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Double Sigma Problems

Sequences & Series

10

$$\sum_{n=1}^{10} \sum_{i=1}^{n} i$$

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B.Tech, M.Tech - IIT-Roorkee

- **10+** years Teaching experience
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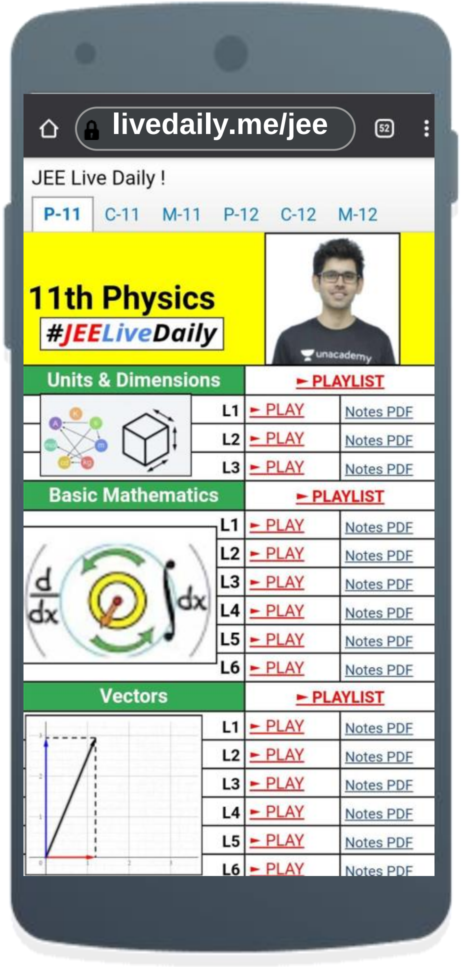

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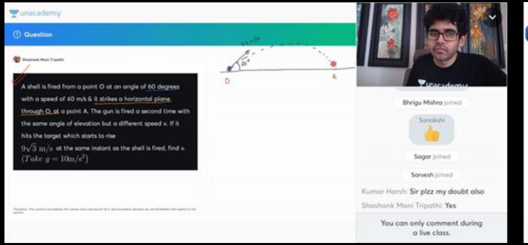

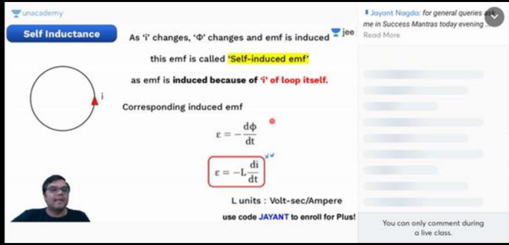

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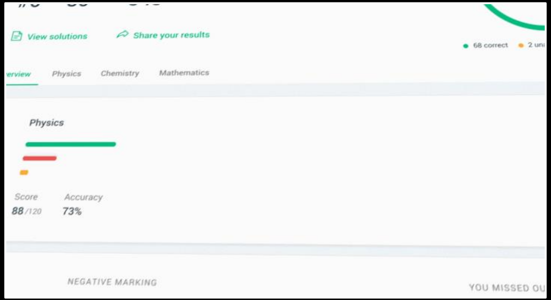

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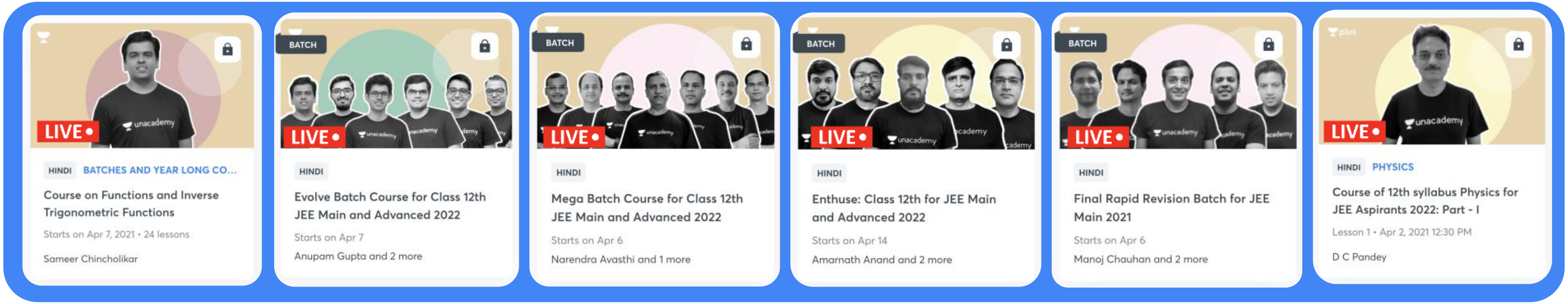

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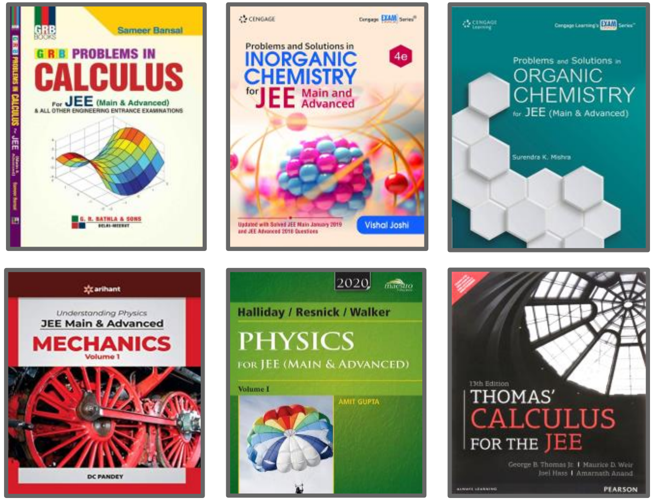


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Double Sigma Problems

Sequences & Series

10

$$\sum_{n=1}^{10} \sum_{i=1}^{n} i$$

Variables independent of each other

Evaluate:

$$\sum_{n=1}^{10}\sum_{i=1}^{n} i$$

$$\sum_{n=1}^{10}(1+2+3+\cdots+n)$$

$$\sum_{n=1}^{10}\frac{n(n+1)}{2} = \frac{1}{2}\left[\sum_{n=1}^{10} n^2 + \sum_{n=1}^{10} n\right]$$

$$= \frac{1}{2}\left[\frac{\cancel{10}^{5} \times 11 \times \cancel{21}^{7}}{\cancel{6}_{\cancel{2}}} + \frac{10 \times 11}{2}\right]$$

$$= \frac{1}{2}\left[385 + 55\right]$$

$$= \boxed{220}$$

Evaluate:

$$\sum_{j=1}^{n}\sum_{i=1}^{n} i.j$$

$$\sum_{j=1}^{n}\sum_{i=1}^{n} i\,j$$

$$\sum_{j=1}^{n} j\sum_{i=1}^{n} i$$

$$\sum_{j=1}^{n} j\cdot\frac{n(n+1)}{2}$$

$$=\frac{n(n+1)}{2}\left(\sum_{j=1}^{n} j\right)$$

$$=\left(\frac{n(n+1)}{2}\right)\left(\frac{n(n+1)}{2}\right)$$

Evaluate:

$$\sum_{j=1}^{n}\sum_{i=1}^{n} i.3^{j}$$

$$= \left(\sum_{j=1}^{n} 3^{j}\right)\left(\sum_{i=1}^{n} i\right)$$

$$= \left(3^{1}+3^{2}+3^{3}+ \cdots +3^{n}\right)\left(\frac{n(n+1)}{2}\right)$$

$$\frac{3(3^n-1)}{(3-1)} \qquad \frac{n(n+1)}{2}$$

$$\boxed{\frac{3}{4}\,n(n+1)(3^n-1)}$$

Evaluate:

$$\sum_{i=1}^{3}\sum_{j=2}^{4}(i+j)$$

$$\sum_{i=1}^{3}\left(\sum_{j=2}^{4} i + \sum_{j=2}^{4} j\right)$$

$$\sum_{i=1}^{3}\left(i\sum_{j=2}^{4} 1 + (2+3+4)\right)$$

$$(1+1+1)$$

$$\sum_{i=1}^{3}(3i+9)$$

$$3\underbrace{\sum_{i=1}^{3} i}_{(1+2+3)} + 9\underbrace{\sum_{i=1}^{3} 1}_{3}$$

$$3(6) + 9(3)$$

$$= 18 + 27$$

$$= 45$$

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Evaluate:

$$\sum_{k=1}^{\infty}\sum_{n=1}^{\infty}\frac{k}{2^{n+k}}$$

$$\sum_{k=1}^{\infty}\sum_{n=1}^{\infty}\frac{k}{2^n\cdot 2^k}$$

$$\underbrace{\left(\sum_{k=1}^{\infty}\frac{k}{2^k}\right)}_{S_1}\cdot\underbrace{\left(\sum_{n=1}^{\infty}\frac{1}{2^n}\right)}_{S_2}$$

$$S_2=\sum_{n=1}^{\infty}\frac{1}{2^n}$$

$$=\frac{1}{2}+\frac{1}{2^2}+\frac{1}{2^3}+\text{----}\infty$$

$$=\frac{1/2}{1-1/2}=1$$

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$$S_1 = \sum_{K=1}^{\infty} \frac{K}{2^K}$$

$$S_1 = \frac{1}{2^1} + \frac{2}{2^2} + \frac{3}{2^3} + \cdots \infty$$

$$\frac{S_1}{2} = \frac{1}{2^2} + \frac{2}{2^3} + \cdots \infty$$

$$\frac{S_1}{2} = \frac{1}{2} + \frac{1}{2^2} + \frac{1}{2^3} + \cdots \infty$$

$$\frac{S_1}{2} = 1 \Rightarrow \boxed{S_1 = 2}$$

$\therefore$ Ans.

$(S_1)(S_2)$

$= 2$

$$\sum_{r=1}^{n} r^2 - \sum_{m=1}^{n} \sum_{r=1}^{m} r$$ is **equal** to

A. 0

B. $\frac{1}{2}\left(\sum_{r=1}^{n} r^2 + \sum_{r=1}^{n} r\right)$

C. $\frac{1}{2}\left(\sum_{r=1}^{n} r^2 - \sum_{r=1}^{n} r\right)$

D. None of these

$$\sum_{m=1}^{n}\sum_{r=1}^{m} r = \sum_{m=1}^{n}\left(\frac{m(m+1)}{2}\right)$$

$$= \frac{1}{2}\sum_{m=1}^{n}(m^2+m)$$

$$\sum_{K=1}^{n} K = \frac{n(n+1)}{2}$$

$$\sum_{t=1}^{n} t = \frac{n(n+1)}{2}$$

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}$$

$$\text{Que} \equiv \sum_{r=1}^{n} r^2 - \sum_{m=1}^{n} \sum_{r=1}^{m} r$$

$$\equiv \sum_{r=1}^{n} r^2 - \frac{1}{2}\left[\sum_{m=1}^{n} m^2 + \sum_{m=1}^{n} m\right]$$

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

$$= \frac{1}{2}\left[\sum_{r=1}^{n} r^2 - \sum_{r=1}^{n} r\right]$$

Find the **value of the expression**

$$\sum_{i=1}^{n}\sum_{j=1}^{i}\sum_{k=1}^{j} 1$$

$$\sum_{i=1}^{n}\sum_{j=1}^{i}\left(\sum_{k=1}^{j} 1\right)$$

$$\sum_{i=1}^{n}\sum_{j=1}^{i}(j)$$

$$= \sum_{i=1}^{n} \frac{i(i+1)}{2}$$

$$= \frac{1}{2}\left[\sum_{i=1}^{n} i^2 + \sum_{i=1}^{n} i\right]$$

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

Variables dependent of each other

Evaluate:

$$\sum_{0 \le i < j \le n}\sum (i.j) = S$$

S

D

S

0 0	0·1	0 2	0 3	- - -	0 n	= 0·Σn
1·0	1 1	1·2	1·3	- - -	1·n	= 1·Σn
2 0	2·1	2·2	2·3	- - -	2·n	= 2·Σn
3 0	3·1	3·2	3·3	- - -	(n-1)n	
n·0	n·1	n·2	n·3	- - -	n·n	n·Σn

$$\text{Total}(T) = 2S + D$$

$$\left(\sum n\right)^2 = 2S + \sum(n^2)$$

$$\boxed{S = \frac{\left(\sum n\right)^2 - \sum(n^2)}{2}}$$

Evaluate:

$$\sum_{i \neq j}\sum (i.j) = T - D$$

$$= \left(\sum n\right)^2 - \left(\sum n^2\right)$$

If for the sequence $\langle a_n \rangle$, sum of n terms is given by $S_n = 2n^2 + 3n$, then find the sum

$$\sum_{1 \le i < j \le 10}\sum a_i \cdot a_j = S$$

S

D

S

$$\begin{array}{llllll}
a_1 \cdot a_1 & a_1 a_2 & a_1 \cdot a_3 & a_1 a_4 & \cdots & a_1 a_{10} = a_1 \cdot S_{10} \\
a_2 a_1 & a_2 a_2 & a_2 \cdot a_3 & a_2 \cdot a_4 & \cdots & a_2 a_{10} = a_2 \cdot S_{10} \\
a_3 a_1 & a_3 a_2 & a_3 a_3 & a_3 \cdot a_4 & \cdots & a_3 \cdot a_{10} = a_3 \cdot S_{10} \\
\vdots & & & & & \vdots \\
 & & & & & a_9 \cdot a_{10} \\
a_{10} a_1 & a_{10} a_2 & \cdots & & & a_{10} \cdot a_{10} \quad a_{10} \cdot S_{10}
\end{array}$$

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$$T = 2S + D$$

$$S = \frac{T - D}{2}$$

$$\boxed{S = \frac{(S_{10})^2 - \sum_{i=1}^{10} a_i^2}{2}}$$

— 1

Now.

$$S_n = 2n^2 + 3n$$

$$S_{10} = 2(100) + 3(10)$$

$$= \boxed{230}$$

— 2

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$$T_n = S_n - S_{n-1}$$

$$= (2n^2 + 3n) - (2(n-1)^2 + 3(n-1))$$

$$= 2(n^2 - (n-1)^2) + 3(n - (n-1))$$

$$= 2(2n-1) + 3$$

$$= 4n+1$$

$$\Rightarrow \boxed{a_i = 4i+1}$$

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Now:

$$\sum_{i=1}^{10} a_i^2 = \sum_{i=1}^{10} (4i+1)^2$$

$$= \sum_{i=1}^{10} (16i^2 + 8i + 1)$$

$$= 16\sum_{i=1}^{10} i^2 + 8\sum_{i=1}^{10} i + \sum_{i=1}^{10} 1$$

$$= \boxed{16\left(\frac{10\times 11\times 21}{6}\right) + 8\left(\frac{10\times 11}{2}\right) + 10} \text{ — } 3$$

using Eq^n 2 & Eq^n 3 in Eq^n 1 :

$\boxed{23145}$

Evaluate:

$$\sum\sum_{1 \le i < j} i \cdot \left(\frac{1}{2}\right)^{j}$$

$$1\left(\frac{1}{2}\right)^{2} + 1\left(\frac{1}{2}\right)^{3} + 1\cdot\left(\frac{1}{2}\right)^{4} + \cdots\cdots \infty$$

$$2\cdot\left(\frac{1}{2}\right)^{3} + 2\left(\frac{1}{2}\right)^{4} + \cdots\cdots \infty$$

$$+ 3\cdot\left(\frac{1}{2}\right)^{4} + \text{———} \infty$$

Using sum of ∞ G.P. in each row.

$$S = \frac{\left(\frac{1}{2}\right)^2}{\left(1 - \frac{1}{2}\right)} + 2\cdot\left(\frac{\left(\frac{1}{2}\right)^3}{\left(1-\frac{1}{2}\right)}\right) + 3\,\frac{\left(\left(\frac{1}{2}\right)^4\right)}{\left(1-\frac{1}{2}\right)} + \cdots \infty$$

$$S = \frac{1}{2} + 2\left(\frac{1}{2}\right)^2 + 3\left(\frac{1}{2}\right)^3 + \cdots \infty$$

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$$S = \frac{1}{2} + \frac{2}{2^2} + \frac{3}{2^3} + \cdots \infty$$

$$\frac{S}{2} = \frac{1}{2^2} + \frac{2}{2^3} + \cdots \infty$$

$$\frac{S}{2} = \frac{1}{2} + \frac{1}{2^2} + \frac{1}{2^3} + \cdots \infty$$

$$S = 2\left(\frac{1/2}{1-1/2}\right) = \boxed{2}$$

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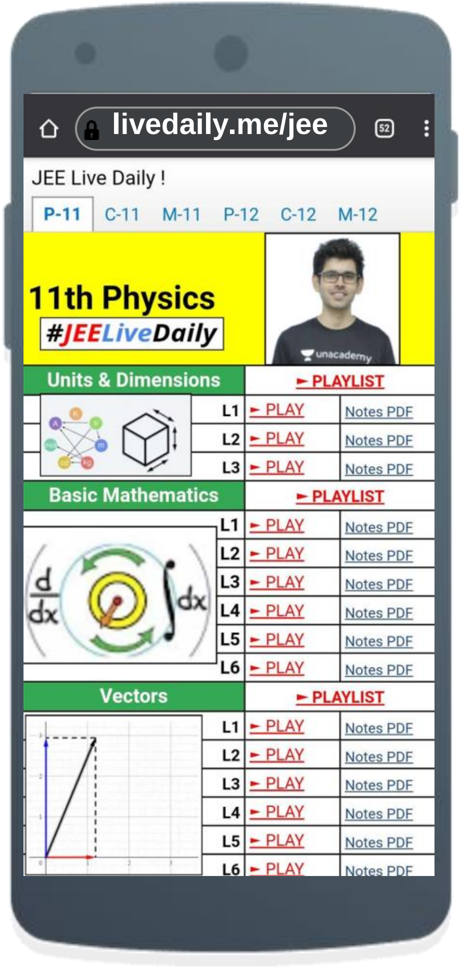

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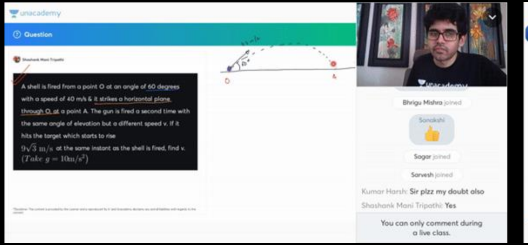

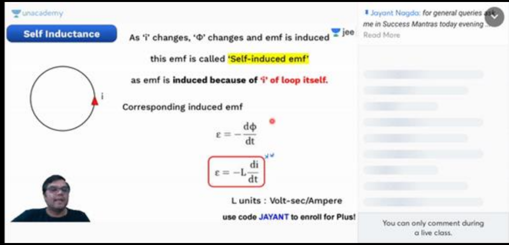

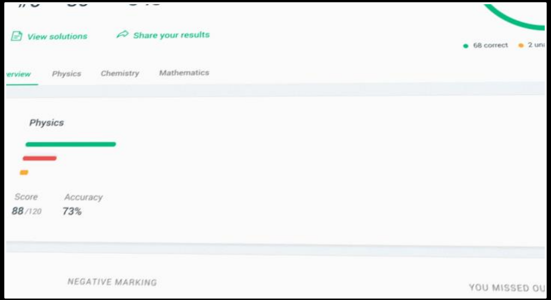

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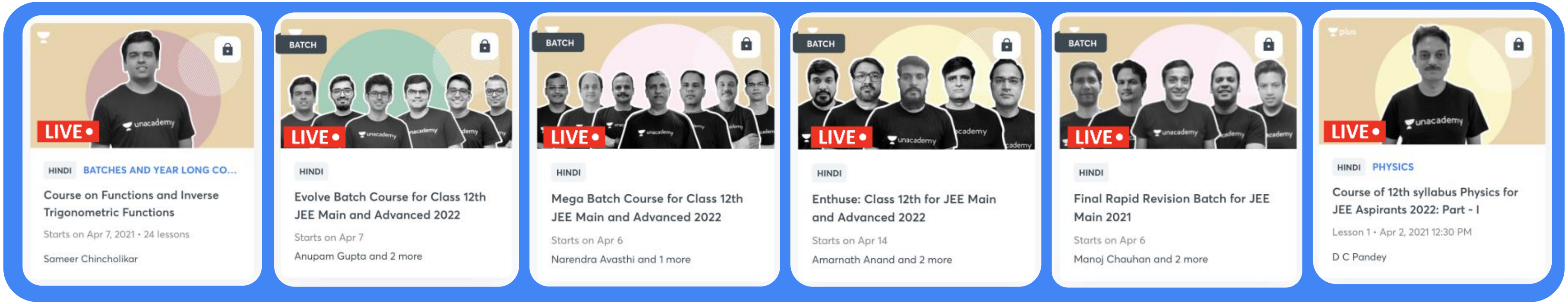

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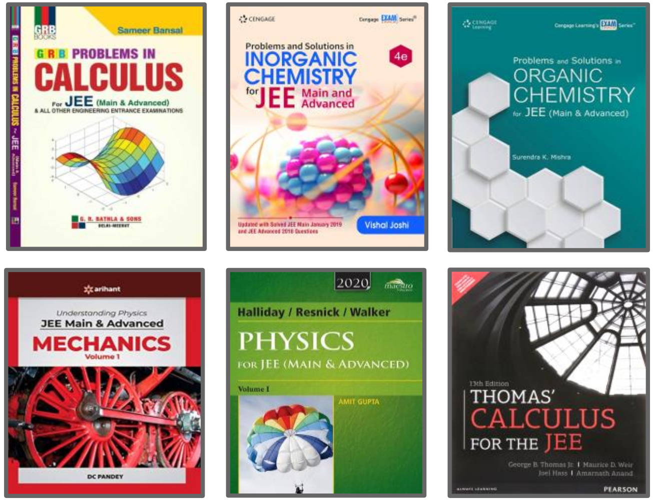


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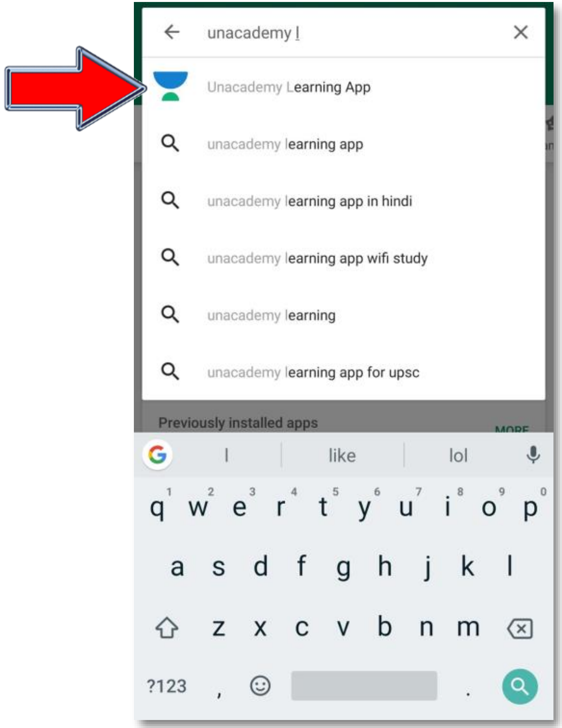
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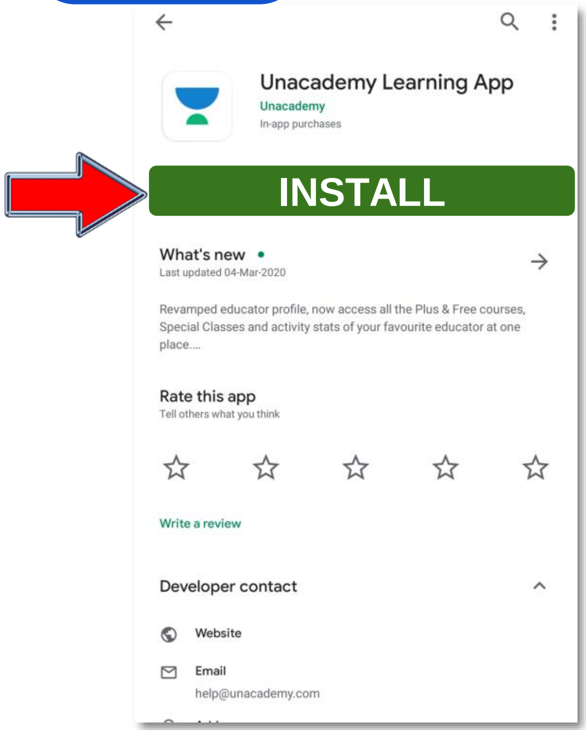
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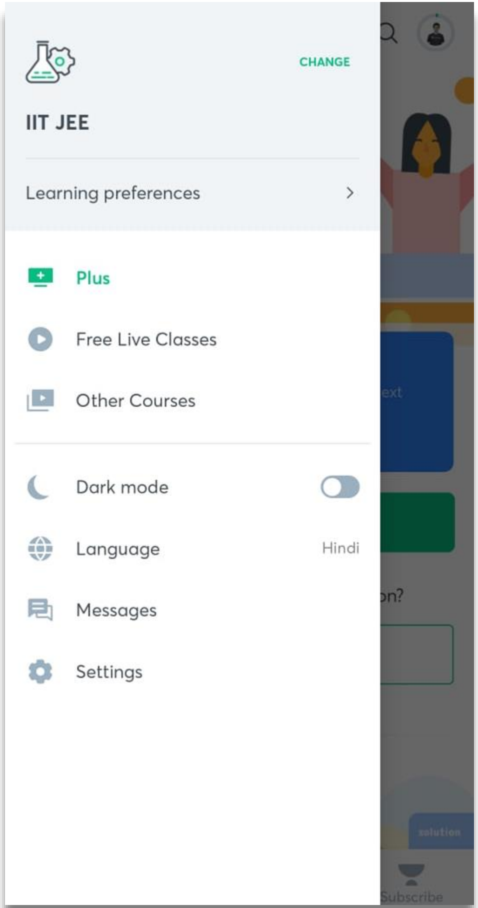
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