28/01/2025
Evening

Medical | IIT-JEE | Foundations

Corporate Office : **AESL, 3rd Floor, Incuspaze Campus-2, Plot-13, Sector-18, Udyog Vihar, Gurugram, Haryana-122018**

Memory Based
Answers & Solutions

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

JEE (Main)-2025 (Online) Phase-1

(Physics, Chemistry and Mathematics)

IMPORTANT INSTRUCTIONS:

(1) The test is of **3 hours** duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains **Three Parts**. **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is **Mathematics**. Each part has only two sections: **Section-A** and **Section-B**.

(4) **Section - A :** Attempt all questions.

(5) **Section - B :** Attempt all questions.

(6) **Section - A (01 – 20)** contains 20 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

(7) **Section - B (21 – 25) contains** 5 **Numerical value** based questions. The answer to each question should be rounded off to the **nearest integer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

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. Bohr's model is applicable for single electron atom of atomic number z. Dependency of frequency of rotation of electron in n^{th} principal quantum number is proportional to

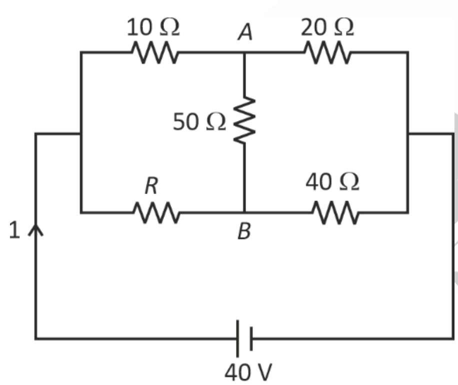
(1) $\frac{z}{n^2}$ (2) $\frac{z^2}{n^3}$

(3) $\frac{n^3}{z}$ (4) $\frac{z}{n}$

Answer (2)

Sol. $f = \frac{v}{2\pi r} \propto \frac{z}{n\left(\frac{n^2}{z}\right)} = \frac{z^2}{n^3}$

2. In the given circuit, find I if the potentials at A and B are equal



(1) $1A$

(2) $2A$

(3) $3A$

(4) $4A$

Answer (2)

Sol. Given potential at A and B are equal.

$\Rightarrow$ This is a wheat-stone Bridge

i.e., $\frac{R}{10\Omega} = \frac{40\Omega}{20\Omega}$

or $R = 20\Omega$

Equivalent resistance = 20Ω

$$I = \frac{40V}{20\Omega} = 2A$$

3. In an electromagnetic wave, the magnetic field is given as $\vec{B} = \left(\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}\right)30\sin(\omega t - kz)$, the corresponding electric field is

(1) $\left(\frac{1}{2}\hat{i} + \frac{\sqrt{3}}{2}\hat{j}\right)9\times10^9\sin(\omega t - kz)$

(2) $\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)9\times10^9\sin(\omega t - kz)$

(3) $\left(\frac{1}{2}\hat{i} + \frac{\sqrt{3}}{2}\hat{j}\right)9\times10^9\cos(\omega t - kz)$

(4) $\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)9\times10^9\cos(\omega t - kz)$

Answer (2)

Sol. $E = BC$

$= 30 \times 3 \times 10^8 = 9 \times 10^9$ N/C

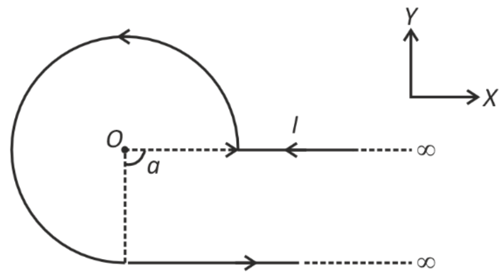
$\hat{E} = \hat{B} \times \hat{C}$

$= \left(\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}\right) \times k$

$= \left(\frac{\sqrt{3}}{2}\hat{j} + \frac{1}{2}\hat{i}\right)$

$\vec{E} = \left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)9\times10^9\sin(\omega t - kz)$

4. The magnetic field $\vec{B}$ at the centre O of the given arrangement is



(1) $\dfrac{+\mu_0 I}{8\pi a}(3\pi+2)\hat{k}$

(2) $\dfrac{-\mu_0 I}{8\pi a}(3\pi+2)\hat{k}$

(3) $\dfrac{+\mu_0 I}{8\pi a}(3\pi-2)\hat{k}$

(4) $\dfrac{-\mu_0 I}{8\pi a}(3\pi-2)\hat{k}$

Answer (1)

Sol. $\vec{B}_{\text{net}} = \vec{B}_{\text{circle}} + \vec{B}_{\text{wire 1}} + \vec{B}_{\text{wire 2}}$

$$= \frac{3}{4}\left(\frac{\mu_0 I}{2a}\right)(+\hat{k}) + \vec{O} + \frac{\mu_0 I}{4\pi a}(+\hat{k})$$

$$= \frac{+\mu_0 I}{8\pi a}(3\pi+2)\hat{k}$$

5. A cube of side 10 cm having bulk modulus of 1.4×10^{11} Pa is placed in atmosphere. Now it is subjected to extra pressure of 7×10^6 Pa then magnitude of change in volume of cube is

(1) 0.03 mL

(2) 0.3 mL

(3) 0.05 mL

(4) 0.2 mL

Answer (3)

Sol. $B = \dfrac{\Delta P}{\Delta V/V}$

$$|\Delta V| = \frac{\Delta PV}{B}$$

$$|\Delta V| = \frac{7\times10^6\times10^{-3}}{1.4\times10^{11}}$$

$$|\Delta V|_{\text{mL}} = \frac{5\times10^3}{10^{11}}\times10^6$$

$$= 0.05 \text{ mL}$$

6. Choose the correct option representing the energy density between the plates of a parallel plate capacitor with plate area A, plate separation d and potential difference V.

(1) $\dfrac{\varepsilon_0 V^2}{2d^2}$

(2) $\dfrac{\varepsilon_0 V d^2}{2}$

(3) $\dfrac{\varepsilon_0 A V^2}{2d}$

(4) $\dfrac{\varepsilon_0 A V^2}{2d^2}$

Answer (1)

Sol. $E = \dfrac{V}{d}$

Energy density $= \dfrac{1}{2}\varepsilon_0 E^2$

$$= \frac{1}{2}\frac{\varepsilon_0 V^2}{d^2}$$

7. Which of the following phenomenon is not explained by wave theory of light

(1) Reflection of light

(2) Refraction of light

(3) Diffraction

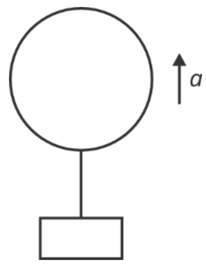
(4) Compton effect

Answer (4)

Sol. Compton effect is based on particle nature of light.

8. A balloon system having mass m is moving up with acceleration a, find the mass to be removed from it to have acceleration $3a$.

(Neglect the volume of mass attached)



(1) $\dfrac{2ma}{3a+g}$

(2) $\dfrac{2ma}{2a+g}$

(3) $\dfrac{ma}{3a+g}$

(4) $\dfrac{ma}{g-3a}$

Answer (1)

Sol. $F_B - mg = ma$ ...(i)

$F_B - (m-x)g = 3(m-x)a$ ...(ii)

On solving

$$x = \frac{2ma}{3a+g}$$

9. Mass M and radius R of a planet is related with mass M_e and Radius R_e of earth as $M_e = 8M_P$ and $R_e = 2R_P$. If escape speed for earth is 11.2 km/sec, then escape speed for the planet is

(1) $11.2\sqrt{2}$ km/sec

(2) 5.6 km/sec

(3) $5.6\sqrt{2}$ km/sec

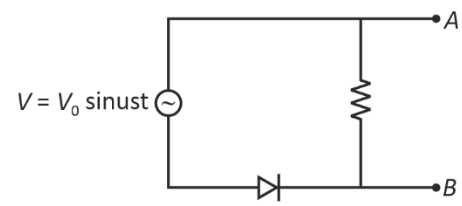
(4) 11.2 km/sec

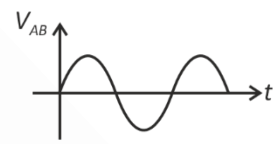
Answer (2)

Sol. $$\frac{v'}{v_e} = \sqrt{\frac{\frac{GM}{R}}{\frac{G(8M)}{2R}}} = \frac{1}{2}$$

$$v' = \frac{v_e}{2} = \frac{11.2}{2} = 5.6$$

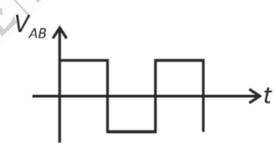
10. The correct variation of voltage across AB is given by (consider that the threshold voltage of the diode is very small)



(1)


(2)


(3)


(4)


Answer (2)

Sol. The diode will only conduct in negative half.

11. An equilateral triangle frame of side l is carrying current i, find magnetic field at its centroid

(1) $\dfrac{3\mu_0 i}{4\pi l}$

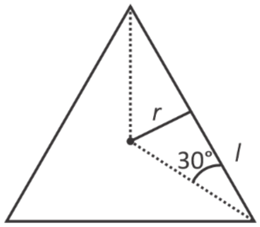
(2) $\dfrac{3\mu_0 i}{\pi l}$

(3) $\dfrac{9\mu_0 i}{2\pi l}$

(4) $\dfrac{\mu_0 i}{\pi l}$

Answer (3)

Sol.



$$B = 3\left(\frac{\mu_0 i}{4\pi l \tan 30^\circ}\right) 2\cos 30^\circ$$

$$= \frac{3\mu_0 i}{2\pi l}\sqrt{3}\cdot\frac{\sqrt{3}}{2}$$

$$= \frac{9\mu_0 i}{2\pi l}$$

12. Select the correct match for dimensions

	Column-I		Column-II
(A)	Angular Momentum	(I)	$[MLT^{-2}]$
(B)	Force	(II)	$[ML^2T^{-1}]$
(C)	Energy	(III)	$[ML^{-1}T^{-2}]$
(D)	Pressure	(IV)	$[ML^2T^{-2}]$

(1) A-(II), B(III), C-(I), D-(IV)

(2) A-(I), B(II), C-(III), D-(IV)

(3) A-(II), B(I), C-(IV), D-(III)

(4) A-(II), B(I), C-(III), D-(IV)

Answer (3)

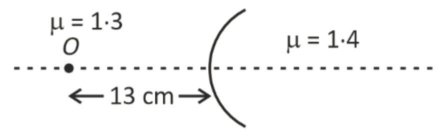
Sol. Angular momentum = $[ML^2T^{-1}]$

Force = $[MLT^{-2}]$

Energy = $[ML^2T^{-2}]$

Pressure = $[ML^{-1}T^{-2}]$

13. In the figure shown the object kept at a distance 13 cm from the interface forms a real image which is double in size. The radius of curvature of the interface is



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

(2) $\frac{2}{3}$ cm

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

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

Answer (2)

Sol. Magnification $= m = \dfrac{\frac{v}{\mu_2}}{\frac{u}{\mu_1}}$

$$\Rightarrow m = -2 = \frac{\frac{v}{1\cdot 4}}{\frac{-13}{1\cdot 3}}$$

$\Rightarrow$ v = + 28 cm

Using formula for refraction at a curved surface

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

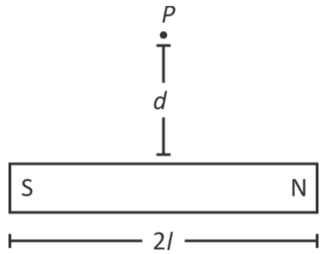
$$\frac{1\cdot 4}{+28\text{ cm}} - \frac{1\cdot 3}{-13\text{ cm}} = \frac{1\cdot 4 - 1\cdot 3}{R}$$

$$\frac{1}{2} + 1 = \frac{1}{R}$$

$$R = \frac{2}{3}\text{ cm}$$

14. Due to the bar magnet shown, if the % uncertainity in d is 1%, find uncertainity in the magnetic field at P.

[d : 10 units, l = 10 units]



(1) 2%

(2) 3%

(3) 1.5%

(4) 0.5%

Answer (3)

Sol. $B = \frac{2\mu_0 m}{4\pi r^2}\cos\theta$

$r = \sqrt{(10)^2 + d^2}$

$\cos\theta = \frac{10}{\sqrt{(10)^2 + (d)^2}}$

$B = 2\left(\frac{\mu_0}{4\pi}\right)\frac{10m}{(10^2 + d^2)^{3/2}}$

$\frac{dB}{dd} = \frac{3B}{2}\frac{2d}{(10^2 + d^2)}$

$\frac{dB}{B} = \left(\frac{3d^2}{10^2 + d^2}\right)\left(\frac{dd}{d}\right)$

= 1.5%

15. A capacitor of capacitance 1 μF is charged to potential of 20 V. Distance between plates is 10 μm, then charge density on plates is

(1) 17.7 nC/m^2 (2) 17.7 μC/m^2

(3) 8.85 nC/m^2 (4) 4.42 μC/m^2

Answer (2)

Sol. $Q = 20 \times 10^{-6}$ C

$\frac{\varepsilon_0 A}{d} = 10^{-6}$

$A = \frac{10^{-6} \times 10 \times 10^{-6}}{8.85 \times 10^{-12}} = \frac{10}{8.85}$

$\sigma = \frac{20 \times 10^{-6}}{10} \times 8.85$

$= 17.7 \times 10^{-6}$

$= 17.7\ \mu\text{C/m}^2$

16. A ring of radius 3 cm has a soap film which is getting evaporated. Light of wavelength λ = 580 nm gives minimum transmission every 12 s. Find the rate of evaporation. (refractive index = 1.45)

(1) 1.5 $\pi \times 10^{-13}$ m^3/s

(2) 15 $\pi \times 10^{-13}$ m^3/s

(3) 3 $\pi \times 10^{-13}$ m^3/s

(4) 3 $\pi \times 10^{-12}$ m^3/s

Answer (2)

Sol. $2\mu l = n\lambda$

$2\mu\Delta l = \Delta n\lambda$

$\left(\frac{\Delta l}{\Delta t}\right) = \frac{\Delta n}{\Delta t}\frac{\lambda}{2\mu}$

$= \frac{1}{12}\frac{580\text{ nm}}{2 \times 1.45\text{ s}} = \frac{5}{3}\text{nm/s}$

Rate of evaporation $= \pi R^2 \frac{\Delta l}{\Delta t}$

$= \pi\left(a \times 10^{-4}\right) \times \left(\frac{5}{3} \times 10^{-9}\right)^{\text{m}^3/\text{s}}$

$= 15\pi \times 10^{-13}\text{m}^3/\text{s}$

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.

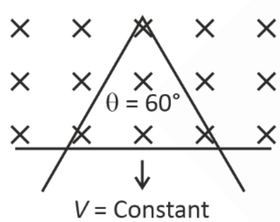
21. An electric dipole of moment 6×10^{-6} cm is placed parallely in electric field of strength 10^6 N/C. Work done required to rotate the dipole by 180° is X joules, then X is

Answer (12)

Sol. $\omega = \Delta U = -pE\cos 180° - (-pE\cos 0)$

$= 2pE = 2 \times 6 \times 10^{-6} \times 10^6$

22. The figure shows a conducting rod sliding on two conducting rails having angle (θ = 60°) in a uniform magnetic field with a constant velocity V. Find n if the motional emf E various with time as $E = ct^n$.



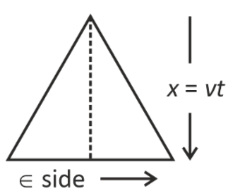
Answer (1)

Sol. Slide $= \dfrac{2}{\sqrt{3}}x$

$= \dfrac{2}{\sqrt{3}}vt$

$Emf = B\left(\dfrac{2}{\sqrt{3}}vt\right)v$

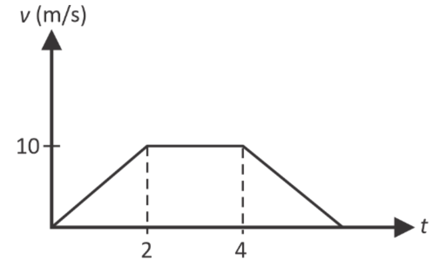
$= \dfrac{2Bv^2}{\sqrt{3}}t$



$E \propto t$

or $n = 1$

23. The velocity vs time graph of a particle moving along X-axis is plotted as shown. The distance travelled (in metre) by the particle in the interval t = 0 s to t = 4 s is



Answer (30)

Sol. Distance = displacement as direction of velocity does not change in the given interval.

$\Rightarrow$ Distance $= \dfrac{1}{2}(2\text{s} + 4\text{s}) \times 10$ m/s

[Area of trapezium with base 4s]

$= 30$m

24. Distance between real object and its three times magnified image formed by concave mirror is 20 cm then radius of curvature of the mirror is X cm, then X is

Answer (15)

Sol. $\left|\dfrac{v}{u}\right| = 3$

$|v| = 3|u|$

$|u| = X$

$|v| = 3X$

$3X - X = 20$

$X = 10$ cm

$\dfrac{1}{-30} - \dfrac{1}{10} = \dfrac{1}{f}$

$-\dfrac{4}{30} = \dfrac{1}{f}$

$R = \dfrac{2 \times 30}{4} = 15$ cm

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. Consider the following oxides, V_2O_3, V_2O_4 and V_2O_5

   Oxidation state of vanadium in amphoteric oxide is

   (1) +3 (2) +4

   (3) +5 (4) +6

Answer (2)

Sol. V_2O_5 is amphoteric, oxidation state of Vanadium is +5

2. Which has maximum oxidising power among the following?

   (1) VO_2^+ (2) $Cr_2O_7^{2-}$

   (3) MnO_4^- (4) TiO_2

Answer (3)

Sol. Oxidising power order :

$$MnO_4^- > Cr_2O_7^{2-} > VO_2^+$$

Due to increasing stability of the lower species to which they are reduced.

3. Which of the following compound(s) are yellow in colour?

   (a) CdS, (b) PbS, (c) CuS, (d) ZnS(cold), (e) $PbCrO_4$

   Choose the correct answer from the options given below:

   (1) (a), (c) and (e) only (2) (a) and (e) only

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

Answer (2)

Sol. CdS, $PbCrO_4$ $\Rightarrow$ yellow coloured

PbS, CuS $\Rightarrow$ black coloured

ZnS $\Rightarrow$ white coloured (when cold)

4. The correct order of energy of the following subshell is

   1*s* 2*s* 3*p* 3*d*

   (1) $1s < 2s < 3d < 3p$

   (2) $2s < 1s < 3p < 3d$

   (3) $1s < 3p < 2s < 3d$

   (4) $1s < 2s < 3p < 3d$

Answer (4)

Sol.: Energy of subshell will depend on n + l

	1*s*	2*s*	3*p*	3*d*
n + l	1 + 0 = 1	2 + 0 = 2	3 + 1 = 4	3 + 2 = 5

Correct order $\boxed{3d > 3p > 2s > 1s}$

5. Which of the following complex is paramagnetic

   (1) $[NiCl_4]^{2-}$ (2) $[Ni(CO)_4]$

   (3) $[Ni(CN)_4]^{2-}$ (4) $[Fe(CO)_5]$

Answer (1)

Sol. (i) $\underset{(sp^3)}{[NiCl_4]^{2-}} \rightarrow Ni^{2+} \rightarrow 3d^8$ in weak field ligand (WFL)

$\rightarrow$ 2 unpaired e^-

(ii) $\underset{(sp^3)}{[Ni(CO)_4]} \rightarrow Ni(0) \rightarrow 3d^{10}$ in strong field ligand (SFL)

$\rightarrow$ 0 unpaired e^-

(iii) $\underset{(dsp^2)}{[Ni(CN)_4]^{2-}} \rightarrow Ni^{2+} \rightarrow 3d^8$ in SFL

$\rightarrow$ 0 unpaired e^-

(iv) $\underset{(dsp^2)}{[Fe(CO)_5]} \rightarrow Fe(0) \rightarrow 3d^8$ in SFL

$\rightarrow$ 0 unpaired e^-

6. 30 gm HNO_3 is added to a solution to prepare 75% w/w solution having density 1.25 g/mL. Volume of solution is

(1) 32 mL

(2) 48 mL

(3) 36 mL

(4) 28 mL

Answer (1)

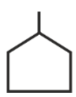
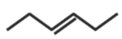
Sol. $M = \dfrac{10 \times \%w/w \times d}{M_0}$

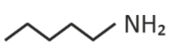
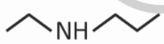
$M = \dfrac{10 \times 75 \times 1.25}{63}$

$M = \dfrac{n}{V_{mL}} \times 1000$

$\dfrac{10 \times 75 \times 1.25}{63} = \dfrac{30}{63 \times V_{mL}} \times 1000$

V_{mL} = 32 mL

7. Statement-I  and  are ring chain isomers

Statement-II  and  are functional isomers

(1) Both Statement -I and Statement -II are correct statements

(2) Statement -I is correct and Statement -II is not correct

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

(4) Both Statement -I and Statement -II are correct

Answer (1)

Sol. 1° amine and 2° amine are functional isomers

8. For an elementary reaction

A + B $\rightarrow$ C + D

When volume becomes $\frac{1}{3}$rd , rate of reaction becomes

(1) 8 times

(2) 9 times

(3) 6 times

(4) 2 times

Answer (2)

Sol. For an elementary reaction

$r = k[A]^1 [B]^1$

When volume becomes $\frac{1}{3}$rd

$[A] \rightarrow 3A$

$[B] \rightarrow 3B$

$r' = k[3A]^1 [3B]^1$

$r' = k\ 3 \times 3\ [A] [B]^1$

$r' = 9 \times r$

rate of reaction becomes 9 times

9. Consider the following sequence of rection

$CH_3 - C \equiv CH \xrightarrow[CaCO_3]{H_2/Pd} A \xrightarrow[H_2O]{O_3/Zn} B + C$

(1) B= CH_3CHO, C = HCHO

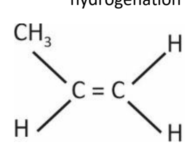
(2) B = CH_3CHO, C = HCOOH

(3) B = $CH_3 - \overset{O}{\overset{||}{C}} - CH_3$, C = HCHO

(4) B $\Rightarrow$ HCHO, C $\Rightarrow$ CH_3COOH

Answer (1)

Sol. $CH_3 - C \equiv CH \xrightarrow[\text{hydrogenation}]{\text{Partial}}$



$\xrightarrow[Zn/H_2O]{O_3}$ CH_3CHO + HCHO

10. Match the following List-I with List-II.

	List-I		List-II
(A)	$[CoF_6]^{3-}$	(i)	sp^3d^2
(B)	$[Co(NH_3)_6]^{3+}$	(ii)	d^2sp^3
(C)	$[NiCl_4]^{2-}$	(iii)	sp^3
(D)	$[Ni(CN)_4]^{2-}$	(iv)	dsp^2

Choose the correct answer from the options given below:

(1) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)

(2) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)

(3) (A)-(i), (B)-(ii), (C)-(iv), (D)-(iii)

(4) (A)-(ii), (B)-(i), (C)-(iii), (D)-(iv)

Answer (1)

Sol.

(A) $[CoF_6]^{3-} \Rightarrow$ Cobalt in +3 O.S. with Flourine ligand. Here, F^- act as weak field ligand

$Co^{3+} \Rightarrow d^6 \Rightarrow t_{2g}^4 e_g^2 \Rightarrow$ e^- configuration.

$\therefore [CoF_6]^{3-}$ has hybridisation $\Rightarrow sp^3d^2$

(B) $[Co(NH_3)_6]^{3+} \Rightarrow Co^{3+}$, NH_3 ligand act as SFL.

$Co^{3+} \Rightarrow d^6 \Rightarrow t_{2g}^6 e_g^0 \Rightarrow$ e^- configuration.

$\therefore [Co(NH_3)_6]^{3+} \Rightarrow$ has hybridisation $\Rightarrow d^2sp^3$

(C) $[NiCl_4]^{2-} \Rightarrow Ni^{2+} \Rightarrow Cl^-$ ligand act as WFL.

$Ni^{2+} \Rightarrow d^8 \Rightarrow t_{2g}^6 e_g^2$ (No pairing by ligand)

$\therefore [NiCl_4]^{2-}$ has hybridisation sp^3

(D) $[Ni(CN)_4]^{2-} \Rightarrow Ni^{2+} \Rightarrow CN^-$ act as weak field ligand.

$Ni^{2+} \Rightarrow d^8 \Rightarrow t_{2g}^6 e_g^2 \Rightarrow$ (Pairing will occur)

$[Ni(CN)_4]^{2-}$ has hybridisation dsp^2

11. The correct name of I & II in the following process is :

$\text{Solid} \xrightarrow{\text{I}} \text{Vapours} \xrightarrow{\text{II}} \text{Solid}$

(1) I $\rightarrow$ Sublimation
II $\rightarrow$ Vaporisation

(2) I $\rightarrow$ Sublimation
II $\rightarrow$ Decomposition

(3) I $\rightarrow$ Sublimation
II $\rightarrow$ Deposition

(4) I $\rightarrow$ Deposition
II $\rightarrow$ Sublimation

Answer (3)

Sol. $\text{Solid} \xrightarrow{\text{sublimation}} \text{Vapours} \xrightarrow{\text{deposition}} \text{Solid}$

12. Which of the following biomolecules doesn't contain $C_1 - C_4$ glycosidic linkage

(1) Amylopectin

(2) Maltose

(3) Lactose

(4) Sucrose

Answer (4)

Sol. Amylopectin $\rightarrow$ branched chain polymer. The chain is formed by C_1–C_4 glycosidic linkage and C_1–C_6 glycosidic linkage

Maltose $\rightarrow$ C_1–C_4 glycosidic linkage

Lactose $\rightarrow$ C_1–C_4 glycosidic linkage

Sucrose $\rightarrow$ C_1–C_2 glycosidic linkage

13. Consider the following statements:

Statement I: In law of octaves, elements were arranged in increasing order of their atomic numbers.

Statement II: Lothar Meyer, plotted the physical properties against atomic weight.

Choose the correct answer from the options given below:

(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

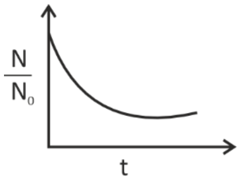
(4) Statement I is incorrect but statement II is correct

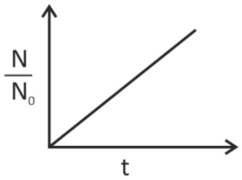
Answer (4)

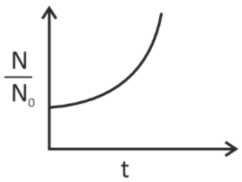
Sol. In law of octaves, elements were arranged in increasing order of their atomic weights.

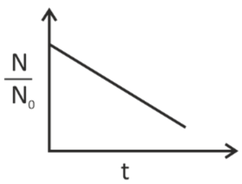
$\therefore$ Statement I is incorrect and statement II is correct statement.

14. The bacterial life grows as per 1st order kinetics. Which of the following graph is correct between $\frac{N}{N_0}$ and t

(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. $\frac{dN}{dt} = kN$

$\frac{dN}{N} = kdt$

On integrating using proper limits

$\int_{N_0}^{N} \frac{dN}{N} = k\int_0^t dt$

$[\ln N]_{N_0}^{N} = k[t]_0^t$

$\ln N - \ln N_0 = kt$

$\ln\frac{N}{N_0} = kt$

$\frac{N}{N_0} = e^{kt}$

Value of $\frac{N}{N_0}$ increases exponentially.

15. Bohr model is applicable for single electron system having atomic number Z. Frequency of rotation of electron is directly proportional to

(1) $\frac{Z}{n^2}$ (2) $\frac{Z^2}{n^3}$

(3) $\frac{n^2}{Z}$ (4) $\frac{n^3}{Z^2}$

Answer (2)

Sol. $f = \frac{v}{2\pi r} \propto \frac{\frac{Z}{n}}{\frac{n^2}{Z}} \propto \frac{Z^2}{n^3}$

16. In which of the following detection of nitrogen is not possible by Lassaigne's extract method?

(1) NH_2–NH_2

(2) $NH_2-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2$

(3) Aniline

(4) Phenyl hydrazine

Answer (1)

Sol. Since, in hydrazine carbon is not present

$\therefore$ It cannot be detected by Lassaigne's test

17. Consider the following sequence of reaction

$C_6H_{12} \xrightarrow{Se/\Delta} A \xrightarrow[AlCl_3]{CH_3-Cl} B \xrightarrow[H_3O^+]{CrO_2Cl_2} C$

Choose the correct option about major product

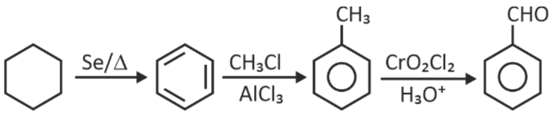
(1) 'C' gives Fehling's solution test

(2) 'C' can be prepared by reaction of PhMgBr with CO_2

(3) 'C' can give Tollen's test

(4) 'C' can give effervescence with $NaHCO_3$

Answer (3)

Sol. 

Benzaldehyde can give Tollen's test

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. Number of paramagnetic species among the following is:

O_2, O_2^+, O_2^-, NO_2, NO, CO

Answer (5)

Sol. O_2, Number of e^- = 16, paramagnetic

O_2^+, Number of e^- = 15, paramagnetic

O_2^-, Number of e^- = 17, paramagnetic

NO_2, odd e^- specie, paramagnetic

NO, Number of e^- = 15, paramagnetic

CO, Number of e^- = 14, diamagnetic

22. How many of the following molecules are polar?

CH_4, CCl_4, CH_2Cl_2, H_2O, NH_3, H_2O_2, O_2F_2

Answer (5)

Sol. Compounds having permanent dipole moment

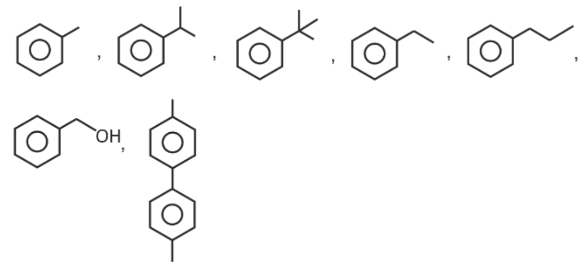
($\mu \neq 0$) are polar

$CH_4, CCl_4 \Rightarrow \mu = 0$

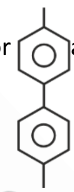
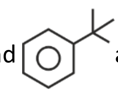
CH_2Cl_2, H_2O, NH_3, H_2O_2, O_2F_2 $\Rightarrow \mu \neq 0$

Number of polar molecules = 5

23. How many of the following will give Benzoic acid on reaction with hot alkaline $KMnO_4$?



Answer (5)

Sol. Except for  and  all will give Benzoic acid on reaction with hot alkaline $KMnO_4$.

Note : Benzylic hydrogen must be present to give Benzoic acid.

24. By passing current in 600 mL of NaCl solution pH increases to 12. Find current (i) if electrolysis occur for 10 min(assume 100% efficiency)

Answer (1)

Sol. $2H_2O + 2e^- \rightarrow 2H_2 + 2OH^-$

pH = 12 pOH = 2 $[OH^-] = 10^{-2}M$

g eq. of OH^- formed = no. of faraday of charge passed

$$10^{-2} \times \frac{600}{1000} \times 1 = \frac{i \times 10 \times 60}{96500}$$

0.965A = i

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. Let $f(x)=\int\frac{dx}{x^{1/4}(x^{1/4}+1)}$. If $f(0) = -6$, then $f(2)$ is

(1) $4\left[\frac{1}{\sqrt{2}}-2^{1/4}+\ln\left|1+2^{1/4}\right|\right]-6$

(2) $4\left[\frac{1}{\sqrt{2}}-2^{1/4}+\ln\left|1+2^{1/4}\right|\right]+6$

(3) $4\left[\frac{1}{\sqrt{2}}+2^{1/3}+\ln\left|2^{1/4}\right|\right]-6$

(4) $4\left[3+2^{1/3}-\ln 2^{1/4}\right]+6$

Answer (1)

Sol. $\int\frac{dx}{x^{1/4}(x^{1/4}+1)}$

$x^{1/4} = t \Rightarrow dx = 4t^3dt$

$$\int\frac{4t^3dt}{t(t+1)}=4\int\frac{t^2dt}{t+1}=4\left[\int\left(\frac{t^2-1}{t+1}+\frac{1}{t+1}\right)dt\right]$$

$$=4\left[\int(t-1)dt+\ln|t+1|\right]+c$$

$$f(x)=4\left[\frac{x^{1/2}}{2}-x^{1/4}+\ln\left|x^{1/4}+1\right|\right]+c$$

$f(0) = -6$

$-6 = 4(0) + c$

$\Rightarrow \quad c = -6$

$$\Rightarrow \quad f(x)=4\left[\frac{\sqrt{x}}{2}-x^{1/4}+\ln\left|1+x^{1/4}\right|\right]-6$$

$$f(2)=4\left[\frac{1}{\sqrt{2}}-(2)^{1/4}+\ln\left|1+2^{1/4}\right|\right]-6$$

2. Evaluate $\sum_{r=1}^{13}\frac{1}{\sin\left[\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right]\sin\left[\frac{\pi}{4}+\frac{r\pi}{6}\right]}$

(1) $2\sqrt{3}+2$

(2) $2\sqrt{3}-2$

(3) $3\sqrt{2}+2$

(4) $3\sqrt{2}-4$

Answer (2)

Sol. $\sum_{r=1}^{13}\frac{1}{\sin\left[\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right].\sin\left[\frac{\pi}{4}+r.\frac{\pi}{6}\right]}$

$$=\sum_{r=1}^{13}\frac{\sin\left\{\left(\frac{\pi}{4}+r.\frac{\pi}{6}\right)-\left(\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right)\right\}}{\sin\frac{\pi}{6}.\sin\left[\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right].\sin\left[\frac{\pi}{4}+r.\frac{\pi}{6}\right]}$$

$\boxed{\sin(A-B)=\sin A\cos B-\cos A\sin B}$

$$=2.\sum_{r=1}^{13}\cot\left(\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right)-\cot\left(\frac{\pi}{4}+r.\frac{\pi}{6}\right)$$

$$=2.\cot\left(\frac{\pi}{4}+0.\frac{\pi}{6}\right)-\cot\left(\frac{\pi}{4}+\frac{13\pi}{6}\right)$$

$$=2.\left\{\cot\frac{\pi}{4}-\cot\left(\frac{\pi}{4}+\frac{\pi}{6}\right)\right\}$$

$$=2\left[1-2+\sqrt{3}\right]$$

$$=2\left[\sqrt{3}-1\right]$$

3. Area bounded between the curves $C_1 : x(1+y^2)-1=0$ and $C_2 : y^2-2x=0$ is (in sq. unit)

(1) $\frac{\pi}{2}-\frac{1}{3}$

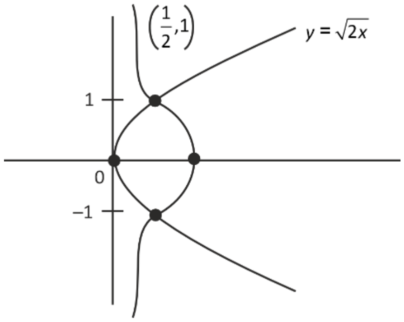
(2) $\frac{\pi}{4}-\frac{1}{6}$

(3) $2\left(\frac{\pi}{2}-\frac{1}{6}\right)$

(4) $\frac{\pi}{6}+\frac{1}{2}$

Answer (1)

Sol.



$$\int_{-1}^{1}(x_2-x_1)dy$$

$$\Rightarrow \int_{-1}^{1}\left(\frac{1}{1+y^2}-\frac{y_2}{2}\right)dy$$

$$=\tan^{-1}y-\frac{y_3}{6}\Bigg|_{-1}^{1}$$

$$=\left(\tan^{-1}-\frac{1}{6}\right)-\left(\tan^{-1}(-1)-\left(\frac{-1}{6}\right)\right)$$

$$=2\tan^{-1}1-\frac{1}{3}=\frac{\pi}{2}-\frac{1}{3}$$

4. There are three bags such that bag 1 has 4 white, 6 blue, bag 2 has 6 white and 4 blue and bag 3 has 5 white and 5 blue balls. A bag is randomly selected and a ball is randomly picked out of it, it comes out to be white then probability that selected bag was bag 2.

(1) $\frac{2}{5}$ (2) $\frac{2}{15}$

(3) $\frac{1}{15}$ (4) $\frac{7}{15}$

Answer (1)

Sol. $\boxed{4W+6B}$ BAG 1 $\boxed{6W+4B}$ BAG 2 $\boxed{5W+5B}$ BAG 3

$$P\left(\frac{B_2}{W}\right)=\frac{P(B_2)\cdot P\left(\frac{W}{B_2}\right)}{P(W)}$$

$$P(W)=\sum_{i=1}^{3}P(Bi)P\left(\frac{W}{B_2}\right)$$

$$P(B_1)=\frac{1}{3}=P(B_2)=(B_3)$$

$$P\left(\frac{W}{B_1}\right)=\frac{4}{10},\ P\left(\frac{W}{B_2}\right)=\frac{6}{10},P\left(\frac{W}{B_3}\right)=\frac{5}{10}$$

$$\Rightarrow P\left(\frac{B_2}{W}\right)=\frac{\frac{1}{3}\times\frac{6}{10}}{\frac{1}{3}\times\frac{4}{10}+\frac{1}{3}\times\frac{6}{10}+\frac{1}{3}\times\frac{5}{10}}$$

$$=\frac{\frac{6}{10}}{\frac{4}{10}+\frac{6}{10}+\frac{5}{10}}=\left(\frac{6}{15}\right)=\frac{2}{5}$$

5. If S is a set of words formed by all the letters of word “GARDEN”, then find the probability that vowels are not in alphabetical order.

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

(3) $\frac{1}{4}$ (4) $\frac{1}{5}$

Answer (1)

Sol. AE GRDN

Only 2 vowels are there.

$\therefore$ Only half of the cases will have A before E and vice-versa.

Required probability $=\frac{1}{2}$

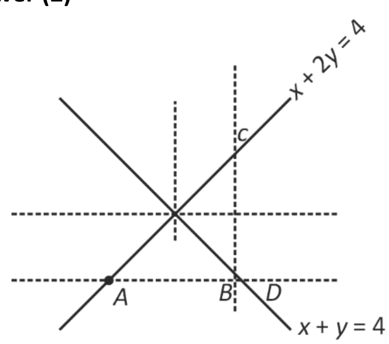
6. In isosceles triangle two sides are $x + 2y = 4$, $x + y = 4$ than the sum of all possible value of slope of third side of triangle is

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

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

Answer (2)

Sol.



Now third side will be parallel to the bisector line of the two given sides.

$$\frac{x+2y-4}{\sqrt{5}}=\pm\left(\frac{x+y-4}{\sqrt{2}}\right)$$

$$L_1:\left(\sqrt{2}-\sqrt{5}\right)x+\left(2\sqrt{2}-\sqrt{5}\right)y-4\sqrt{2}+4\sqrt{5}=0$$

$$L_2:\left(\sqrt{2}+\sqrt{5}\right)x+\left(2\sqrt{2}+\sqrt{5}\right)y-4\sqrt{2}-4\sqrt{5}=0$$

$$M_{L_1}+M_{L_2}=-\left[\frac{\sqrt{2}-\sqrt{5}}{2\sqrt{2}-\sqrt{5}}+\frac{\sqrt{2}+\sqrt{5}}{2\sqrt{2}+\sqrt{5}}\right]$$

7. If α, β, γ, δ are real numbers such that $\alpha + i\beta$ and $\gamma + i\delta$ are roots of the equation $x^2 - (3 - 2i)x - (2i - 2) = 0$. (where $i=\sqrt{-1}$), then $(\alpha\gamma + \beta\delta)$ is

(1) –2 (2) 2

(3) 6 (4) –6

Answer (2)

Sol. $x^2-(3-2i)x-(2i-2)=0$

$\Rightarrow x^2-(3-2i)x+(2-2i)=0$

$\Rightarrow \alpha+\beta=3-2i$

$\alpha\beta=(2-2i)$ (i),

by observation

$(\alpha,\beta)=(1,2-2i)$

$\Rightarrow \alpha+i\beta=i+0i$

$\gamma+i\delta=2-2i$

$\Rightarrow \alpha\gamma+\beta\delta=(1)(2)+(0)(-2)$

$=2$

8. The domain of the function $f(x) = sec^{-1}(2[x] + 1)$ is (where [·] represents greatest integer function))

(1) $(-\infty,\ \infty)$ (2) $(-\infty,\ -1]\ \cup[1,\ \infty)$

(3) $(-\infty,\ \infty)-\{0\}$ (4) $(-\infty,-1]\cup[0,\ \infty)$

Answer (1)

Sol. $2[x]+1\notin(-1,1)$

$2[x]\notin(-2,0)$

$[x]\notin(-1,0)$

But $[x]\notin(-1,0)$ for any x.

$\Rightarrow$ $x\in R$ is the domain.

9. If p is the number of possible values of r such that T_r, T_{r+1}, T_{r+2} are three terms of $(a + b)^{12}$ are in geometric progression and if q is the sum of rational terms in the expansion of $(3^{1/4} + 4^{1/3})^{12}$, then $(p + q)$ is

(1) 283

(2) 238

(3) 240

(4) 250

Answer (1)

Sol. Let $T_{r+1}={}^{12}C_r a^{12-r}b^r$

T_r, T_{r+1}, T_{r+2} in G.P.

$\Rightarrow$ $\left({}^{12}C_r\cdot a^{12-r}\cdot b^2\right)^2=\left({}^{12}C_{r-1}\cdot b^{r-1}\cdot a^{13-r}\right)\left({}^{12}C_{r+1}b^{r+1}\cdot a^{11-r}\right)$

$\Rightarrow$ $\left({}^{12}C_r\right)^2=\left({}^{12}C_{r-1}\right)\cdot\left({}^{12}C_{r+1}\right)$

but no three consecutive binomial coefficients are in G.P. or H.P. but A.P. is possible.

$\Rightarrow$ P = 0

$T_{k+1}={}^{12}C_k\cdot(4^{1/3})^k\cdot 3^{1/4(12-k)}$

$={}^{12}C_k\cdot 4^{k/3}\cdot 3^{\left(3-\frac{k}{4}\right)}$

for terms to be rational (4, 3) divides $k\Rightarrow$ 12 divides k

$\Rightarrow k = 0, 12$

$\Rightarrow$ Sum of rational terms

${}^{12}C_0 4^0\cdot 3^3+{}^{12}C_{12}\cdot 4^4\cdot 3^0={}^{12}C_0(3^3+4^4)$

= 27 + 256 = 283

$\Rightarrow$ $p + q = 283$

10. Let P_i be image of parabola $P : y^2 = 4x$ with respect to line $x + y + 1 = 0$. Let the line $y + 5 = 0$ intersect P_i at A and B. If a is the distance between A and B and d be the area of triangle SAB, where S is the focus of parabola P_i. Then $(a + d)$ is

(1) 10

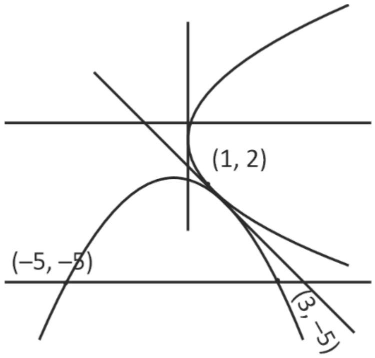
(2) 20

(3) 12

(4) 8

Answer (2)

Sol.



To find image of $P(t^2, 2t)$

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

$\Rightarrow$ $x = t^2 - (t+1)^2 = -2t - 1$

$y = 2t - (t+1)^2 = -t^2 - 1$

$$t=\left(\frac{-1-x}{2}\right)$$

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

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

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

$\Rightarrow$ $X^2 = -4y$, the vertex is

$X = 0, y = 0$

$\Rightarrow$ Focus $\Rightarrow (-1, -2)$

Other method would have been to find image of $(1, 0)$ about $x + y + 1 = 0$

$\Rightarrow$ $y = -5$ intersect

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

$\Rightarrow$ $(x + 1) = \pm 4$

$\Rightarrow$ $x = 3, -5$

$\Rightarrow$ $a = 8$

$$d=\frac{1}{2}\times a\times \text{height}=\frac{1}{2}\times 8\times(-2-(-5))$$

$= 4.\ 3 = 12$ Sq. unit

$\Rightarrow$ $\boxed{a+d=20}$

11. For positive integer n, $4a_n = n^2 + 5n + 6$ and $S_n=\sum_{K=1}^{n}\frac{1}{a_K}$. Then the value of $507(S_{2025})$ is

(1) 675 (2) 540

(3) 1350 (4) 725

Answer (1)

Sol. $S_n=\sum_{K=1}^{n}\frac{4}{K^2+5K+6}$

$$=\sum_{K=1}^{n}\frac{4}{(K+2)(K+3)}=4\sum_{K=1}^{n}\left(\frac{1}{K+2}-\frac{1}{K+3}\right)$$

$$=4\left[\frac{1}{3}-\frac{1}{4}\right]$$

$$=4\left[\frac{1}{4}-\frac{1}{5}\right]$$

$$=4\left[\frac{1}{n+2}-\frac{1}{n+3}\right]$$

$$S_n=4\left[\frac{1}{3}-\frac{1}{n+3}\right]$$

$$S_{2025}=4\left[\frac{1}{3}-\frac{1}{2028}\right]$$

$$S_{2025}=4\left[\frac{675}{2028}\right]$$

$507\ S_{2025} = 675$

12. The number of natural numbers between 212 to 999 such that sum of their digit is 15 is equal to

(1) 63 (2) 61

(3) 62 (4) 65

Answer (2)

Sol.
717 $\rightarrow$ 3
726 $\rightarrow$ 3!
735 $\rightarrow$ 3!
744 $\rightarrow$ 3
636 $\rightarrow$ 3
645 $\rightarrow$ 3!
555 $\rightarrow$ 1

915 $\rightarrow$ 3!
924 $\rightarrow$ 3!
933 $\rightarrow$ 3
816 $\rightarrow$ 3!
825 $\rightarrow$ 3!
834 $\rightarrow$ 3!
Total : 61

13.

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 $Q=\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{bmatrix}$, $B = QPQ^T$ and matrix A is defined as $A = Q^TB^{10}Q$ (where $P=\begin{bmatrix}\sqrt{2} & -2\\ 0 & 1\end{bmatrix}$), then trace of matrix A is

Answer (33)

Sol. $Q=\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{bmatrix}$

$B = QPQ^T$

$A = Q^TB^{10}Q$

$Q^TQ=\begin{bmatrix}\cos\theta & \sin\theta\\ -\sin\theta & \cos\theta\end{bmatrix}\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{bmatrix}$

$=\begin{bmatrix}\cos^2\theta+\sin^2\theta & 0\\ 0 & \sin^2\theta+\cos^2\theta\end{bmatrix}=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}=I$

$\Rightarrow$ $Q^TQ = QQ^T$

$A = Q^T(QPQ^T)B^9Q$

$= IPQ^TB^9Q = PQ^TB^9Q$

$\Rightarrow$ $A = PQ^T(QPQ^T)B^8Q$

$= P^2Q^TB^8Q = P^9Q^TB^1Q$

$= P^9Q^T(QPQ^T)Q = P^{10}$

Trace (P^{10}) = $\left(d_1^{10}+d_2^{10}\right)$ where d_1 and d_2 are diagonal elements

$\Rightarrow$ Trace (A) = $(\sqrt{2})^{10}+1^{10}$

$= 2^{10/2} + 1 = 2^5 + 1 = 33$

22. $f: [0, 3] \to b, f(x) = 2x^3 - 15x^2 + 36x + 7$ is an onto function $g: [0, \infty) \to d,\ g(x) = \frac{x^{2025}}{x^{2025}+1}$ is also an onto function. Find the number of elements in the set $S = \{x : x \in Z, x \in b \text{ or } x \in d\}$

Answer (30)

Sol. $f(x) = 2x^3 - 15x^2 + 36x + 7$

$f'(x) = 6x^2 - 30x + 36 = 0$

$\Rightarrow$ $x^2 - 5x + 6 = 0$

$\therefore$ $x = 1, 5$

$f(0) = 7, f(2) = 35, f(3) = 34$

$\therefore$ $b = [7, 35]$

$g(x)=\dfrac{x^{2025}}{1+x^{2025}}$

$d = [0, 1)$

$\therefore$ $S = [0, 7, 8, 9, \ldots, 35]$

Number of elements = 30

23. The maximum interior angle of a polygon is 171° with n sides such that its angles are in Arithmetic progression with common difference of 6°. Then n is equal to

Answer (10)

Sol. Sum of interior angle

$\Rightarrow \frac{n}{2}\left(2a+(n-1)d\right)=180°(n-2)$

$\Rightarrow 171=a+(n-1)d$

$\Rightarrow \frac{n}{2}\left(171+a\right)=180(n-2)$

$a = 171 - 6(n-1) = 177 - 6n$

$\Rightarrow \frac{n}{2}\left(171+177-6n\right)=180(n-2)$

$\Rightarrow n\left(174-3n\right)=180n-360$

$\Rightarrow 3n^2+6n-360=0$

$n^2+2n-120=0$

$(n+12)(n-10)=0$

$\Rightarrow n=10$

24.

25.

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