \pi S \times 10^{-3}$

2. A rod is placed along principal axis as shown. Find length of image



(1) 10 cm (2) 5 cm

(3) 15 cm (4) 20 cm

Answer (2)

Sol. Image of *A* will be at *A* only as if is center of curvature

For *B*

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$\Rightarrow \frac{1}{v} = \frac{-1}{10} + \frac{1}{30}$

$\Rightarrow \frac{1}{v} = \frac{-3+1}{30}$

$v = -15$ cm

$\therefore$ Length of image will be 5 cm.

3. Nuclei A and B form a nucleus C. BE/N for A, B and C are 3 MeV, 7 MeV and 6 MeV. Then energy produced in

$2A^3 + B^4 \rightarrow C^{10}$

(1) 8 MeV (2) 12 MeV

(3) 14 MeV (4) 10 MeV

Answer (3)

Sol. $\Delta E = 10 \times 6 - (2 \times 3 \times 3) - (4 \times 7)$

$= 60 - 18 - 28$

$= 60 - 46 = 14$

4. Find coefficient of friction if time taken by block in rough surface is 50% more than time taken by smooth surface. The distance slide by the mass is same in both the cases.

(1) $\mu = \frac{5}{7}$ (2) $\mu = \frac{5}{9}$

(3) $\mu = \frac{4}{7}$ (4) $\mu = \frac{4}{9}$

Answer (2)

Sol. $\frac{1}{2} g \frac{1}{\sqrt{2}} t_1^2 = s$

$\Rightarrow t_1^2 = \frac{2\sqrt{2}s}{g}$ ...(i)

And $\dfrac{\left(\dfrac{mg}{\sqrt{2}}-\dfrac{\mu mg}{\sqrt{2}}\right)}{m}=a_2$

$\dfrac{1}{2}a_2t_2^2=s$

Also $t_2=\left(\dfrac{3}{2}t_1\right)$

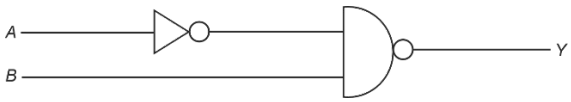
So $t_2^2=\dfrac{2s\cdot\sqrt{2}}{g(1-\mu)}$ …(ii)

$\dfrac{9}{4}t_1^2=\dfrac{2\sqrt{2}s}{g(1-\mu)}$ = $\dfrac{9}{4}\cdot\dfrac{2\sqrt{2}s}{g}$

$\Rightarrow \quad \dfrac{9}{4}=\dfrac{1}{1-\mu} \Rightarrow 9-9\mu=4$

$\Rightarrow \quad \dfrac{5}{9}=\mu$

5. Inputs of *A* and *B* are given. Find output result *Y* of the circuit



(1) $A+\overline{B}$ (2) $\overline{A}+B$

(3) $\overline{A}B$ (4) $A\cdot\overline{B}$

Answer (1)

Sol. $Y=\overline{\overline{A}\cdot B}$

$\Rightarrow Y=\overline{\overline{A}}+\overline{B}=\left(A+\overline{B}\right)$

6. A uniform sphere of mass *m* and radius *R* is divided into two equal parts one part of sphere has moment inertia I_1 about diameter and moment of inertia of disc of radius 2*R* and mass *m* about perpendicular axis through its center is I_2. Find $\dfrac{I_2}{I_1}$

(1) 10 (2) 2

(3) 5 (4) 1

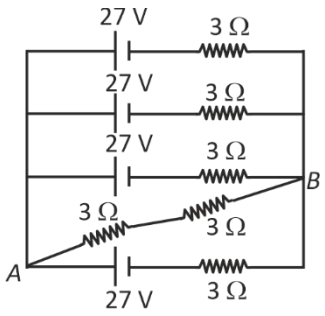
Answer (1)

Sol. $I_2=\dfrac{m(2R)^2}{2}=2mR^2$

and $I_1=\dfrac{2}{5}\dfrac{m}{2}R^2=\dfrac{mR^2}{5}$

$\dfrac{I_2}{I_1}=10$

7. For the circuit given below, find the V_{AB} and i_{AB}.



(1) 18 V, 8 A (2) 18 V, 6 A

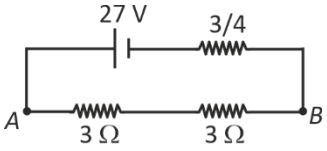
(3) 24 V, 3 A (4) 24 V, 4 A

Answer (4)

Sol. $\dfrac{1}{r_0}=\dfrac{1}{3}+\dfrac{1}{3}+\dfrac{1}{3}+\dfrac{1}{3}=\dfrac{4}{3}$

$\Rightarrow \quad r_0=\dfrac{4}{3}\Omega$

And $\varepsilon_0=\dfrac{\varepsilon(r)^3\times 4}{4(r)^3}=\quad \varepsilon=27$ volts

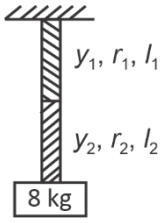


So $i_{AB}=\dfrac{27\times 4}{27}$ = 4 Ampere

And V_{AB} = 4 × 6 = 24 volts

8. A system of two composite wire is having a mass 8 kg attached with it as shown in figure. For wire (1) $y_1 = 2 \times 10^{11}$ N/m^2, $r_1 = 2$ mm, and $l_1 = 0.314$ m. And for wire (2) $y_2 = 4 \times 10^{11}$ N/m^2, $r_2 = 2$ mm, $l_2 = 0.628$ m.

Find total tension in the wires.



[$y \rightarrow$ Youngs modulus, $r \rightarrow$ radius, $l \rightarrow$ length)

(1) 4×10^{-5} m (2) 4×10^{-4} m

(3) 2×10^{-5} m (4) 2×10^{-4} m

Answer (3)

Sol. $\Delta l = \frac{F_1 l_1}{A_2 y_1} + \frac{F_2 l_2}{A_2 y_2}$

$\Rightarrow \Delta l = \frac{mg}{\pi r^2}\left[\frac{l_1}{y_1} + \frac{l_2}{y_2}\right]$

$\Rightarrow \Delta l = \frac{8 \times 10}{3.14 \times 4 \times 10^{-6}}\left[\frac{0.314}{2 \times 10^{11}} + \frac{0.628}{4 \times 10^{11}}\right]$

$\Rightarrow \Delta l = \frac{8 \times 10}{3.14 \times 4 \times 10^{-6}} \times \frac{2 \times 0.314}{2 \times 10^{11}} = 2 \times 10^{-5}$ m

9. There are two samples of gases :

Sample A $\rightarrow$ Number of moles is 2 and volume is 3 V_0

Sample B $\rightarrow$ Number of moles is 2 and volume is V_0

If relation between pressure and volume for both samples is $P = \frac{P_0}{\left(1 + \left(\frac{V}{V_0}\right)^2\right)}$.

Then find difference between temperature of sample *B* and sample *A*

(1) $\frac{P_0 V_0}{10R}$ (2) $\frac{P_0 V_0}{R}$

(3) $\frac{P_0 V_0}{20R}$ (4) $\frac{P_0 V_0}{8R}$

Answer (1)

Sol. $P_A = \frac{P_0}{1+9} = \frac{P_0}{10}$

$P_B = \frac{P_0}{2}$

$\Rightarrow T_B = \frac{\frac{P_0}{2} V_0}{2R} = \frac{P_0 V_0}{4R}$

$T_A = \frac{\frac{P_0}{10} \times 3V_0}{2R} = \frac{3P_0 V_0}{20R}$

$T_B - T_A = \frac{5P_0 V_0 - 3P_0 V_0}{20R}$

$\Rightarrow \frac{P_0 V_0}{10R}$

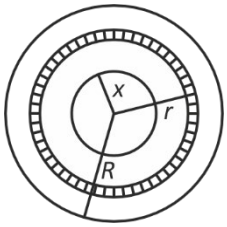
10. A spiral coil having total 200 turns, inner radius 3 cm and outer radius 6 cm has 20 mA current through it. Find its magnetic moment.

(1) $42\pi \times 10^{-4}$ Am^2 (2) $36\pi \times 10^{-3}$ Am^2

(3) $84\pi \times 10^{-4}$ Am^2 (4) $27\pi \times 10^{-4}$ Am^2

Answer (3)

Sol.



$\int dM = \int di\pi r^2$

$M = \int \frac{Ndri\pi r^2}{(R-x)}$

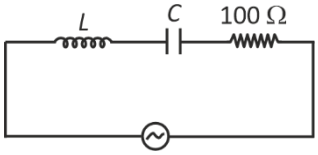
$\Rightarrow \frac{Ni}{R-x}\pi\left[\frac{r^3}{3}\right]_x^R$

$\Rightarrow \frac{Ni\pi}{3(R-x)}(R^3 - x^3)$

$\Rightarrow \frac{Ni\pi}{3}(R^2 + Rx + x^2)$

$\Rightarrow \frac{200}{3} \times 20 \times 10^{-3}\pi(36 + 18 + 9) \times 10^{-4}$

$84\pi \times 10^{-4}$

11. 

Power factor of the above circuit is 0.5. Find $|X_L - X_C|$.

(take $\sqrt{3} = 1.73$)

(1) 346 W (2) 173 W

(3) 86.5 W (4) 58 W

Answer (2)

Sol. cos$f$ = 0.5

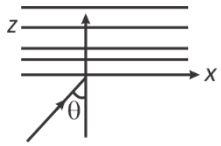
$f = 60°$

$$\tan 60° = \frac{X_L - X_C}{R}$$

$$\Rightarrow \sqrt{3} = \frac{|(X_L - X_C)|}{100}$$

$$\Rightarrow |X_L - X_C| = 173$$

12. Electric field of EMW is given as $\vec{E} = \left(E_1\hat{i} + E_2\hat{k}\right)$ sin(kx + $kz - \omega t$). Find reflected ray equation if θ is Brewster angle



(1) $\left(E_1\hat{i} + E_2\hat{k}\right)$ sin($kx + kz - \omega t$)

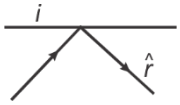
(2) $E_1\hat{i} + E_2\hat{k}$ sin($kx - kz - \omega t$)

(3) $E_0\hat{j}$ sin($kx + kz - \omega t$)

(4) $E_0\hat{j}$ sin($kx - kz - \omega t$)

Answer (4)

Sol. If $\hat{i} = x\hat{i} + z\hat{k}$



then $\hat{r} = x\hat{i} - z\hat{k}$

& $\vec{E}$ in $(\hat{i}\ \&\ \hat{k})$ is null because of polarization.

Only transverse component of electric field will be reflected. So only (E_1). And the direction of propagation in z direction will be reversed.

13. A telescope has resolving power of 5×10^{-7} radian. The wavelength of light is 500 nm. Find diameter of telescope. (in fermi meter)

(1) 112 (2) 224

(3) 61 (4) 305

Answer (4)

Sol. Resolving Power = $\frac{D}{1.22\lambda}$

$\Rightarrow$ D =1.22 λ × R

$\Rightarrow$ D = 1.22 × 5 × 10–7 × 500 × 10–9

$\Rightarrow$ D = $25 \times 1.22 \times 10^{-14}$ m

D = 305×10^{-15} m

D = 305 m

14. Two forces $\vec{F}_1$ and $\vec{F}_2$ act simultaneously on a body $\vec{F}_1 = 3\hat{i} + 5\hat{j}$ and $\vec{F}_2 = 2\hat{i} - 4\hat{j} + 2\hat{k}$ and body is displaced by 25 cm along $3\hat{i} - 4\hat{j}$ find work done by net force.

(1) 55 J (2) 60 J

(3) 70 J (4) 86 J

Answer (1)

Sol. $\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = 5\hat{i} + \hat{j} + 2\hat{k}$

$w = \vec{F}\cdot\vec{S} = FS\cos\theta$

$$w = (5\hat{i} + \hat{j} + 2\hat{k}) \cdot \frac{(3\hat{i} - 4\hat{j})}{5} \times 25$$

$w = (15 - 4) \times 5$

w = 55 J

15. In single slit diffraction, distance between third minima & 1st minima is (*a* is slit width, *D* is distance of screen & λ is wavelength)

(1) $\frac{3\lambda D}{a}$ (2) $\frac{4\lambda D}{a}$

(3) $\frac{2\lambda D}{a}$ (4) $\frac{\lambda D}{2a}$

Answer (3)

Sol. $a\theta = n\lambda$ for minima

$$\theta_1 = \frac{\lambda}{a}, \quad \theta_2 = \frac{3\lambda}{a}$$

$$\text{Distance} = D\Delta\theta = D\frac{2\lambda}{a}$$

16. Bulk modulus of water is 2.2×10^9 Pa. At depth 220 m find % change in density (w.r.t the density at the surface).

(1) 0.1%

(2) 1%

(3) 0.2%

(4) 2%

Answer (1)

Sol. $dp = \rho gh$

$$\frac{dv}{v} = \left|\frac{d\rho}{\rho}\right|$$

$$\text{Also } dp = \left|\frac{dv}{v}B\right|$$

$$\text{So } d_p = \left(\frac{d\rho}{\rho}\right) \times B = \rho gh$$

$$\Rightarrow \left(\frac{d\rho}{\rho}\right) \times 100 = \left(\frac{\rho ph}{\beta}\right) \times 100$$

$$= \frac{1000 \times 10 \times 220 \times 100}{2.2 \times 10^9} = 0.1\%$$

17.

18.

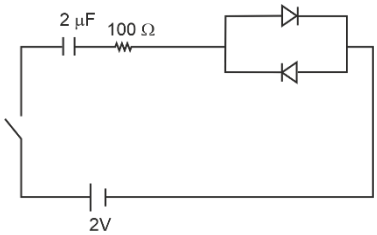
19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If resistance of diode in forward bias is 10Ω then time constant of the circuit would be $\alpha \times 10^{-5}$. Find α



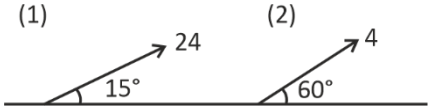
Answer (22)

Sol. $\tau : RC$

$\tau = 110 \times 2 \times 10^{-6}$

$\Rightarrow \tau = 22 \times 10^{-5}$

22.



Range of projectile (1) is *N* times

Range of projectile (2) then $\sqrt{3}N$ is

Answer (4)

Sol. $R = \frac{u^2 \sin 2\theta}{g}$

$$\frac{R_1}{R_2} = 4 \times \frac{\sin 30}{\sin 120} = \frac{2 \times 2}{\sqrt{3}} = \frac{4}{\sqrt{3}}$$

23.

24.

25.

CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. Statement I : BP order is HI < HBr < HCl < HF.

   Statement II : MP order is HI < HF < HCl < HBr.

   (1) Statement I and Statement II are correct

   (2) Statement I is correct and Statement II is wrong

   (3) Statement I is wrong and Statement II is correct

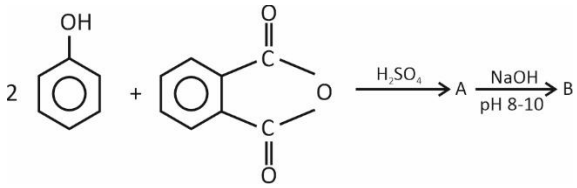
   (4) Statement I wrong and Statement II is correct

Answer (3)

Sol.

	BP (K)	MP (K)
HF	293	190
HCl	189	159
HBr	206	185
HI	238	222

2. Consider the following reaction



   The color of the compound(B) formed is

   (1) Violet

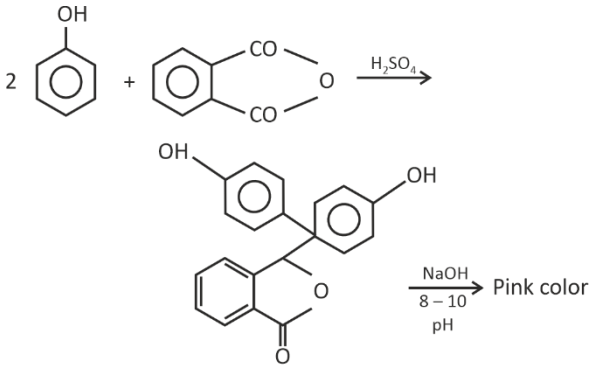
   (2) Red

   (3) Colourless

   (4) Pink

Answer (4)

Sol.



Phenolphthalein

3. Given below are two statements :

   Statement I : Maltose is a non-reducing sugar

   Statement II : Lactose is a reducing sugar

   (1) Both statement I and statement II are correct

   (2) Statement I is correct but statement II is incorrect

   (3) Statement I is incorrect but statement II is correct

   (4) Both statement I and statement II are incorrect

Answer (3)

Sol. Maltose $\rightarrow$ 2 units of α-D-glucose ($C_1 - C_4$ glycosidic linkage)

Lactose $\rightarrow$ β-D-galactose + β-D-glucose

Both are reducing sugar

4. If the wavelength of first line of Balmer series and of Brackett series of Hydrogen atom are respectively λ_1 and λ_2 respectively, then value of $\frac{\lambda_1}{\lambda_2}$ is

   (1) 0.16 (2) 0.04

   (3) 0.28 (4) 0.35

Answer (1)

Sol. $\frac{1}{\lambda_1} = R \times 1^2 \times \left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}, \lambda_1 = \frac{36}{5R}$

$$\frac{1}{\lambda_2} = R \times 1^2 \times \left(\frac{1}{4^2} - \frac{1}{5^2}\right) = \frac{9R}{400}, \lambda_2 = \frac{400}{9R}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{36}{5R} \times \frac{9R}{400} = 0.16$$

5. What will be the pH at 25°C of solution obtained by mixing of 100 mL, 0.5 M NH_4OH solution and 0.01 M, 25 mL NH_4Cl solution? (pK_b of NH_3 = 4.74)

(1) 11.56 (2) 9.0

(3) 2.44 (4) 4.5

Answer (1)

Sol. After mixing :

$$[NH_4OH] = \frac{50}{125} M$$

$$[NH_4Cl] = \frac{0.25}{125} M$$

Solution acts as buffer solution

$$pOH = pK_b + \log\frac{0.25}{50}$$

pOH = 4.74 – 2.3 = 2.44

pH = 14 – 2.44 = 11.56

6. Match the following

	Species		**Magnetic moment (BM)**
(I)	Mn^{2+}	(P)	$\sqrt{24}$
(II)	Co^{2+}	(Q)	$\sqrt{35}$
(III)	Cu^{2+}	(R)	$\sqrt{15}$
(IV)	Cv^{2+}	(S)	$\sqrt{3}$

(1) (i) → (Q), (ii) → (R), (iii) → (S), (iv) → (P)

(2) (i) → (R), (ii) → (S), (iii) → (P), (iv) → (Q)

(3) (i) → (P), (ii) → (Q), (iii) → (R), (iv) → (S)

(4) (i) → (S), (ii) → (Q), (iii) → (P), (iv) → (R)

Answer (1)

Sol. $Mn^{2+} \to 3d^5 \to M = \sqrt{35}$, $Co^{2+} \to 3d^7 \to M = \sqrt{15}$

$Cu^{+2} \to 3d^9 \to M = \sqrt{3}$, $Cr^{2+} \to 3d^4 \to M = \sqrt{24}$

7. Match the following :

	List-I (Amino Acid)		**List-II (Single letter code)**
(I)	Arginine	(P)	D
(II)	Lysine	(Q)	K
(III)	Glutamic acid	(R)	E
(IV)	Aspartic acid	(S)	R

Choose the correct option

(1) (I)-(S), (II)-(Q), (III)-(P), (IV)-(R)

(2) (I)-(Q), (II)-(S), (III)-(P), (IV)-(R)

(3) (I)-(S), (II)-(Q), (III)-(R), (IV)-(P)

(4) (I)-(P), (II)-(Q), (III)-(R), (IV)-(S)

Answer (3)

Sol. Arginine → R

Lysine → K

Glutamic acid → E

Aspartic acid → D

8. Given

$A + B \rightleftharpoons C$; $K_{eq} = 2.7 \times 10^{-5}$

$\frac{1}{3}A + \frac{1}{3}B \to \frac{1}{3}C$; $K'_{eq} = x$

The value of x is

(1) 9×10^{-6} (2) 3×10^{-2}

(3) 2.7×10^{-5} (4) 4×10^{-2}

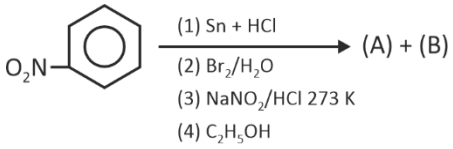
Answer (2)

Sol. $A + B \rightleftharpoons C$; $K_{eq} = 27 \times 10^{-6}$

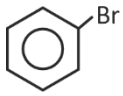
$$\frac{1}{3}A + \frac{1}{3}B \rightleftharpoons \frac{1}{3}C = K'_{eq} = \left(K_{eq}\right)^{\frac{1}{3}}$$

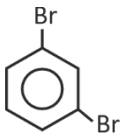
$K^1_{eq} = 3 \times 10^{-2}$

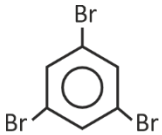
9. Consider the reaction :

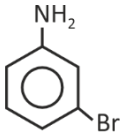


Identify 'A' (it is benzenoid product).

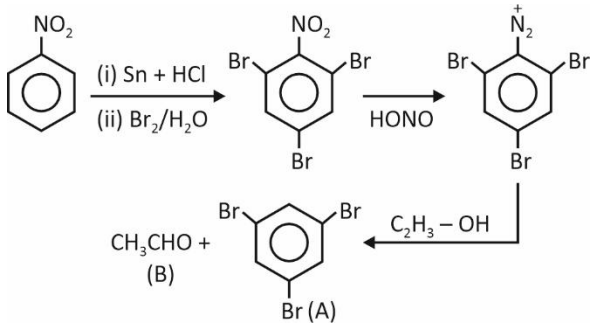
(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. 

10. If 'n' is the number of lone pairs of electrons in the equatorial position of the most stable structure of ClF_3, which of the following ions also have 'n' unpaired electrons?

A. V^{3+} B. Ti^{3+}

C. Cu^{2+} D. Ni^{2+}

E. Ti^{2+}

(1) A and C only (2) A, D and E only

(3) B and C only (4) B and D only

Answer (2)

Sol. ClF_3 is T-shaped, so 2 lone pairs are present at equatorial position (n = 2)

Number of unpaired e –

A. $V^{3+} \rightarrow d^2$ (2e) B. $Ti^{3+} \rightarrow d^1$ (e)

C. $Cu^{2+} \rightarrow d^9$ (1e) D. $Ni^{2+} \rightarrow d^8$ (2e)

E. $Ti^{2+} \rightarrow d^2$ (2e)

11. Consider the statements :

Statement I : Actinoid contraction > Lanthanoid contraction (element to element)

Statement II : Tb^{4+}, Ce^{4+} – oxidant

Statement III : Yb^{2+}, Eu^{2+} – reductant

Mark the correct statement(s) :

(1) I, II only (2) I, II only are correct

(3) I, II, III are correct (4) Only II is correct

Answer (3)

Sol. I, II, III are correct; $Eu^{2+} \rightarrow 4f^7$, $Yb^{2+} \rightarrow 4f^{14}$, $Ce^{4+} \rightarrow 4f^0$ $Tb^{4+} \rightarrow 4f^7$

12. Match List-I with List-II and choose the correct option.

List-I (Naming Reaction)		List-II (Reactions)	
I.	Wurtz reaction	P	R-X + AgF $\rightarrow$ R-F+ AgX
II.	Swarts reaction	Q	R-X + NaI $\rightarrow$ R-I+ NaX
III.	Finkelstein reaction	R	2Ar-X + 2Na $\rightarrow$ Ar-Ar + 2NaX
IV.	Fittig reaction	S	2R-X + 2Na $\rightarrow$ R-R + 2NaX

(1) I – P, II – Q, III – R, IV – S

(2) I – S, II – P, III – Q, IV – R

(3) I – P, II – S, III – Q, IV – R

(4) I – R, II – P, III – Q, IV – S

Answer (2)

Sol. I – S, II – P, III – Q, IV – R

13. The calculated spin only magnetic moment of $K_3[Fe(OH)_6]$ and $K_4[Fe(OH)_6]$ respectively are

(1) 5.92 BM and 4.90 BM

(2) 5.92 BM and 5.92 BM

(3) 4.90 BM and 4.90 BM

(4) 4.90 BM and 5.92 BM

Answer (1)

Sol. $K_3[Fe(OH)_6] \Rightarrow Fe^{3+} \Rightarrow 3d^5 \Rightarrow n = 5$

$$\mu = \sqrt{35}\ BM = 5.92\ BM$$

$K_4[Fe(OH)_6] \Rightarrow Fe^{2+} \Rightarrow 3d^6 \Rightarrow n = 4$

$$\mu = \sqrt{24}\ BM = 4.90\ BM$$

14. Arrange the following functional groups in increasing order of electron withdrawing effect.

–CN ; $–NO_2$; –I ; –COOH

(1) $–NO_2 < –CN < –I < –COOH$

(2) $–I < –COOH < –CN < –NO_2$

(3) $–COOH < –I, –NO_2 < –CN$

(4) $–I < –COOH < –NO_2 < –CN$

Answer (2)

Sol. Order of electron withdrawing :

$–I < –COOH < –CN < –NO_2$

15. The number of moles of $F_2C_2O_4$ and $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ required to completely react with 2 mol of acidified $KMnO_4$ for each of them is respectively

(1) 3.33 moles and 10 moles

(2) 5 moles and 10 moles

(3) 5 moles and 3.33 moles

(4) 3.33 moles and 5 moles

Answer (1)

Sol. Equivalents of $KMnO_4$ = Equivalents of FeC_2O_4

$2 \times 5 =$ mol of $FeC_2O_4 \times (1 + 2)$

$$\text{Mol of } FeC_2O_4 = \frac{10}{3} = 3.33$$

Equivalents of $KMnO_4$ = Equivalents of $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

$2 \times 5 = 1 \times$ mol of $FeSO_4 \cdot (NH_4)_2SO_4 \times 6H_2O = 10$

16. Consider the following reaction

$P \rightarrow Q$

If the reaction follows first order kinetics, find the fraction of decomposed molecule at time t

(1) $1 – e^{kt}$ (2) $1 + e^{kt}$

(3) $1 – e^{–kt}$ (4) $1 + e^{–kt}$

Answer (3)

Sol. $[At] = [A_0]\ e^{–kt}$

Amount decomposed = $[A_0] – [At]$

$= [A_0] – [A_0]\ e^{–kt}$

$= [A_0]\ \left(1 – e^{–kt}\right)$

$$\text{Fraction decomposed} = \frac{[A_0]\left(1 – e^{–kt}\right)}{[A_0]} = 1 – e^{–kt}$$

17. 4 g of solute is dissolved in a certain amount of solvent and its vapour pressure decreases from 760 mm to 750 mm. 4 gram of same solute is dissolved in same amount of that solvent that causes increase in boiling point by 0.15°C. Calculate the molar mass of solvent. [K_b = 0.5 K kg/mol]. Consider solute to be non-electrolyte.

(1) 22.22 g/mol (2) 44.44 g/mol

(3) 60 g/mol (4) 70 g/mol

Answer (2)

Sol. $$\frac{P^\circ – P_s}{P_s} = \frac{n}{N}$$

$$\frac{760 – 750}{750} = \frac{n}{N}$$

$$\frac{30}{750} = \frac{n}{N}$$

$$\frac{n}{N} = \frac{1}{75}$$

$\Delta T_b = m \times K_b$

$0.15 = m \times 0.5$

$m = 0.3$

$$m = \frac{W \times 1000}{M_2 \times W} = \frac{n \times 1000}{W}$$

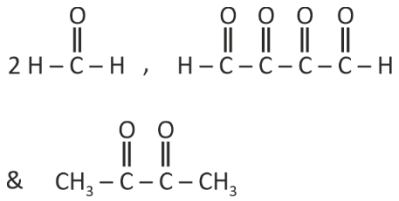
$$M = \frac{n \times 1000}{N \times M_1}$$

$$0.3 = \frac{1}{75} \times \frac{1000}{M_1}$$

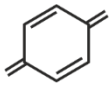
$$M_1 = \frac{10,000}{75 \times 3}$$

M_1 = 44.4 g/mol

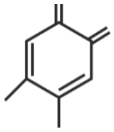
18. An organic compound on reductive ozonolysis gives the following products

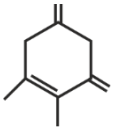


The structure of organic compound is

(1) 

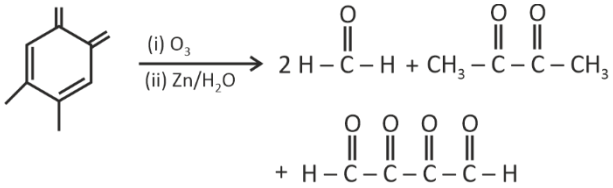
(2) 

(3) 

(4) 

Answer (3)

Sol.



19. 112 dm^3 of SO_2 is given at STP. The number of moles and number of molecules of SO_2 respectively are

(1) 0.5, 30.11×10^{24} (2) 5, 3.011×10^{24}

(3) 8, 3.011×30^{23} (4) 8, 6.022×20^{24}

Answer (2)

Sol. Number of moles of $SO_2 = \frac{112}{22.4} = 5$ moles

Number of molecules of $SO_2 = 5 \times 6.022 \times 10^{23}$

$= 3.011 \times 10^{24}$

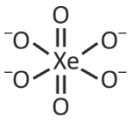
20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Total number of lone pairs and sigma (σ) bond pairs formed by central atom (Xe) in XeO_6^{4-}

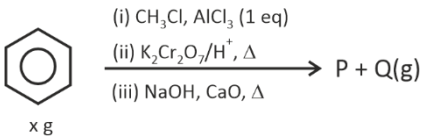
Answer (6)

Sol. 

Number of lone pair on Xe = 0

Number of σ bond pair = 6

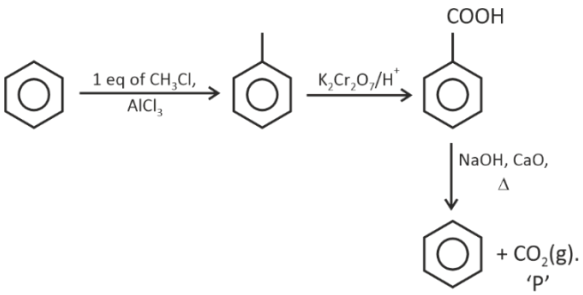
22. Consider the reaction,



If volume of Q(g) is 0.112 dm^3 at STP. Find value of 10(x) (Nearest integer).

(Mass of benzene taken initially = x g)

Answer (4)

Sol. 

Volume = 0.112 dm^3

$$n_{CO_2} = \frac{0.112}{22.4} = 5 \times 10^{-3} = n_{benzene}$$

Mass of benzene (M) = $5 \times 10^{-3} \times 78$

0.39 g

23.

24.

25.

MATHEMATICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. If z be a complex number such that $|z+2| = |z-2|$ and $\arg\left(\frac{z-3}{z+i}\right)=\frac{\pi}{4}$ then the value of $|z|^2$ is

(1) 9 (2) 3

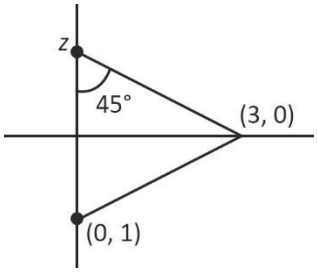
(3) 2 (4) 4

Answer (1)

Sol. $|z-2| = |z+2|$

$\Rightarrow z$ lie on y-axis

$\arg\left(\frac{z-3}{z+i}\right)=\arg\left(\frac{3-z}{-i-z}\right)=\frac{\pi}{4}$ represent



$\Rightarrow z = 3i$ is the only one solution

2. Let A is a matrix of order 3 such that $|A| = -4$. Then, the value of $|adj(adj(2adj(A))^{-1})|$ is

(1) $\frac{1}{2^{16}}$ (2) $\frac{1}{2^{28}}$

(3) $\frac{1}{2^{30}}$ (4) $\frac{1}{2^{20}}$

Answer (2)

Sol. $|adj(adj(2adj(A)))^{-1}| = |(2adj(A)^{-1})|^{2^2}$

$$= \frac{1}{|2adj(A)|^4}$$

$$= \frac{1}{2^{12}|adjA|^4}$$

$$= \frac{1}{2^{12}|A|^8}$$

$$= \frac{1}{2^{12}\times(-4)^8} = \frac{1}{2^{28}}$$

3. The number of ways 4 boys and 3 girls are to be arranged in a row so that all 3 girls are not together, is equal to

(1) 2320 (2) 4320

(3) 4920 (4) 1440

Answer (2)

Sol. $\Rightarrow$ Total ways = 7!

We need to remove cases where all 3 girls are together.

$\Rightarrow \boxed{G_1\ G_2\ G_3}\ B_1\ B_2\ B_3\ B_4$

$\Rightarrow$ 3! × 5!

$\Rightarrow$ Required ways = 7! – 3! × 5!

= 4320

4. $y=\tan^{-1}\left(\frac{3\cos x-4\sin x}{4\cos x+3\sin x}\right)+\tan^{-1}\left(\frac{x}{1+\sqrt{1+x^2}}\right)$, then find $\frac{dy}{dx}$ at $x=\frac{\sqrt{3}}{2}$

(1) $\frac{5}{7}$ (2) $\frac{-5}{7}$

(3) $\frac{3}{7}$ (4) $\frac{-3}{2}$

Answer (2)

Sol.

$$\tan^{-1}\left(\frac{3\cos x-4\sin x}{4\cos x+3\sin x}\right)+\tan^{-1}\left(\frac{x}{1+\sqrt{1+x^2}}\right)$$

$$\tan^{-1}\left(\frac{\frac{3}{4}-\tan x}{1+\frac{3}{4}\tan x}\right)+\tan^{-1}\left(\frac{\tan\phi}{1+\sec\phi}\right) \text{ \{put } x=\tan\phi\}$$

$$\tan^{-1}(\tan(A-x)+\tan^{-1}\left(\frac{\sin\phi}{1+\cos\phi}\right)$$

$$(A-x)+\tan^{-1}\left(\frac{2\sin\frac{\phi}{2}\cos\frac{\phi}{2}}{2\cos^2\frac{\phi}{2}}\right)$$

$$(A-x)+\tan^{-1}\left(\tan\frac{\phi}{2}\right)$$

$$\therefore y=(A-x)+\frac{\phi}{2}=(A-x)+\frac{1}{2}\tan^{-1}x$$

$$\frac{dy}{dx}=-1+\frac{1}{2}\cdot\frac{1}{1+x^2}$$

$$\left.\frac{dy}{dx}\right|_{x=\frac{\sqrt{3}}{2}}=-1+\frac{1}{2}\cdot\frac{1}{1+\frac{3}{4}}=\frac{-5}{7}$$

5. The domain of the function $\cos^{-1}\left\{\frac{4\pi+2[x]}{3}\right\}$, where $[\cdot]$ is greatest integer function, is

(1) $\left[0,\frac{3}{4}\right]$ (2) $\left[\frac{-1}{4},\frac{1}{4}\right]$

(3) $\left[\frac{-1}{4},\frac{3}{4}\right]$ (4) $\left[\frac{-3}{4},\frac{1}{4}\right]$

Answer (3)

Sol. $\cos^{-1}(t)$ is defined for $t \in [-1, 1]$

$\Rightarrow \frac{4x+2[x]}{3}\in[-1,1]$

$\Rightarrow -3 \le 4x + 2[x] \le 3$

(i) If $x \ge 1$

$\Rightarrow [x] \ge 1$

$\Rightarrow 4x + 2[x] \ge 6$

Not is not required

(ii) If $0 \le x < 1$

$\Rightarrow [x] = 0$

$\Rightarrow -3 \le 4x \le 3 \Rightarrow \frac{-3}{4} \le x \le \frac{3}{4}$

$\Rightarrow x \in \left[0,\frac{3}{4}\right]$

(iii) If $-1 \le x < 0$

$\Rightarrow [x] = -1$

Then $- \le 4x \le 5$

$\Rightarrow x\in\left[\frac{-1}{4},\frac{5}{4}\right]$

$\Rightarrow x\in\left[\frac{-1}{4},0\right)$

Similarly, if $x < -1 \Rightarrow [x] \le -2$

$\Rightarrow$ no such solution

$\Rightarrow x\in\left[\frac{-1}{4},\frac{3}{4}\right]$

6. Let S_n is the sum of first n terms of an A.P and a_n is the n^{th} term of A.P. If first term of the given A.P is $\frac{10}{3}$ and $S_{30}=a_{30}^3$. Then, the common difference of the given A.P is

(1) $\frac{5}{87}$ (2) $\frac{5}{83}$

(3) $\frac{4}{87}$ (4) $\frac{3}{83}$

Answer (1)

Sol. $S_{30}=\frac{30}{2}\left[2\left(\frac{10}{3}\right)+(30-1)d\right]=15\left[\frac{20}{3}+29d\right]$

$a_{30}=\frac{10}{3}+(30-1)d$

$= \frac{10}{3} + 29d$

$S_{30} = a_{30}^3$

$15\left[\frac{20}{3} + 29d\right] = \left(\frac{10}{3} + 29d\right)^3$

Let $x = \frac{10}{3} + 29d$ ...(1)

$15\left[\frac{10}{3} + x\right] = x^3$

$50 + 15x = x^3$

$x^3 - 15x - 50 = 0$

$(x-5)(x^2 + 5x + 10) = 0$

$\Rightarrow x = 5$

Put $x = 5$ in eqn (1)

$\frac{10}{3} + 29d = 5$

$29d = \frac{5}{3}$

$\Rightarrow d = \frac{5}{87}$

7. The value of $A = \frac{\sin 3^\circ}{\cos 9^\circ} + \frac{\sin 9^\circ}{\cos 27^\circ} + \frac{\sin 27^\circ}{\cos 81^\circ}$ and B = $\tan 81^\circ - \tan 3^\circ$. The value of $\frac{A}{B}$ is equal to

(1) 1 (2) 2

(3) $\frac{1}{2}$ (4) 4

Answer (2)

Sol. $\frac{\sin\theta}{\cos 3\theta}$

$= \frac{2\sin\theta\cdot\cos\theta}{2\cos 3\theta\cdot\cos\theta}$

$= \frac{\sin(3\theta - \theta)}{2\cos 3\theta\cdot\cos\theta}$

$= \frac{1}{2}(\tan 3\theta - \tan\theta)$

$\therefore \frac{\sin 3^\circ}{\cos 9^\circ} + \frac{\sin 9^\circ}{\cos 27^\circ} + \frac{\sin 27^\circ}{\cos 81^\circ}$

$= \frac{1}{2}(\tan 9^\circ - \tan 3^\circ + \tan 27^\circ - \tan 9^\circ + \tan 81^\circ - \tan 27^\circ)$

$= \frac{1}{2}(\tan 81^\circ - \tan 3^\circ)$

$= \frac{A}{B} = 2$

8. If the value of $\int_{-2}^{2}(|\sin x| + |x\sin x|)dx$ = $\beta(1 - 3\cos\alpha)$ + $\beta\sin\beta$, then β is equal to

(1) 3 (2) 2

(3) 5 (4) –2

Answer (2)

Sol. Since $\pi > 2$

$\Rightarrow |\sin x| = \sin x \forall x \in (-2, 2)$

and (x sin$x$) is even function

$\Rightarrow \int_{-2}^{2}|\sin x|dx = 2\int_{0}^{2}\sin x dx$

= 2(1 – cos$x$)

Similarly,

$\int_{-2}^{2} x\sin x = 2\int_{0}^{2}\sin x dx$

$= 2\left(-x\cos x\big|_0^2 + \int_0^2 \cos x dx\right)$

= 2(–2cos2 + sin$x$2)

= 2(sin2 – 2 cos2)

$\Rightarrow 2 + 2\sin 2 - 6\cos 2$

$\Rightarrow \beta = 2$

9. Let $P(1, 2)$ be any point from which two chords bisected at y-axis are drawn to the circle whose equation is $x^2 + y^2 + x - 6y = 0$. Then, a equation of the chord is

(1) $\left(1+\sqrt{3}\right)x+2y-\left(5+\sqrt{3}\right)=0$

(2) $\left(1+\sqrt{3}\right)x-2y+\left(5+\sqrt{3}\right)=0$

(3) $\left(1-\sqrt{3}\right)x+2y+\left(5+\sqrt{3}\right)=0$

(4) $\left(1-\sqrt{3}\right)x-2y+\left(5+\sqrt{3}\right)=0$

Answer (1)

Sol. Let chords are bisected at $M(0, y)$ equation of chord is T = S_1

$\Rightarrow x \times 0 + y \times y_1 + \frac{1}{2}(x+0) - 3(y + y_1) = y_1^2 - 6y_1$

passes through $p(1, 2)$

$\Rightarrow 2y_1 + \frac{1}{2} - 3(2 + y_1) = y_1^2 - 6y_1$

$\Rightarrow 4y_1 + 1 - 12 - 6y_1 = 2y_1^2 - 12y_1$

$\Rightarrow 2y_1^2 - 10y_1 + 11 = 0$

$\Rightarrow y_1 = \frac{10 \pm \sqrt{100-88}}{4} = \frac{5 \pm \sqrt{3}}{2}$

$\Rightarrow$ There are two possible mid-points $M_1\left(0, \frac{5+\sqrt{3}}{2}\right)$ and $M_2\left(0, \frac{5-\sqrt{3}}{2}\right)$

$\Rightarrow$ equation of chords PM_1 and PM_2 are $\left(1+\sqrt{3}\right)x+2y-\left(5+\sqrt{3}\right)=0$ and $\left(1-\sqrt{3}\right)x+2y-\left(5-\sqrt{3}\right)=0$ respectively.

10. Let $f(x) = f'(x) \cdot f''(x)$ and $f(0) = 0$, where $f(x)$ is a polynomial function of n^{th} degree. The value of $36\left[f'(2)+f''(2)+\int_0^1 f(x)dx\right]$ is equal to

(1) 36 (2) 40

(3) 48.5 (4) 38.5

Answer (3)

Sol. $n = (n-1) + (n-2)$

$\Rightarrow n = 2n - 3$

$\Rightarrow n = 3$

$f(0) = 0, d = 0$

$f(x) = ax^3 + bx^2 + cx$

$ax^3 + bx^2 + cx = (3ax^2 + 2bx + c)(6ax + 2b)$

$= 18a^2x^3 + x^2(6ab + 12ab) + x(6ac + 4b^2) + 2bc$

$a = 18a^2 \Rightarrow a = \frac{1}{18}$

$b = 18 \times \frac{1}{18} \times b \Rightarrow b = b$

Let $c = 0 \Rightarrow b = 0$

$\therefore \quad f(x) = \frac{x^3}{18}$

$\therefore \quad f'(2) = \frac{2}{3}$

$f''(2) = \frac{2}{3}$

$\int_0^1 f(x)dx = \frac{1}{72}$

$\therefore$ Required Value = $36\left[\frac{2}{3}+\frac{2}{3}+\frac{1}{72}\right]$ = 48.5

11. Let $A(-2, -34, 6)$ and lines $L_1 : \frac{x-1}{2} = \frac{y-4}{4} = \frac{z-0}{1}$ and $L_2 : \frac{x-2}{1} = \frac{y+2}{-4} = \frac{z+2}{3}$. Then, the distance of A from L_2 measured along L_1 is

(1) $3\sqrt{21}$ (2) $4\sqrt{21}$

(3) $7\sqrt{5}$ (4) $6\sqrt{7}$

Answer (2)

Sol. Any point on L_2

$P(K+2, -4K-2, 3K-2)$

$\overrightarrow{AP} = (K+4, -4K+32, 3K-8)$

$\frac{K+4}{2} = \frac{-4K+32}{4} = \frac{3K-8}{1}$

$\Rightarrow \quad \frac{K+4}{2} = \frac{3K-8}{1}$

$\Rightarrow \quad K + 4 = 6K - 16$

$\Rightarrow \quad 20 = 5K$

$\Rightarrow \quad K = 4$

$P(6, -18, 10)$

$|AP| = \sqrt{(6+2)^2 + (-34+18)^2 + (10-6)^2}$

$= \sqrt{64 + 256 + 16}$

$= 4\sqrt{21}$

12. Let $S = \{A : A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}, a, b, c, d \in \{0,1,2,3,4\},$

$A^2 - 4A + 3I = 0\}$. The number of elements in the set S is equal to

(1) 10 (2) 19

(3) 1 (4) 9

Answer (2)

Sol. $A^2 - 4A + 3I = 0$

$\Rightarrow \text{tr}(A) = 4, \ |A| = 3$

$a + d = 4, \ ad - bc = 3$

$a, b, c, d \in \{0, 1, 2, 3, 4\}$

$a = 0 \Rightarrow d = 4 \Rightarrow bc = -3$ (not possible)

$a = 1 \Rightarrow d = 3 \Rightarrow bc = 0$ (9 cases)

$a = 2 \Rightarrow d = 2 \Rightarrow bc = -1$ (1 case)

$a = 3 \Rightarrow d = 1 \Rightarrow bc = 0$ (9 cases)

$a = 4 \Rightarrow d = 0 \Rightarrow bc = -3$ (not possible)

Total = 19 cases

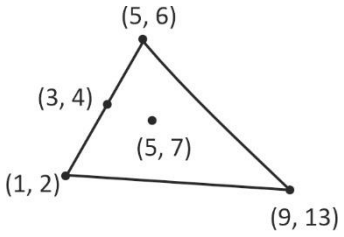
13. Let A, B and C be are vertices of a triangle such that $A(1, 2)$ and mid point of AB is (3, 4) and centroid is (5, 7). If the vertices of circumcentre of ΔABC is (α, β) then $12(\alpha + \beta)$ is

(1) 72 (2) 84

(3) 64 (4) 81

Answer (2)

Sol.



$\Rightarrow$ we can find vertices of Δ as $5 = \frac{1+5+9}{3}$ and

$7 = \frac{2+6+13}{3}$

Now, to find circumcentre

$(\alpha - 1)^2 + (\beta - 2)^2 = (\alpha - 5)^2 + (\beta - 6)^2$

$= (\alpha - 9)^2 + (\alpha - 13)^2$

$\Rightarrow \alpha + \beta = 7$

$12(\alpha + \beta) = 84$

14.

15.

16.

17.

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Let $A = \{1, 2, 3, 4, 5\}$ and $B = \{a, b, c\}$. Then the number of functions which are not onto are

Answer (93)

Sol. Total number of into function = total function – (Number of onto function)

$= 3^5 - (3^5 - {}^3C_1 (3-1)^5 + {}^3C_2(3-2)^5)$

$= 3 \times 32 - 3 \times 1$

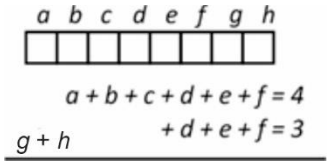
$= 96 - 3$

$= 93$

22. If fair coin is tossed 8 times. If the probability that first 6 throws contains 4 heads and last 5 throws contains exactly 3 heads is P then $96P$ is equal to

Answer (09.00)

Sol. If score = 1 it head and 0 if tail then



A. If $d + e + f = 3$ then $a + b + c = 1$ and $g + h = 0$

B. If $d + e + f = 2$ then $a + b + c = 2$ and $g + h = 1$

C. If $d + e + f = 1$ then $a + b + c = 3$ and $g + h = 2$

A. $${}^3C_3 \times \left(\frac{1}{2}\right)^3 \times {}^3C_1 \left(\frac{1}{2}\right)^1 \left(\frac{1}{2}\right)^2 \times {}^2C_0 \left(\frac{1}{2}\right)^0 \left(\frac{1}{2}\right)^2$$

$$= \left(\frac{1}{2}\right)^8 [{}^3C_3 \times {}^3C_1 \times {}^2C_0] = 3 \times \frac{1}{2^8}$$

B. $$\left(\frac{1}{2}\right)^8 ({}^3C_2 \times {}^3C_2 \times {}^2C_1) = 18 \times \frac{1}{2^8}$$

C. $$\left(\frac{1}{2}\right)^8 ({}^3C_1 \times {}^3C_3 \times {}^2C_2) = 3 \times \frac{1}{2^8}$$

$$\Rightarrow \text{total probability} = \frac{24}{2^8} = \frac{3}{2^5} = \frac{3}{32}$$

$$\Rightarrow \frac{96 \times 3}{32} = 9$$

23. Consider 8 observations a, b, 8, 103, 13, 21, 67, 17 where $a > b$. If Median and Mean deviation about Median are 21 and 26 respectively. Then, the value of $2a$ is

Answer (152)

Sol. 8, 13, 17, 21, 67, 103, b, a

Since, Median = 21

$\Rightarrow$ 21 should be on 4^{th} or 5^{th} place

and since $b < a$

$b = 21$

Now Mean deviation about Median = 26

$$\Rightarrow \frac{|8-21| + |13-21| + |17-21| + |67-21| |a-21|}{8} = 26$$

$\Rightarrow |a - 21| + 153 = 208$

$\Rightarrow |a - 2| = 55$

$\Rightarrow a = 76$

Note : In the case of $a + b = 42$ and lie b/w 17 top 21, that is not possible hence $b < a$ is sufficient condition to uniquely determine a and b.

24.

25.

❑ ❑ ❑