24/01/2026
Evening

Aakash
Medical | IIT-JEE | Foundations

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Memory Based
Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2026 (Online) Phase-1

(Physics, Chemistry and Mathematics)

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:

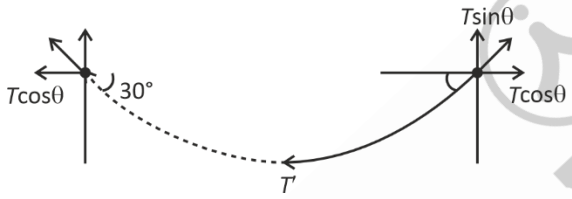
1. A uniform rope is supported by two level pin support as shown in the figure. Mass of the rope is m. Find the tension at mid-point.

(1) mg (2) $\frac{mg\sqrt{3}}{2}$

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

Answer (2)

Sol.

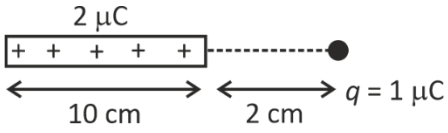


$2T\sin 30 = mg$

$T = mg$

$$T'' = T\cos\theta = mg\frac{\sqrt{3}}{2}$$

2. Find force on charge q = 1 μC due to unfirmly charged rod as shown in the figure



(1) 7.5 N (2) 6 N

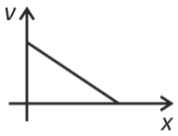
(3) 12 N (4) 18 N

Answer (1)

Sol. $F = \frac{k\,9Q}{2\times 12\times 10^{-4}} = \frac{9\times 10^{9}\times 2\times 10^{-6}\times 1\times 10^{-6}}{12\times 2\times 10^{-3}}$

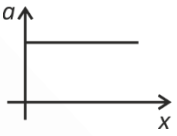
$$= \frac{5}{6}\times 9N = \frac{45}{6} = 7.5$$

3. Velocity of particle varies with position as shown in the below graph.

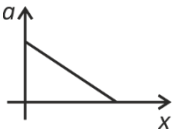


Find the correct variation of acceleration with position.

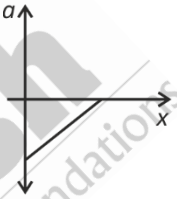
(1)



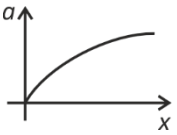
(2)



(3)



(4)

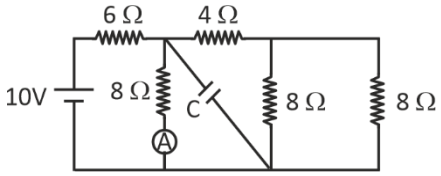


Answer (3)

Sol. $\frac{vdv}{dx} = a = \left(-\frac{v_0}{x_0}\right)\left(-\frac{v_x}{x_0} + v_0\right)$

$$= \frac{v_0^2}{x_0^2}x - \frac{v_0^2}{x_0}$$

4. Find current through ammeter (in A)



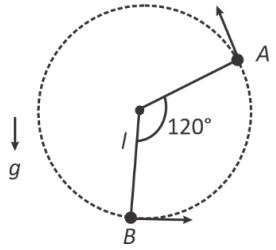
(1) 1 (2) 0.5

(3) 2 (4) 0.75

Answer (2)

Sol. $i = \frac{10}{10} \times \frac{1}{2} = 0.5\ \text{A}$

5. A particle attached to an ideal string is project from position *B* (lowest position). At position *A*, tension in string becomes zero. Find speed in string at *B*.



(1) $\sqrt{\frac{3gl}{2}}$ (2) $\sqrt{2gl}$

(3) $\sqrt{\frac{7gl}{2}}$ (4) $\sqrt{5gl}$

Answer (3)

Sol. At *A*

$$mg\cos 60° = \frac{mv^2}{l}$$

$$v^2 = \frac{gl}{2}$$

& Energy at *B* = Energy *NA*

$$\Rightarrow \frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg \times \frac{3l}{2}$$

$$\Rightarrow u^2 = \frac{gl}{2} + 3gl$$

$$= \frac{7gl}{2}$$

6. Radius of a soap bubble is changed from 7 cm to 14 cm then the work done in this process is (in μJ) is (15000 – *x*) find the value of *x*. $\left(\pi = \frac{22}{7}\right)(\sigma = 0.04\ \text{N/m})$

(1) 216 (2) 196

(3) 256 (4) 225

Answer (1)

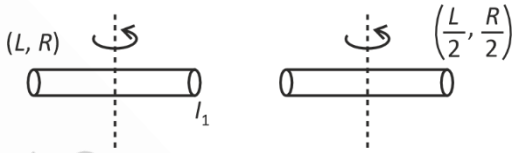
Sol. $\sigma 4\pi(2R)^2 \times 2 - \sigma\, 4\pi R^2 \times 2 = \Delta V = \Delta W$

$$\Delta W = \sigma 8\pi \times \left(3R^2\right)$$

$$\left(R = 7 \times 10^{-2}\ \text{m},\ \sigma = \frac{4}{100}\ \pi = \frac{22}{7}\right)$$

$$\Delta W = 14784\ \mu\text{J}$$

7. For a uniform cylinder of length *L* and radius *R* the moment of inertia is I_1. Now for similar situation but length $\frac{L}{2}$ and radius $\frac{R}{2}$ moment of inertia is I_2. Find $\frac{I_1}{I_2}$



(1) 32

(2) 8

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

(4) 16

Answer (1)

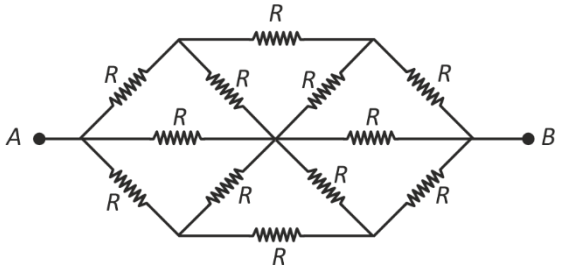
Sol. $\because \quad I_1 = \frac{mR^2}{4} + \frac{mL^2}{12} = \pi R^2 L\rho\left[\frac{R^2}{4} + \frac{L^2}{12}\right]$

and $I_2 = \frac{\pi R^2}{4} \cdot \frac{L}{2}\rho\left[\frac{R^2}{4\times 4} + \frac{L^2}{4\times 12}\right]$

$$\frac{I_1}{I_2} = \frac{\pi R^2 \rho L\left[\frac{R^2}{4} + \frac{L^2}{12}\right]}{\frac{1}{8}\pi R^2 \rho L \times \frac{1}{4}\left[\frac{R^2}{4} + \frac{L^2}{12}\right]}$$

= 32

8. Find the equivalent resistance between A & B of the resistor's network. Each value of the resistor is R.



(1) $\frac{14}{19}R$ (2) $\frac{4}{5}R$

(3) $\frac{3}{4}R$ (4) $\frac{4}{3}R$

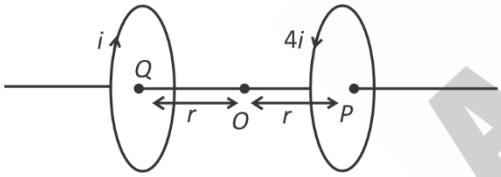
Answer (2)

Sol. $\frac{1}{R_{eq}}=\frac{1}{2R}+\frac{3}{8R}+\frac{3}{8R}$

$\Rightarrow \frac{1}{R_{eq}}=\frac{10}{8R}$

$\Rightarrow R_{eq}=\frac{4R}{5}$

9. Two identical loops are placed coaxially as shown. Radius of both loops is r



Find magnetic field at O.

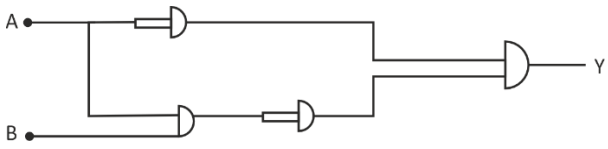
(1) $\frac{3\mu_0 i}{4\sqrt{2}r}$ towards P (2) $\frac{3gm_0 i}{4\sqrt{2}r}$ towards Q

(3) $\frac{\mu_0 i}{4\sqrt{2}r}$ towards Q (4) $\frac{\mu_0 i}{4\sqrt{2}r}$ towards P

Answer (1)

Sol. $\frac{\mu_0\times 4i}{4\sqrt{2}\,r}-\frac{\mu_0 i}{4\sqrt{2}\,r}=\frac{3\mu_0 i}{4\sqrt{2}\,r}$

10. The correct truth table for the given logic circuit is



(1)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(2)

A	B	Y
0	0	0
1	0	1
0	1	0
1	1	0

(3)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(4)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	0

Answer (4)

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

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

11. Distance between an object and its image formed by a lens is 30 cm with magnification m = 3. Find the focal length of lens (in cm)

(1) 11.25 cm (2) 22.5 cm

(3) 45 cm (4) 15 cm

Answer (2)

Sol. $|v| - |u| = 30$ cm

$u = 3u$ (given for $m = +3$)

$u = -15$ cm

$v = -45$ cm and $\frac{1}{\rho} = -\frac{1}{45} + \frac{1}{15}$

$f = \frac{45}{2} = 22.5$ cm

12. Two nucleon reactions are given below:

$He_2^3 + n \rightarrow He_2^4 + 20\,Mev$

$He_2^4 + n \rightarrow He_2^5 - 0.9\,Mev$

Find stability order of He_2^3, He_2^4, He_2^5

(1) $He_2^5 < He_2^4 < He_2^3$

(2) $He_2^3 < He_2^5 < He_2^4$

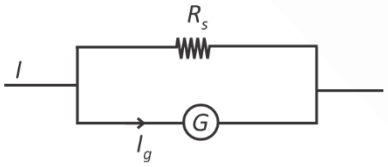
(3) $He_2^4 < He_2^3 < He_2^5$

(4) $He_2^5 < He_2^3 < He_2^4$

Answer (2)

Sol. Higher binding energy for nucleon $\rightarrow$ higher stability.

13. A galvanometer of 100 Ω resistance can give full scale deflection for I_g = 1 mA. Find the value of shunt resistance R_s to get the 5 mA range ammeter.



(1) 25 Ω

(2) 10 Ω

(3) 2 Ω

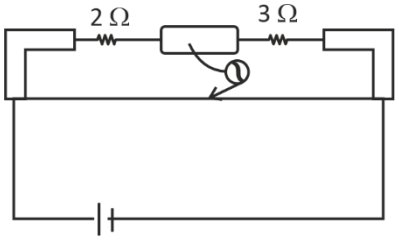
(4) 1 Ω

Answer (1)

Sol. $R_s 4 = 100 \times 1$

$\Rightarrow R_s = 25\ \Omega$

14. In meter bridge given below, when X Ω of resistor is connected in parallel to 3W, null point shifts by 10 cm. Find x



(1) 4 Ω (2) 6 Ω

(3) 2 Ω (4) 8 Ω

Answer (2)

Sol. $3\ell = 2(100 - \ell)$

$\Rightarrow 5\ell = 40$ cm

and $\frac{3X}{3+X}(1+10) = 2(90-\ell)$

$\Rightarrow \frac{3X}{3+X} 50 = 2 \times 50$

$\Rightarrow \frac{3X}{3+X} = 2$

$3X = 6 + 2X$

$X = 6\ \Omega$

15. A cubical block of density 600 kg/m^3 is floating in a liquid of density 900 kg/m^3. The height of cube immersed in liquid is (cube side = 10 cm)

(1) 6.67 cm (2) 10 cm

(3) 5 cm (4) 7.2 cm

Answer (1)

Sol. $h \times A\rho g = a \times A\sigma g$

$\Rightarrow h = a\frac{\sigma}{\rho} = 10 \times \frac{6}{9} = 10 \times .667 = 6.67$ cm

16. In a Vernier calliper 50 vernier scale dimension coincides with 48 mass scale dimensions. If one mass scale dimension is 1 mm then the least count of the measurement is

(1) 0.04 cm (2) 0.004 cm

(3) 0.02 cm (4) 0.002 cm

Answer (2)

Sol. $1\text{ VSD} = \frac{48}{50} \times \text{MSD} = 0.96\text{ MSD}$

LC = (1 – 0.96) MSD = 0.04 MSD

LC = 0.004 cm

17. Stopping potential for a photoelectric experiment is $v_0 = 3.2$ V for wavelength λ. If wavelength is doubled, the stopping potential becomes $v_0' = 0.7$ V. Find the wavelength λ.

(1) 80 nm (2) 410 nm

(3) 248 nm (4) 516 nm

Answer (3)

Sol. $eV_0 = \frac{hc}{\lambda} - \phi = \frac{32e}{10}$ …(i)

$\frac{hc}{2\lambda} - \phi = \frac{7}{10}e$ …(ii)

$\Rightarrow \quad \frac{hc}{2\lambda} = \frac{25}{10}e$

$\Rightarrow \quad \lambda = \frac{hc}{5e} \approx 248$ nm

18. The object and image distances from lens are recorded by student as $(u, v) - P_1(-30, 60)$, $P_2(30, 12)$, $P_3(20, 60)$ & $P_4(-25, 100)$. (Values are magnitudes of distances with sign). If power of lens is 5D. Which Readings is/are correct

(1) P_1, P_2 (2) P_1, P_4

(3) P_2, P_3 (4) P_1, P_3

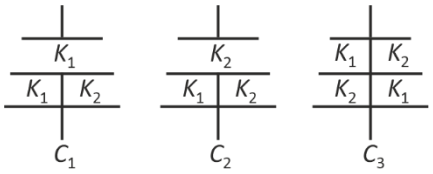
Answer (2)

Sol. $f = 20$ cm

$P_1(30, 60)$

$\Rightarrow \frac{1}{60} + \frac{1}{30} = \frac{1+2}{60} = \frac{1}{20}$

19. If $K_1 > K_2$ which order of C_{eq} for the 3 given configuration is correct.



(1) $C_1 > C_2 > C_3$ (2) $C_3 > C_2 > C_1$

(3) $C_2 > C_3 > C_1$ (4) $C_1 > C_3 > C_2$

Answer (4)

Sol. If one sq. has capacitance $C_0 = \frac{\varepsilon_0 \frac{A}{2}}{\frac{d}{2}}$

then $C_1 = \frac{K_1K_1}{K_1+K_1}C_0 + \frac{K_1K_2}{K_1+K_2}C_0$

$C_2 = \frac{K_2K_2}{K_2+K_2}C_0 + \frac{K_1K_2}{K_1+K_2}C_0$

$C_3 = \frac{K_1K_2}{K_2+K_2}C_0 + \frac{K_1K_2}{K_1+K_2}C_0$

If $K_1 > K_2$

then $C_1 > C_3 > C_2$

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. Given the half life of a radioactive sample $t_{1/2} = 245$ days. After X days 25% of sample is remaining the find X.

Answer (490)

Sol. $25\% \equiv \frac{1}{4}$ th of sample left means $\left(\frac{1}{2}\right)^2$

2 half lines spent,

$\therefore \quad X = 2 \times 245$

$= 490$

22. An ideal gas of molar mass 50 g is given 300 J heat at constant volume. Its temperature changes from 20°C to 50°C. If $C_0 = \frac{7}{2}R$ and $R = 8.3$ in SI unit, then mass of gas is (in g) (approx.)

Answer (17)

Sol. $Q = nCv\Delta T$

$300 = \frac{m}{50} \times \frac{7}{2} \times 8.3 \times 30 = 17.2$

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. An electron make transition from higher energy orbit (n_2) to lower energy orbit (n_1) in Li^{2+}ion such that $n_1 + n_2 = 4$ & $n_2 - n_1 = 2$. Determine the wavelength emitted in the transition (in nm)

(1) 12.9 nm (2) 11.4 nm

(3) 16.7 nm (4) 9.2 nm

Answer (1)

Sol. $n_1 + n_2 = 4$

$n_2 - n_1 = 2$

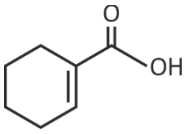
$n_2 = 2, n_1 = 1$

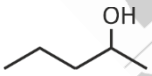
$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

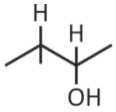
$$= 1.097 \times 10^7 \times 3^2\left(\frac{1}{1^2} - \frac{1}{3^2}\right)$$

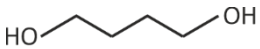
$\lambda \approx 11.39$ nm

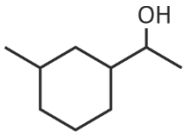
2. Which of the following molecules is secondary alcohol?

a. 

b. 

c. 

d. 

e. 

(1) b, c, e only (2) b, c, d, e only

(3) a, c, d, e only (4) a, b, d only

Answer (1)

Sol. a $\rightarrow$ carboxylic acid

b, c, e $\rightarrow$ secondary alcohol

d $\rightarrow$ primary alcohol

3. Choose the correct order of second IE of O, C, N and F.

(1) C < N < F < O (2) C < F < O < N

(3) C < N < O < F (4) C < O < F < N

Answer (1)

Sol. $O \xrightarrow{-e^-} O^+(2p^3)$

$C \xrightarrow{-e^-} C^+(2p^1)$

$N \xrightarrow{-e^-} N^+(2p^2)$

$F \xrightarrow{-e^-} F^+(2p^4)$

$IE = C^+ < N^+ < F^+ < O^+$

$IE_2 = C < N < F < O$

4. How many linear tripeptides are possible with valine (Val), Glycine (Gly) and Alanine (Ala). No amino acid should be repeated?

(1) 8 (2) 5

(3) 6 (4) 4

Answer (3)

Sol. Gly – Ala – Val

Gly – Val – Ala

Ala – Gly – Val

Ala – Val – Gly

Val – Gly – Ala

Val – Ala – Gly

5. Order of wavelength of absorbed radiation for the below given complexes is,

(a) $[Co(NH_3)_6]^{3+}$

(b) $[Co(NH_3)_5H_2O]^{3+}$

(c) $[CoF_6]^{3-}$

(d) $[Co(CN)_6]^{3-}$

(1) d > a > c > b

(2) d > a > b > c

(3) d < a < b < c

(4) d < a < c < b

Answer (3)

Sol. Strength of ligand:

$CN^- > NH_3 > H_2O > F^-$

Stronger ligand $\Rightarrow \Delta_o\uparrow \Rightarrow \lambda_{max}\downarrow$

6. Given :

ΔH_{atom} (CH_4) = x kJ mole^{-1}

ΔH_{atom} (C_2H_6) = y kJ mole^{-1}

Find out bond energy (C – C) (kJ/mole).

(1) y – x

(2) y – 4x

(3) $y-\frac{3x}{2}$

(4) y – 2x

Answer (3)

Sol. $y = (C - C) + 6\left(\frac{x}{4}\right)$

$(C - C) = y-\frac{6x}{4}$

$(C - C) = y-\frac{3x}{2}$

7. Which of the following have same bond order and are paramagnetic?

(1) O_2^+, N_2^-

(2) O_2^+, O_2^-

(3) O_2^-, N_2^-

(4) O_2^-, N_2^+

Answer (1)

Sol. $O_2^+(15e) \rightarrow$ Paramagnetic,

Bond order = $\frac{\text{Bonding e} - \text{Antibonding e}}{2}$

$=\frac{(10-5)}{2}=2.5$

$N_2^-(15e) \rightarrow$ Paramagnetic,

Bond order = $\frac{(10-5)}{2}=2.5$

$N_2^+(13e) \rightarrow$ Paramagnetic,

Bond order = $\frac{(9-4)}{2}=2.5$

$O_2^-(17e) \rightarrow$ Paramagnetic,

Bond order = $\frac{(10-7)}{2}=1.5$

Species having odd number of e are paramagnetic.

8. In fifth group of cations Ba^{2+} and Ca^{2+} are precipitated as

(1) Carbonate, sulphide

(2) Sulphide, hydroxide

(3) Carbonate, carbonate

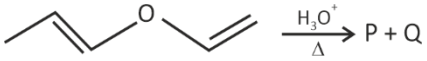
(4) Hydroxide, sulphide

Answer (3)

Sol. Group V cations precipate as carbonates

(Reagent – $NH_4Cl + (NH_4)_2CO_3$)

9. How would you distinguish between product P and Q formed in reaction given below



(1) Fehling solution test

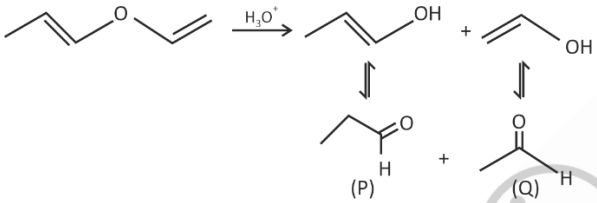
(2) Tollens test

(3) 2, 4 DNP test

(4) Iodoform test

Answer (4)

Sol.



Q can give iodoform test but (P) can't give

10. A group VII element which has a +7 oxidation state forms a salt with potassium (K). What is the colour of this salt?

(1) Green

(2) Yellow

(3) Orange

(4) Purple

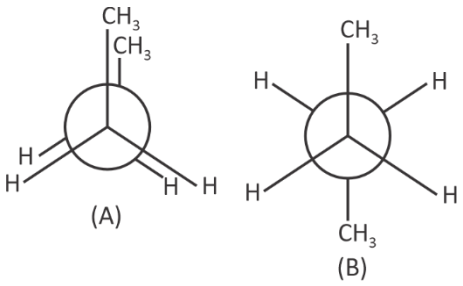
Answer (4)

Sol. In group VII, Mn is having maximum +7 oxidation state.

The salt should be $KMnO_4$.

The colour of $KMnO_4$ is purple (dark violet) due to charge transfer.

11. Given below are two statements based on structures given



(A) (B)

Statement I : B is more stable than A.

Statement II : Dihedral angle of B is more than A.

In the light of the above two statements, choose the correct option.

(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

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

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

Answer (1)

Sol. In B both $-CH_3$ group are anti, so less torsional strain.

Dihedral angle in B = 180º and in A = 0º.

12. Vapor pressures of two volatile species A and B are 55 mm Hg and 120 mm Hg respectively. If mole fraction of 'A' in liquid state is 0.8, then mole fraction of 'B' in vapor state is

(1) 0.65

(2) 0.45

(3) 0.35

(4) 0.53

Answer (3)

Sol. $P_{total} = 55 \times 0.8 + 120 \times 0.2 = 44 + 24 = 68$

$$Y_B = \frac{120 \times 0.2}{P_{total}} = \frac{24}{68} = 0.35$$

13. Find incorrect statement among the following

(1) C^{13} is a radioactive isotope

(2) Covalency of carbon greater than 4 is possible

(3) Carbon can exhibit +2 & +4 oxidation state

(4) In group-14, CO_2 is most acidic

Answer (2)

Sol. Maximum covalency of carbon is 4.

14. Which of the following statement is correct about resonance and resonating structures?

(1) Resonating structure with more covalent bonds is more stable

(2) The resonance structures differ in position of electrons and relative position of atoms

(3) The stability of resonance hybrid decreases with increasing number of equivalent resonating structure

(4) Electronegative atom bearing positive charge in the canonical form is more stable

Answer (1)

Sol. The resonance structures differ only in position of electrons and not in the relative position of atoms.

The stability of resonance hybrid increases with increasing number of equivalent resonating structure.

15. Consider the following reversible reaction wherein the moles of species at equilibrium is given

	P_2	+	Q_2	$\rightleftharpoons$	2PQ
$t = t_{eq}$	2 mol		2 mol		2 mol

If one mole of P_2 and one mole of Q_2 are added at equilibrium. The number of moles of P_2, Q_2 and PQ at new equilibrium, respectively are

(1) $\frac{4}{3}, \frac{4}{3}, \frac{8}{3}$

(2) $\frac{8}{3}, \frac{8}{3}, \frac{8}{3}$

(3) $\frac{4}{3}, \frac{4}{3}, \frac{4}{3}$

(4) $\frac{8}{3}, \frac{8}{3}, \frac{4}{3}$

Answer (2)

Sol.

		P_2	+	Q_2	$\rightleftharpoons$	2PQ
$t = t_{eq}$		2 mol		2 mol		2 mol
$t = t'_{eq}$		$3-x$		$3-x$		$2+2x$

$$\therefore \quad K_{eq} = \frac{(2)^2}{2 \times 2} = 1$$

$$\therefore \quad 1 = \frac{(2+2x)^2}{(3-x)^2} \Rightarrow \frac{2+2x}{3-x} = 1$$

$$\Rightarrow \quad 2+2x = 3-x$$

$$\Rightarrow \quad 3x = 1$$

$$\Rightarrow \quad x = \frac{1}{3}$$

$$\therefore \quad n_{P_2} = 3-x = 3-\frac{1}{3} = \frac{8}{3}$$

$$\therefore \quad n_{Q_2} = 3-x = \frac{8}{3}$$

$$\therefore \quad n_{PQ} = 2+2X = 2+\frac{2}{3} = \frac{8}{3}$$

16. $\underset{(2M,2L)}{KOH} + \underset{(1mol)}{Cl_2} \longrightarrow Cl^{\ominus} + ClO^{\ominus} + K^{\oplus}$

Find the conc. of each product and choose correct option

(1) $[Cl^-] = [ClO^-] = [K^+] = 0.5$ M

(2) $[Cl^-] = [K^+] = 1.5$ M

(3) $[Cl^-] = [ClO^-] = 0.5$ M

(4) $[Cl^-] = [ClO^-] = 0.75$ M

Answer (3)

Sol. Balanced equation is n of KOH = 2 × 2 = 4 mol

$$2KOH + 1Cl_2 \rightarrow 1Cl^- + 1ClO^- + 2K^+ + 1H_2O$$

Initial →	4 mol	1 mol	0	0	0
	−2	−1	+1	+1	+2
Final→	2 mol	0	1 mol	1 mol	1 mol

Conc. of $Cl^- = \frac{mol}{v} = \frac{1}{2} = 0.5\,M$

Conc. of $ClO^- = \frac{1}{2} = 0.5\,M$

Conc. of $K^+ = \frac{2}{2} = 1\,M$

17. Given below are two statements.

Statement I: Two different aldehydes on cross aldol condensation always give four products.

Statement II: Among benzaldehyde and acetophenone, only acetophenone reacts with semicarbazide.

In the light of the above two statements, choose the correct option.

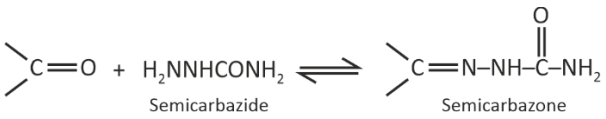
(1) Both statement I and statement II are correct

(2) Both statement I and statement II are incorrect

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

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

Answer (2)

Sol. 

∴ Both PhCHO and $PhCOCH_3$ reacts with semicarbazide.

Two different aldehydes on cross aldol condensation can give number of products different than 4.

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. In a first order reaction, $t_{1/2}$ = 245 days of compound 'A'. After x days 75% of 'A' remains, then calculate the value of 'x'. (Take log 2 = 0.3 and log 3 = 0.48)

Answer (98)

Sol. $k = \frac{2.303 \log 2}{t_{1/2}}$

$k = \frac{0.693}{245}\,days^{-1}$

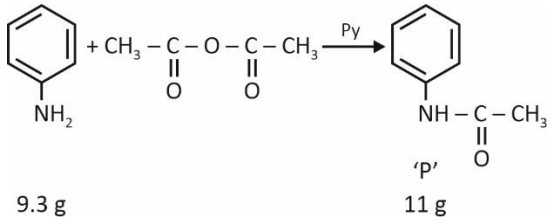
$K = \frac{2.303}{t} \log \frac{100}{75}$

$t = \frac{2.303 \times 245}{2.303 \times 0.3} \log \frac{4}{3}$

$t = \frac{245}{0.3}(0.6 - 0.48)$

$t = \frac{245 \times 0.12}{0.30} = 98$ days

22. Consider the following reaction :



If % yield of reaction is x, tvalue of $\frac{x}{10}$ is (nearest integer)

Answer (8)

Sol. Moles of aniline = $\frac{9.3}{93} = 0.1$

Moles of 'P' formed = 0.1 (if 100% yield)

Actual moles of 'P' formed = $\frac{11}{135} = 0.0814$

% yield = $\frac{0.0814}{0.1} \times 100 = 81.48\%$

x = 8

23. A compound $Cr(H_2O)_6 \cdot Cl_3$ show conductance similar to 1 : 2 electrolyte in aq. solution. 9.6 g of this complex is passed through a cation exchanger then excess of $AgNO_3$ solution is added. Find mass of AgCl precipitated in gram?

[Molar mas of Cr = 52, Cl = 35.5]

Answer (10)

Sol. Since complex is similar to 1 : 2 electrolyte

complex should be $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

Mole of complex = $\frac{9.6}{266.5}$ mol = 0.036 mol

Mole of Cl^- to be precipitated = 2 × 0.036 mol

Mole of AgCl precipitated = 0.072 mol

Mass of AgCl = 0.072 × 143.5 g

= 10.332 g

$\approx$ 10 g

24. 0.18 M HQ solution has molar conductivity $\frac{1}{30}$ times the molar conductivity of 0.02 M HZ solution. Find the value of pKa(HQ) – pKa(Hz). [Given that α <<< 1]

Assume that $\lambda_m^\infty Q^\ominus = \lambda_m^\infty Z^\ominus$

Answer (2)

Sol. $\lambda_m^\infty Q^\ominus = \lambda_m^\infty Z^\ominus$, so $\wedge_m^\infty HQ = \wedge_m^\infty HZ$ (Let it Y)

For 0.02 M HZ, let $\wedge_m = x$

Then for 0.18 M HQ, $\wedge_m = \frac{x}{30}$

For HQ $\Rightarrow$ $Ka_1 = C \times \alpha^2 = 0.18 \times \left(\frac{x}{30Y}\right)^2$ ...(I) {α <<<1}

For HZ $\Rightarrow$ $Ka_2 = C \times \alpha^2 = 0.02 \times \left(\frac{x}{Y}\right)^2$ ...(II) {α <<<1}

$$\frac{Eq(I)}{Eq(II)} \Rightarrow \frac{Ka_1}{Ka_2} = \frac{0.18 \times \left(\frac{x}{30Y}\right)^2}{0.02 \times \left(\frac{x}{Y}\right)^2} \Rightarrow \frac{Ka_1}{Ka_2} = \frac{1}{100}$$

$pKa_1 - pKa_2 = -\log\left(\frac{1}{100}\right) = 2$

So, pKa(HQ) – pKa(HZ) = 2

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. The maximum value of n for which 40^n divides 60! is equal to

(1) 11 (2) 12

(3) 13 (4) 14

Answer (4)

Sol. $40 = 2^3 \times 5$

Let $60! = 2^a \cdot 3^b \cdot 5^c \ldots$

$$a = \left[\frac{60}{2}\right]+\left[\frac{60}{4}\right]+\left[\frac{60}{8}\right]+\left[\frac{60}{16}\right]+\left[\frac{60}{32}\right]+\left[\frac{60}{64}\right]$$

$= 30 + 15 + 7 + 3 + 1$

$= 56$

$\therefore 2^a = (8)^{a/3}$

$\Rightarrow$ max power of $8 = \left[\frac{56}{3}\right] = 18$

$$c = \left[\frac{60}{5}\right]+\left[\frac{60}{25}\right]+\left[\frac{60}{125}\right]$$

$= 12 + 2 = 14$

$$\min\left(c, \frac{a}{3}\right) = c = 14$$

$\therefore 14$

2. If $z = (1 + i)(1 + 2i)(1 + 3i).....(1 + ni)$, $n \in N$ and $|z|^2 = 44200$, then n is equal to

(1) 6 (2) 5

(3) 8 (4) 4

Answer (2)

Sol. $z = (1 + i)(1 + 2i)(1 + 3i).....(1 + ni)$

$z\bar{z} = (1 + i)(1 - i)(1 + 2i)(1 - 2i).....(1 + ni)(1 - ni)$

$|z|^2 = (2)(5)(1 + 9).....(1 + n^2)$

$\Rightarrow 2 \times 5 \times 10 \times.....(1 + n^2) = 44200$

$$\prod_{r=1}^{n}\left(1+r^2\right) = 44200$$

Since $210 < \sqrt{44200} < 211$

$\Rightarrow n$ will be small

$\Rightarrow$ Since $13 \mid 44200 \Rightarrow (5^2 + 1) \mid 44200$

$\Rightarrow$ checking small values of n, $\prod_{r=1}^{5}\left(1+r^2\right) = 44200$

$\Rightarrow n = 5$

3. The image of the parabola $x^2 = 4y$ in the line $x - y = 1$ is

(1) $(y - 1)^2 = 4(x + 1)$

(2) $(y + 1)^2 = 4(x - 1)$

(3) $(y + 1)^2 = 4(x + 1)$

(4) $(y - 1)^2 = 4(x - 1)$

Answer (2)

Sol. Any point $P : (2t, t^2)$

Image of point P in the line $x - y = 1$ is

$$\frac{x-2t}{1} = \frac{y-t^2}{-1} = \frac{-2(2t-t^2-1)}{2}$$

$$\Rightarrow x-2t = \frac{y-t^2}{-1} = t^2-2t+1$$

$\Rightarrow x = t^2 + 1$

$y = 2t - 1$

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

4. The value of sum

$$s=\left(\frac{1}{3}+\frac{4}{7}\right)+\left(\left(\frac{1}{3}\right)^2+\left(\frac{4}{7}\right)^2+\left(\frac{1}{3}\right)\left(\frac{4}{7}\right)\right)+$$

$$\left(\left(\frac{1}{3}\right)^3+\left(\frac{1}{3}\right)^2\left(\frac{4}{7}\right)+\left(\frac{1}{3}\right)\left(\frac{4}{7}\right)^2+\left(\frac{4}{7}\right)^3\right)+\ldots,$$

then s is equal to

(1) $\frac{3}{2}$ (2) $\frac{5}{2}$

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

Answer (2)

Sol. Let $\frac{1}{3}=a, \frac{4}{7}=b$

then

$s=(a+b)+(a^2+b^2+ab)+(a^3+a^2b+ab^2+b^3)+\ldots$

multiplying by $(a-b)$

$s(a+b)=(a^2-b^2)+(a^3-b^3)+(a^4-b^4)+\ldots$

$$\Rightarrow s=\frac{1}{(a-b)}\left((a^2+a^3+a^4+\ldots-(b^2+b^3+b^4+\ldots)\right)$$

$$\Rightarrow s=\frac{1}{(a-b)}\left[\frac{a^2}{1-a}-\frac{b^2}{1-b}\right]$$

$$=\frac{1}{(a-b)}\left[\frac{a^2-a^2b-b^2+ab^2}{(1-a)(1-b)}\right]$$

$$=\frac{1}{(a-b)}\left[\frac{a^2-b^2}{(1-a)(1-b)}+\frac{ab(-a+b)}{(1-a)(1-b)}\right]$$

$$=\frac{a+b}{(1-a)(1-b)}-\frac{ab}{(1-a)(1-b)}$$

$$=\frac{\frac{19}{21}}{\frac{2}{3}\times\frac{3}{7}}-\frac{\frac{4}{21}}{\frac{6}{21}}=\frac{19}{6}-\frac{4}{6}=\frac{15}{6}=\frac{5}{2}$$

5. Let the equation $x^4 - ax^2 + 9 = 0$ have four real and distinct roots. Then the least integral value of a is

(1) 5 (2) 6

(3) 7 (4) 8

Answer (3)

Sol. $x^4 - ax^2 + 9 = 0$

$$a=x^2+\frac{9}{x^2}$$

$\because$ A.M $\geq$ G.M

$$\Rightarrow \frac{x^2+\frac{9}{x^2}}{2}\geq\sqrt{x^2.\frac{9}{x^2}}$$

$\Rightarrow a \geq 6$

If $a = 6$, then $x^2+\frac{9}{x^2}\Rightarrow x^4 = 9 \Rightarrow x^2 = 3$

$\Rightarrow x=\pm\sqrt{3}$ (two distinct roots)

$\because$ all roots are distinct and real

$\Rightarrow a > 6$

$\Rightarrow$ minimum integral value of a is 7

6. The domain of $\sin^{-1}\left(\frac{1}{x^2-2x-1}\right)$ is $(-\infty,\alpha]\cup[\beta,\delta]\cup[\lambda,\infty)$. The value of $\alpha + \beta + \delta + \lambda$ is equal to

(1) 17 (2) 4

(3) 3 (4) 6

Answer (2)

Sol. $-1\leq\frac{1}{x^2-2x-1}\leq 1 \Rightarrow \frac{1}{x^2-2x-1}\in[-1,1]$

$\Rightarrow x^2-2x-1\in(-\infty,-1]\cup[1,\infty)$

$x^2-2x-1\leq -1$ $\quad$ $x^2-2x-1\geq -1$

$\Rightarrow x^2-2x\leq 0$ $\quad$ $\Rightarrow x^2-2x-2\geq 0$

$x\in[0,2]$ $\quad$ $x\in(-\infty,1-\sqrt{3}]\cup[1+\sqrt{3},\infty)$

Domain : $(-\infty,1-\sqrt{3}]\cup[0,2]\cup[1+\sqrt{3},\infty)$

$\alpha = 1-\sqrt{3}$

$\beta = 0$

$\delta = 2$

$\lambda = 1+\sqrt{3}$

$\therefore \alpha + \beta + \delta + \lambda = 4$

7. Consider these statements regarding the function $f(x) = |\ln x| - |x-1|$

Statement 1 : $f(x)$ is differentiable for all $x > 0$

Statement 2 : $f(x)$ is increasing in $(1, \infty)$

Statement 3 : $f(x)$ is decreasing in $(0, 1)$

(1) Statement 1 and statement 3 is true

(2) All Statement are correct

(3) Statement 2 and statement 3 are correct

(4) Statement 1 and statement 2 are correct

Answer (1)

Sol. $f(x) = |\ln x| - |x-1|$

$$= \begin{cases} \ln x - (x-1), & x \geq 1 \\ -\ln x + (x-1), & 0 < x < 1 \end{cases}$$

$$= \begin{cases} \ln x - x + 1, & x \geq 1 \\ -\ln x + x - 1, & 0 < x < 1 \end{cases}$$

$$f'(x) = \begin{cases} \frac{1}{x} - 1, & x \geq 1 \\ -\frac{1}{x} + 1, & 0 < x < 1 \end{cases}$$

$0 = f'(1^+) = f'(1^-)$

$\Rightarrow f(x)$ is differentiable $\forall x > 0$

$f'(x) < 0 \ \forall x > 1$

$f'(x) < 0 \ \forall \ 0 < x < 1$

$\Rightarrow f(x)$ is decreasing $\forall x \in (0, 0)$

8. $\lim\limits_{x \to 0} \dfrac{\tan(\tan x) - \tan(\sin x)}{\tan x - \sin x}$ is equal to

(1) 1 (2) 2

(3) –1 (4) $\frac{1}{2}$

Answer (1)

Sol. $\lim\limits_{x \to 0} \dfrac{[\tan(\tan x) - \tan(\sin x)][1 + \tan(\tan x)\tan(\sin x)]}{(\tan x - \sin x)(1 + \tan(\tan x)\tan(\sin x))}$

$\Rightarrow \lim\limits_{x \to 0} \dfrac{\tan(\tan x - \sin x)}{(\tan x - \sin x)} \times (1 + \tan(\tan x)\tan(\sin x))$

$\Rightarrow (1) \times (1) = 1$

9. If $4x^2 + y^2 < 52$, $x, y, \in Z$, then the number of ordered pairs (x, y) is

(1) 67 (2) 87

(3) 77 (4) 38

Answer (3)

Sol. $4x^2 + y^2 < 52$

$y^2 < 52 - 4x^2$

$y^2 < 4(13 - x^2)$

x	$y^2 <$	y	Number of possible values of y
0	52	–7 to 7	15
±1	48	–6 to 6	13 each
±2	36	–5 to 5	11 each
±3	16	–3 to 3	7 each

$\Rightarrow$ number of possible order pairs (x, y)

$= 15 + 2 \times 13 + 2 \times 11 + 2 \times 7 = 77$

10. If $\int \dfrac{7x^{10} + 9x^8}{\left(1 + x^2 + 2x^9\right)^2} dx = f(x) + c$ and $f(1) = \frac{1}{4}$. Then $f(x)$ is

(1) $\dfrac{x^9}{2x^2 + 9 + x^9}$ (2) $\dfrac{x^9}{2 + x^2 + x^9}$

(3) $\dfrac{x^9}{1 + x^2 + 2x^9}$ (4) $\dfrac{x^9}{1 + x^9 + 2x^2}$

Answer (3)

Sol. $\because I = \int \dfrac{7x^{10} + 9x^8}{(1 + x^2 + 2x^9)^2} dx = \int \dfrac{\frac{7}{x^8} + \frac{9}{x^{10}}}{\left(\frac{1}{x^9} + \frac{1}{x^7} + 2\right)^2} dx$

Let $\dfrac{1}{x^9} + \dfrac{1}{x^7} + 2 = t$

$$-9x^{-10}-7x^{-8}=\frac{dt}{dx}$$

$$\left(\frac{7}{x^8}+\frac{9}{x^{10}}\right)dx=-dt$$

$$\therefore\ I=\int\frac{-dt}{t^2}=\frac{1}{t}+C=\frac{1}{\frac{1}{x^9}+\frac{1}{x^7}+2}+C$$

Here $f(1)=\frac{1}{4}$ hence C=0.

and $f(x)=\frac{1}{\frac{1}{x^9}+\frac{1}{x^7}+2}=\frac{x^9}{1+x^2+2x^9}$

11. Let $X=\{1, 2, 3, \ldots. 19\}$. If new data $Y=\{y_i : y_i=x_i+b, x_i \in X\}$. Such that mean and variance of y is 30 and 120 respectively, then the sum of value(s) of b is

(1) 50

(2) 60

(3) 40

(4) 30

Answer (2)

Sol. $y_i=ax_i+b$

$$\sum y_i = a\sum x_i+19b$$

$$\Rightarrow \sum y_i=\frac{a\times19\times20}{2}+19b$$

$$\Rightarrow \frac{\sum y_i}{19}=10a+b=30$$

original variance

$$\Rightarrow \frac{\sum x_{i^2}}{19}-\left(\frac{\sum x_i}{19}\right)^2$$

$$=\frac{19\times20\times39}{19\times6}-(10)^2=\frac{780}{6}-100=30$$

Variance of y_i = 30(a^2) = 120

$\Rightarrow a=\pm2$

$\Rightarrow$ If a = 2, b = 10

If a = –2, b = 50

12. Let $A=\{a, b, c, d, e\}$ and $P(A)=S$, where $P(A)$ is the power set of A. Number of elements (P, Q) in $S\times S$ such that $(P \cap Q)=\phi$ is equal to

(1) 245 (2) 343

(3) 233 (4) 243

Answer (4)

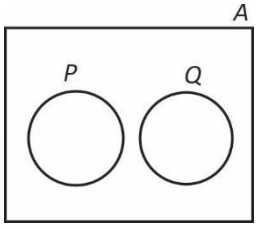
Sol. $S=P(A)$

$=\{\phi, \{a\}, \{b\}.....\{a, b, c, d, e\}\}$

$n(S)=32$

$n(S\times S)=32\times32$

we want P and Q from $S\times S$ such $P\cap Q=\phi$



Method-1 :

Each element has three ways to chose from.

Therefore total number of element is equal to $(3)^5=243$

Method-2 :

Let $n(P)=a$, $n(Q)=6$

and $n((P\cup Q)^c)=c$

$\Rightarrow a+b+c=5$, since $P\cap Q=\phi$

$\sum_{a=0}^{5}{}^5C_a\ {}^{5-a}C_b$, where $a+b+c=5$

For $c=0$, $a+b=5$

$$\sum_{a=0}^{5}{}^5c_a\ {}^{5-a}c_{5-a}=2^5=32$$

For $c=1$, $\sum_{a=0}^{4}{}^5c_a\ {}^{5-a}c_{4-a}=80$

For $c=2$, $\sum_{a=0}^{3}{}^5c_a\ {}^{5-a}c_{3-a}=80$

For $c=3$, $\sum_{a=0}^{2}{}^5c_a\ {}^{5-a}c_{2-a}=40$

For $c = 4$, $\sum_{a=0}^{1} {}^{5}C_{a}\ {}^{5-a}C_{1-a} = 10$

for $c = 5$, only 1 case

$\Rightarrow 243$

13. Let $\langle a_i \rangle$ be an A.P of natural numbers with common difference l such that $a_1 + a_2 + a_3 + a_4 = 18$ and $a_1a_2a_3a_4 + l^4 = 361$. Then max $\{a_1, a_2, a_3, a_4\}$ is equal to

(1) 6

(2) 18

(3) 14

(4) 12

Answer (6)

Sol. Notic that $361 = 1 + 3 \times 4 \times 5 \times 6$

and if $l = 1$, then

terms will be 3, 4, 5, 6

$\Rightarrow \max\{a_1, a_2, a_3, a_4\} = 6$

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. If all the words with or without meaning made using all the letters of the word "UDAYPUR" are arranged as in a dictionary, then the rank of the word "UDAYPUR" is _____

Answer (1922)

Sol. UDAYPUR

A, D, P, R, U, U, Y

words starting with A = $\frac{6!}{2!} = 360$

words starting with D = $\frac{6!}{2!} = 360$

words starting with P = $\frac{6!}{2!} = 360$

words starting with R = $\frac{6!}{2!} = 360$

words starting with UA = 5! = 120

words starting with UDAP = 3! = 6

words starting with UDAR = 3! = 6

words starting with UDAU = 3! = 6

Then next word is UDAYPRU

and next word is UDAYPUR

$\Rightarrow$ Rank of UDAYPUR is $(360) \times 4 + 120 + (6) \times 3 + 1 + 1 = 1580$

22. Let point (h, k) lies on $x^2 + y^2 = 4$, and $(2h + 1, 3k + 2)$ lies on ellipse having eccentricity e. Then the value of $\frac{5}{e^2}$ is

Answer (9)

Sol. $\because$ (h, k) lies on $x^2 + y^2 = 4$

$\therefore h = 2\cos\theta, k = 2\sin\theta$

then $(2h + 1, 3k + 2) \equiv (4\cos\theta + 1$ and $6\sin\theta + 2)$

Here let $4\cos\theta + 1 = x$ and $6\sin\theta + 2 = y$

$\therefore$ Required ellipse is:

$$\frac{(x-1)^2}{4^2} + \frac{(y-2)^2}{6^2} = 1$$

$$\therefore \text{ eccentricity } = e^2 = 1 - \frac{4^2}{6^2} = \frac{20}{36} = \frac{5}{9}$$

$$\therefore \frac{5}{e^2} = 9$$

23. Given $P = [p_{ij}]_{3\times 3}$ and $Q = [q_{ij}]_{3\times 3}$ are 3×3 matrices, where $q_{ij} = 2^{i+j-1}\, p_{ij}$. If $|Q| = 2^{10}$, then the value of $|\text{adj}(\text{adj}(P))|$ is

Answer (16)

Sol. $q_{ij} = 2^{i+j-1}p^{ij}$, $|Q| = 2^{10}$

$$\Rightarrow Q = \begin{bmatrix} 2p_{11} & 2^2 p_{12} & 2^3 p_{13} \\ 2^2 p_{21} & 2^3 p_{22} & 2^4 p_{24} \\ 2^3 p_{31} & 2^4 p_{32} & 2^5 p_{33} \end{bmatrix}$$

$$\Rightarrow Q = 2\cdot 2^2 \cdot 2^3 \begin{bmatrix} p_{11} & p_{12} & p_{13} \\ 2p_{22} & 2p_{22} & 2p_{24} \\ 2^2 p_{31} & 2^2 p_{32} & 2^2 p_{33} \end{bmatrix}$$

$= 2^{1+2+3+1+2}|P|$

$|Q| = 2^9|P|$

$\Rightarrow |P| = 2$

$\Rightarrow |\text{adj}(\text{adj}(P))| = |\text{adj}(P)|^2 = |P|^4 = 2^4 = 16$

24.

25.

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