JEE (Main)-2026

Session-1

24 January 2026 Shift-1

Memory-Based Answers & Solutions

(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. A spring of stiffness k= 15 N/m is cut into a ratio of 3 : 1. Find the spring constant of smaller length spring thus formed.

   (1) 15 N/m (2) 30 N/m

   (3) 45 N/m (4) 60 N/m

Answer (4)

Sol. $\frac{1}{k}=\frac{4}{k_1}$

$\Rightarrow k_1 = 4k$

$\Rightarrow k_1 = 60$ N/m

2. EM waves and their source are given

	Column-I		Column-II
(a)	X-rays	(p)	Hot bodies & Molecules
(b)	Infrared rays	(q)	Oscillating current in antennas
(c)	Microwaves	(r)	Magnetron
(d)	Radio waves	(s)	Fast moving electrons Striking a metal plate

   (1) (a)-(p); (b)-(s); (c)-(r); (d)-(q)

   (2) (a)-(s); (b)-(p); (c)- (r); (d)-(q)

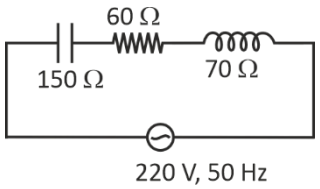
   (3) (a)-(s); (b)-(p); (c)- (s); (d)-(q)

   (4) (a)-(s); (b)-(r); (c)- (p); (d)-(q)

Answer (2)

Sol. Theoretical

3. For the given AC circuit find the power factor.

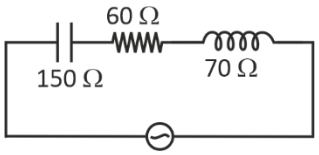


   (1) $\frac{4}{5}$ (2) $\frac{3}{5}$

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

Answer (2)

Sol.



$X = |X_L - X_C| = 80\ \Omega$

$R = 60\ \Omega$

$\Rightarrow \tan\theta = \frac{80}{60} = \frac{4}{3}$

$\Rightarrow \cos\theta$ = Power factor = $\frac{3}{5}$

4. In H-like atom ratio of speed in two orbits is 3 : 2, then ratio of energy is

   (1) 2 : 3 (2) 9 : 4

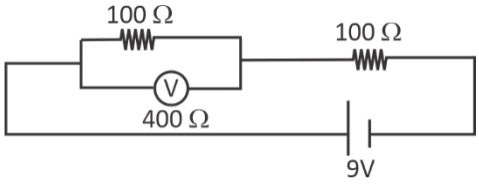
   (3) 2 : 1 (4) 5 : 3

Answer (2)

Sol. $v = \frac{Z}{n}$

$\text{KE} = \left(\frac{Z}{n}\right) = 9:4$

5. A voltmeter of 400 Ω resistance is in parallel with 100 Ω resistor. And the combination is connected with 100 Ω resistor and a battery of 9 volt in series as shown. Find the reading of voltmeter.



(1) 5 volts (2) 3 volts

(3) 4 volts (4) 6 volts

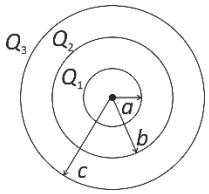
Answer (3)

Sol. $R_{eq.} = \frac{400\times100}{500} + 100 = 180$

$I = \frac{9}{180}$

So, V(voltmeter) = $\frac{9}{180}\times80$ = 4 volts.

6. Three concentric uniformly charged shells are kept as show. Find potential of the each shell.



(1) $V_A = \frac{kQ_1}{a} + \frac{kQ_2}{b} + \frac{kQ_3}{c}$

$V_B = \frac{k(Q_1+Q_2+Q_3)}{b}$

$V_C = \frac{k(Q_1+Q_2+Q_3)}{c}$

(2) $V_A = \frac{kQ_1}{a} + \frac{kQ_2}{b} + \frac{kQ_3}{c}$

$V_B = \frac{k(Q_1+Q_2)}{b} + \frac{kQ_3}{c}$

$V_C = \frac{k(Q_1+Q_2+Q_3)}{c}$

(3) $V_A = \frac{kQ_1}{a} + \frac{k(Q_2+Q_3)}{c}$

$V_B = \frac{k(Q_1+Q_2)}{b} + \frac{kQ_3}{c}$

$V_C = \frac{k(Q_1+Q_2+Q_3)}{c}$

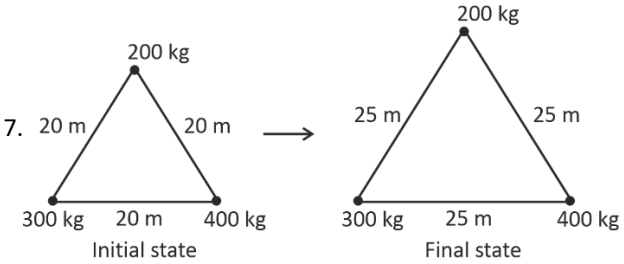
(4) $V_A = \frac{kQ_1}{a} + \frac{kQ_2}{b} + \frac{kQ_3}{c}$

$V_B = \frac{k(Q_1+Q_2)}{a} + \frac{kQ_2}{b}$

$V_C = \frac{k(Q_1+Q_2+Q_3)}{c}$

Answer (2)

Sol. Formula based

7. 

Find the work done.

(Given: $G = 6.67 \times 10^{-11}$ N-m^2/kg^2)

(1) 1.7342×10^{-7} J (2) 1.6253×10^{-7} J

(3) 2.5232×10^{-7} J (4) 6.6325×10^{-7} J

Answer (1)

Sol. $U_i = -\frac{G\times200\times300}{20} - \frac{G\times200\times400}{20} - \frac{G\times300\times400}{20}$

$U_i = -\frac{26\times10^4\times G}{20} = -8.671\times10^{-7}$ J

$U_f = -\frac{G\times200\times300}{25} - \frac{G\times200\times400}{25} - \frac{G\times300\times400}{25}$

$U_f = -\frac{26}{25}\times10^4\times6.67\times10^{-11}$

$U_f = -6.9368 \times 10^{-7}$ J

$W = \Delta U = 1.7342 \times 10^{-7}$ J

8. Match the two lists given below .

	List-I		List-II
a.	Magnetic flux	1.	$M^1L^2T^{-2}A^{-2}$
b.	Magnetic permeability	2.	$M^1L^2T^{-2}A^{-1}$
c.	Magnetic induction	3.	$M^1L^1T^{-2}A^{-2}$
d.	Self-induction	4.	$M^1L^0T^{-2}A^{-1}$

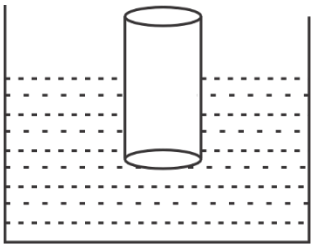
(1) a-2, b-3, c-4, d-1 (2) a-3, b-2, c-1, d-4

(3) a-4, b-3, c-1, d-2 (4) a-1, b-2, c-3, d-4

Answer (1)

Sol. Theoretical

9. A cylinder of mas *m*, length *l* and area of cross section *A* is in equilibrium in liquid of density ρ. Find time period of small vertical oscillations.



(1) $2\pi\sqrt{\frac{mA}{\rho g}}$ (2) $2\pi\sqrt{\frac{mg}{\rho A}}$

(3) $2\pi\sqrt{\frac{m}{\rho A^2 g}}$ (4) $2\pi\sqrt{\frac{m}{\rho A g}}$

Answer (4)

Sol. $F = (\rho A g)x$

$$T = 2\pi\sqrt{\frac{m}{\rho A g}}$$

10. A dipole is placed in uniform magnetic field B = 800 gauss at an angle 30° then it experiences the torque of 16×10^{-3} N-m. Find the work done in slowly moving the dipole from stable equilibrium to unstable equilibrium.

(1) 12.8×10^{-3} J (2) 5×10^{-3} J

(3) 24.5×10^{-3} J (4) 7.6×10^{-3} J

Answer (1)

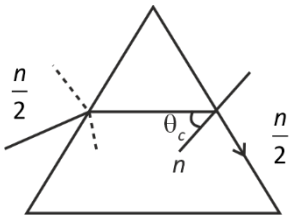
Sol. $\left|\vec{\tau}\right| = \left|\overline{M} \times \vec{B}\right| = \frac{\left|\overline{M} \times \vec{B}\right|}{2}$

$$\Rightarrow \left|\overline{M}\right| = \frac{2 \times 16 \times 10^{-3}}{800 \times 10^{-4}} = \frac{4}{10}$$

So $\Delta W = 2\left|\overline{M}\right|\left|\vec{B}\right| = \frac{2 \times 4}{10} \times 800 \times 10^{-4}$

$\Rightarrow \Delta W = 64$ mJ

11. A light ray incident on the prism such that deviation is minimum and angle of incidence on 2nd surface is critical angle. Find prism angle.



(1) 90° (2) 60°

(3) 105° (4) 74°

Answer (2)

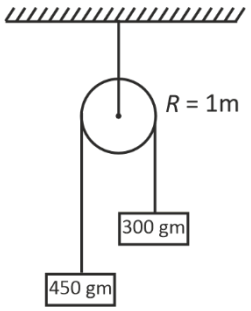
Sol. $\sin\theta_c = \frac{1}{2}$

$\theta_c = 30°$

$r_1 = r_2 = 30°$

$A = 30 + 30 = 60°$

12. When system is released from rest the heavier mass goes 81 cm in 9 sec, find rotational inertia. (g = 10 m/s^2)



(1) 74.25 kg-m^2

(2) 100.25 kg-m^2

(3) 50.25 kg-m^2

(4) 25.25 kg-m^2

Answer (1)

Sol. $s=\frac{1}{2}at^2$

$0.81=\frac{1}{2}a\times 9^2$

a = 0.02 m/s^2

$a=\frac{(0.45-0.3)\times 10}{0.45+0.3+\frac{I}{R^2}}$

$0.02=\frac{0.15\times 10}{0.75+\frac{I}{R^2}}$

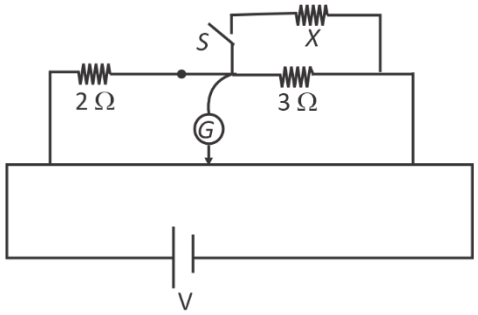
$0.75+\frac{I}{R^2}=75$

$\frac{I}{R^2}=74.25$

I = 74.25 × 1^2

I = 74.25 kg-m^2

13. In meter bridge diagram given below, if S is closed, null point shifts by 25 cm. Find value of resistance X. (in cm).



(1) 4.1 (2) 1.68

(3) 6.28 (4) 5.4

Answer (2)

Sol. $\Rightarrow \quad \frac{2}{3}=\frac{I}{100-I} \quad \Rightarrow \quad I$ = 40 cm

Now $\frac{2(3+x)}{3x}=\frac{65}{35}=\frac{13}{7}$

$\Rightarrow$ 42 + 14x = 39x

$\Rightarrow$ 42 = 25x $\Rightarrow$ x = 1.68 Ω

14. **Statement-1 :** Binding energy per nucleon always increase with mass number.

Statement-2 : Binding energy per nucleon for smaller mass number always performs nucleon fusion.

(1) Statement-1, true Statement-2, false

(2) Statement-1, true Statement-2, true

(3) Statement-1, false Statement-2, true

(4) Statement-1, false Statement-2, false

Answer (3)

Sol. Statement-1 False $\rightarrow$ Binding energy per nucleons does net always increase with mass number.

Statement-2 : True $\rightarrow$ Light nuclei with low binding energy per nucleon generally undergo nucleon fusion to become stable by increasing their binding energy per nucleons towards the iron-56 peak.

15. Velocity of electron in n^{th} shell of a hydrogen like atom is 3×10^5 m/s and velocity of electron in m^{th} shell of that atom is 2.5×10^5 m/s. Find ratio of radius of m^{th} shell to n^{th} shell.

(1) $\frac{25}{40}$ (2) $\frac{25}{36}$

(3) $\frac{36}{25}$ (4) $\frac{36}{35}$

Answer (3)

Sol. $V \propto \frac{z}{n}$ and $r \propto \frac{n^2}{z}$

$\frac{V_n}{V_m} = \frac{m}{n} = \frac{6}{5}$

$\frac{r_m}{r_n} = \frac{m^2}{n^2} = \frac{36}{25}$

16.

17.

18.

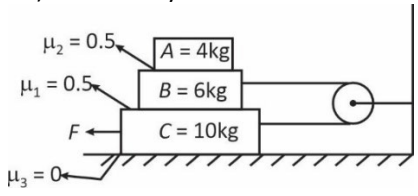
19.

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. For the given arrangement find the value of F(in Newton) so that body c moves with constant velocity.



Answer (100)

Sol. $fr_{(max)} = \frac{1}{2} \times 10 \times 10 = 50$ N

Since B also moves with uniform velocity

So, friction between A & B is zero.

Now, $F - T - 50 = 0$

$\Rightarrow \quad F = 50 + T \quad ....(1)$

Also, $T - 50 = 0 \quad T = 50$ N

So, $F = 100$ N

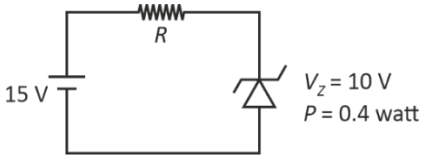
22. For a microscope focal length of objective is 2 cm and focal length of eyepiece is 4 cm. Tube length is L = 10 cm. Magnification for normal adjustment is 5^x. Find the value of x.

Answer (2)

Sol. $M = \frac{1}{fo} \cdot \frac{D}{fe}$

M = $\frac{10}{2} \cdot \frac{25}{5} = 25 = (5)^2$

23. For the given circuit the breakdown voltage of Zener diode is $V_Z = 10$ volts and it can with-stand the power dissipation of 0.4 watt. Find the value of resistance R (in Ω)



Answer (125)

Sol. Current in Zener diode is

$I_{(Z)} = \frac{4}{10 \times 10} = \frac{4}{100}$ Ampere

So, $R = \frac{(15-10)}{4} \times 100 = 125\ \Omega$

24. If potential varies as distance r as $v(r) = ar^3 + b$. Total magnitude of charge Q inclosed within a sphere of unit radius is $Q = \alpha(\pi a \varepsilon_0)$. Find the value of α.

Answer (12)

Sol. $v(r) = ar^3 + b$

$\Rightarrow E(r) = \frac{-dv}{dr} = -3ar^2$

So $\int E \cdot ds = \frac{|q_{in}|}{\varepsilon_0}$

$\Rightarrow \quad 3ar^2 \cdot 4\pi r^2 = \frac{|q_{in}|}{\varepsilon_0}$

$\Rightarrow \quad |q_{in}| = 12\pi a \varepsilon_0 (1)^4 = 12\pi a \varepsilon_0$

So, $\alpha = 12$

25

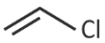
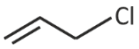
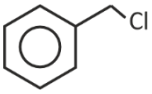
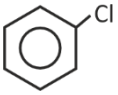
CHEMISTRY

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. Match List-I with List-II.

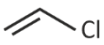
	List-I		List-II
A.	Vinyl halide	(I)	
B.	Allyl halide	(II)	
C.	Benzyl halide	(III)	
D.	Aryl halide	(IV)	

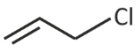
Select the correct option.

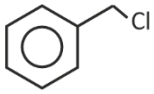
(1) A(II), B(I), C(III), D(IV) (2) A(I), B(II), C(III), D(IV)

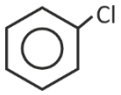
(3) A(I), B(II), C(IV), D(III) (4) A(II), B(I), C(IV), D(III)

Answer (2)

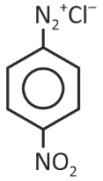
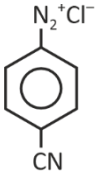
Sol. Vinyl halide → 

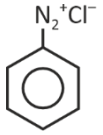
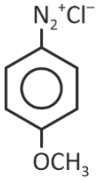
Allyl halide → 

Benzyl halide → 

Aryl halide → 

2. The correct order of stability of following diazonium ions is

a.  b. 

c.  d. 

(1) a < b < c < d (2) a < b < d < c

(3) c < d < b < a (4) d < c < b < a

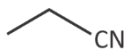
Answer (1)

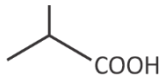
Sol. Stronger the electron withdrawing group attached at para position of $-N_2^+$ in diazonium ion, lesser is the stability and more electrophilicity.

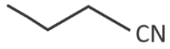
Stability : (d) > (c) > (b) > (a)

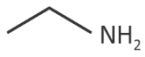
3. $A \xrightarrow[\text{II. } H_3O^+]{\text{I. } SnCl_2/HCl} B \xrightarrow[H^+]{KMnO_4} C \xrightarrow[H_2O]{Cl_2, P} C_3H_5O_2Cl$

Final product has one chiral centre. Structure of A is

(1) 

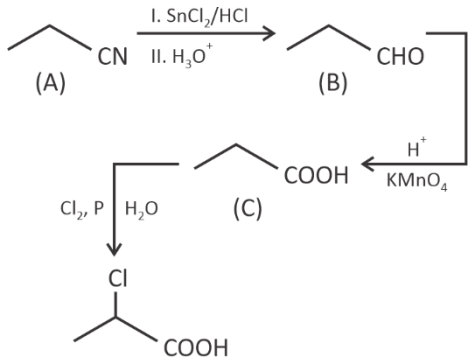
(2) 

(3) 

(4) 

Answer (1)

Sol.



4. Which of following compound contains 3 unpaired electrons?

(1) V_2O_5

(2) $[TiF_6]^{3-}$

(3) $[CoF_6]^{4-}$

(4) $[Fe(CN)_6]^{3-}$

Answer (3)

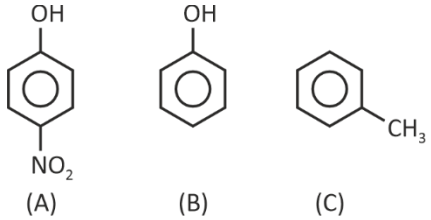
Sol. V_2O_5 : 0 unpaired electrons

$[TiF_6]^{3-}$: Ti^{3+} : [Ar] $4s^0 3d^1$: 1 unpaired e^-

$[CoF_6]^{4-}$: Co^{2+} : [Ar] $4s^0 3d^7$: 3 unpaired e^-

$[Fe(CN)_6]^{3-}$: Fe^{3+} : [Ar] $4s^0 3d^5$: 1 unpaired e^-

5. Consider the following molecules.



The correct order of dipole moment is

(1) A > B > C

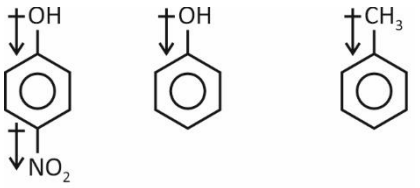
(2) A > C > B

(3) B > A > C

(4) C > A > B

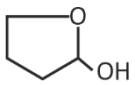
Answer (1)

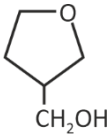
Sol.

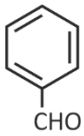


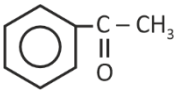
Dipole moment A > B > C

6. Which of the following compounds with give positive Tollen's reagent test?

A. 

B. 

C. 

D. 

(1) A, B and C only

(2) A and C only

(3) A, C and D only

(4) B, C and D only

Answer (2)

Sol. Aldehydes and compounds with hemiacetal linkage gives positive Tollen's test. A and C give +ve T.R. test.

7. $K_2Cr_2O_7 + I^- + H^+ \rightarrow I_2$ (x = number of moles of e^- exchanged per mol I_2)

$K_2Cr_2O_7 + S^{2-} \rightarrow S$ (y = number of moles of e^- exchanged for mole of S)

x + y is

(1) 12

(2) 9

(3) 4

(4) 6

Answer (3)

Sol. $6I^- + Cr_2O_7^{2-} + 7H_2SO_4 \rightarrow 3I_2 + 2Cr^{3+} + 7SO_4^{2-} + 7H_2O$

x = 2

$K_2Cr_2O_7 + 3S^{2-} \rightarrow 2Cr^{3+} + 3S$

y = 2

8. Match the column

	Column-I		**Column-II**
(A)	IF_3	(I)	sp^3d^3, Pentagonal bipyramidal
(B)	IF_5	(II)	sp^3d, T-shaped
(C)	IF_7	(III)	sp^3, Tetrahedral
(D)	ClO_4^-	(IV)	sp^3d^2, Square pyramidal

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

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

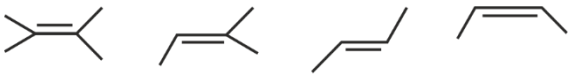
(3) (A)-(II); (B)-(IV); (C)-(I); (D)-(III)

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

Answer (3)

Sol. (A)-(II); (B)-(IV); (C)-(I); (D)-(III)

9. Consider the following alkene



I II III IV

The correct stability order of alkenes is

(1) II > I > III > IV

(2) I > II > IV > III

(3) I > II > III > IV

(4) III > I > II > IV

Answer (3)

Sol. Alkene stability $\propto$ no. of α-hydrogen

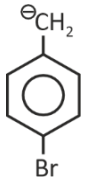
I $\rightarrow$ 12 α – H

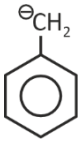
II $\rightarrow$ 9 αH

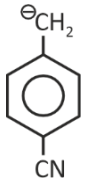
III & IV $\rightarrow$ 6 αH

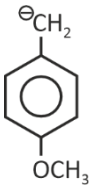
$\therefore$ Trans alkene is more stable than cis.

10. The correct order of stability of following species is

a. 

b. 

c. 

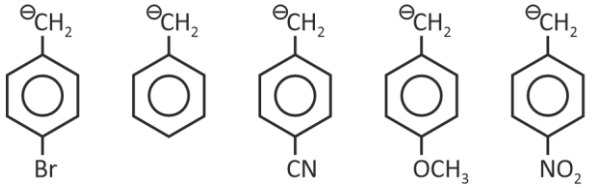
d. 

e. 

(1) e > c > a > b > d (2) d > c > b > a > e

(3) e > a > c > b > d (4) e > a > b > c > d

Answer (1)

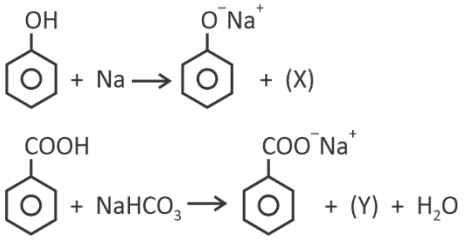
Sol. 

Br CN OCH_3 NO_2

–I Effect –M Effect +M Effect –M Effect

–M of $–NO_2$ is stronger than that of –CN.

11. What is the sum of molar mass of X and Y formed in the given reactions?



(1) 46 (2) 44

(3) 2 (4) 42

Answer (1)

Sol. (X) = H_2, (Y) = CO_2

$M_{H_2} = 2$ $M_{CO_2} = 44$

12.

	Sparingly soluble in cold water	Sparingly soluble at room temp.	Sparingly soluble in hot water
Compared →	x	y	z

x, y and z are

(1) $AlCl_3$, AgCl, Hg_2Cl_2 (2) AgCl, $AlCl_3$, Hg_2Cl_2

(3) $PbCl_2$, AgCl, Hg_2Cl_2 (4) AgCl, $HgCl_2$, $PbCl_2$

Answer (3)

Sol. x $\rightarrow$ $PbCl_2$

y $\rightarrow$ AgCl

z $\rightarrow$ Hg_2Cl_2

13. Given below are two statements.

Statement I: Atomic radius is always more than ionic radius.

Statement II: The correct order of metallic character is K > Mg > Al > B

In the light of above 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 (4)

Sol. Order of radius : $\underset{\text{cation}}{A^+} < \underset{\text{atom}}{A} < \underset{\text{anion}}{A^-}$

Metallic character : K > Mg > Al > B

On moving along the period of periodic table, metallic character decreases.

14. Match the following.

	Column-I		Column-II
A.	Free expansion	(I)	$W = -P_{ext}\Delta V$
B.	Reversible isothermal	(II)	$W = nC_vdT$
C.	Irreversible isothermal	(III)	$W = 0$
D.	Adiabatic reversible	(IV)	$W = -nRT\ln\frac{V_f}{V_i}$

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

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

Answer (2)

Sol. For free expansion,

$P_{ext} = 0$, $W = 0$

For adiabatic reversible,

$q = 0$, $W = \Delta U = nC_vdT$

For reversible isothermal,

$$W = -nRT\ln\frac{V_f}{V_i}$$

For irreversible isothermal,

$W = -P_{ex}\Delta V$

15. Non-volatile solute A of mass 0.3 g (Molecular mass = 60 g/mol), and non-volatile solute B of mass 0.9 g (Molecular mass = 180 g/mol) are dissolved in 100 mL H_2O at 27°C. (Take i = 1; $d_{H_2O} = 1\,g/mL$)

If $K_b = 0.52\ K\cdot kg\cdot mol^{-1}$, then elevation of boiling point is

(1) 0.52 K

(2) 0.052 K

(3) 0.026 K

(4) 0.083 K

Answer (2)

Sol. mol of A = $\frac{0.3}{60} = \frac{1}{200}$, mol of B = $\frac{0.9}{180} = \frac{1}{200}$

mass of solvent = 100 mL × (1 g/mL) = 100 g

$$\Delta T_f = K_f \times m = 0.52 \times \left(\frac{\frac{1}{200} + \frac{1}{200}}{0.1} \right) = 0.052\ K$$

16. A solution contains two group-IV cations, X^{2+} and Y^{2+}, each at an initial concentration of 0.1 M. H_2S gas is passed through the solution to form a saturated solution. Given

K_{sp} of YS = $2 \times 10^{-27}\ M^2$

K_{sp} of XS = $1 \times 10^{-27}\ M^2$

What is the minimum concentration of sulphide in $[S^{2-}]$ required to begin precipitation of YS?

(1) 2×10^{-26}

(2) 10^{-26}

(3) 3.2×10^{-14}

(4) 0.1

Answer (1)

Sol. For precipitation

$Q_{ip} > K_{sp}$

$YS(s) \rightleftharpoons Y^{2+}(aq) + S^{2-}(aq)$

$[Y^{2+}]\,[S^{2-}] = K_{sp}(YS)$

$[Y^{2+}] = 0.1\ M$

$$[S^{2-}] = \frac{Ksp(Ys)}{0.1}$$

$$= \frac{2 \times 10^{-27}}{0.1}$$

$= 2 \times 10^{-26}\ M$

17. What is the hybridisation and spin only magnetic moment of complex $[Co(CO)_6]Cl_3$?

(1) d^2sp^3, 0 BM

(2) sp^3d^2, 4.90 BM

(3) d^2sp^3, 4.90 BM

(4) sp^3d^2, 0 BM

Answer (1)

Sol. CO is SFL with Co^{3+}

$3d^6 \Rightarrow t_{2g}^6 e_g^0$

hybridisation = d^2sp^3

$$\mu\,(\text{spin only}) = \sqrt{n(n+2)}\ BM$$

n = 0

μ spin only = 0 BM

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. Two solutes A and B of 0.3 g and 0.9 g respectively (molar mass of A and B are 30 g/mol and 90 g/mol respectively) are dissolved in 100 mL water. (Take solutes to be non-electrolyte). Calculate osmotic pressure at 300 K (in atm)

Answer (5)

Sol. $n_A = \frac{0.3}{30} = 10^{-2}$ mol

$n_B = \frac{0.9}{90} = 10^{-2}$ mol

$[A] = \frac{10^{-2}}{100} \times 1000 = 0.1\,M$

$[B] = \frac{10^{-2}}{100} \times 1000 = 0.1\,M$

π = i CRT

$\pi = 1 \times 0.2 \times 0.0821 \times 300 = 4.926$ atm ≈ 5

22. Minimum energy transition of Balmer series (energy line having minimum energy) of H-atom has energy of L eV. If the value of minimum energy of Lyman series (energy line having minimum energy) of H-atom in terms of L is y, then the value of 10y is _____.

Answer (54)

Sol. $(\Delta E_{min})_{Balmer} = 13.6\left(\frac{1}{4} - \frac{1}{9}\right)$ eV

$= 13.6\frac{5}{36} = L$ eV

$(\Delta E_{min})_{Lyman} = 13.6\left(\frac{1}{1} - \frac{1}{4}\right) = 13.6\frac{3}{4}$ eV

$= 13.6 \times \frac{5}{36} \times \frac{36}{5} \times \frac{3}{4}$

5.4 L = y

10y = 54

23. Find % of 'N' in 0.5 g organic compound which gives 34 mL N_2 (g) at 715 mm Hg pressure and 300 K.

(Aq. tension = 15 mm Hg)

(Report to nearest integer) $R = 0.0821 \frac{\text{Lit-atm}}{\text{K-mol}}$

Answer (7)

Sol. % N = $\frac{\frac{715-15}{760} \times 34 \times 10^{-3}}{\frac{0.082 \times 300}{0.5}} \times 28 \times 100$ = 7.12%

24. Find the value of $\log\left(\frac{k_{catalysed}}{k_{uncatalysed}}\right)$ at 300K if the change in activation energy (ΔEa) is 10 kJ/mol. (R = 8 $JK^{-1}\,mol^{-1}$)

(lnx = 2.3 logx)

Answer (2)

Sol. $k = Ae^{-Ea/RT}$

Ea_1 (catalysed)

Ea_2 (uncatalysed)

$\frac{k_{cat}}{k_{uncat}} = e^{\frac{-Ea_1 + Ea_2}{RT}}$

$\log\frac{k_{cat}}{k_{uncatalysed}} = \frac{-Ea_1 + Ea_2}{2.303RT}$

$(Ea_2 - Ea_1) = 10000$ J/mol

$\log\frac{K_{cat}}{K_{uncatalysed}} = \frac{10000}{300 \times 8 \times 2.3}$

$= \frac{4.167}{2.3}$

$= 1.81$

≈ 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 value of $\frac{\sqrt{3}\,\text{cosec}20^\circ - \sec 20^\circ}{\cos 20^\circ \cos 40^\circ \cos 60^\circ \cos 80^\circ}$ is

(1) 12 (2) 16

(3) 64 (4) 32

Answer (3)

Sol. $\therefore \sqrt{3}\,\text{cosec}20^\circ - \sec 20^\circ$

$= \frac{\sqrt{3}}{\sin 20^\circ} - \frac{1}{\cos 20^\circ}$

$= 4\cdot\frac{\frac{\sqrt{3}}{2}\cos 20^\circ - \frac{1}{2}\sin 20^\circ}{2\sin 20^\circ \cdot \cos 20^\circ}$

$= 4\cdot\frac{\sin 40^\circ}{\sin 40^\circ}$

$= 4$

and $\cos 20^\circ \cdot \cos 40^\circ \cdot \cos 60^\circ \cdot \cos 80^\circ$

$= \cos 20^\circ \cdot \cos 40^\circ \cdot \cos 80^\circ \cdot \cos 60^\circ$

$= \frac{1}{4}\cos 60^\circ \cdot \cos 60^\circ$

$\left\{\cos\left(\frac{\pi}{3}-\theta\right)\cdot\cos\theta\cdot\cos\left(\frac{\pi}{3}+\theta\right) = \frac{1}{4}\cos 3\theta\right\}$

$= \frac{1}{16}$

$\therefore \frac{\sqrt{3}\,\text{cosec}20^\circ - \sec 20^\circ}{\cos 20^\circ \cdot \cos 40^\circ \cdot \cos 80^\circ \cdot \cos 60^\circ} = \frac{4}{\frac{1}{16}}$

$= 64$

2. The number of solution for $x \in R$, $x|x-4|+|x-1|-2=0$ is

(1) 1 (2) 2

(3) 3 (4) 4

Answer (1)

Sol. The number of real roots of

$x|x-4| + |x-1| - 2 = 0$

1 4

If $x \geq 4 \Rightarrow x(x-4) + x - 1 - 2 = 0$

$x^2 - 3x - 3 = 0$

$\Rightarrow x = \frac{3 \pm \sqrt{21}}{2}$ $\Rightarrow$ both roots less than 4 $\Rightarrow$ so solution

If $1 \leq x < 4$

$\Rightarrow x(4-x) + x - 1 - 2 = 0$

$\Rightarrow x^2 - 5x + 3 = 0$

$\Rightarrow x = \frac{5 \pm \sqrt{13}}{2}$, both are not in interval

If $x \leq 1$

$\Rightarrow x(4-x) + 1 - x - 2 = 0$

$x^2 - 3x + 1 = 0$

$\Rightarrow x = \frac{3 \pm \sqrt{5}}{2}$

$\Rightarrow$ only one solution $x = \frac{3-\sqrt{5}}{2}$

3. Consider 10 data such that their mean is 10 and variance is 2. If one of the data α is removed and new data entry β is inserted. Now new mean is 10.1 and new variance is 1.99 then $(\alpha + \beta)$ is equal to

(1) 10 (2) 20

(3) 1 (4) 2

Answer (2)

Sol. $\Sigma x_i = 100$

$$\frac{\Sigma x_i^2}{10} - (10)^2 = 2$$

$$\Rightarrow \Sigma x_i^2 = 1020$$

$$\mu' = \frac{\Sigma(x_i) - \alpha + \beta}{10} \Rightarrow 100 - \alpha + \beta = 101$$

$$\Rightarrow \beta - \alpha = 1$$

$$\sigma' = \left(\frac{\Sigma x_i^2 - \alpha^2 + \beta^2}{10}\right) - \left(\frac{101}{10}\right)^2 = \frac{199}{100}$$

$$\Rightarrow \frac{1020 - \alpha^2 + \beta^2}{10} = \frac{199}{100} + \left(\frac{101}{100}\right)^2$$

$$= \frac{10400}{100} = 104$$

$$\Rightarrow 1020 - \alpha^2 + \beta^2 = 1040$$

$$\Rightarrow \beta^2 - \alpha^2 = 20$$

$$\beta - \alpha = 1$$

$$\Rightarrow (\beta + \alpha)(\beta - \alpha) = 20$$

$$\Rightarrow \alpha + \beta = 20$$

4. If $F(t) = \int \frac{1 - \sin(\ln t)}{1 - \cos(\ln t)} dt$ and $F(e^{\pi/2}) = -e^{\pi/2}$ then $F(e^{\pi/4})$ is

(1) $\left(-1 - \sqrt{2}\right)e^{\pi/4}$

(2) $\left(1 - \sqrt{2}\right)e^{\pi/4}$

(3) $\left(1 + \sqrt{2}\right)e^{\pi/4}$

(4) $\left(-2 - \sqrt{2}\right)e^{\pi/4}$

Answer (1)

Sol. $\int \frac{1 - \sin(\ln t)}{1 - \cos(\ln t)} dt$

Let lnt = x

$$t = e^x$$

$$dt = e^x dx$$

$$\int e^x \frac{(1 - \sin x)}{1 - \cos x} dt$$

$$\Rightarrow \int e^x \left(\frac{1 - 2\sin\frac{x}{2}\cos\frac{x}{2}}{2\sin^2\frac{x}{2}}\right) dx$$

$$\Rightarrow \int e^x \left(\frac{1}{2} - \operatorname{cosec}^2\frac{x}{2} - \cot\frac{x}{2}\right) dx$$

$$\Rightarrow \int e^x \left[\underbrace{-\cot\frac{x}{2}}_{f(x)} + \underbrace{\frac{1}{2}\operatorname{cosec}^2\frac{x}{2}}_{f'(x)}\right]$$

$$\Rightarrow -e^x \cot\frac{x}{2} + c$$

$$f(t) = -t\cot\left(\frac{\ln t}{2}\right) + c$$

$$f(e^{\pi/2}) = -e^{\pi/2} + c = -e^{-\pi/2}$$

$$\Rightarrow c = 0$$

$$f(e^{\pi/4}) = -e^{\pi/4}\cot\left(\frac{\pi}{8}\right)$$

$$= -e^{\pi/4}\left[\sqrt{2} + 1\right]$$

5. Consider a sequence 729, 81, 9, 1, ……..

Let P_n = product of first n terms of the given sequence

and $\sum_{n=1}^{40} (P_n)^{\frac{1}{n}} = \frac{3^\alpha - 1}{2 \times 3^\beta}$.

Then the value of $\alpha + \beta$ is

(1) 73 (2) 75

(3) 76 (4) 81

Answer (1)

Sol. $3^6, 3^4, 3^2, 3^0, ...$

$P_n = 3^{6+4+2+\ldots n \text{ terms}}$

$= 3^{\frac{n}{2}[2\times 6+(n-1)(-2)]} = 3^{n(6-n+1)} = 3^{n(7-n)}$

$$\Rightarrow \sum_{n=1}^{40}(P_n)^{\frac{1}{n}} = \sum_{n=1}^{40} 3^{7-n} = 3^7 \times \frac{1}{3}\left(\frac{1-\frac{1}{3^{40}}}{1-\frac{1}{3}}\right)$$

$$= 3^7\left(\frac{3^{40}-1}{2\times 3^{40}}\right) = \frac{3^{40}-1}{2\cdot 3^{33}}$$

$\Rightarrow \quad \alpha + \beta = 73$

6. If $a_1, a_2, a_3, \ldots\ldots\ldots, a_n$ are in *A.P.* and given that $a_2 - a_1 = -\frac{3}{4}$ and $a_1 + a_2 + \ldots..+a_n = \frac{525}{2}$ and $a_n = \frac{1}{4}a_1$. Then $\sum_{i=1}^{17} a_i$ is equal to

(1) 276 (2) 238

(3) 189 (4) 258

Answer (2)

Sol. $\because a_1, a_2, a_3, \ldots\ldots\ldots a_n$ are in *A.P.*

Given that $a_2 - a_1 = -\frac{3}{4}$ = common difference (d).

$\therefore d = -\frac{3}{4}$

and also given that $a_n = \frac{1}{4}a_1$

$\therefore S_n = \frac{n}{2}(a_1 + a_n) = \frac{525}{2}$

$\therefore \; n\left(a_1 + \frac{1}{4}a_1\right) = 525$

$\therefore a_1 n = 420 \qquad \ldots(i)$

Now $\frac{n}{2}\left\{2a_1 + (n-1)\left(-\frac{3}{4}\right)\right\} = \frac{525}{2}$

$8 \times 420 - 3n^2 + 3n = 2100$

$\therefore \; 3n^2 - 3n - 1260 = 0$

$\therefore \; n^2 - n - 420 = 0$

$(n - 21)(n + 20) = 0$

$\therefore \; n = 21$

$\therefore \; a_1 = 20$

$$\sum_{i=1}^{17} a_i = \frac{17}{2}\left\{40 + 16 \times -\frac{3}{4}\right\} = 238$$

7. Number of matrices A of order 3 × 2 such that all of its elements are from the set {–2, –1, 0, 1, 2} such that trace of AA^T is 5, is equal to

(1) 120 (2) 312

(3) 192 (4) 126

Answer (2)

Sol. $AA^T = \begin{bmatrix} a & d \\ b & e \\ c & f \end{bmatrix}\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix}$

$$= \begin{bmatrix} a^2+d^2 & - & - \\ - & b^2+e^2 & - \\ - & - & c^2+f^2 \end{bmatrix}$$

$\Rightarrow$ sum of diagonal (trace) = 5

$\Rightarrow a^2 + b^2 + c^2 + d^2 + e^2 + f^2 = 5$

where $a, b, c, d, e, f \in \{-2, -1, 0, 1, 2\}$

Case A 5 of them square is 1

$\Rightarrow ({}^6C_5) \times (2^5) = 6 \times 32 = 192$

Case B one of them square 4 and another one is square is 1

$\Rightarrow$ {4, 1, 0, 0, 0, 0} are possible as square

$\Rightarrow {}^6C_4 \times (2!) \cdot (2 \cdot 2) = 15 \times 8 = 12$

$\Rightarrow$ number of such matrices

= 192 + 120 = 312

8. Out of 100 bulbs, 10 are defective and 90 are non-defective. If the probability of finding 7 defective bulbs out of 8 draws, with replacement, is $\frac{K}{10^8}$, then the value of K is

(1) 69 (2) 72

(3) 75 (4) 96

Answer 2)

Sol. Probability a bulb is defective on any draw

$$p=\frac{10}{100}=\frac{1}{10}$$

$$\Rightarrow\ q=\frac{9}{10}, n=8$$

$$\Rightarrow\ P(X=7)={}^8C_7\left(\frac{1}{10}\right)^7\left(\frac{9}{10}\right)^1=\frac{72}{10^8}$$

$$\Rightarrow K = 72$$

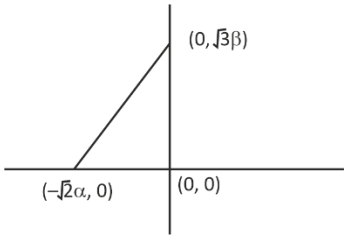
9. Let a circle passes through points $A(-\sqrt{2}\alpha, 0)$, $B(0, \sqrt{3}\beta)$ and O (0, 0) such that its radius is 4. Then the radius of locus of centroid of triangle OAB is

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

(3) $\frac{4}{3}$ (4) $\frac{11}{3}$

Answer (2)

Sol.



$$\Rightarrow \text{radius}=\frac{\sqrt{(\sqrt{3}\beta)^2+\left(-\sqrt{2}\alpha\right)}}{2}=4$$

$$\Rightarrow 3\beta^2+2\alpha^2=64$$

Let the centroid of the triangle is

$(h, k) \Rightarrow h=\frac{-\sqrt{2}\alpha}{3}$ and $k=\frac{-\sqrt{3}\beta}{3}$

$$\Rightarrow \alpha=\frac{-3h}{\sqrt{2}}, \beta=\frac{3k}{\sqrt{3}}$$

$$\Rightarrow 2\left(\frac{9h^2}{2}\right)+3\left(\frac{9k^2}{3}\right)=64$$

$$\Rightarrow 9h^2+9k^2=64$$

$\Rightarrow$ Locus is $x^2+y^2=\frac{64}{9}$

10. Let $\cot\theta=\frac{5}{12}$ and $\theta\in\left(\pi,\frac{3\pi}{2}\right)$.

Then the value of $\cos7\theta\left(\sin\frac{13\theta}{2}+\cos\frac{13\theta}{2}\right)+$

$\sin7\theta\left(\sin\frac{13\theta}{2}-\cos\frac{13\theta}{2}\right)$ is

(1) $-\frac{1}{\sqrt{13}}$ (2) $\frac{1}{\sqrt{13}}$

(3) $-\frac{5}{\sqrt{13}}$ (4) $\frac{5}{\sqrt{13}}$

Answer (3)

Sol. $\because \cot\theta=\frac{5}{12},\quad \theta\in\left(\pi,\frac{3\pi}{2}\right)$

$$\Rightarrow \sin\theta=-\frac{12}{13},\quad \cos\theta=-\frac{5}{13}$$

Let $P(\theta)=\cos7\theta\left(\sin\frac{13\theta}{2}+\cos\frac{13\theta}{2}\right)$

$$+\sin7\theta\left(\sin\frac{13\theta}{2}-\cos\frac{13\theta}{2}\right)$$

$$=\left(\sin\frac{13\theta}{2}\cos 7\theta-\cos\frac{13\theta}{2}\sin 7\theta\right)$$

$$+\left(\cos 7\theta\cos\frac{13\theta}{2}+\sin 7\theta\sin\frac{13\theta}{2}\right)$$

$$=\sin\left(\frac{13\theta}{2}-7\theta\right)+\cos\left(7\theta-\frac{13\theta}{2}\right)$$

$$=-\sin\frac{\theta}{2}+\cos\frac{\theta}{2}$$

$$\left(P(\theta)\right)^2=1-\sin\theta=1+\frac{12}{13}=\frac{25}{13}$$

$$\Rightarrow P(\theta)=\pm\frac{5}{\sqrt{13}}$$

$$\theta\in\left(\pi,\frac{3\pi}{2}\right),\ \frac{\theta}{2}\in\left(\frac{\pi}{2},\frac{3\pi}{4}\right)$$

$$\sin\frac{\theta}{2}>0,\cos\frac{\theta}{2}<0$$

$$\Rightarrow\cos\frac{\theta}{2}-\sin\frac{\theta}{2}<0$$

$$\Rightarrow P(\theta)=-\frac{5}{\sqrt{13}}$$

11. A line passing through point P (1, 1, 1), which is perpendicular to $\frac{x-17}{1}=\frac{y-71}{1}=\frac{z}{0}$ and $\frac{x-4}{4}=\frac{y-1}{1}=\frac{z-1}{1}$. Let the line intersect the $y-z$ plane at point Q. Another line parallel to L and passing through S(1, 0, –1) intersect another plane at point R. Then the square of area of parallelogram $PQRS$ is

(1) 11 (2) 12

(3) 13 (4) 6

Answer (4)

Sol. Line passing through P(1, 1, 1) and perpendicular to the lines $\frac{x-4}{4}=\frac{y-1}{1}=\frac{z-1}{1}$ and $\frac{x-17}{1}=\frac{y-71}{1}=\frac{z}{0}$

will have DC

$$\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\4&1&1\\1&1&0\end{vmatrix}$$

$=-\hat{i}+\hat{j}+3\hat{k}$

L: $\frac{x-1}{-1}=\frac{y-1}{1}=\frac{z-1}{3}=\lambda$

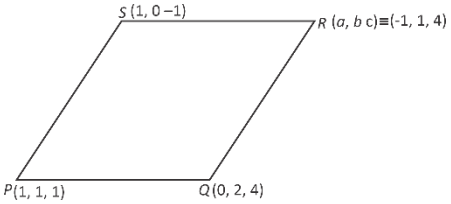
any point $(1-\lambda, \lambda+1, 3\lambda+1)$

$\therefore$ L intersect $y-z$ Plane $\Rightarrow 1-\lambda=0$

$\Rightarrow \lambda = 1$

$\Rightarrow Q$ (0, 2, 4)

$L_1 = \frac{x-1}{-1}=\frac{y}{1}=\frac{z+1}{3}$



Now $\frac{1}{2}=\frac{a+1}{2}\Rightarrow a=-1$

$\frac{2}{2}=\frac{b+1}{2}\Rightarrow b=1$

$\frac{3}{2}=\frac{c+1}{2}\Rightarrow c=2$

Area = $|PQ\times PS|$

$$=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\1&-1&-3\\0&1&2\end{vmatrix}=|\hat{i}-2\hat{j}+\hat{k}|$$

$\Rightarrow$ Area^2 = 1 + 4 + 1

3 vertices are sufficient to get area of parallelogram

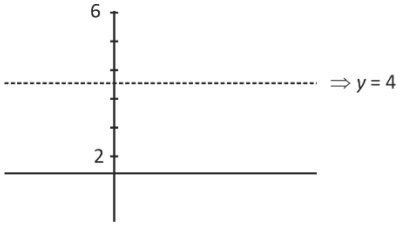
12. Let $\left|\frac{z-6i}{z-2i}\right|=1, \left|\frac{z-8+2i}{z+2i}\right|=\frac{3}{5}$ then if ω satisfy both equation then find $\Sigma|\omega^2|$.

(1) 398 (2) 385

(3) 413 (4) 433

Answer (2)

Sol. $|z-6i| = |z-2i|$



$z = x + iy$

$5|(x-8)+(y+2)i| = 3|(x+0)^2+(y+2)^2|$

$\Rightarrow 25(x-8)^2 + 25(y+2)^2$

$= 9(x^2) + 9(y+2)^2$

$\Rightarrow 25x^2 - 16 \times 25x + 25 \times 64 + 25y^2 + 100y + 100$

$= 9x^2 + 9y^2 + 36y + 36$

$\Rightarrow 16x^2 + 16y^2 - 400x + 64y + 166y = 0$

$\Rightarrow x^2 + y^2 - 25x + 4y + 104 = 0$

This circle intersects lines $y = 4$

at $x^2 + 16 - 25x + 16 + 104 = 0$

$x^2 - 25x + 136 = 0 \Rightarrow x = 8, 17$

$\Rightarrow z$ can be (17, 4) and (8, 4)

$$\Rightarrow \Sigma|z|^2=\left(\sqrt{8^2+4^2}\right)^2+\left(\sqrt{4^2+17^2}\right)^2$$

$= 64 + 16 + 16 + 289 = 385$

13. Let A_1 be the area enclosed by $y = x^2 + 2$, y-axis and $x + y = 8$ and

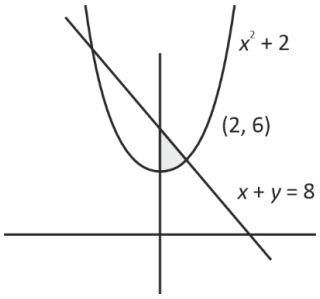
Let A_2 be the area enclosed by $y = x^2 + 2$, $y^2 = x$, $x = 2$ and y-axis, then the value of $A_1 - A_2$ is

(1) $\frac{4+8\sqrt{2}}{3}$ (2) $\frac{2+4\sqrt{2}}{3}$

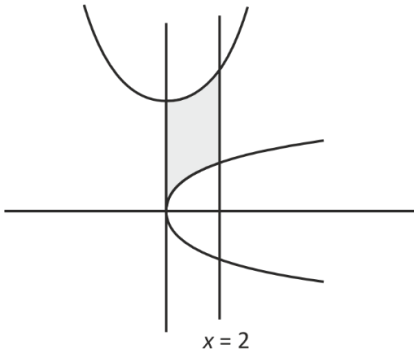
(3) $\frac{8+2\sqrt{2}}{3}$ (4) $\frac{8-2\sqrt{2}}{3}$

Answer (2)

Sol.



$$A_1=\int_0^2((8-x)-(x^2+2))dx=\frac{22}{3}$$



$$A_2=\int_0^2((x^2+2)-(\sqrt{x}))dx$$

$$=\frac{x^3}{3}+2x-\frac{2x^{3/2}}{3}\Big]_0^2$$

$$=\frac{8}{3}+4-\frac{2(2)^{3/2}}{3}$$

$$=\frac{20}{3}-\frac{4\sqrt{2}}{3}$$

$$A_1-A_2=\frac{22}{3}-\frac{20}{3}+\frac{4\sqrt{2}}{3}=\frac{2+4\sqrt{2}}{3}$$

14. If $f(x)=\frac{e^x(\tan x-x)+\ln(\sec x+\tan x)-x}{\tan x-x}$, $x \neq 0$. If $f(x)$ is continuous at $x = 0$, then $f(0)$ is equal to

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

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

Answer (1)

Sol. $f(x)=e^x+\ln\dfrac{(\sec x+\tan x)-x}{\tan x-x}$

since $\lim\limits_{x\to0}\dfrac{\ln(\sec x+\tan x)-x}{\tan x-x}$ $\lim\limits_{x\to0}\dfrac{\sec x-1}{\sec^2 x-1}=\dfrac{1}{2}$

Using L'Hospital

$\Rightarrow \lim\limits_{x\to0} f(x)=f(0)=1+\dfrac{1}{2}=\dfrac{3}{2}$

15. $E_1:\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}=1$

$E_2:\dfrac{x^2}{A^2}+\dfrac{y^2}{B^2}=1$

Let eccentricity of both E_1 and E_2 be $\dfrac{4}{5}$, $2l_1^2=9l_2$

where l_1 and l_2 are the length of latus rectum of E_1 and E_2 respectively. Distance between the foci of E_1 be 8. Then distance between foci of ellipse E_2 is

(1) $\dfrac{32}{5}$ (2) $\dfrac{16}{5}$

(3) $\dfrac{8}{5}$ (4) $\dfrac{4}{5}$

Answer (1)

Sol. $\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}=1$ $\dfrac{x^2}{A^2}+\dfrac{y^2}{B^2}=1$

$l_1^2=1-\dfrac{b^2}{a^2}$ $l_2^2=1-\dfrac{B^2}{A^2}$

$\dfrac{16}{25}=1-\dfrac{b^2}{a^2}$ $\dfrac{16}{25}=1-\dfrac{B^2}{A^2}$

$\boxed{\dfrac{b^2}{a^2}=\dfrac{9}{25}}$ ... (1) $\boxed{\dfrac{B^2}{A^2}=\dfrac{9}{25}}$ ... (2)

Now $2l_1^2=9l_2$

$2\left(\dfrac{2b^2}{a}\right)^2=9\left(\dfrac{2B^2}{A}\right)$

$8\dfrac{b^4}{a^2}=18\dfrac{B^2}{A}$

$\boxed{\dfrac{b^4}{a^2}=\dfrac{9}{4}\dfrac{B^4}{A}}$

Also given: $2ae = 8$

$2\times\dfrac{4}{5}a=8$

$\boxed{a=5}$

$\Rightarrow$ $\boxed{b=3}$

Now $\dfrac{81}{25}=\dfrac{9}{4}\dfrac{B^2}{A}$

$\dfrac{36}{25}A=B^2$

Sub in (2)

$\dfrac{36}{25}\dfrac{A}{A^2}=\dfrac{9}{25}$

$\boxed{A=4}$

Now $2Ae$

$=2\times4\times\dfrac{4}{5}$

$=\dfrac{32}{5}$

16. Find the number of numbers greater than 5000 and less than 9000, formed by using numbers 0, 1, 2, 5, 9 with repetition allowed and divisible by 3.

(1) 31 (2) 42

(3) 48 (4) 52

Answer (2)

Sol. As number is more than 5000 and less than 9000 then thousand place must be 5.

5	a	b	c

For (a, b, c) = $(0, 0, 1) \to 3$ ways

$(0, 1, 9) \to 6$ ways

$(0, 2, 5) \to 6$ ways

$(0, 2, 2) \to 3$ ways

$(0, 5, 5) \to 3$ ways

$(1, 1, 2) \to 3$ ways

$(1, 1, 5) \to 3$ ways

$(1, 9, 9) \rightarrow 3$ ways

$(2, 2, 9) \rightarrow 3$ ways

$(2, 5, 9) \rightarrow 6$ ways

$(5, 5, 9) \rightarrow 3$ ways

42

$\therefore$ Total 42 numbers are possible.

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 $S = \frac{1}{25!} + \frac{1}{23!3!} + \frac{1}{21!5!} + \ldots\ldots$ upto 13 terms. Then $13S = \frac{2^{\alpha}}{\beta!}$, then $\alpha + \beta$ is

Answer (49)

Sol. $\frac{1}{25!} + \frac{1}{23!3!} + \frac{1}{21!5!} + \ldots\ldots$ till 13 term = S

$$26!S = \frac{26!}{25!1!} + \frac{26!}{23!3!} + \frac{26!}{21!5!} + \ldots\ldots$$

$$= {}^{26}C_1 + {}^{26}C_3 + {}^{26}C_5 + \ldots\ldots + {}^{26}C_{25}$$

$$26!\, S = 2^{25}$$

$$S = \frac{2^{25}}{26!}$$

$$13\, S = 13 \times \frac{2^{25}}{26 \times 25!}$$

$$= \frac{2^{24}}{25!} \Rightarrow \alpha = 24 \;\; \beta = 25$$

$$\alpha + \beta = 49$$

22.

23.

24.

25.

❑ ❑ ❑