JEE Main 2024

6th April Session 2

Physics

Q.1. Energy supplied to 1 mole of monatomic gas is $48\ \mathrm{J}$ and changes its temperature by $2^{\circ}\mathrm{C}$. Find the work done by gas. Given $R=\frac{25}{3}$.

A) $21\ \mathrm{J}$

B) $25\ \mathrm{J}$

C) $23\ \mathrm{J}$

D) $20\ \mathrm{J}$

Answer: $23\ \mathrm{J}$

Solution: The first of thermodynamics for the given process can be written as

$$\begin{aligned} dQ &= dU + dW \\ &= \frac{3}{2}nRdT + dW \quad \ldots(1) \end{aligned}$$

Hence, from equation (1), it follows that

$$\begin{aligned} &48\ \mathrm{J} = \left(\frac{3}{2}\times 1\times\frac{25}{3}\times 2\right)\ \mathrm{J} + dW \\ &\Rightarrow dW = 48\ \mathrm{J} - 25\ \mathrm{J} \\ &= 23\ \mathrm{J} \end{aligned}$$

Q.2. Find the refractive index of a convex lens whose R_1 and R_2 are $15\ \mathrm{cm}$ and $30\ \mathrm{cm}$ respectively and its focal length is $20\ \mathrm{cm}$.

A) $\frac{3}{2}$

B) $\frac{1}{2}$

C) $\frac{5}{2}$

D) $\frac{7}{2}$

Answer: $\frac{3}{2}$

Solution: The formula to calculate the refractive index of the lens is given by

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \ldots(1)$$

From equation (1), considering the lens to be a convex one, it follows that

$$\begin{aligned} &\frac{1}{20} = (\mu-1)\left(\frac{1}{15} - \frac{1}{-30}\right) \\ &\Rightarrow (\mu-1) = \frac{1}{20}\times 10 \\ &\Rightarrow \mu = 1 + \frac{1}{2} \\ &= \frac{3}{2} \end{aligned}$$

Q.3. Light of wavelength $300\ \mathrm{nm}$ is incident on a metal surface whose work function is $2.4\ \mathrm{eV}$, then find stopping potential. Given, $hc = 1.24\times 10^{-6}\ \mathrm{eV\cdot m}$.

A) $1.5\ \mathrm{V}$

B) $1.0\ \mathrm{V}$

C) $1.7\ \mathrm{V}$

D) $1.3\ \mathrm{V}$

Answer: $1.7\ \mathrm{V}$

Solution: The stopping potential is related to the work function as follows:

$$\frac{hc}{\lambda} = eV_s + \phi \quad \ldots(1)$$

Equation (1) implies that

$$\begin{aligned} &\frac{1.24\times10^{-6}\ \mathrm{eV\cdot m}}{300\times10^{-9}\ \mathrm{m}} = eV_s + 2.4\ \mathrm{eV} \\ &\Rightarrow eV_s = \frac{1.24\times10^{-6}\ \mathrm{eV\cdot m}}{300\times10^{-9}\ \mathrm{m}} - 2.4\ \mathrm{eV} \\ &\approx 4.1\ \mathrm{eV} - 2.4\ \mathrm{eV} \\ &= 1.7\ \mathrm{eV} \\ &\Rightarrow V_s = 1.7\ \mathrm{V} \end{aligned}$$

Q.4. A tree branch holds a weight of $200\ \mathrm{N}$ by a uniform chain of mass $10\ \mathrm{kg}$. Calculate the force applied by branch to hold this weight. (Take $g = 10\ \mathrm{m\ s^{-2}}$)

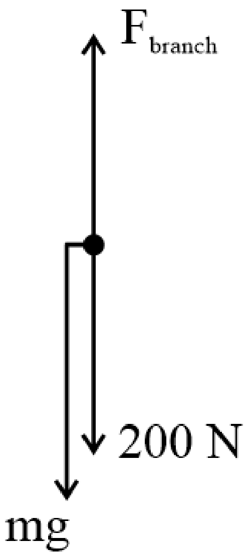
A) $100\ \mathrm{N}$

B) $150\ \mathrm{N}$

C) 200 N D) 300 N

Answer: 300 N

Solution: The free body diagram for the given scenario can be drawn as follows:



From the above diagram, it follows that

$$F_{\text{branch}} = mg + 200 \text{ N}$$
$$= 10 \text{ kg} \times 10 \text{ m s}^{-2} + 200 \text{ N}$$
$$= 300 \text{ N}$$

Q.5. The weight of an object measured on the surface of earth is 300 N. What will be the weight of the same object at depth $\frac{R}{4}$ inside the earth? (Given $R =$ Radius of earth)

A) 200 N B) 210 N

C) 220 N D) 225 N

Answer: 225 N

Solution: Weight of an object on the surface of earth, $mg = 300 \text{ N}$.

Weight of the object at depth $\frac{R}{4}$ will be,

$$mg' = mg\left(1 - \frac{d}{R}\right)$$
$$= mg\left(1 - \frac{\frac{R}{4}}{R}\right)$$
$$= mg \times \frac{3}{4}$$
$$= 300 \times \frac{3}{4}$$
$$= 225 \text{ N}$$

Q.6. Given below are two statements

Statement(I): Dimensions of specific heat is $\left[L^2T^{-2}K^{-1}\right]$.

Statement(II): Dimensions of gas constant is $\left[ML^2T^{-1}K^{-1}\right]$.

A) Both Statement (I) and Statement (II) are correct

B) Both Statement (I) and Statement (II) are incorrect

C) Statement (I) is correct but Statement (II) is incorrect

D) Statement (I) is incorrect but Statement (II) is correct

Answer: Statement (I) is correct but Statement (II) is incorrect

Solution: The dimension of specific heat can be calculated as follows:

$$[s]=\left[\frac{Q}{m\Delta T}\right]$$
$$=\frac{\left[\mathrm{ML^2T^{-2}}\right]}{[\mathrm{M}][\mathrm{K}]}$$
$$=\left[\mathrm{L^2T^{-2}K^{-1}}\right]$$

The dimension of gas constant can be calculated as follows:

$$[R]=\frac{[Q]}{[T]}$$
$$=\frac{\left[\mathrm{ML^2T^{-2}}\right]}{[\mathrm{K}]}$$
$$=\left[\mathrm{ML^2T^{-2}K^{-1}}\right]$$

Hence, Statement (I) is correct but Statement (II) is incorrect.

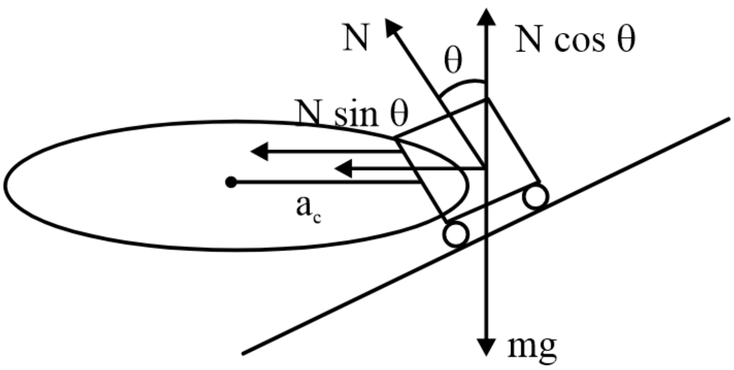
Q.7. If a car is moving on banked road of radius $300\ \mathrm{m}$ and angle of banking 30°, then find the safe speed of the car. Take $g=10\ \mathrm{m\ s^{-2}}$.

A) $42\ \mathrm{m\ s^{-1}}$ B) $40\ \mathrm{m\ s^{-1}}$

C) $45\ \mathrm{m\ s^{-1}}$ D) $48\ \mathrm{m\ s^{-1}}$

Answer: $42\ \mathrm{m\ s^{-1}}$

Solution: Let's consider the following diagram:



According to the above figure, it can be written that

$$N\cos\theta = mg \quad \ldots(1)$$
$$N\sin\theta = ma_c \quad \ldots(2)$$

Both equations imply that

$$\tan\theta=\frac{ac}{g}$$
$$=\frac{vs^2}{rg} \quad \ldots(3)$$

From equation (3), it follows that

$$\tan 30^\circ = \frac{vs^2}{300\ \mathrm{m}\times 10\ \mathrm{m\,s^{-2}}}$$
$$\Rightarrow vs^2 = 300\ \mathrm{m}\times 10\ \mathrm{m\ s^{-2}}\times\tan 30^\circ$$
$$\Rightarrow v_s = \sqrt{300\ \mathrm{m}\times 10\ \mathrm{m\ s^{-2}}\times\tan 30^\circ}$$
$$\approx 42\ \mathrm{m\ s^{-1}}$$

Q.8. If the kinetic energy of a block of mass m becomes 36 times by keeping its mass constant, by what percentage will the momentum increase?

A) 600% B) 6%

C) 60% D) 500%

Answer: 500%

Solution: The initial momentum of the block is given by

$p_1 = \sqrt{2mK} \quad \ldots(1)$

And, the final momentum of the block is given by

$$p_2 = \sqrt{2m(36K)}$$
$$= \sqrt{72mK} \quad \ldots(2)$$

Hence, the percentage increase in momentum (r) can be calculated as follows:

$$r = \frac{p_2 - p_1}{p_1} \times 100\%$$
$$= \frac{\sqrt{72mK} - \sqrt{2mK}}{\sqrt{2mK}} \times 100\%$$
$$= \left(\sqrt{\frac{72}{2}} - 1\right) \times 100\%$$
$$= (6-1) \times 100\%$$
$$= 500\%$$

Q.9. Two waves of intensity $I_1 = 4I$ and $I_2 = I$ produces interference, find the ratio of maximum and minimum intensity.

A) $2:1$

B) $4:1$

C) $3:1$

D) $9:1$

Answer: $9:1$

Solution: The ratio of the maximum to the minimum intensity can be calculated as follows:

$$\frac{I\text{max}}{I\text{min}} = \frac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\left(\sqrt{I_1} - \sqrt{I_2}\right)^2}$$
$$= \frac{(\sqrt{4I} + \sqrt{I})^2}{\left(\sqrt{4I} - \sqrt{I}\right)^2}$$
$$= \frac{(2+1)^2 I}{(2-1)^2 I}$$
$$= \frac{9}{1}$$

Q.10. Find the largest wavelength of Paschen series for hydrogen atom (Rydberg constant $= 10^7 \text{ m}^{-1}$)

A) $4.86\ \mu\text{m}$

B) $48.6\ \mu\text{m}$

C) $2.06\ \mu\text{m}$

D) $20.6\ \mu\text{m}$

Answer: $2.06\ \mu\text{m}$

Solution: For largest wavelength in Paschen series, we can write

$$\frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right]$$
$$\Rightarrow \frac{1}{\lambda} = 10^7\left[\frac{1}{9} - \frac{1}{16}\right]$$
$$\Rightarrow \lambda = \frac{144}{7 \times 10^7} \approx 2.06\ \mu\text{m}$$

Q.11. There are two fixed charged spheres P and Q repelling each other with a force of 16 N. A third neutral sphere is placed between the charged spheres. The new force between the spheres is (assuming all the spheres are insulating)

A) 8 N

B) 32 N

C) 16 N

D) 4 N

Answer: 16 N

Solution: According to the superposition principle, the electrostatic force between a number of charges is independent on each other.

In other words, the presence of one charge does not affect the force due to the other.

Hence, even if a neutral sphere is placed between the charged sphere, the amount of electrostatic force will remain the same, i.e., 16 N.

Q.12. If $x^2 = 1 + t^2$, and acceleration as a function of x is given by x^{-n}. Find the value of n.

Answer: 3

Solution: Differentiating the given equation, with respect to time, we have

$$2x\frac{dx}{dt} = 2t$$
$$xv = t \quad \ldots(1)$$

Equation (1) implies that

$$v = \frac{t}{x} \quad \ldots(2)$$

Differentiating equation (1) with respect to time, we have

$$x\frac{dv}{dt} + \frac{dx}{dt}v = 1$$
$$\Rightarrow ax + v^2 = 1$$
$$\Rightarrow ax = 1 - v^2$$
$$= 1 - \frac{t^2}{x^2} \quad [\text{by equation (2)}]$$
$$= \frac{x^2 - t^2}{x^2}$$
$$= \frac{1}{x^2} \quad [\text{by the given equation}]$$
$$\Rightarrow a = \frac{1}{x^3}$$
$$= x^{-3}$$

Hence, $n = 3$.

Q.13. The time period of SHM is $3.14\ \text{s}$ with amplitude $0.06\ \text{m}$. The maximum velocity of particle is $k \times 10^{-2}\ \text{m s}^{-1}$. Find the value of k.

Answer: 12

Solution: As we know, $\omega = \frac{2\pi}{T} = \frac{2\times3.14}{3.14} = 2\ \text{rad s}^{-1}$.

Then maximum velocity will be, $v_{max} = A\omega = 0.06 \times 2 = 0.12 = 12 \times 10^{-2}\ \text{m s}^{-1}$.

Therefore, $k = 12$.

Q.14. For a device, power consumed is $100\ \text{W}$ and the voltage supplied is $200\ \text{V}$. The number of electrons that flow in $1\ \text{s}$ is $\frac{x}{4} \times 10^{17}$. Find x.

Answer: 125

Solution: The current flows through the device can be calculated as follows:

$$P = IV$$
$$\Rightarrow I = \frac{P}{V}$$
$$= \frac{100\ \text{W}}{200\ \text{V}}$$
$$= 0.5\ \text{A} \quad \ldots(1)$$

Also, the current can be written as

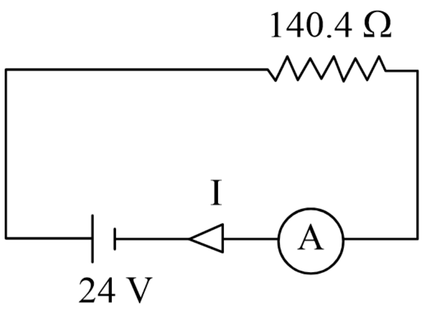
$$I = \frac{ne}{t} \quad \ldots(2)$$

Equations (1) and (2) imply that

$$\frac{ne}{t} = 0.5$$
$$\Rightarrow n = \frac{0.5t}{e}$$
$$= \frac{0.5\times1}{1.6\times10^{-19}}$$
$$= 31.25 \times 10^{17}$$
$$= \frac{125}{4} \times 10^{17}$$

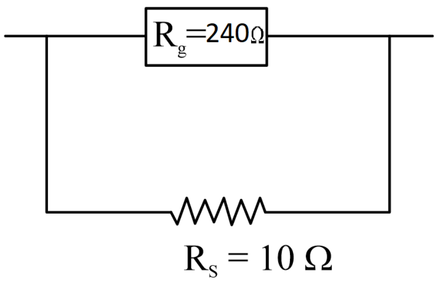
Hence, $x = 125$.

Q.15. For the given circuit find the ammeter reading in mA, if shunt $= 10\ \Omega$ and resistance of coil of galvanometer is $240\ \Omega$.



Answer: 160

Solution:



Since, both resistance are in parallel, so net resistance will be $R_A = \frac{240\times10}{240+10} = 9.6\ \Omega$.

Now, the total resistance of the circuit will be, $R_{net} = 140.4 + R_A = 140.4 + 9.6 = 150\ \Omega$

Therefore, current will be $I = \frac{24}{150} = 0.16 = 160\ \mathrm{mA}$.

Q.16. For a series LCR circuit it is found that maximum current is drawn when value of variable capacitance is $2.5\ nF$. If the resistance of $200\ \Omega$ and $100\ \mathrm{mH}$ inductor is being used in the given circuit. The frequency of source is ______$\times 10^3\ \mathrm{Hz}$

(Take $\pi^2 = 10$)

Answer: 10

Solution: Maximum current can be drawn when resonance happens in the circuit.

Therefore,

$$f = \frac{1}{2\pi\sqrt{LC}}$$

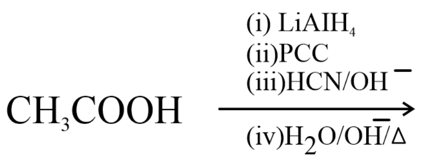
$$= \frac{1}{2\pi\sqrt{\left(100\times10^{-3}\right)\times\left(2.5\times10^{-9}\right)}}$$

$$= \frac{1}{2\sqrt{\pi^2\times2.5\times10^{-10}}}$$

$$= \frac{1}{2\times5\times10^{-5}} = 10\times10^3\ \mathrm{Hz}$$

Chemistry

Q.17. Identify the major product in the below given reaction:

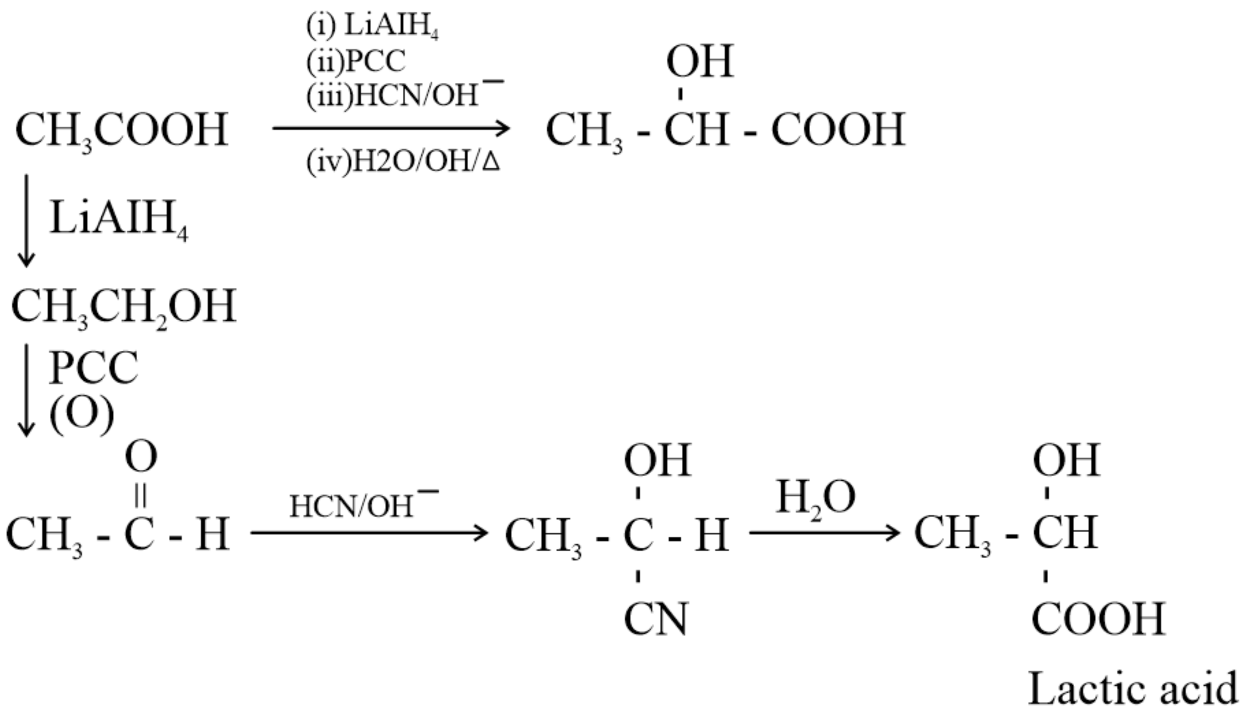


A) CH_3CH_2OH B) $CH_3CH(OH)COOH$

C) CH_3COOH D) CH_3CH_2CHO

Answer: $CH_3CH(OH)COOH$

Solution: Lithium aluminium hydride is used to reduce carboxylic acids, esters, and acid halides to their corresponding primary alcohols.



Q.18. Find out the shortest wavelength of Paschen series for H-atom.

A) $\frac{9}{R}$

B) $\frac{16}{R}$

C) $\frac{144}{7R}$

D) $\frac{7R}{144}$

Answer: $\frac{9}{R}$

Solution: Shortest wavelength in Paschen series:

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

Take $n_1 = 3,\ n_2 = \infty$, putting these values in above equation, we get

$$\frac{1}{\lambda} = R\left(\frac{1}{3^2} - \frac{1}{\infty}\right) = R\left(\frac{1}{9}\right)$$

$$\Rightarrow \lambda = \frac{9}{R}$$

Q.19. Which of the following d-block elements has maximum unpaired electron in ground state electronic configuration?

A) Ti (22)

B) V (23)

C) Cr (24)

D) Mn (25)

Answer: Cr (24)

Solution:

1. **Titanium (Ti)**: Atomic number = 22
   - Ground state electron configuration: $\left[Ar\right]3d^2 4s^2$
   - Number of unpaired electrons: 2 (in the 3d orbitals)
2. **Vanadium (V)**: Atomic number = 23
   - Ground state electron configuration: $\left[Ar\right]3d^3 4s^2$
   - Number of unpaired electrons: 3 (in the 3d orbitals)
3. **Chromium (Cr)**: Atomic number = 24
   - Ground state electron configuration: $\left[Ar\right]3d^5 4s^1$
   - Number of unpaired electrons: 6 (in the 3d orbitals)
4. **Manganese (Mn)**: Atomic number = 25
   - Ground state electron configuration: $\left[Ar\right]3d^5 4s^2$
   - Number of unpaired electrons: 5 (in the 3d orbitals)

Q.20. Incorrect statement for But-2-ene.

A) It forms two stereoisomers

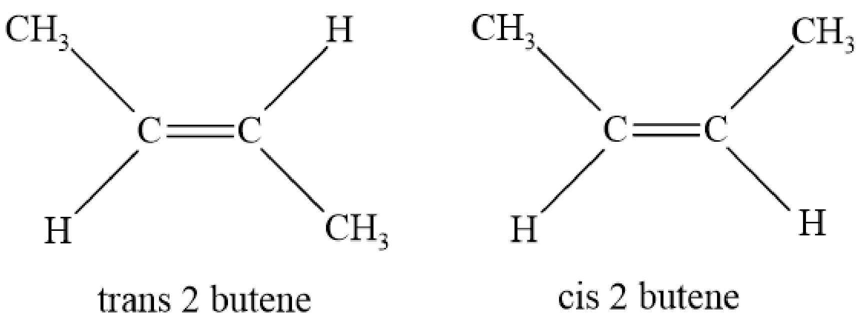
B) Trans form is more stable than cis

C) Dipole moment of Trans>cis

D) Melting point of trans>cis

Answer: Dipole moment of Trans>cis

Solution: The two stereoisomers of 2-butene are cis isomer which has the methyl groups on the same side of the double bond where as the trans isomer has the methyl groups on opposite sides of the double bond.



As we can see from the structures that in trans 2 butene, the steric factor is much less. Cis 2 butene has both bulky methyl groups on same side, so steric factor is more. Hence, the stability of trans 2 butene is more but it is based on the fact of stability and not hyperconjugation.

trans-2-Butene has no dipole moment because the bond moments of the two bonds to alkyl groups are opposed and cancel. In contrast, the dipole moment of cis-2-butene is 0.3 D because the bond moments of the two bonds to the methyl groups add to each other and do not cancel.

The melting point of trans isomers is generally higher than that of cis isomers because in trans isomer, bulky groups lie on the opposite side of the double bond. Therefore, the molecule is symmetrical and hence packed well in the crystal lattice.

Q.21. Correct increasing order of atomic radii of the following metals $Li,\ Cs,\ Rb,\ K$.

A) $Li > Cs > Rb > K$

B) $Rb > K > Li > Cs$

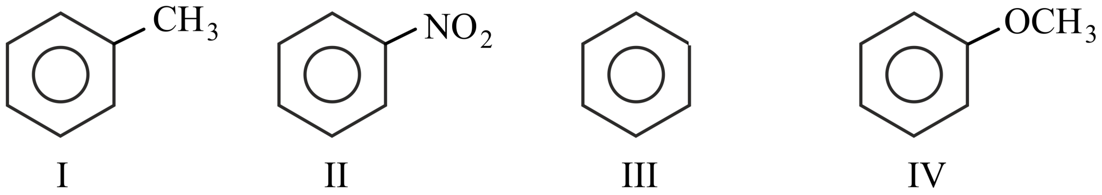
C) $Cs > Rb > K > Li$

D) $Cs > Li > Rb > K$

Answer: $Cs > Rb > K > Li$

Solution: As we move from top to bottom in group the atomic radius will be increased, because the in coming electron enters into a new sub shell.
$Li,\ K,\ Rb,\ Cs$ are IA group elements from Li to Rb the atomic radius will be increased. So the correct order of atomic radius is $Cs > Rb > K > Li$
Hence, option C is correct.

Q.22. Arrange the following compounds according to their rate of electrophilic substitution reactions.



A) IV > III > II > I
B) IV > I > III > II
C) I > II > IV > III
D) II > III > IV > I

Answer: IV > I > III > II

Solution: This is an electrophilic aromatic substitution reaction. The rate of electrophilic aromatic substitution reaction depends upon the activating and deactivating groups. The activating groups has the more rate of electrophilic aromatic substitution than the deactivating groups. Activating groups are the electron donating groups but the deactivating groups are the electron withdrawing groups. Activating groups give the electrophilic aromatic substitution reaction at the otho and para positions but the deactivating groups are the meta- directing. The $-NO_2$ group is the deactivating groups and the $-OCH_3$ and $-CH_3$ groups are the activating groups. $-OCH_3$ is strong activating group than $-CH_3$ group.

Q.23. An electron present in first excite state in H-atom having energy -3.4 eV. Find its kinetic energy.

A) 13.6 eV
B) 3.4 eV
C) 10.2 eV
D) 6.8 eV

Answer: 3.4 eV

Solution: We know that the total energy of electron in an orbit is equal to the sum of kinetic energy and potential energy and is given by,

$$E = -\frac{KZe^2}{2r} --- (i)$$

Also, the kinetic energy of electron is,

$$K.E. = \frac{KZe^2}{2r} --- (ii)$$

From (i) and (ii), it is clear that,

$$K.E. = -E$$

Given: $E = -3.4$ eV

$$K.E. = -(-3.4)$$
$$K.E. = 3.4 \text{ eV}$$

Q.24. For reaction

$$CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$$

The value of $\frac{K_P}{K_C}$ will be

A) $\frac{1}{(RT)^{1/2}}$
B) $(RT)^{1/2}$
C) $\frac{1}{RT}$
D) RT

Answer: $\frac{1}{(RT)^{1/2}}$

Solution: The relation between K_P and K_C is $K_P = K_C(RT)^{\Delta n}$

$\Delta n =$ Number of gaseous products-number of gaseous reactants

$CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$

For the above reaction,

$\Delta n = -\frac{1}{2}$

$\frac{K_P}{K_C} = (RT)^{-1/2}$

Q.25. Among the $VO_2^-, Cr_2O_7^{2-}, MnO_4^-$, find the magnetic moment of compound having the least oxidising power.

A) 2.83 BM

B) 0 BM

C) 3.89 BM

D) 4.95 BM

Answer: 2.83 BM

Solution: Out of $VO_2^-, Cr_2O_7^{2-}, MnO_4^-$, VO_2^- has the least oxidising power. In VO_2^-, the oxidation state of Vanadium is $+3$. The V^{3+} ion electronic configuration is $3d^2$. It has two unpaired electrons. Hence, the magnetic moment is $\sqrt{2(2+2)}$ BM i.e., 2.83 BM

Q.26. $\text{Salt} \xrightarrow{AgNO_3} \text{Yellow ppt} \xrightarrow{NH_4OH} \text{Insoluble}$

The salt may contain anion:

A) I^-

B) Br^-

C) Cl^-

D) F^-

Answer: I^-

Solution: Silver iodide is prepared by reaction of an iodide solution (e.g., potassium iodide) with a solution of silver ions (e.g., silver nitrate). A yellowish solid quickly precipitates.

$\text{Salt} + AgNO_3 \rightarrow \underset{\text{Yellow ppt}}{AgI} \xrightarrow{NH_4OH} \text{Insoluble}$

AgI has a lower K_{sp} because the lattice has covalent character and the hydration energy for I^- is much less. That is why it does not dissolve in NH_4OH.

Hence, the answer is option A.

Q.27. Correct statement about enzymes

A) Enzyme is bio catalyst

B) Enzymes are non specific for different reaction

C) Most of the enzymes are non-globular protein

D) Enzyme oxidase interconvert maltose into glucose

Answer: Enzyme is bio catalyst

Solution: Enzymes are protein catalysts that speed up the rate of biochemical reactions but do not change the structure of the final product. Like a catalyst, without being used up, the enzymes control the speed and specificity of the reaction, but unlike catalysts, only living cells generate enzymes.

Properties of Enzymes

1.Enzymes initiate the biochemical reaction rate and accelerate it.

2.The activity of enzymes depends on the medium acidity of the (pH specific). At a particular pH, each catalyst is most active. PH 2 for pepsin, pH 8.5 for trypsin, for example. At near neutral pH, most intracellular enzymes act.

3.The reaction in either direction can be accelerated by enzymes.

4. Both enzymes have active sites involved in biochemical reactions.

5. Enzymes, often soluble in water, dilute glycerol, NaCl, and dilute alcohol, are very unstable compounds.

6. At the optimum temperature, enzymes work aggressively.

7.In nature, all enzymes are proteins, but all proteins may not be enzymes.

8.Enzymes lower the molecule's activation energy so that the biochemical reaction can take place at the normal temperature of the body, which is 37 degrees Celsius.

Q.28. Choose correct statement

Statement-1: PCl_5 and BrF_5 are sp^3d hybridised.

Statement-II: SF_6 and $\left[Co\left(NH_3\right)_6\right]^{3+}$ are sp^3d^2 hybridised.

A) Both statements are correct.

B) Only statement-I is correct

C) Both statements are incorrect

D) Only statement-II is correct

Answer: Both statements are incorrect

Solution: PCl_5, phosphorus has five bond pairs, hence it requires five hybrid orbitals. So phosphorus undergo sp^3d.

BrF_5, bromine has five bond pairs and a lone pair, hence it requires six hybrid orbitals. So bromine undergo sp^3d^2. SF_6, sulphur has six bond pairs, hence it requires six hybrid orbitals. So sulphur undergo sp^3d^2.

In $\left[Co\,(NH_3)_6\right]^{3+}$, cobalt ion undergo d^2sp^3 hybridisation, because ammonia is strong field ligand.

Q.29. IUPAC name of $\left[PtBr_2\,(PMe_3)_2\right]$

A) $\mathrm{Dibromidobis\,(trimethylphosphine)\,platinum\ \ (II)}$

B) $\mathrm{Dibromido\,(trimethylphosphine)\,platinum\ \ (IV)}$

C) $\mathrm{Dibromido\,(trimethylphosphine)\,platinate\ \ (IV)}$

D) $\mathrm{(trimethylphosphine)\,Dibromidoplatinum\ \ (IV)}$

Answer: $\mathrm{Dibromidobis\,(trimethylphosphine)\,platinum\ \ (II)}$

Solution: Rules are followed for naming coordination compounds recommended by IUPAC :

1. In case of a complexion or a neutral molecule, name the ligand first and then the metal.

2. The names of anionic ligands are obtained by changing the ending -ide to -o and -ate to -ato. 3. The name of a complex is one single word. There must not be any space between different ligand names as well as between ligand name and the name of the metal.

4. After the name of the metal, write its oxidation state in Roman number which appears in parentheses without any space between metal name and parentheses.

5. If complex has more than one ligand of the same type, the number is indicated with prefixes, di-, tri-, tetra-, penta-, hexa- and so on.

6. For the complex having more than one type of ligands, they are written in an alphabetical order. Suppose two ligands with prefixes are tetraaqua and dichloro. While naming in alphabetical order, tetraaqua is written first and then dichloro.

7. If the ligand itself contains numerical prefix in its name, then display number by prefixes bis for 2, tris for 3, tetrakis for 4 and so forth. Put the ligand name in parentheses.

In the given case there are 2 Bromine and 2 trimethyl phosphine groups and the name of the metal is platinum and the oxidation state is (II).

Hence, the name is

$\mathrm{Dibromidobis\,(trimethylphosphine)\,platinum\ \ (II)}$

Q.30. Given two first order reactions, so that $\frac{t^1_{1/2}}{t^2_{1/2}} = \frac{2}{5}$. Find the $\frac{t^1_{2/3}}{t^2_{4/5}}$.

A) $\frac{2}{5}\frac{\log 3}{\log 5}$

B) $\frac{2}{5}\frac{\log 5}{\log 3}$

C) $\frac{1}{5}\frac{\log 3}{\log 5}$

D) $\frac{1}{5}\frac{\log 5}{\log 3}$

Answer: $\frac{2}{5}\frac{\log 3}{\log 5}$

Solution: $\frac{k_1}{k_2}=\frac{t^2_{1/2}}{t^1_{1/2}}=\frac{5}{2}$

The integrated rate equation for first order reaction is

$k=\frac{2.303}{t}\log\frac{a}{a-x}$

$\frac{k_1}{k_2}=\frac{t^2_{4/5}}{t^1_{2/3}}\frac{\log\frac{1}{1/3}}{\log\frac{1}{1/5}}$

$\Rightarrow\frac{5}{2}=\frac{t^2_{4/5}}{t^1_{2/3}}\frac{\log 3}{\log 5}$

$\Rightarrow\frac{t^1_{2/3}}{t^2_{4/5}}=\frac{2}{5}\frac{\log 3}{\log 5}$

Q.31. The density of $3\ \mathrm{M}$ solution of NaCl is $1.25\ \mathrm{g/mL}$. Calculate molality of the solution.

Give answer to the nearest integer.

Answer: 3

Solution: 3 Molar solution means there are 3 moles of NaCl salt in 1 Litre.

Molecular weight of $NaCl=58.44$. Hence, there are $3\times 58.44\ gms$ in 1 Litre of water.

$Density=\frac{mass}{volume}$

Mass of 1 litre of solution $=1.25\ gms/mL\times 1000\ mL=1250\ gms$

$V=$ volume of water added to make the solution or volume of solvent

Mass of solute $+$ Mass of solvent $=$ Mass of solution

$175.32\ gms$ $+$ mass of solvent $=1250\ gms$

mass of solvent $=1250-175.32=1074.8$

So $1074.68\ gms$ of water is mixed with 3 moles of $NaCl$ to make the $3M$ solution.

Molality $=$ mass of solute in number of moles $/$ mass of solvent in kg

$=\frac{3}{1.0746}=2.7915\ \mathrm{Molal}$

$\approx 3\ \mathrm{Molal}$

Q.32. For a certain reaction, ΔH_r is $400\ \mathrm{kJ/mol}$ and $\Delta S=0.2\ \mathrm{kJ/mol\ K}$. Above what minimum tempearature in kelvin, the reaction becomes spontaneous.

Answer: 2000

Solution: From the expression,

$\Delta G=\Delta H-T\Delta S$

Assuming the reaction at equilibrium, ΔT for the reaction would be:

$T=(\Delta H-\Delta G)\frac{1}{\Delta S}$

$=\frac{\Delta H}{\Delta S}(\Delta G=0\ \text{at equilibrium})$

$=\frac{400\ \mathrm{kJmol^{-1}}}{0.2\ \mathrm{kJ\ K^{-1}mol^{-1}}}$

$T=2000\ \mathrm{K}$

For the reaction to be spontaneous, ΔG must be negative. Hence, for the given reaction to be spontaneous, T should be greater than $2000\ \mathrm{K}$.

Q.33. Which of the following carbocation is not stabilised by hyperconjugation?

Answer: 4

Solution: Hyperconjugation is the stabilising interaction that results from the interaction of the electrons in a σ-bond (usually C-H or C-C) with an adjacent empty or partially filled p-orbital or a π-orbital to give an extended molecular orbital that increases the stability of the system.

Structures 2, 4, 5 are stabilised by resonance and 6 does not have alpha hydrogen for hyperconjugation.

Structures 2, 4, 5 and 6 are not stabilised by hyperconjugation.

Q.34. Total number of molecules in which the central atom is sp^2 hybridised.

SiO_2, NH_3, CO_2, SO_2, C_2H_4, C_2H_2, C_6H_6

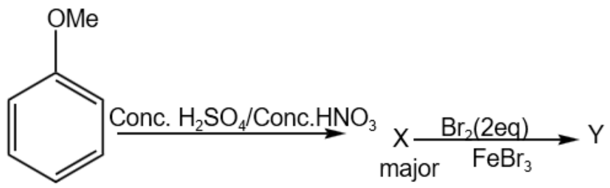
Answer: 3

Solution: Hybridization is defined as the intermixing of atomic orbitals with the same energy levels to give the same number of a new type of hybrid orbitals. This intermixing usually results in the formation of hybrid orbitals having entirely different energies, shapes, etc.

SiO_2 : sp^3
NH_3 : sp^3
CO_2 : sp
SO_2 : sp^2
C_2H_4 : sp^2
C_2H_2 : sp
C_6H_6 : sp^2

Hence, the answer is 3

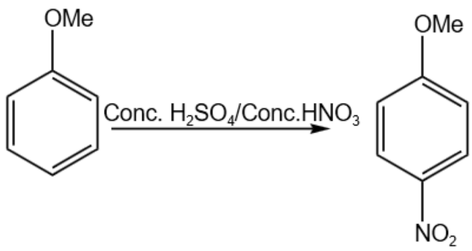
Q.35.



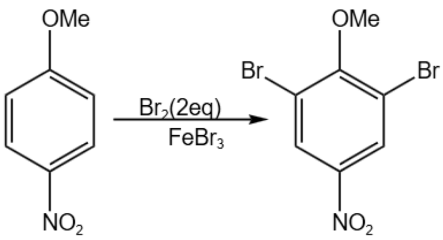
In the compound Y, ratio of oxygen and bromine is $n \times 10^{-1}$, then find the value of n.

Answer: 15

Solution: When anisole is nitrated with a mixture of conc HNO_3 and H_2SO_4 it gives a mixture of ortho-Nitroanisole and para-Nitroanisole (major) products.



para-Nitroanisole on dibromination gives the product as shown below.



The number of oxygen atoms in Y = 3

The number of bromine atoms in Y = 2

So, the ratio $= 3/2 = 15 \times 10^{-1}$

Mathematics

Q.36. If the words with or without meaning made using all the letters of the word '$NAGPUR$' are arranged in dictionary order, then the 315^{th} word is

A) $NRAPGU$ B) $NRAGPU$

C) $NRAGUP$ D) $NRAPUG$

Answer: $NRAPGU$

Solution: Number of words starting with A are: $5! = 120$

Number of words starting with G are: $5! = 120$

Number of words starting with NA are: $4! = 24$

Number of words starting with NG are: $4! = 24$

Number of words starting with NP are: $4! = 24$

Total words till now are 312.

313^{th} word $\rightarrow NRAGPU$

314^{th} word $\rightarrow NRAGUP$

314^{th} word $\rightarrow NRAPGU$

Q.37. Find the range of $\frac{1}{7-\sin 5x}$

A) $\left[\frac{1}{7}, \frac{1}{6}\right]$ B) $\left[\frac{1}{7}, \frac{1}{5}\right]$

C) $\left[\frac{1}{8}, \frac{1}{6}\right]$ D) $\left[\frac{1}{8}, \frac{1}{5}\right]$

Answer: $\left[\frac{1}{8}, \frac{1}{6}\right]$

Solution: We know that, $-1 \leq \sin\theta \leq 1$.

$\Rightarrow -1 \leq \sin 5x \leq 1$

$\Rightarrow 1 \geq -\sin 5x \geq -1$

$\Rightarrow 7+1 \geq 7-\sin 5x \geq 7-1$

$\Rightarrow 8 \geq 7-\sin 5x \geq 6$

$\Rightarrow \frac{1}{8} \leq \frac{1}{7-\sin 5x} \leq \frac{1}{6}$

Q.38. If α, β are the roots of the equation $x^2-\sqrt{2}x-8=0$ and $A_n=\alpha^n+\beta^n$, $n \in N$, then the value of $\frac{A_{10}-\sqrt{2}A_9}{2A_8}$

A) 5

B) 4

C) 7

D) 6

Answer: 4

Solution: Given: $x^2-\sqrt{2}x-8=0$ has roots α and β. Also, $A_n=\alpha^n+\beta^n$.

$\Rightarrow \alpha^2-\sqrt{2}\alpha-8=0$

$\Rightarrow \alpha^2-\sqrt{2}\alpha=8$

Similarly, $\Rightarrow \beta^2-\sqrt{2}\beta=8$

$\Rightarrow \frac{A_{10}-\sqrt{2}A_9}{2A_8}=\frac{\alpha^{10}+\beta^{10}-\sqrt{2}\alpha^9-\sqrt{2}\beta^9}{2\left(\alpha^8+\beta^8\right)}$

$\Rightarrow \frac{A_{10}-\sqrt{2}A_9}{2A_8}=\frac{\alpha^8\left(\alpha^2-\sqrt{2}\alpha\right)+\beta^8\left(\beta^2-\sqrt{2}\beta\right)}{2\left(\alpha^8+\beta^8\right)}$

$\Rightarrow \frac{A_{10}-\sqrt{2}A_9}{2A_8}=\frac{8\left(\alpha^8+\beta^8\right)}{2\left(\alpha^8+\beta^8\right)}$

$\Rightarrow \frac{A_{10}-\sqrt{2}A_9}{2A_8}=\frac{\left(\alpha^2-\sqrt{2}\alpha\right)}{2}$

$\Rightarrow \frac{A_{10}-\sqrt{2}A_9}{2A_8}=4$

Q.39. If $\int \frac{dx}{a^2\sin^2 x+b^2\cos^2 x}=\frac{1}{12}\tan^{-1}(3\tan x)+c$ then the maximum value of $a\sin x+b\cos x$ will be

A) $\sqrt{20}$

B) $\sqrt{40}$

C) $\sqrt{30}$

D) $\sqrt{50}$

Answer: $\sqrt{40}$

Solution: Let, $I=\int \frac{dx}{a^2\sin^2 x+b^2\cos^2 x}$

$\Rightarrow I=\int \frac{\sec^2 x dx}{a^2\tan^2 x+b^2}$

Now, let $\tan x=t \Rightarrow \sec^2 x dx=dt$

$\Rightarrow I=\frac{1}{a^2}\int \frac{dt}{t^2+\left(\frac{b}{a}\right)^2}$

$\Rightarrow I=\frac{1}{a^2}\cdot\frac{a}{b}\tan^{-1}\left(\frac{at}{b}\right)+c$

$\Rightarrow I=\frac{1}{ab}\tan^{-1}\left(\frac{a\tan x}{b}\right)+c$

Now, comparing $\frac{1}{ab}\tan^{-1}\left(\frac{a\tan x}{b}\right)+c=\frac{1}{12}\tan^{-1}(3\tan x)+c$

So, on comparing we get, $ab=12$ & $\frac{a}{b}=3$

$\Rightarrow a^2=36$ & $b^2=4$

Now, we know that the maximum value of $a\sin x+b\cos x$ is given by $\sqrt{a^2+b^2}=\sqrt{36+4}=\sqrt{40}$

Q.40. If $|A|=3$ and order of matrix is 3×3 then $\left|adj\left(4adj\left(-3adj\left(3adj(2A)^{-1}\right)\right)\right)\right|=2^m\times 3^n$. Find $2n+m$.

A) 200

B) 60

C) 100

D) 120

Answer: 100

Solution: Given: $\left|adj\left(4adj\left(-3adj\left(3adj(2A)^{-1}\right)\right)\right)\right|=2^m\times 3^n$

We know that, $adj\,(kA)=k^{n-1}adj\,(A)$

$\Rightarrow \left|adj\left(4adj(-3)^3adj\left(adj(2A)^{-1}\right)\right)\right|=2^m\times 3^n$

$\Rightarrow \left|adj\left(2^2\times 3^6adj\left(adj\left(adj(2A)^{-1}\right)\right)\right)\right|=2^m\times 3^n$

$\Rightarrow \left|2^4\times 3^{12}adj\left(adj\left(adj(2A)^{-1}\right)\right)\right|=2^m\times 3^n$

$\Rightarrow 2^{12}\times 3^{36}\left\{\left|(2A)^{-1}\right|^{2^4}\right\}=2^m\times 3^n$

$\Rightarrow 2^{12}\times 3^{36}\times\left(2^3\right)^{16}\frac{1}{|A|^{16}}=2^m\times 3^n$

$\Rightarrow 2^{60}\times 3^{36}\times\frac{1}{3^{16}}=2^m\times 3^n$

$\Rightarrow 2^{60}\times 3^{20}=2^m\times 3^n$

$\Rightarrow m=60,\ n=20$

$\Rightarrow 2n+m=100$

Q.41. If the sides of a triangle are $AB=9,\ BC=7$ and $AC=8$, then find the value of $|\cos 3C|$

A) $\frac{260}{343}$

B) $\frac{262}{343}$

C) $\frac{261}{343}$

D) $\frac{255}{343}$

Answer: $\frac{262}{343}$

Solution: Given,

Sides of triangle $AB = 9,\ BC = 7$ and $AC = 8$

Using cosine formula,

$\Rightarrow \cos C = \frac{7^2+8^2-9^2}{2\times7\times8}$

$\Rightarrow \cos C = \frac{32}{112}$

$\Rightarrow \cos C = \frac{2}{7}$

Now, $\cos 3C = 4\cos^3 C - 3\cos C$

$\Rightarrow \cos 3C = 4\left(\frac{8}{343}\right) - 3\left(\frac{2}{7}\right)$

$\Rightarrow \cos 3C = \frac{32-294}{343}$

$\Rightarrow |\cos 3C| = \frac{262}{343}$

Q.42. Find the locus of P such that the ratio of distance of P from $A(3,1)$ and $B(1,2)$ is $5:4$.

A) Parabola

B) Ellipse

C) Circle

D) Hyperbola

Answer: Circle

Solution: Let, $P \equiv (h,k)$.

$\Rightarrow \frac{PA}{PB} = \frac{5}{4}$

$\Rightarrow \frac{\sqrt{(3-h)^2+(1-k)^2}}{\sqrt{(1-h)^2+(2-k)^2}} = \frac{5}{4}$

$\Rightarrow 16\left[(3-h)^2 + (1-k)^2\right] = 25\left[(1-h)^2 + (2-k)^2\right]$

$\Rightarrow 16\left[9 + h^2 - 6h + 1 + k^2 - 2k\right] = 25\left[1 + h^2 - 2h + 4 + k^2 - 4k\right]$

$\Rightarrow 16\left[h^2 - 6h + k^2 - 2k + 10\right] = 25\left[h^2 - 2h + k^2 - 4k + 5\right]$

$\Rightarrow -9h^2 - 9k^2 - 96h + 50h - 32k + 100k + 160 - 125 = 0$

$\Rightarrow 9h^2 + 9k^2 + 46h - 68k - 35 = 0$

So, the locus of P- is given by $9x^2 + 9y^2 + 46x - 68y - 35 = 0$, which represents a circle.

Q.43. There are letters to be delivered to 5 different locations, then find the probability that letter is delivered to exactly two correct locations assuming each letter is delivered to unique address.

A) $\frac{1}{5}$

B) $\frac{1}{6}$

C) $\frac{1}{4}$

D) $\frac{1}{3}$

Answer: $\frac{1}{6}$

Solution: Out of total 5 letters, 2 are to be delivered at correct locations and 3 are to be delivered at incorrect locations.

So, the required number of favourable ways is given by,

$N={}^5C_2(\text{for letters delivered to correct location})\times 3!\left[1-\frac{1}{1!}+\frac{1}{2!}-\frac{1}{3!}\right](\text{for dearrangement of 3 letters})$

$\Rightarrow N=\frac{5\times4}{2}\times 6\left(\frac{1}{2}-\frac{1}{6}\right)$

$\Rightarrow N=10\times 6\times\frac{1}{3}$

$\Rightarrow N=20$

So, the required probability is,

$P(E)=\frac{20}{120}=\frac{1}{6}$

Q.44. Let $A=\{1,2,3,4,5\}$, m be the number of relations such that $4x\leq 5y$ and n be the minimum number of elements to be added to $A\times A$ to make it symmetric relation, Then find the value of $m+n$.

A) 21 B) 20

C) 16 D) 25

Answer: 25

Solution: Given: $A=\{1,2,3,4,5\}$ and $4x\leq 5y$

$\Rightarrow R=\{(1,1),(1,2),(1,3),(1,4),(1,5),(2,2),(2,3),(2,4),(2,5),(3,3),(3,4),(3,5),(4,4),(4,5),(5,4),(5,5)\}$

$\Rightarrow m=16$

The elements that needs to be added to make R as symmetric are,

$(2,1),(3,1),(4,1),(5,1),(3,2),(4,2),(5,2),(4,3)$ and $(5,3)$

$\Rightarrow n=9$

$\Rightarrow m+n=25$

Q.45.

$\lim_{n\to\infty}\frac{\sum\left(n^4-2n^3+n^2\right)}{\sum\left((3n)^4+n^3-n^2\right)}$ is equal to

A) $\frac{1}{81}$ B) $\frac{1}{57}$

C) $\frac{1}{72}$ D) $\frac{1}{93}$

Answer: $\frac{1}{81}$

Solution:

Let, $y=\lim_{n\to\infty}\frac{\sum\left(n^4-2n^3+n^2\right)}{\sum\left((3n)^4+n^3-n^2\right)}$

$\Rightarrow y=\lim_{n\to\infty}\frac{\sum n^4\left(1-\frac{2}{n}+\frac{1}{n^2}\right)}{\sum n^4\left(81+\frac{1}{n}-\frac{1}{n^2}\right)}$

$\Rightarrow y=\lim_{n\to\infty}\frac{\sum n^4(1-0+0)}{\sum n^4(81+0-0)}$

$\Rightarrow y=\frac{1}{81}\lim_{n\to\infty}\frac{\sum n^4}{\sum n^4}$

$\Rightarrow y=\frac{1}{81}$

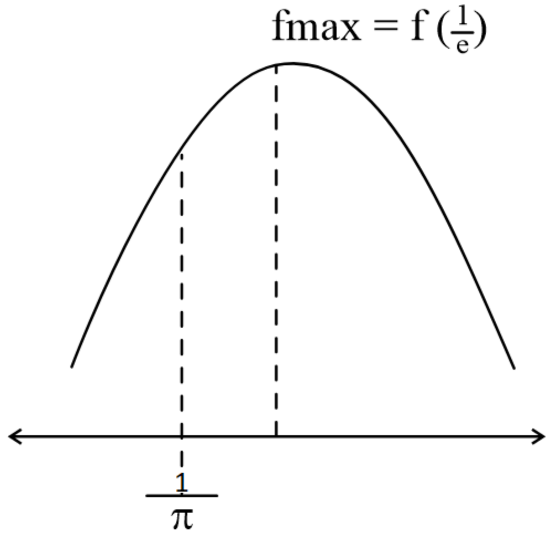
Q.46. If the function $f(x)=\left(\frac{1}{x}\right)^{2x}$; $x>0$ attains the maximum value at $x=\frac{1}{e}$, then

A) $\pi^e>e^\pi$ B) $\pi^e<e^\pi$

C) $\pi^{2e} < (2e)^{\pi}$ D) $e^{2\pi} < (2\pi)^{e}$

Answer: $\pi^{e} < e^{\pi}$

Solution: Given: $f(x) = \left(\frac{1}{x}\right)^{2x}$



$\Rightarrow f\left(\frac{1}{\pi}\right) < f\left(\frac{1}{e}\right)$

$\Rightarrow \pi^{\frac{2}{\pi}} < e^{\frac{2}{e}}$

$\Rightarrow \pi^{2e} < e^{2\pi}$

$\Rightarrow \pi^{e} < e^{\pi}$

Q.47. If ${}^{n+1}C_{r+1} : {}^{n}C_{r} : {}^{n-1}C_{r-1} = 55 : 35 : 21$ then find the value of $2n + 5r$

Answer: 50

Solution: Given ${}^{n+1}C_{r+1} : {}^{n}C_{r} : {}^{n-1}C_{r-1} = 55 : 35 : 21$

$\Rightarrow {}^{n+1}C_{r+1} : {}^{n}C_{r} = 55 : 35$ and ${}^{n}C_{r} : {}^{n-1}C_{r-1} = 35 : 21$

Take, ${}^{n+1}C_{r+1} : {}^{n}C_{r} = 55 : 35$

We know that,

$\frac{{}^{n+1}C_{r+1}}{{}^{n}C_{r}} = \frac{n+1}{r+1} = \frac{55}{35}$

$\Rightarrow 7n + 7 = 11r + 11$

$\Rightarrow 7n - 11r = 4 \ldots (i)$

And $\frac{{}^{n}C_{r}}{{}^{n-1}C_{r-1}} = \frac{n}{r} = \frac{5}{3}$

$\Rightarrow 3n = 5r \ldots (ii)$

Now, solving above equations we get,

$\Rightarrow 7n - 11 \cdot \frac{3n}{5} = 4$

$\Rightarrow 35n - 33n = 20$

$\Rightarrow n = 10$ and $r = 6$

Hence, $2n + 5r = 20 + 30 = 50$

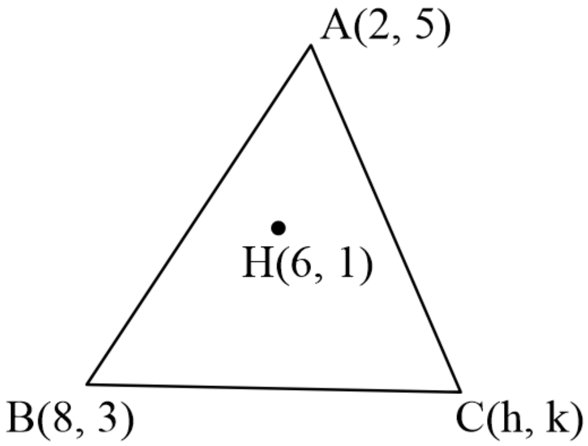
Q.48. In $\triangle ABC$ vertices $A(2, 5)$, $B(8, 3)$ & $C(h, k)$ and orthocentre is $(6, 1)$ then value of $2h + k$ is

Answer: 13

Solution: Given,

In $\triangle ABC$ vertices $A(2,5),\ B(8,3)\ \&\ C(h,k)$ and orthocentre is $(6,1)$

So, plotting the diagram we get,



Now, finding the slope of $AH = \frac{5-1}{2-6} = -1$, so the slope of $BC = 1 \Rightarrow \frac{k-3}{h-8} = 1$

$\Rightarrow h - k = 5\ \ ....(i)$

Similarly, the slope of $BH = \frac{-2}{-2} = 1$, so the slope of $AC = -1 \Rightarrow \frac{k-5}{h-2} = -1$

$\Rightarrow k + h = 7\ .....(ii)$

On solving above equations we get, $h = 6\ \&\ k = 1$

Hence, the value of $2h + k = 12 + 1 = 13$

Q.49. If $\vec{a} = \hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \left(\vec{a} \times \left(\hat{i} + \hat{j}\right)\right) \times \hat{i}$ then find the length of projection of $\vec{a}$ on $\vec{b}$

Answer: 2

Solution: Given,

$\vec{a} = \hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \left(\vec{a} \times \left(\hat{i} + \hat{j}\right)\right) \times \hat{i}$

Now, finding $\vec{a} \times \left(\hat{i} + \hat{j}\right) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix}$

$\Rightarrow \vec{a} \times \left(\hat{i} + \hat{j}\right) = 2\hat{i} - 2\hat{j}$

Now, finding $\left(\vec{a} \times \left(\hat{i} + \hat{j}\right)\right) \times \hat{i} = \left(2\hat{i} - 2\hat{j}\right) \times \hat{i} = 2\hat{k}$

So, the length of projection of $\vec{a}$ on $\vec{b}$ will be $\left|\vec{a} \cdot \hat{b}\right| = \left|\frac{\vec{a} \cdot \vec{b}}{\left|\vec{b}\right|}\right| = \left|\frac{-4}{2}\right| = 2$

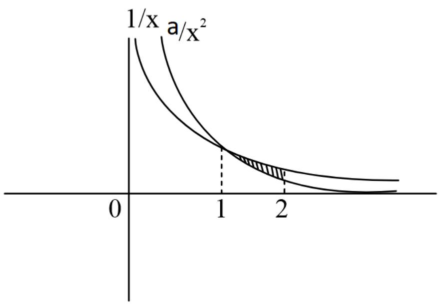
Q.50. If the area bounded by the region (x, y) such that $\left\{(x,y) \middle| \frac{a}{x^2} < y < \frac{1}{x};\ 1 < x < 2,\ 0 < a < 1\right\}$ is $\left(\ln 2 - \frac{2}{7}\right)$ square units, then find the value of $(7a - 3)$

Answer: 1

Solution: Given,

$\frac{a}{x^2} < y < \frac{1}{x};\ 1 < x < 2,\ 0 < a < 1$

Now, plotting the diagram of the function we get,



Now, from diagram we get,

Area $A = \int_1^2 \frac{1}{x} - \frac{a}{x^2}\,\mathrm{d}x = \ln 2 - \frac{2}{7}$

$\Rightarrow \left[\ln x + \frac{a}{x}\right]_1^2 = \ln 2 - \frac{2}{7}$

$\Rightarrow \left[\ln 2 + \frac{a}{2} - \ln 1 - \frac{a}{1}\right] = \ln 2 - \frac{2}{7}$

$\Rightarrow \left[\ln 2 - \frac{a}{2}\right] = \ln 2 - \frac{2}{7}$

$\Rightarrow a = \frac{4}{7}$

$\Rightarrow 7a - 3 = 4 - 3 = 1$

Q.51. If $\int_0^3 \left(\left[x^2\right] + \left[\frac{x^2}{2}\right]\right)\mathrm{d}x = a + b\sqrt{2} + c\sqrt{6} - \sqrt{3} - \sqrt{5} - \sqrt{7}$ $\{\text{where } a, b, c \in I\}$ then the value of $a + b + c$ will be,

Answer: 23

Solution: Let,

$I = \int_0^3 \left(\left[x^2\right] + \left[\frac{x^2}{2}\right]\right)\mathrm{d}x$

Now, here $x \in (0, 3) \Rightarrow x^2 \in (0, 9)$

So, $I = \int_0^1 0\,\mathrm{d}x + \int_1^{\sqrt{2}} 1\,\mathrm{d}x + \int_{\sqrt{2}}^{\sqrt{3}} 3\,\mathrm{d}x + \int_{\sqrt{3}}^{2} 4\,\mathrm{d}x + \int_2^{\sqrt{5}} 6\,\mathrm{d}x + \int_{\sqrt{5}}^{\sqrt{6}} 7\,\mathrm{d}x + \int_{\sqrt{6}}^{\sqrt{7}} 9\,\mathrm{d}x + \int_{\sqrt{7}}^{\sqrt{8}} 10\,\mathrm{d}x + \int_{\sqrt{8}}^{9} 12\,\mathrm{d}x$

$\Rightarrow I = 0 + \left(\sqrt{2} - 1\right) + 3\left(\sqrt{3} - \sqrt{2}\right) + 4\left(2 - \sqrt{3}\right) + 6\left(\sqrt{5} - 2\right) + 7\left(\sqrt{6} - \sqrt{5}\right) + 9\left(\sqrt{7} - \sqrt{6}\right) + 10\left(\sqrt{8} - \sqrt{7}\right) + 12\left(9 - \sqrt{8}\right)$

$\Rightarrow I = 31 - 6\sqrt{2} - 2\sqrt{6} - \sqrt{3} - \sqrt{5} - \sqrt{7}$

Hence, on comparing with $\int_0^3 \left(\left[x^2\right] + \left[\frac{x^2}{2}\right]\right)\mathrm{d}x = a + b\sqrt{2} + c\sqrt{6} - \sqrt{3} - \sqrt{5} - \sqrt{7}$ we get,

$a = 31,\ b = -6\ \&\ c = -2$

Hence, $a + b + c = 23$