JEE Main 2024 Question Paper with Solution
April 4 Shift 1
(B.E./B.Tech)

JEE Main Physics Questions

Ques 1. Five identical convex lenses are placed one after the other in close contact. The power of this arrangement is 25 D. Then, the power of one such lens is

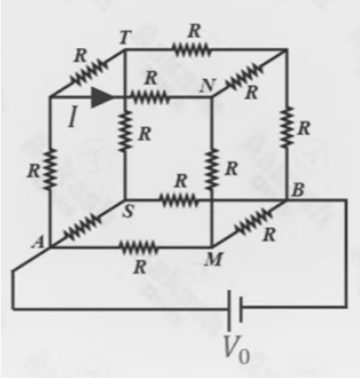
A. 10 D
B. 5 D
C. 125 D
D. 20 D

Ans. B
Solu. To find the power of one lens in the arrangement, we can use the formula for combining the powers of lenses in contact:
P_total = (1/f1 + 1/f2 + 1/f3 + 1/f4 + 1/f5)
Where:
- `P_total` is the total power of the arrangement,
- `f1, f2, f3, f4, f5` are the focal lengths of the lenses.

Given that the total power of the arrangement is `25 D` and all the lenses are identical, let's denote the focal length of each lens as `f`:
25 D = (1/f + 1/f + 1/f + 1/f + 1/f)
25 D = 5/f
f = 5/25 m = 0.2 m
Now, the power of a lens is given by `P = 1/f`. Thus, the power of one such lens is:

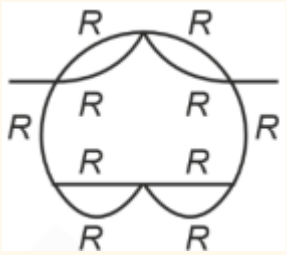
P = 1/0.2 D = 5 D
So, the correct answer is `5 D`.

Ques 2. A cubical arrangement of 12 resistors each having resistance R is shown. Find I.



A. $V_0/3R$
B. $V_0/6R$
C. $V_0/4R$
D. $V_0/8R$

Ans. B

Solu. 

Req= 3R || R
Req= 3R/4
$I_{3R}= I_0/4$
$I= I_0/8$
=> I = $= \frac{1}{8}\left\{\frac{V_0}{3R/4}\right\} = \frac{V_0}{6R}$

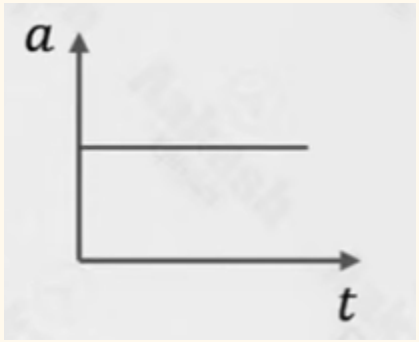
Ques 3. On a given rough incline plane, a solid sphere and a hollow cylinder having the same radius are rolled one by one, with the same

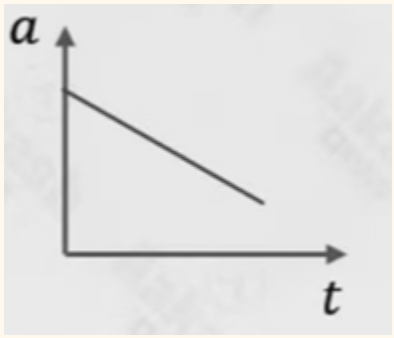
speed. Ratio of heights attained by solid sphere and hollow cylinder is

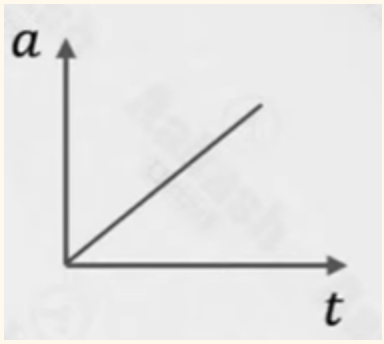
A. 9/10
B. 3/10
C. 7/10
D. 6/10

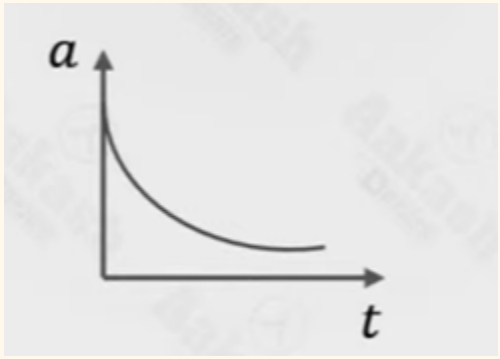
Ans. C
Solu. Conserving energy :
= ½ mv^2 + ½ Iw^2 =mgh
= 7/10 mv^2 = mgh_1 & m'v2 =m^2gh_2
= 7/10 = h_1/h_2

Ques 4. A wooden block is initially at rest on a smooth surface. Now a horizontal force is applied on the block which increases linearly with time. The acceleration- time (a - t) graph for the block would be

A. 

B. 

C. 

D. 

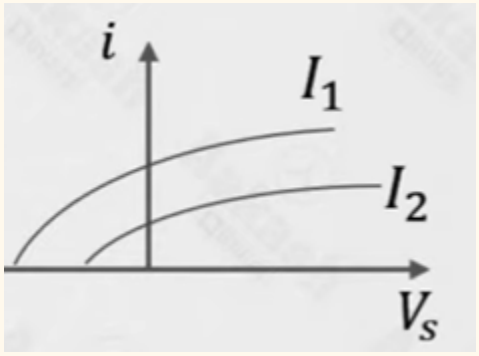
Ans. C
Solu. F = ma
=> a - t graph is also linearly increasing.

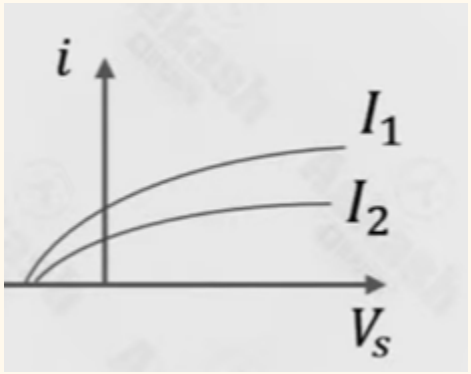
Ques 5. An electron is projected along the axis of solenoid which carries constant current i, the trajectory of electron shall be

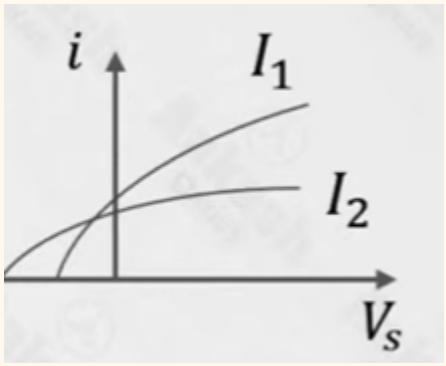
A. Circular path
B. Uniform motion along the axis
C. Uniform accelerated motion in straight line
D. Parabolic path

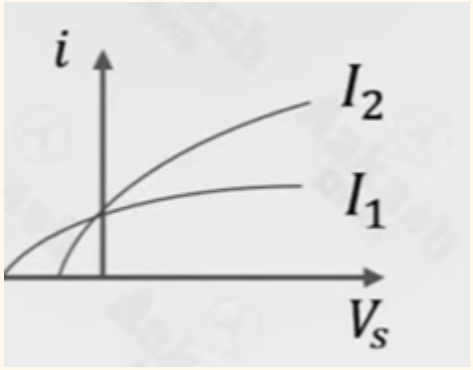
Ans. B
Solu. . F = q(v*B) = v II B
Therefore, F = 0
And magnetic force can never do work
Straight line and uniform motion

Ques 6. Which graph correctly represents the photo current (i) vs stopping potential (Vs) for the same frequency but different intensity? (here, $I_1 > I_2$)

A. 

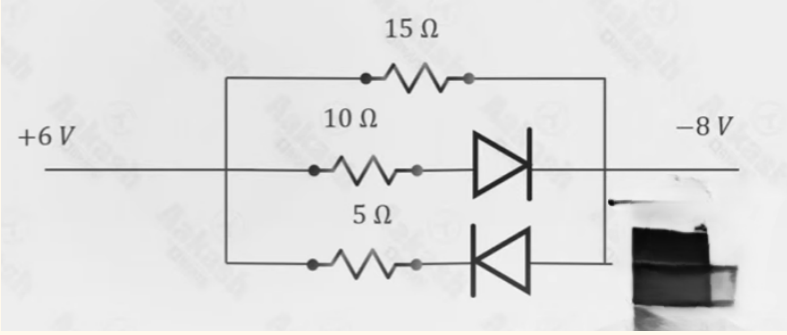
B. 

C. 

D. 

Ans. B
Solu. f same => same stopping potential
I1 > I2 =>Saturation current is higher for higher intensity photons.

Ques 7. Consider the network shown:



The equivalent resistance of the network is

A. 12 Ω
B. 36 Ω
C. 20 Ω
D. 6 Ω

Ans. D
Solu. One diode: short
One diode: open
R_{eq} =(15*10)/(15+10)Ω= 6Ω

Ques 8. Instantaneous current in a circuit is i(t) = [6+ √54 sin(2πt +π/3)]A RMS value of current is

A. 2 √6 A
B. 7A
C. 3 √7 A
D. 6 √2 A

Ans. C

Solu. i(t) = i1 + i2 sin(ωt +Ø)

I_{rms} = $\sqrt{\frac{\int\left[i_1 + i_2 \sin(\omega t + \phi)\right]^2 dt}{T}}$

=> $\sqrt{i_1^2 + \frac{i_2^2}{2}}$

Ques 9. The equation of stationary wave is given as y = 2A sin (2π/λ . nt) cos (2π/λ . x), then which of the following is not correct.

- **A. Dimension of x is [L]**
- **B. Dimension of n is [LT^{-1}]**
- **C. Dimension of n/λ is [T]**
- **D. Dimension of nt is [L]**

Ans. C

Solu. From dimensional analyses nt/λ=>$M^0L^0T^0$

nT/L = $M^0L^0T^0$

n = [LT^{-1}]

Again x/λ = $M^0L^0T^0$

x = [L]

Ques 10. Because of force (separately) of 3 N & 2 N, elongation in spring are found to be 'a' and 'b' unit respectively then (2a -3b) is.

Ans. 0

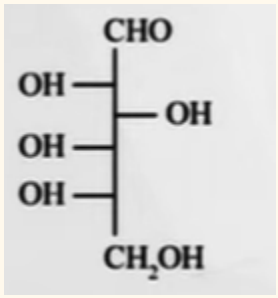
Solu. a= 3/k

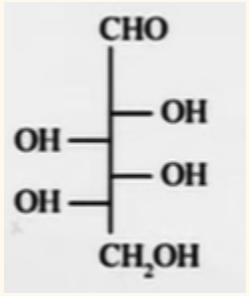
b= 2/k

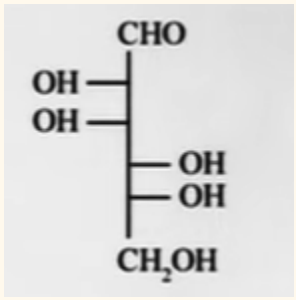
=> 2a-3b =0

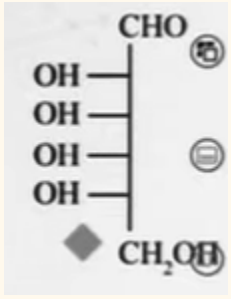
JEE Main Chemistry Questions

Ques 1. Which of the following is the correct structure of L- Glucose

A. 

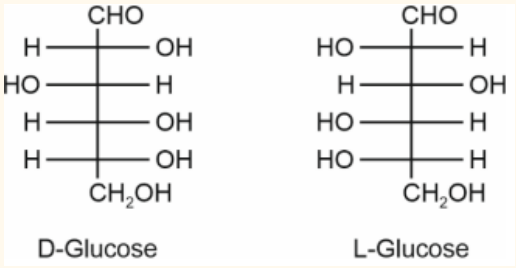
B. 

C. 

D. 

Ans. B

Solu.

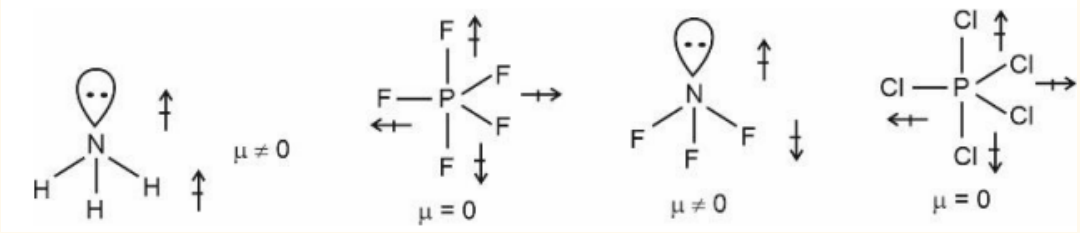


Ques 2. Which of the following has a maximum dipole moment?

- **A. NH_3**
- **B. NF_3**
- **C. PF_5**
- **D. PCl_5**

Ans. A

Solu. NH3 has greater dipole moment than NF3



Ques 3. If emf of hydrogen electrode at 25 ℃ is zero in pure water, then pressure of H_2 in bar is?

- **A. 10^{-14}**
- **B. 10^{-7}**
- **C. 1**
- **D. 0.5**

Ans. A

Solu. $E_{SHE} = -0.0591/2 * \log(P_{H2}/[H^+]^2)$

$P_{H2} = (10^{-7})^2$

$= 10^{-14}$ bar

Ques 4. For which of the following elements, only one oxidation state is possible?

- **A. Sc**
- **B. Co**
- **C. Ni**
- **D. Fe**

Ans. A
Solu. Only +3 oxidation state is possible for Sc For other options, more than one oxidation states are possible, correct answer is A

Ques 5. Among the following, decreasing order of basic strength will be:

OH^-, H^-, $HCOO^-$, CH_3COO^-, ^-OR

(I) (II) (III) (IV) (V)

- **A. II > V > III > | > IV**
- **B. II > V > I > IV > III**
- **C. III > IV > I > V > II**
- **D. V > I > IV > II > III**

Ans. B
Solu. Basic strength= 1/ Strength of conjugate acid
Acidic strength: HCOOH > CH3COOH > H2O > ROH > H2 Basic strength: HCOO– < CH3COO– < OH– < RO– < H–

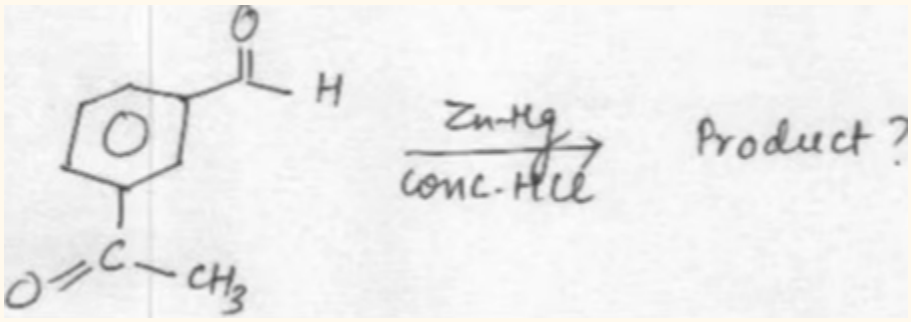
Ques 6. Which of the following is the correct order of first ionization enthalpy?

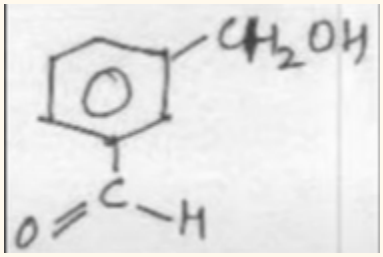
- **A. Be<B<O<F<N**
- **B. B<Be<O<N<F**

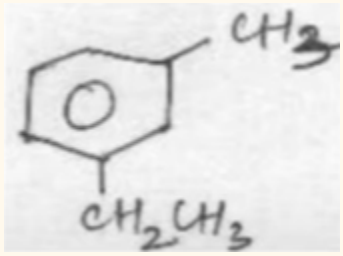
C. B < Be < N < F < O
D. Be < B < N < F < O

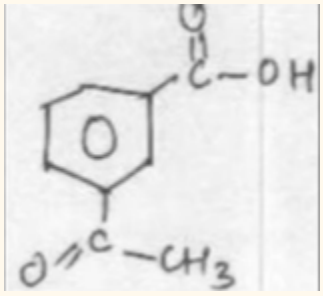
Ans. B
Solu. Be has more value of first ionization enthalpy than B due to fully filled configuration and N has more value of first ionization enthalpy than O due to half filled configuration The correct order is B < Be < O < N < F

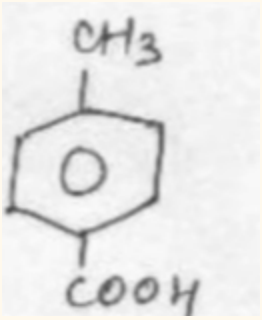
Ques 7.



A. 

B. 

C. 

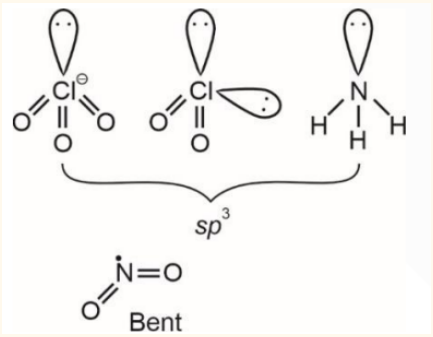
D. 

Ans. B
Solu. This is an example of Clemmensen reduction reaction. In this reaction carbonyl group is reduced to methylene group.

Ques 8. How many of the following compounds are sp^3 hybridised

A. ClO^-_3
B. ClO^-_2
C. NH_3,
D. NO_2

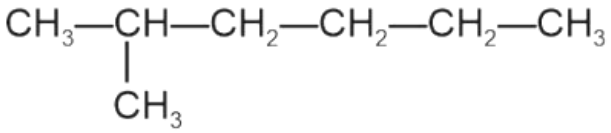
Ans. 3

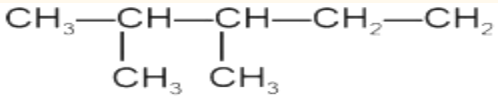
Solu. 

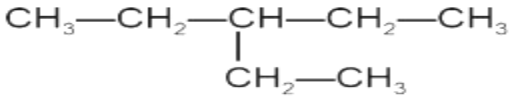
Ques 9. The total number of chain isomers possible for a compound with molecular formula C_7H_{16} are:

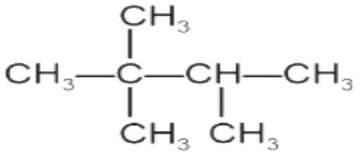
Ans. 9
Solu. C7H16 has DoU = 0

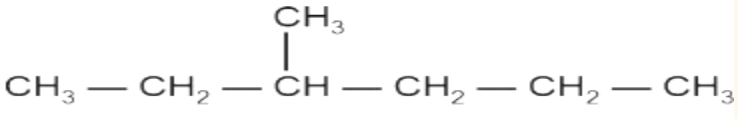
(i) $CH_3—CH_2—CH_2—CH_2—CH_2—CH_2—CH_3$

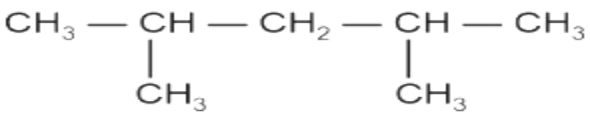
(ii) 

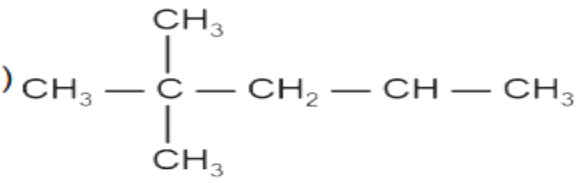
(iii) 

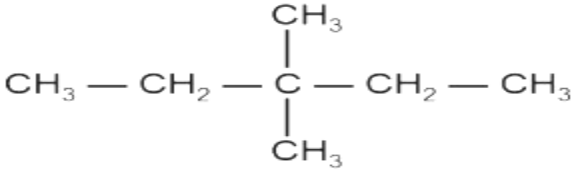
(iv) 

(v) 

(vi) 

(vii) 

(viii) 

(ix) 

Ques 10. Statement-1: Aldol condensation is caused by acidity of a hydrogens.

Statement-2: Cross aldol is not possible between Ph-CHO and CH3CHO

A. Both Statememt-1 and Statement-2 are correct
B. Both Statememt-1 and Stataement-2 are incorrect
C. Statement-1 is correct but Statement-2 is incorrect

D. Statement-1 is incorrect but Statement-2 is correct

Ans. C
Solu. Aldol reaction is given by those carbonyl compounds which have at least one hydrogen atom because -hydrogen of carbonyl compounds is acidic. Benzaldehyde and acetaldehyde will form cross aldol because acetaldehyde has -hydrogen atom.

Ques 11. Which of the following will not give Lassaigne's test?

A. Urea
B. Azobenzene
C. Hydrazine
D. Phenylhydrazine

Ans. C
Solu. Hydrazine (NH2 – NH2) does not contain carbon. On fusion with sodium metal, it cannot form NaCN. So hydrazine does not show Lassaigne's test.

Ques 12. Among the following, species that have one unpaired electron:

A. CN^-
B. O^{-2}_2
C. O^+_2
D. NO^-

Ans. C
Solu. CN →14e→ zero
O →18e →zero
O →15e →one
NO →16e →two

Ques 13. Decreasing order of the field strength of the following ligands will be: CO, CN^- , Cl^-, H_2O

A. CO > CN^- > H_20 > Cl^-
B. CO > CN^- > Cl^- > H_2O
C. CN^- > CO > H_2O > Cl^-
D. CN^- > CO > Cl^- > H_2O

Ans. A

JEE Main Mathematics Questions

Ques 1. If f(x) =

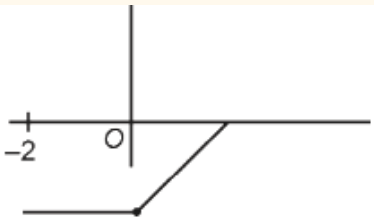
$$\begin{cases} x-2, & 0 \le x \le 2 \\ -2, & -2 \le x \le 0 \end{cases}$$

and h(x) = f(|x|) + |f(x)|, $\int_0^k h(x)\,dx$ is equal to _____.(k>0)

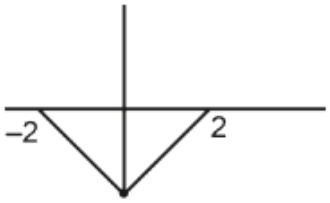
A. 0
B. k/2
C. 2k
D. K

Ans. A

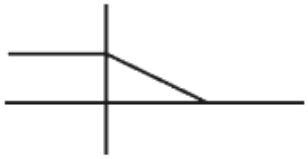
Solu. Graph of f(x)



$f(|x|)$



$$\Rightarrow f(|x|) = \begin{cases} -2-x, & x<0 \\ x-2, & x>0 \end{cases}$$



$$|f(x)| = \begin{cases} 2, & x<0 \\ 2-x, & x>0 \end{cases}$$

$$\Rightarrow h(x) = f(|x|) + |f(x)| = \begin{cases} -x, & x<0 \\ 0, & x>0 \end{cases}$$

$$\Rightarrow \int_0^k h(x)dx = \int_0^k 0dx = 0$$

Ques 2. Find the number of rational numbers in the expansion of $(2^{1/5} + 5^{1/3})^{15}$.

A. 3133
B. 6131
C. 931
D. 633

Ans. A

Solu. Tr + 1 = 15Cr(51/3) r (21/5) 15-r , r {0, 1, ….15}

$$= {}^{15}C_r 5^{\left(\frac{r}{3}\right)} \cdot 2^{\left(3-\frac{r}{5}\right)}, \qquad r \in \{0, 1, \ldots 15\}$$

For rational terms, r/3 ∈ integer and r/5 ∈ integer
=> 3 and 5 divides r => 15 divides r
=> r = 0 and 15
=> only 2 rational terms

Ques 3. Three urn A, B, C, A has 7 red and 5 black balls, B has 5 red and 7 black balls, C has 6 red and 6 black balls. One urn is selected and black ball is taken out. Find probability that the selected urn is A.

A. 7/18
B. 5/17
C. 7/19
D. 5/18

Ans. D

Solu. Urn A has 7 red, 5 black balls
Urn B has 5 red, 7 black balls.
Urn C has 6 red, 6 black balls
If ball drawn is black then probability that it is chosen from urn A.

$$= \frac{\frac{1}{3} \times \frac{5}{12}}{\frac{1}{3} \times \frac{5}{12} + \frac{1}{3} \times \frac{7}{12} + \frac{1}{3} \times \frac{6}{12}}$$

$$= \frac{\frac{5}{36}}{\frac{5}{36} + \frac{7}{36} + \frac{6}{36}}$$

$$= \frac{\frac{5}{36}}{\frac{18}{36}} = \frac{5}{18}$$

Ques 4. Find $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{\sin^2 x}{1+2^x} dx$

A. π/4
B. π/8
C. 4π
D. π/2

Ans. A

Solu.

$$I = \int_0^{\pi/2} \left(\frac{\sin^2 x}{1+2^x} + \frac{\sin^2 (x)}{1+2^{-x}} \right) dx$$

$$I = \int_0^{\pi/2} \sin^2 x \, dx$$

$$I = \int_0^{\pi/2} \cos^2 x \, dx$$

$$2I = \int_0^{\pi/2} 1 \, dx$$

$$I = \frac{\pi}{4}$$

Ques 5.

$$f(x) = \frac{2x^2-3x+8}{2x^2+3x+8}$$

Then sum of maximum and minimum values of f(x) is:

A. 136/55
B. 146/55
C. 146/11
D. 136/11

Ans. B

Solu.

$y = \frac{2x^2 - 3x + 8}{2x^2 + 3x + 8}$, $2x^2+3x+8>0 \ \forall \ x \in R$

$x^2(2y - 2) + x(3y + 3) + 8y - 8 = 0$ Since x R, the equation has real roots

Discriminant is greater than or equal to 0

$(3y + 3)2 - 4(2y - 2)(8y - 8) >= 0$

$9(y + 1)2 - 64y(y - 1)2>=0$

$(3y + 3)2 - (8y - 8)2>=0$

$(11y - 5)(-5y + 11)>= 0$

$(y-15/11)(y-11/5)<=0$

$y \in [5/11, 11/5]$

Sum of y_{max} and y_{min} = 5/11 +11/5

= 146/55

Ques 6. The coefficient of x^7 in $(1 - x - x^2 + x^3)^6$

A. 132
B. 144
C. -132
D. -144

Ans. D

Solu. Coefficient of x^7 in $(1 - x)^6 (1 - x^2)^6$

${}^6C_1 \, {}^6C_3 - {}^6C_3 \, {}^6C_2 + {}^6C_5 \, {}^6C_1$

$120 - 15 \times 20 + 6 \times 6$

$120 - 300 + 36 = -144$

Ques 7. If $(z)^2 + |z| = 0$ and if a is sum of roots and ß is product of non-zero roots, then find $4(\alpha^2 + ß^2)$

A. ¼
B. 1
C. 4
D. 2

Ans. C

Solu.

$(\bar{z})^2 + |z| = 0$

Let $z = x + iy$

$\Rightarrow (x - iy)^2 + \sqrt{x^2 + y^2} = 0$

$\Rightarrow (x^2 - y^2) + \sqrt{x^2 + y^2} - 2xyi = 0$

$\Rightarrow x^2 - y^2 + \sqrt{x^2 + y^2} = 0$ and $2xy = 0$

$\Rightarrow x = 0$ and $y \neq 0$

Case I

$\Rightarrow -y^2 + |y| = 0 \Rightarrow |y| = y^2 \Rightarrow y = \pm 1$

Cas II

$x \neq 0$ and $y = 0$

$\Rightarrow x^2 + |x| = 0 \Rightarrow x = 0$ only not possible

$\Rightarrow x = 0, y = 0$ satisfies

$\Rightarrow z = i, -i, 0$ are solution

$\alpha = i - i = 0$

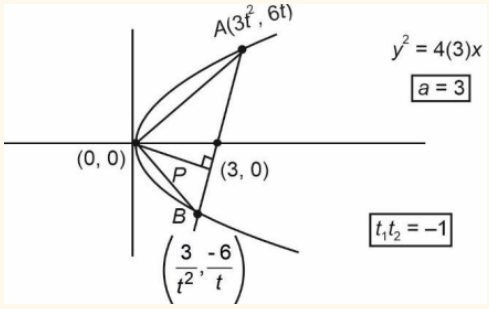
$\beta = (i)(-i) = -1 \Rightarrow 4(\alpha^2 + \beta^2) = 4$

Ques 8. If the length of focal chord of $y^2 = 12x$ is 15 and if the distance of the focal chord from origin is p then $10p^2$ is equal to:

A. 36
B. 25
C. 72
D. 144

Ans. C

Solu.



$\Rightarrow AB = 15$

$$\left(3t^2-\frac{3}{t^2}\right)^2+\left(6t+\frac{6}{t}\right)^2=225$$

$$\Rightarrow 9\left(t^2-\frac{1}{t^2}\right)^2+36\left(t+\frac{1}{t}\right)^2=225$$

$$\Rightarrow 9\left(t+\frac{1}{t}\right)^2\left[\left(t-\frac{1}{t}\right)^2+4\right]=225$$

$$\Rightarrow 9\left(t+\frac{1}{t}\right)^2\left(t+\frac{1}{t}\right)^2=225$$

$$\Rightarrow t+\frac{1}{t}=\left(\frac{225}{9}\right)^{1/4}=(25)^{1/4}=\sqrt{5}$$

Equation of $AB \equiv (y-0)=\frac{2}{\left(t-\frac{1}{t}\right)}(x-3) \Rightarrow \left|t-\frac{1}{t}\right|=1$

$\Rightarrow y = 2x - 6 \Rightarrow y - 2x + 6 = 0$

Distance from origin $\Rightarrow P=\frac{6}{\sqrt{5}} \Rightarrow 10P^2=\frac{10\times 36}{5}$

$= 72$

Ques 9.

$$\text{If } f(x)=\begin{cases}\dfrac{1-\cos x}{x^2}\,;x<0\\ 2\,;x=0\\ \dfrac{\beta\sqrt{1-\cos x}}{x}\,;x>0\end{cases}$$

is continuous at x = 0, then $\alpha^2 + ß^2 = ?$

A. 10
B. 12
C. 13
D. 9

Ans. B
Solu. Given f(x) is continuous at x = 0

$$\therefore \lim_{x\to 0^-} f(x) = f(0) = \lim_{x\to 0^+} f(x)$$

When $x < 0$, $x = 0 - h$

$$\therefore \lim_{h\to 0} \frac{1-\cos(\alpha(0-h))}{(0-h)^2}$$

$$= \lim_{h\to 0} \frac{1-\cos(h\alpha)}{h^2}$$

$$= \lim_{h\to 0} \left(\frac{1-\cos(\alpha h)}{\alpha^2 h^2}\right)\alpha^2$$

$$= \alpha^2 \lim_{h\to 0} \frac{1-\cos(\alpha h)}{(\alpha h)^2}$$

$$= \frac{\alpha^2}{2} \qquad \ldots(1)$$

When $x > 0$

$x = 0 + h$

$$\lim_{h\to 0} \frac{\beta\sqrt{1-\cos h}}{h} = \lim_{h\to 0} \frac{\beta\sqrt{\frac{1-\cosh}{h^2}\cdot h^2}}{h}$$

$$= \frac{\beta}{\sqrt{2}} \qquad \ldots(2)$$

as $f(0) = 2$ $\qquad \ldots(3)$

$\therefore$ From (1), (2) and (3)

$$\frac{\alpha^2}{2} = 2, \qquad \frac{\beta}{\sqrt{2}} = 2$$

$$\alpha = 2, \qquad \beta = 2\sqrt{2}$$

$\alpha^2 + \beta^2 = 4 + 8 = 12$

Ques 10. In $\triangle ABC$, there are 18 points. On side AB, there are P1, P2, P3, P4, P5 . On BC, P6, P7, P8, P9, P10, P11 points. On CA, P12, ... ,

P18 points. By joining any three points from P1, P2, ... , P18 forms a triangle. How many triangles are possible.

Ans. 751
Total ways to select three points out of 18 points = 18C3 Total ways to select 3 points from P1…P5 = 5C3 Total ways to select 3 points from P6…P11 = 6C3 Total ways to select 3 points from P12…P18 = 7C3 Total number of triangles possible = $^{18}C_3 - {}^5C_3 - {}^6C_3 - {}^7C_3 = 751$

Solu. Total ways to select three points out of 18 points = $^{18}C_3$
Total ways to select 3 points from $P_1 \ldots P_5 = {}^5C_3$
Total ways to select 3 points from P6…P11 = $^6C_3$
Total ways to select 3 points from P12…P18 = $^7C_3$
Total number of triangles possible = $^{18}C_3 - {}^5C_3 - {}^6C_3 - {}^7C_3 = 751$

Ques 11.

$$\text{If } \lim_{x\to 1} \frac{(5x+1)^{\frac{1}{3}}-(x+5)^{\frac{1}{3}}}{(2x+3)^{\frac{1}{2}}-(x+4)^{\frac{1}{2}}} = \frac{m(5)^{\frac{1}{2}}}{n(2n)^{\frac{2}{3}}}$$

Then 8m + 12n is ?

Ans. 100
Solu.

$$\lim_{x\to 1}\frac{(5x+1)^{1/3}-(x+5)^{1/3}}{(2x+3)^{1/2}-(x+4)^{1/2}}$$

$$\lim_{x\to 1}\frac{\frac{1}{3}(5x+1)^{-2/3}\cdot 5-\frac{1}{3}(x+5)^{-2/3}}{2\times\frac{1}{2}(2x+3)^{-1/2}-\frac{1}{2}(x+4)^{-1/2}}$$

$$=\frac{\frac{1}{3}\times\frac{5}{(6)^{2/3}}-\frac{1}{3}\times\frac{1}{(6)^{2/3}}}{\frac{1}{2}\times\frac{2}{(5)^{1/2}}-\frac{1}{2}\times\frac{1}{(5)^{1/2}}}$$

$$=\frac{\frac{4}{3\times(6)^{2/3}}}{\frac{1}{2.(5)^{1/2}}}=\frac{8(5)^{1/2}}{3(6)^{2/3}}=\frac{m(5)^{1/2}}{n(2n)^{2/3}}$$

m = 8, n = 3

8m + 12n = 64 + 36 = 100

Ques 12. In a G.P., T1 = 2, T2 = P,T3 = Q. These are also terms of an A.P. (7th, 8th & 13th term). If 5th term of G.P. = nth term of A.P., then find n.

Ans. 27

Solu. $T_1 = 2$, a = 2

$T_2 = P$, $2r = P \Rightarrow r = P/2$

$T_3 = Q$, $2r^2 = Q$, $r^2 = Q/2$

a' + 6d = 2 …(1)

a' + 7d = P …(2)

a' + 12d = Q …(3)

d = 2(r – 1)

2r (r – 1) = 5d

5d/d = -2r(r-1)/ 2(r-1)

r =5 =>d = 8

a + 48 = 2

a = – 46

$2.3^4 = -46 + (n-1)\times 8$

n = 27