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Class: XII
Subject: Mathematics
Topic: ASK15E11UT03
No. of Questions: 30
Duration: 90 Min
Maximum Marks: 90

1. If the third term of a G.P. is equal to 4, then product of it's first five terms is equal to:

(A) 2^6 (B) 2^{10}

(C) 2^8 (D) None of these

Sol. (A)

The r^{th} term of the series is given by $T_r = (n - r + 1)r$

Sum of the series = $\sum_{r=1}^{n} T_r = (n+1)\sum_{r=1}^{n} r - \sum_{r=1}^{n} r^2$

$\Rightarrow S_n = \frac{(n+1)n(n+1)}{2} - \frac{n(n+1)(2n+1)}{6}$

$\Rightarrow S_n = \frac{n(n+1)}{2}\left[(n+1) - \frac{2n+1}{3}\right] = \frac{n(n+1)(n+2)}{6}$

2. If a, b, c be in AP and a^2, b^2, c^2 be in HP, then $-\frac{a}{2}$, b, c are in:

(A) A.P. (B) G. P.

(C) H. P. (D) can't be said

Sol. (B)

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$$\frac{1}{b-a}+\frac{1}{b-c}=\frac{2b-(a+c)}{(b-a)(b-c)}$$

$$=\frac{2b-(a+c)}{b^2-b(a+c)+ac}$$

$$=\frac{2b-(a+c)}{b^2-2ac+ac}$$

$$=\frac{2b-(a+c)}{b^2-ac}$$

$$=\frac{2b-\frac{2ac}{b}}{b^2-ac}=\frac{2}{b}$$

3. Value of $\frac{1}{1.3.5}+\frac{1}{3.5.7.}+\frac{1}{5.7.9}+.....'n'$ terms is equal to:

(A) $\frac{4n^2+8n}{12(2n+1)(2n+3)}$

(B) $\frac{1}{4}\left(\frac{1}{(2n+1)(2n+3)}-\frac{1}{3}\right)$

(C) $\frac{4n^2+6n}{12(2n+1)(2n+3)}$

(D) None of these

Sol. (A)

$a_1, a_2, a_3, \ldots, a_n$ are in H. P. Then $\frac{1}{a_1}, \frac{1}{a_2}, \frac{1}{a_3}, \ldots\ldots, \frac{1}{a_n}$ are in A.P.

$$\Rightarrow \frac{1}{a_2}-\frac{1}{a_1}=\frac{1}{a_3}-\frac{1}{a_2}=\frac{1}{a_4}-\frac{1}{a_3}=\ldots\ldots=\frac{1}{a_n}-\frac{1}{a_{n-1}}=d \quad \text{(say)} \ldots . (1)$$

$$\Rightarrow a_1a_2=\frac{a_1-a_2}{d}, a_2a_3=\frac{a_2-a_3}{d}, a_3a_4=\frac{a_3-a_4}{d}, \ldots, a_{n-1}a_n=\frac{a_{n-1}-a_n}{d}$$

$$a_1a_2 + a_2a_3 + a_3a_4 + \ldots + a_{n-1}a_n = \frac{1}{d}(a_1 - a_n). \ldots \quad (2)$$

If we add all (n-1) terms of (1), we get

$$\frac{1}{a_n}-\frac{1}{a_1}=(n-1)\,d \Rightarrow \frac{a_1-a_n}{d}=(n-1)a_1a_n.$$

Thus from (2) $a_1a_2 + a_2a_3 + a_3a_4 + \ldots + a_{n-1}a_n = (n-1)a_1a_n$.

4. If a, b, c and d are distinct positive numbers in H.P. , then

(A) a+b > c+d (B) a+c > b+d

(C) a+d > b+c (D) none of these

Sol. (C)

$$A_1=\frac{a+b}{2}, G_1=a.\left(\frac{b}{a}\right)^{1/3}, G_2=a.\left(\frac{b}{a}\right)^{2/3}$$

$$G_1^3=a^2b,\ G_2^3=b^2a,\ G_1G_2=a^2.\left(\frac{b}{a}\right)=ab$$

$$\Rightarrow \frac{G_1^3+G_2^3}{G_1G_2A_1}=\frac{ab(a+b).2}{ab(a+b)}=2$$

5. If a, b, c $\in R^+$ such that a + b + c = 18, then the maximum value of $a^2b^3c^4$ is equal to:

(A) $2^{18}.3^2$ (B) $2^{18}.\ 3^3$

(C) $2^{19}.\ 3^2$ (D) $2^{19}.\ 3^3$

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Sol. (B)

$S_n = 5n^2 + 2n$, $S_{n-1} = 5(n-1)^2 + 2(n-1)$

$\Rightarrow T_n = S_n - S_{n-1} = 10n - 3 \Rightarrow T_2 = 20 - 3 = 17$

6. H_1 is the H.M. and G_1 is the G.M. of positive real numbers 'a' and 'b'. If $H_1 : G_1 = 4 : 5$ then a : b is:

(A) 5 : 4 (B) 1 : 4

(C) 1 : 5 (D) None of these

Sol. (B)

$2\angle B = \angle A + \angle C$

$\Rightarrow \angle B = \frac{\pi}{3}$

$\Rightarrow \cos\frac{\pi}{3} = \frac{a^2 + c^2 - b^2}{2ac} = \frac{1}{2}$

$\Rightarrow a^2 + c^2 - ac = b^2$

7. $A_i(x_i, y_i)$, i = 1, 2, …., n is a point on the curve $y = 2\sqrt{x}$. If $x_1, x_2, \ldots. x_n$ are in G.P. with $x_1 = 1, x_2 = 2$, then y_n is equal to:

(A) $\left(\sqrt{2}\right)^n$ (B) $\left(\sqrt{2}\right)^{n+1}$

(C) 2^n (D) None of these

Sol. (C)

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a, b, c are in H.P. $\Rightarrow$ b = $\frac{2ac}{a+c} \Rightarrow \frac{b}{a} = \frac{2c}{a+c} \Rightarrow \frac{b+a}{b-a} = \frac{3c+a}{c-a}$ . . . . (A)

Again a, b, c are in H.P.

$\Rightarrow$ b = $\frac{2ac}{a+c} \Rightarrow \frac{b}{c} = \frac{2a}{a+c} \Rightarrow \frac{b+c}{b-c} = \frac{3a+c}{a-c}$ . . . . (B)

From (A) and (B) $\frac{b+a}{b-a} + \frac{b+c}{b-c} = \frac{3c+a}{c-a} + \frac{3a+c}{a-c}$ = 2.

8. The least value of the expression $5^{\sin x-1} + 5^{-\sin x-1}$

(A) 2/5 (B) 1/5

(C) 5 (D) 5/2

Sol. (C, D)

Let α be the first and β be the (2n-1) terns of an A.P. , G.P. and H.P. , then α, a, β will be in A.P. , α, b, β will be G.P. α, c, β will be in H.P.

Hence a, b, c are respectively A. M. , G.M. and H.M. of α and β.
Since A.M. $\geq$ G.M. $\geq$H.M. , a $\geq$ b $\geq$ c.
Again a = $\frac{\alpha+\beta}{2}$, b2 = $\alpha\beta$ and c = $\frac{2\alpha\beta}{\alpha+\beta}$. Hence ac-$b^2$ =0.

9. Sum of first 'n' terms of the sequence 5, 7, 11, 17, 25,…. is equal to:

(A) $\frac{2n\left(n^2+4\right)}{3}$ (B) $\frac{n^2\left(n+4\right)}{2}$

(C) $\frac{n}{6}\left(n^2+29\right)$ (D) $\frac{n}{6}\left(2n^2+28\right)$

Sol. (A)

Using A. M. $\geq$ G. M. $\frac{1}{3}\left(\frac{a}{b}+\frac{b}{c}+\frac{c}{a}\right) \geq \left[\left(\frac{a}{b}\right)\left(\frac{b}{c}\right)\left(\frac{c}{a}\right)\right]^{1/3} \Rightarrow \frac{a}{b}+\frac{b}{c}+\frac{c}{a} \geq 3.$

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10. If $\log_4 x + \log_4 \sqrt{x} + \log_4 \sqrt[4]{x} + \log_4 \sqrt[8]{x} + \ldots\ldots + \log_4 \sqrt[n]{x} = \log_2 x$, then values of n is

(A) 1 (B) 2

(C) 3 (D) infinite

Sol. (D)

$2b = a + c$

$\Rightarrow \quad 8b^3 = (a+c)^3 = a^3 + c^3 + 3ac\,(a + c)$

$\Rightarrow \quad 8b^3 = a^3 + c^3 + 3ac\,(2b)$

$\Rightarrow \quad a^3 + c^3 - 8b^3 = -6\,abc$

11. If $\frac{b+c-2a}{a}$, $\frac{c+a-2b}{b}$, $\frac{a+b-2c}{c}$ are in A.P., then a, b, c are in

(A) A.P (B) G.P

(C) H.P (D) none of these

Sol. (A)

$$S = \frac{1}{1\cdot 4} + \frac{1}{4\cdot 7} + \ldots \infty = \sum_{r=1}^{\infty} \frac{1}{(3r-2)(3r+1)} = \frac{1}{3}\sum_{r=1}^{\infty}\left(\frac{1}{(3r-2)} - \frac{1}{3r+1}\right)$$

$$= \frac{1}{3}\left[\frac{1}{1} - \frac{1}{4} + \frac{1}{4} - \frac{1}{7} + \ldots\right] = \frac{1}{3}$$

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12. If a, b, c, d are in H.P., then ab + bc + cd is equal to:

(A) a(2c + d) (B) c(2a + d)

(C) b(2c + d) (D) None of these

Sol. (B)

$$\frac{1}{b}-\frac{1}{a}=\frac{1}{c}-\frac{1}{b}$$

$$\Rightarrow \quad \frac{a-b}{ab}=\frac{b-c}{bc}$$

$$\Rightarrow \quad \frac{a-b}{b-c}=\frac{a}{c}$$

13. The co-efficient of y in the expansion of $(y^2+c/y)^5$ is

(A) $10\ c^3$ (B) $20\ c^2$

(C) 10 c (D) 20 c

Sol. (A)

$(r + 1)^{th}$ terms = ${}^5C_r\ y^{10-2r}.\ C^r.\ y^{-r}$

power of y = 1

$\Rightarrow 10 - 3\ r = 1 \Rightarrow r = 3$

Required coefficient = ${}^5C_2\ .\ x^3 = 10\ x^3$

14. If the coefficients of x^2 and x^3 in the expansion of $(3 + kx)^9$ are equal, then the value of k is

(A) $-\frac{9}{7}$ (B) $\frac{9}{7}$

(C) $\frac{7}{9}$ (D) None of these.

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Sol. (B)

T_{r+1} In $(3+kx)^9 = {}^9C_r 3^{9-r}(kx)^r$

$= {}^9C_r 3^{9-r} k^r x^r$

$\therefore$ Coefficient of $x^r = {}^9C_r 3^{9-r} k^r$.

Now coefficient of x^2 = coefficient of x^3

$\therefore \quad {}^9C_2 3^{9-2} k^2 = {}^9C_3 3^{9-3} k^3$

$\Rightarrow \quad 36 \times 3^7 k^2 = 84 \times 3^6 k^3$

$\Rightarrow \quad 36 = 28k \quad \Rightarrow \quad k = \frac{9}{7}$.

15. If $(1+x)^n = C_0 + C_1 x + C_2 x^2 + ... + C_n x^n$, then

$C_0 + \frac{C_1}{2} + \frac{C_2}{3} + ... + \frac{C_n}{n+1}$ is equal to

(A) 2^{n+1}

(B) $\frac{2^{n+1} - 1}{n+1}$

(C) $\frac{2^{n+1}}{n+1}$

(D) $2^{n+1} - 1$

Sol. $C_0 + \frac{C_1}{2} + \frac{C_2}{3} + ... + \frac{C_n}{n+1}$

$= 1 + \frac{\frac{n}{1}}{2} + \frac{\frac{n(n-1)}{1.2}}{3} + ... + \frac{1}{n+1}$

$= 1 + \frac{n}{2!} + \frac{n(n-1)}{3!} + ... + \frac{1}{n+1}$

$$= \frac{1}{n+1}\left[(n+1) + \frac{(n+1)n}{2!} + \frac{(n+1)\,n(n-1)}{3!} + \ldots + 1\right]$$

$$= \frac{1}{n+1}\left[{}^{n+1}C_1 + {}^{n+1}C_2 + {}^{n+1}C_3 + \ldots + {}^{n+1}C_{n+1}\right]$$

$$= \frac{1}{n+1}\left[2^{n+1} - {}^{n+1}C_0\right] = \frac{2^{n+1}-1}{n+1}.$$

Hence (B) is the correct answer.

16. The term independent of x in the expansion of $\left(2x + \frac{1}{3x}\right)^6$ is

(A) $\frac{160}{9}$

(B) $\frac{80}{9}$

(C) $\frac{160}{27}$

(D) $\frac{80}{3}$

Sol. $T_{r+1} = {}^6C_r (2x)^{6-r}\left(\frac{1}{3x}\right)^r = {}^6C_r \frac{2^{6-r}}{3^r} x^{6-2r}$

Let T_{r+1} be independent of x.

$\therefore$ 6 – 2r = 0 or r = 3

$\therefore T_{r+1} = T_{3+1} = {}^6C_3 \frac{2^{6-3}}{3^3} x^{6-2(3)}$

$= \frac{20 \times 8}{27} = \frac{160}{27}$

Hence (C) is the correct answer.

17. The middle term in the expansion of $(1+x)^{2n}$ is

(A) ${}^{2n}C_n$

(B) ${}^{2n}C_{n+1}x^{n+1}$

(C) ${}^{2n}C_{n-1}x^{n-1}$

(D) $\frac{1.3.5...(2n-1)}{n!}\times 2^n x^n$

Sol. (D)

2n is even.

$\therefore$ Middle term

$$= T_{\frac{2n+2}{2}} = T_{n+1} = {}^{2n}C_n\, 1^{2n-n} x^n = {}^{2n}C_n x^n$$

$$= \frac{2n!}{n!\,n!}x^n = \frac{1.2.3.4.5.6......2n}{n!\,n!}x^n$$

$$= \frac{1.3.5.......(2n-1)\,2^n.n!}{n!\,n!}x^n$$

18. If the binomial expansion of $(a+bx)^{-2}$ is $\frac{1}{4} - 3x + ...$, where a > 0, then (a, b) is

(A) (2, 12)

(B) (2, 8)

(C) (–2, 12)

(D) None of these.

Sol. (A)

$$(a+bx)^{-2} = a^{-2}\left(1+\frac{b}{a}x\right)^{-2}$$

$$= \frac{1}{a^2}\left[1+(-2)\left(\frac{b}{a}x\right)+......\right] = \frac{1}{a^2} - \frac{2b}{a^3}x + ...$$

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Also, $(a+bx)^{-2} = \frac{1}{4} - 3x + ...$

$\therefore \quad \frac{1}{a^2} = \frac{1}{4} \quad ...(1) \quad$ and $-\frac{2b}{a^3} = -3 \quad ...(2)$

(1) $\Rightarrow a^2 = 4 \Rightarrow a = 2$ and from (2) b = 12

19. $(4 - 5x^2)^{-1/2}$ can be expanded as a power series of x if

(A) $|x| < \sqrt{5}/2$

(B) $|x| < 2/\sqrt{5}$

(C) $-1 < x < 1$

(D) None of these

Sol. (B)

$$(4-5x^2)^{-1/2} = 4^{-1/2}\left(1 - \frac{5}{4}x^2\right)^{-1/2}$$

$$= \frac{1}{2}\left(1 + \left(-\frac{5}{4}x^2\right)\right)^{-1/2}.$$

$\backslash \quad \left|-\frac{5}{4}x^2\right| < 1$ or $\left|-\frac{5}{4}x^2\right| |x^2| < 1$ or $\frac{5}{4}x^2 < 1$

or $x^2 < \frac{4}{5}$ or $|x| < \frac{2}{\sqrt{5}}$.

20. If the coefficient of mth, (m + 1)th and (m + 2)th terms in the expansion $(1+x)^n$ are in A.P., then

(A) $n^2 + 4(4m+1) + 4m^2 - 2 = 0$

(B) $n^2 + n(4m+1) + 4m^2 + 2 = 0$

(C) $(n-2m)^2 = n+2$

(D) $(n+2m)^2 = n+2$

Sol. (C)

We have ${}^nC_{m-1}, {}^nC_m, {}^nC_{m+1}$ in A.P.

$\Rightarrow \; 2\,{}^nC_m = {}^nC_{m-1} + {}^nC_{m+1}$

$$\Rightarrow \frac{2(n!)}{m!(n-m)!} = \frac{n!}{(m-1)!\,(n-m+1)!} + \frac{n!}{(m+1)!\,(n-m+1)!}$$

$$\Rightarrow \frac{2}{m\,(n-m)} = \frac{1}{(n-m+1)\,(n-m)} + \frac{1}{m(m+1)}$$

$$\Rightarrow 2(m+1)\,(n-m+1) = m(m+1) + (n-m+1)(n-m)$$

On simplification, we get

$$n^2 - 4mn + 4m^2 - n - 2 = 0 \;\Rightarrow\; (n-2m)^2 = n+2.$$

21. If n is a positive integer which of the following will always be integers?

I. $(\sqrt{2}+1)^{2n} + (\sqrt{2}-1)^{2n}$

II. $(\sqrt{2}+1)^{2n} - (\sqrt{2}-1)^{2n}$

III. $(\sqrt{2}+1)^{2n+1} + (\sqrt{2}-1)^{2n+1}$

IV. $(\sqrt{2}+1)^{2n+1} - (\sqrt{2}-1)^{2n+1}$

(A) only I and III

(B) only I and II

(C) only I and IV

(D) only II and III’

Sol. (C)

In I and IV only even powers of $\sqrt{2}$ occurs whereas in II and III only odd powers of $\sqrt{2}$ occurs.

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22. Coefficient of x^5 in the expansion of $(1 + x^2)^5(1 + x)^4$ is

(A) 61 (B) 59

(C) 0 (D) 60

Sol. (D)

$(1 + x^2)^5(1 + x)^4 = (1 + 5x^2 + 10x^4 + ...)(1 + x)^4$

$\Rightarrow$ Coefficient of $x^5 = 5 \times {}^4C_3 + 10\times {}^4C_1 = 20 + 40 = 60$.

23. The term independent of x in $\left[\sqrt{\frac{x}{3}} + \sqrt{\left(\frac{3}{2x^2}\right)}\right]^{10}$ is

(A) 1 (B) 5/12

(C) ${}^{10}C_1$ (D) None of these

Sol. General term in the expansion is ${}^{10}C_r\left(\frac{x}{3}\right)^{\frac{r}{2}}\left(\frac{3}{2x^2}\right)^{\frac{10-r}{2}} = {}^{10}C_r\, x^{\frac{3r}{2}-10} \cdot \frac{3^{5-r}}{2^{\frac{10-r}{2}}}$

For constant term, $\frac{3r}{2} = 10 \Rightarrow r = \frac{20}{3}$

Which is not an integer? Therefore, there will be no constant term.

Hence (D) is the correct answer.

24. If $(1+ x + x^2)^n = a_0 + a_1x+ a_2x^2 + \ldots+a_{2n} x^{2n}$, then the value of $a_0 + a_3 + a_6 + \ldots$ is

(A) $a_1+ a_4 +a_7 + \ldots$ (B) $a_1+ a_2 +a_3 + \ldots$

(C) 2^{n+1} (D) none of these.

Sol. (A)

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$(1 + x + x^2)^n = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \dots$

put $x = w, w^2$ we get

$0 = (a_0 + a_3 + a_6 + \dots) + w(a_1 + a_4 + a_7 + \dots) + w^2(a_2 + a_5 + a_8 + \dots)$ … (1)

$0 = (a_0 + a_3 + a_6 + \dots) + w^2(a_1 + a_4 + a_7 + \dots) + w(a_2 + a_5 + a_8 + \dots)$ … (2)

from (1) and (2) we get,

$a_0 + a_3 + a_6 \dots = a_1 + a_4 + a_7 + \dots$

25. The value of ${}^{2n}C_n - {}^nC_1 . {}^{2n-2}C_n + {}^nC_2 . {}^{2n-4}C_n - \dots$ is equal to

(A) 3^n (B) 4^n

(C) 5^n (D) none of these

Sol (D)

${}^{2n}C_n - {}^nC_1\, {}^{2n-2}C_n + {}^nC_2\, {}^{2n-4}C_n - \dots$

= coefficient of x^n in $[{}^nC_0 (1 + x)^{2n} - {}^nC_1 (1 + x)^{2n-2} + {}^nC_2 (1 + x)^{2n-4} - \dots\dots]$

= coefficient of x^n in $[1 - (1 + x)^2]^n = 2^n$

26. If | x | < 1, then the coefficient of x^n in the expansion of $(1 + x + x^2 + x^3 + \dots)^2$ is

(A) n (B) n –1

(C) n + 2 (D) n + 1

Sol. (D)

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$(1 + x + x^2 + x^3 + \ldots)^2 = \left(\frac{1}{1-x}\right)^2 = (1 - x)^{-2} = 1 + 2x + 3x^2 + 4x^3 + \ldots$

coefficient of $x^n = (n + 1)$

27. If $(1+ax)^n = 1+8x+24x^2+\ldots\ldots$ then

(A) a= 3
(B) a= 5
(C) a= 2
(D) none of these

Sol. (C)

$(1 + a x)^n = 1 + n a x + \frac{n(n-1)}{2} a^2 x^2 + \ldots = 1 + 8x + 24x^2 + \ldots \Rightarrow n a = 8$

$n(n-1) a^2 = 48 \Rightarrow n = 4, a = 2$

28. The two successive terms in the expansion of $(1+x)^{24}$ whose coefficients are in the ratio 4 :1 are

(A) 3^{rd} and 4^{th}
(B) 4^{th} and 5^{th}
(C) 5^{th} and 6^{th}
(D) 6^{th} and 7^{th}

Sol: (C)

Let the coefficient of successive terms be ${}^{24}C_r$ and ${}^{24}C_{r+1}$, then

$\frac{{}^{24}C_r}{{}^{24}C_{r+1}} = 4 \Rightarrow \frac{r+1}{(24-r)} = 4 \Rightarrow r = 19$

${}^{24}C_{19}, {}^{24}C_{20} \Rightarrow {}^{24}C_5, {}^{24}C_4 \Rightarrow 6^{th}$ and 5^{th} terms

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29. The co-efficient of x^k $(0 \le k \le n)$ in the expansion of $E = 1+(1+x)+(1+x)^2+...(1+x)^n$ is

(A) ${}^{n+1}C_{k+1}$

(B) ${}^{n}C_{k}$

(C) ${}^{n+1}C_{n-k-1}$

(D) none of these

Sol. (A)

$$E = \frac{(1+x)^{n+1}-1}{(1+x)-1} = \frac{{}^{n+1}C_0 + {}^{n+1}C_1 x + {}^{n+1}C_2 x^2 + ... - 1}{x}$$

$= {}^{n+1}C_1 + {}^{n+1}C_2\ x + {}^{n+1}C_3\ x^2 + \ldots$

Coefficient of $x^4 = {}^{n+1}C_{k+1}$

30. The coefficient of x^n in $\left(1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + ... + \frac{(-1)^n x^n}{n!}\right)^2$ is

(A) $\frac{(-n)^n}{n!}$

(B) $\frac{(-2)^n}{n!}$

(C) $\frac{1}{(n!)^2}$

(D) $-\frac{1}{(n!)^2}$

Sol. (B)

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Coefficient of x^n in $\left(1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \ldots + \frac{(-1)^n x^n}{n!}\right)^2$

Coefficient of x^n in $\left(1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \ldots\right)^2$

Coefficient of x^n in $(e^{-x})^2$

Coefficient of x^n in $e^{-2x} = \frac{(-2)^n}{n!}$