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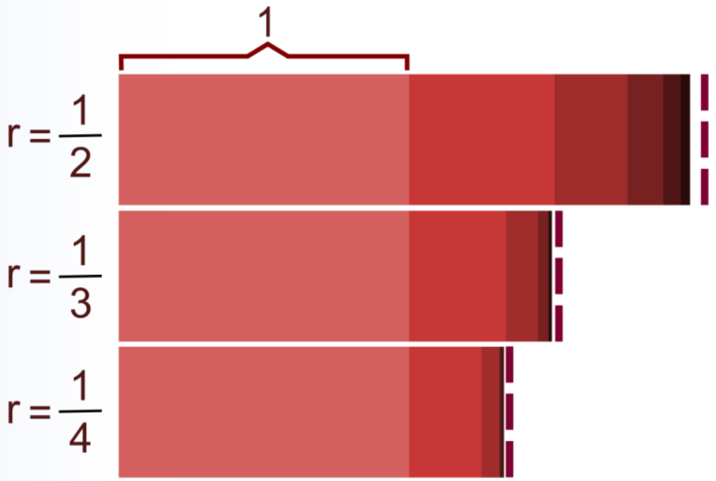
Geometric Progression - 1

Sequences & Series

3



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B.Tech, M.Tech - IIT-Roorkee

- **10+** years Teaching experience
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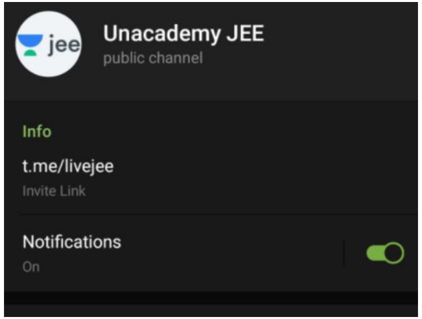

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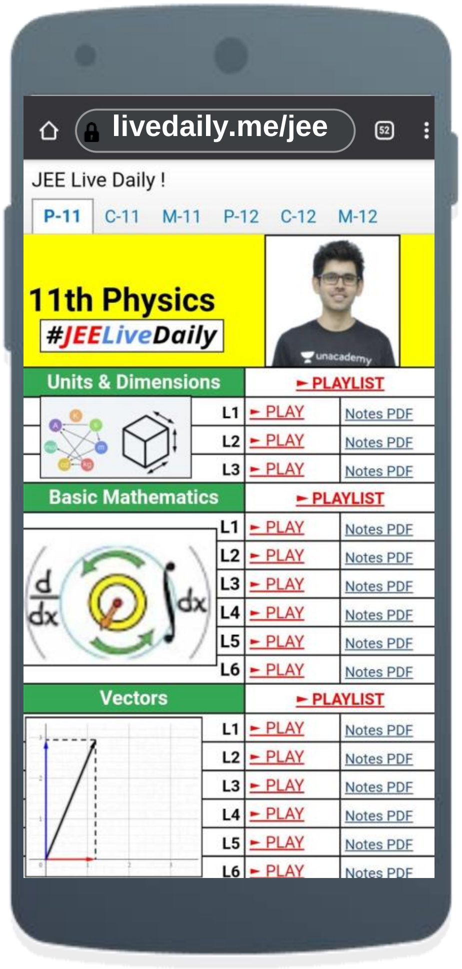

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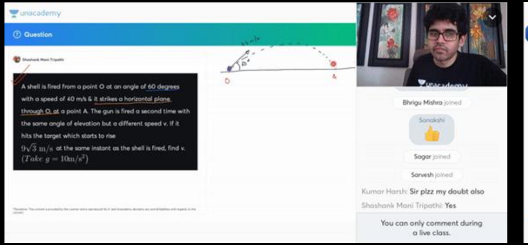

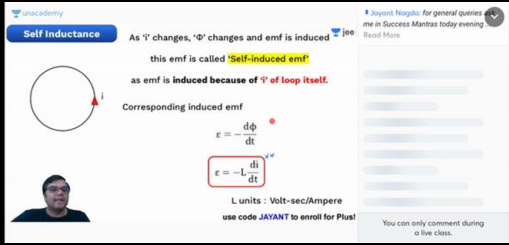

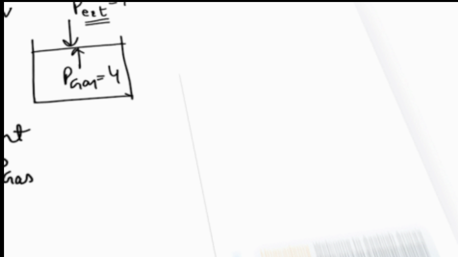

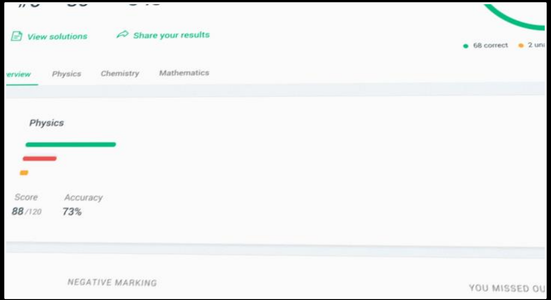

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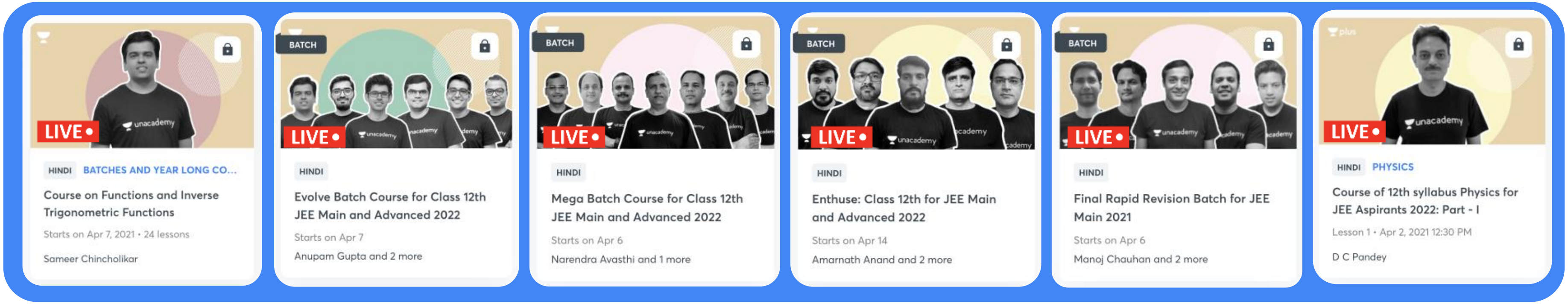

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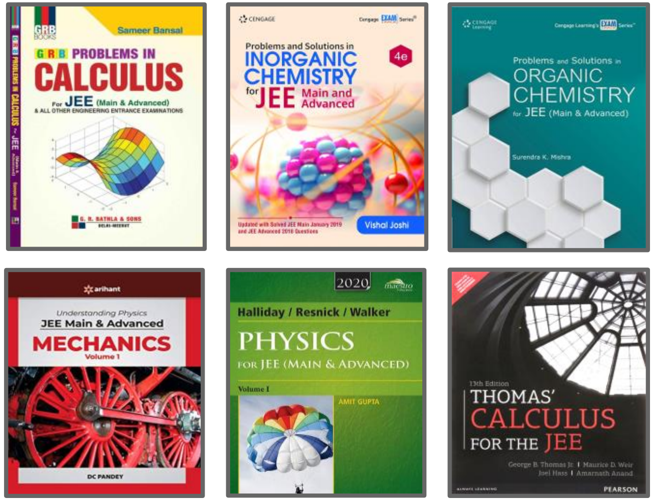

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Adnan 99.95

Ashwin Prasanth 99.94

Tanmay Jain 99.86

Kunal Lalwani 99.81

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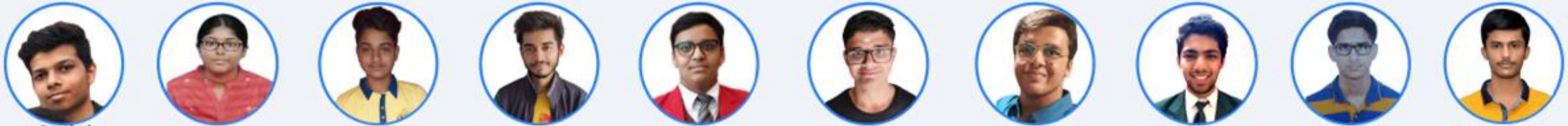
Aravindan K Sundaram 99.69

Manas Pandey 99.69

Mihir Agarwal 99.63

Akshat Tiwari 99.60



Sarthak Kalankar 99.59

Vaishnovi Arun 99.58

Devashish Tripathi 99.52

Maroof 99.50

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Sahil 99.38

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LET'S BEGIN!!

Homework Question

If $\sum_{j=1}^{21} a_j = 693$, where $a_1, a_2, \ldots, a_{21}$, are in A.P., then $\sum_{i=0}^{10} a_{2i+1}$ is

A. 361 **B.** 396 **C.** 363 **D.** Data insufficient

$$a_1 + a_2 + a_3 + \cdots + a_{21} = 693$$

$$\Rightarrow \frac{\cancel{21}}{2}(a_1 + a_{21}) = \cancel{693}\ 33$$

$$\Rightarrow \boxed{a_1 + a_{21} = 66}$$

$$\sum_{i=0}^{10} a_{2i+1} = \underline{\underline{a_1}} + a_3 + a_5 + \cdots + \underline{\underline{a_{21}}}$$

$$a_1 + a_{21} = 66$$

$$a_3 + a_{19} = 66$$

$$a_5 + a_{17} = 66$$

$$a_7 + a_{15} = 66$$

$$a_9 + a_{13} = 66$$

$$a_{11} = \frac{a_1 + a_{21}}{2} = 33$$

$$\sum_{i=0}^{10} a_{2i+1} = 5 \times 66 + 33$$

$$= 330 + 33$$

$$= \boxed{363}$$

Geometric Progression

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Geometric Progression (G.P.)

G.P. is a sequence of numbers whose first term is non zero & each of the succeeding terms is equal to the proceeding terms multiplied by a constant.

This constant multiplier is called common ratio ($r \neq 0$)

Eg: 1, 2, 4, 8, 16, 32, . . . —

$r = \frac{2}{1} = \frac{4}{2} = \frac{8}{4}$

General Term of G.P.

If 'a' is the first term and 'r' the common ratio, of GP

$$a, \; ar, \; ar^2, \; ar^3, \; ar^4, \; \ldots$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$T_1 \quad T_2 \quad T_3 \quad T_4 \quad T_5$$

$$\boxed{T_n = ar^{n-1}}$$

Eg:

$-1, -2, -4, -8, \text{-----} \quad \left\{ \begin{array}{l} a = -1 \\ r = 2 \end{array} \right.$

$1, -2, 4, -8, 16, \text{----} \quad r = -2$

$1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \text{-----} \quad \left\{ r = \frac{1}{2} \right.$

Every term of a G.P. is positive and also every term is the sum of two preceding terms. Then the common ratio of the G.P. is

A. $\frac{1-\sqrt{5}}{2}$ **B.** $\frac{\sqrt{5}+1}{2}$ **C.** $\frac{\sqrt{5}-1}{2}$ **D.** 1

$a, ar, ar^2 \rightarrow$ G.P.

$\Rightarrow ar^2 = a + ar$

$\Rightarrow r^2 = 1 + r$

$r^2 - r - 1 = 0$

$r = \frac{1 \pm \sqrt{1+4}}{2}$

$r = \frac{1-\sqrt{5}}{2}$; $r = \frac{1+\sqrt{5}}{2}$

Let α and β be the roots of $x^2 - 3x + p = 0$ and γ and δ be the roots of $x^2 - 6x + q = 0$. If α, β, γ and δ form a G.P. The ratio of $(2q + p) : (2q - p)$ is:

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A. 3 : 1 **B.** 9 : 7 **C.** 5 : 3 **D.** 33 : 31

$x^2 - 3x + p = 0 ; (\alpha, \beta)$

$\alpha + \beta = 3$ — 1

$\alpha\beta = p$ — 2

$x^2 - 6x + q = 0 ; (\gamma, \delta)$

$\gamma + \delta = 6$ — 3

$\gamma\delta = q$ — 4

$\alpha, \beta, \gamma, \delta \to$ G.P

$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$

a, ar, ar^2, ar^3

using Eqⁿ ①: $(a + ar) = 3$

using Eqⁿ ③: $ar^2 + ar^3 = 6$

$\Rightarrow r^2(a + ar) = 6$

$\Rightarrow \boxed{r^2 = 2}$

Now:

$$\frac{2q + p}{2q - p}$$

$$= \frac{2(\gamma\delta) + (\alpha\beta)}{2(\gamma\delta) - (\alpha\beta)}$$

$$= \frac{2(a^2r^5) + (a^2r)}{2(a^2r^5) - (a^2r)}$$

$$= \frac{2x^4+1}{2x^4-1}$$

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

$$= \boxed{\frac{9}{7}}$$

In a G.P if the **(m + n)th** term be **a** and **(m - n)th** term be **b**, then its mth term is

A. $\sqrt{ab}$ **B.** $\sqrt{\frac{a}{b}}$ **C.** $\sqrt{\frac{b}{a}}$ **D.** $\frac{a}{b}$

$$T_{m+n} = A \cdot R^{m+n-1} = a \quad \text{--- (1)}$$

$$T_{m-n} = A \cdot R^{m-n-1} = b \quad \text{--- (2)}$$

$$T_m = AR^{m-1} = ?$$

Eqⁿ 1 × Eqⁿ 2 .

$$A^2 R^{2m-2} = a \cdot b$$

$$\left(A R^{m-1}\right)^2 = a \cdot b$$

$$A \cdot R^{m-1} = \sqrt{ab}$$

Let a be the first term and b be the n^{th} term of a G.P. if P is the product of n terms, then $\mathbf{P^2}$ =

A. ab **B.** $(ab)^n$ **C.** $(ab)^{n/2}$ **D.** None of these

$T_1 = a$

$T_n = \boxed{b = ar^{n-1}}$

Now:

$P = (a)(ar^1)\cdot(ar^2)\text{ ------ }(ar^{n-1})$

$P = (a^n)\cdot(r)^{1+2+3+\cdots+(n-1)}$

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

$\frac{(n-1)(n)}{2}$

$$P = (a^n)\left(r^{\frac{(n-1)n}{2}}\right)$$

$$\Rightarrow P^2 = (a^{2n})\left(r^{n(n-1)}\right)$$

$$= \left(a^2 \cdot r^{n-1}\right)^n$$

$$= \left(a \cdot ar^{n-1}\right)^n$$

$$\boxed{P^2 = (ab)^n}$$

Let a, b, c, d and p be any non zero distinct real numbers such that $(a^2 + b^2 + c^2)p^2 - 2(ab + bc + cd)p + (b^2 + c^2 + d^2) = 0$. Then

A. a, c, p are in A.P.

B. a, c, p are in G.P.

C. a, b, c, d are in G.P.

D. a, b, c, d are in A.P.

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$$(a^2+b^2+c^2)p^2-2(ab+bc+cd)p+(b^2+c^2+d^2)=0$$

$$a^2p^2+b^2-2abp$$
$$+b^2p^2+c^2-2bcp=0$$
$$+c^2p^2+d^2-2cdp$$

$$(ap-b)^2+(bp-c)^2$$
$$+(cp-d)^2=0$$

$$\begin{cases} ap - b = 0 \\ bp - c = 0 \\ cp - d = 0 \end{cases}$$

$$p = \frac{b}{a} = \frac{c}{b} = \frac{d}{c}$$

$$a,\ b,\ c,\ d$$

$$\frac{b}{a} = \frac{c}{b} = \frac{d}{c} = r$$

$\Rightarrow$ G.P.

Sum of G.P.

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Sum of n terms of G.P.

$$S_n = a + ar + ar^2 + \dots + ar^{n-2} + ar^{n-1} + \boxed{}$$

$$r \cdot S_n = \boxed{} \quad ar + ar^2 + ar^3 + \dots + ar^{n-1} + ar^n$$

$$(1-r)S_n = a - ar^n$$

$$\boxed{S_n = \frac{a(1-r^n)}{(1-r)}}$$

$$S_n = \begin{cases} \dfrac{a(1-r^n)}{(1-r)} & ; r < 1 \\ na & ; r = 1 \\ \dfrac{a(r^n-1)}{(r-1)} & ; r > 1 \end{cases}$$

Sum of infinite terms of G.P.

$\underline{\underline{Eg}}$ $1, 2, 4, 8, \ldots\ldots \infty$: $S_\infty = \infty$

$\underline{\underline{Eg}}$: $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \ldots\ldots \infty$: $S_\infty = ?$

$|r| < 1 \Rightarrow \boxed{-1 < r < 1}$

$$S_n = \frac{a(1-r^n)}{(1-r)}, \quad r < 1$$

$n \to \infty \;;\; (r)^n \longrightarrow 0$

$$\boxed{S_\infty = \frac{a}{1-r}}$$

Eg:

$\left(\frac{1}{2}\right)^{10} \longrightarrow$

$\left(\frac{1}{2}\right)^{100}$

$\left(\frac{1}{2}\right)^{\infty} \longrightarrow 0$

The sum of an infinite G.P., whose first term is 28 and fourth term is $\frac{4}{49}$, is

A. $\frac{98}{3}$ ✓ **B.** $\frac{49}{3}$ **C.** $\frac{78}{3}$ **D.** None of these

$T_4 = ar^3 = \frac{4}{49}$

$\Rightarrow (28)r^3 = \frac{4}{49}$

$\Rightarrow r^3 = \left(\frac{1}{7}\right)^3$

$\boxed{r = \frac{1}{7}}$

$S_\infty = \frac{a}{1-r} = \frac{28}{1-\frac{1}{7}}$

$= \frac{28 \times 7}{6}$

Let a_n be the n^{th} term of the G.P. of positive numbers.

Let $\sum_{n=1}^{100} a_{2n} = \alpha$ and $\sum_{n=1}^{100} a_{2n-1} = \beta$, such that $\alpha \neq \beta$, then the common ratio is

A. $\frac{\alpha}{\beta}$ B. $\frac{\beta}{\alpha}$ C. $\sqrt{\frac{\alpha}{\beta}}$ D. $\sqrt{\frac{\beta}{\alpha}}$

$$\begin{cases} a_2 + a_4 + a_6 + \cdots + a_{200} = \alpha \\ a_1 + a_3 + a_5 + \cdots + a_{199} = \beta \end{cases}$$

$$\begin{cases} ar + ar^3 + ar^5 + \cdots + ar^{199} = \alpha \\ a + ar^2 + ar^4 + \cdots + ar^{198} = \beta \end{cases}$$

$$r\underbrace{\left(a + ar^2 + ar^4 + \cdots + ar^{198}\right)}_{\beta} = \alpha$$

$$r(\beta) = \alpha$$

$$\boxed{r = \frac{\alpha}{\beta}}$$

If S be the sum, P the product and R the sum of the reciprocals of n terms of a G.P. then $\left(\frac{S}{R}\right)^n$ is

A. P

B. P^2

C. P^3

D. $\sqrt{P}$

$a, ar, ar^2, \ldots\ldots, ar^{n-1}$

$$S = \frac{a(1-r^n)}{(1-r)} \quad \text{— (1)}$$

$P = (a)(ar)(ar^2)\ldots(ar^{n-1})$

$P = a^n r^{1+2+3+\ldots(n-1)}$

$$\boxed{P = a^n r^{\frac{(n-1)(n)}{2}}} \quad \text{— (3)}$$

Now:

$$\frac{1}{a}, \frac{1}{ar}, \frac{1}{ar^2}, \text{-----}, \frac{1}{ar^{n-1}}$$

$$\equiv \frac{1}{ar^{n-1}}, \frac{1}{ar^{n-2}}, \text{------}, \frac{1}{ar^2}, \frac{1}{ar}, \frac{1}{a}$$

$$R = \frac{\frac{1}{(ar^{n-1})}\left(1-r^n\right)}{(1-r)} \quad \text{---} \quad 2$$

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Now:

$$\left(\frac{S}{R}\right)^n = \left(\frac{a\cancel{(1-r^n)}}{\cancel{(1-r)}} \times \frac{\cancel{(1-r)}\,ar^{n-1}}{\cancel{(1-r^n)}}\right)^n$$

$$= \left(a^2 r^{n-1}\right)^n$$

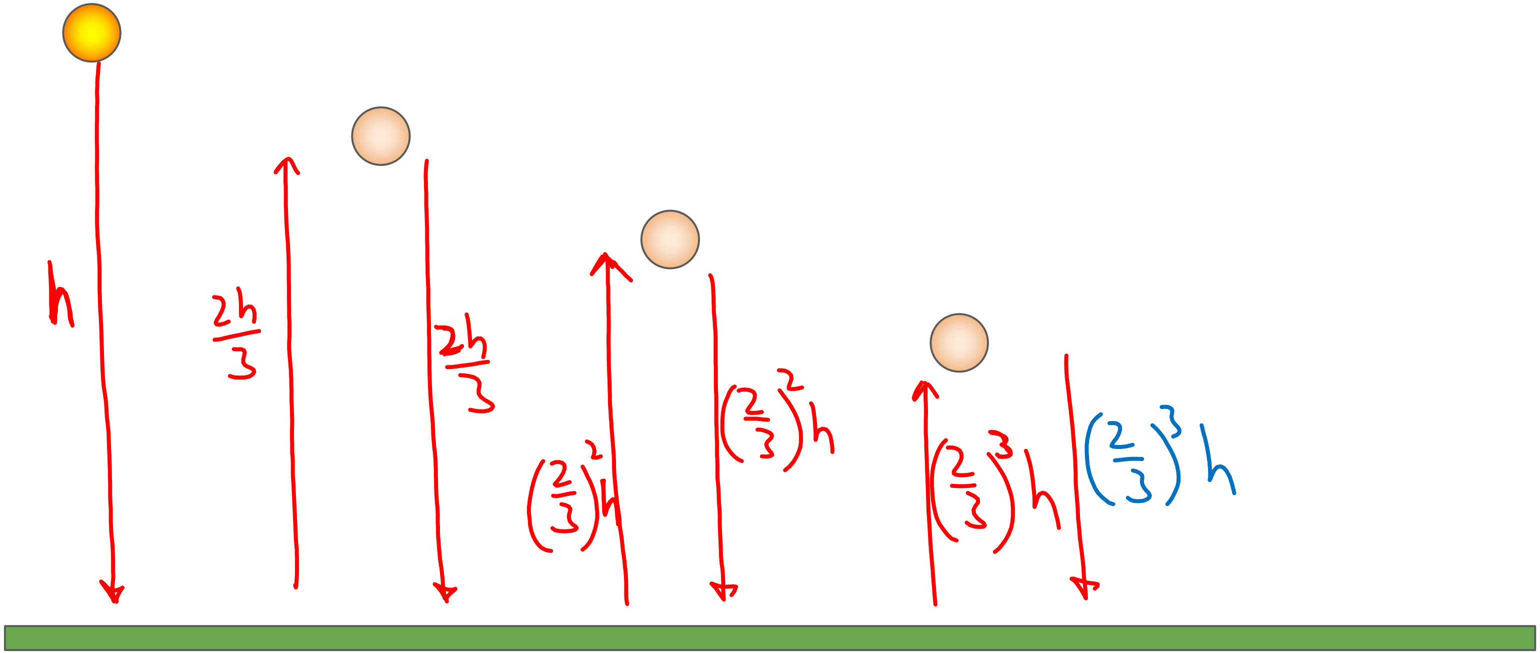
$$= a^{2n} \cdot r^{n(n-1)}$$

$$= \left(a^n \cdot r^{\frac{n(n-1)}{2}}\right)^2$$

$$= (P)^2$$

using Eq^n 3

A football is dropped from a height of 600 cm. Each time it rebounds, it rises to 2/3 of the height it has fallen through. Find the total distance travelled by the ball before it comes to rest.



$$h + 2\left(\frac{2h}{3} + \left(\frac{2}{3}\right)^2 h + \left(\frac{2}{3}\right)^3 h + \text{-----} \infty\right)$$

$$h + 2\left(\frac{\left(\frac{2h}{3}\right)}{1 - \frac{2}{3}}\right)$$

$$h + \frac{4h}{\cancel{3}} \times \cancel{3}$$

$$\boxed{5h} \xrightarrow{h = 600} \boxed{3000\text{ cm}}$$

If in a G.P. of 3n terms, S_1 denotes the sum of the first n terms, S_2 the sum of the second block of n terms & S_3 the sum of the last n terms, then S_1, S_2, S_3 are in

A. A.P. **B.** G.P. **C.** H.P. **D.** None of these

H.W. - 1

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11th

Namo Sir | Physics

6:00 - 7:30 PM

Ashwani Sir | Chemistry

7:30 - 9:00 PM

Sameer Sir | Maths

9:00 - 10:30 PM

12th

Jayant Sir | Physics

1:30 - 3:00 PM

Anupam Sir | Chemistry

3:00 - 4:30 PM

Nishant Sir | Maths

4:30 - 6:00 PM

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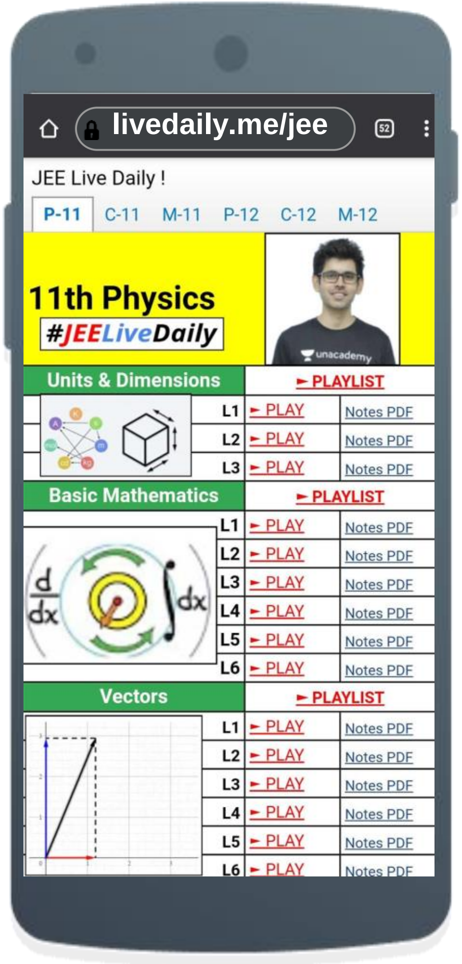

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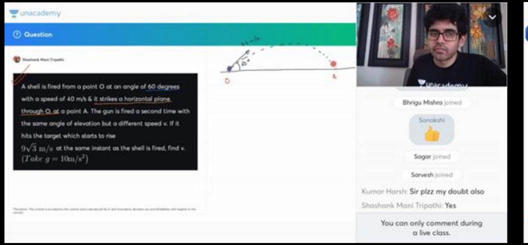

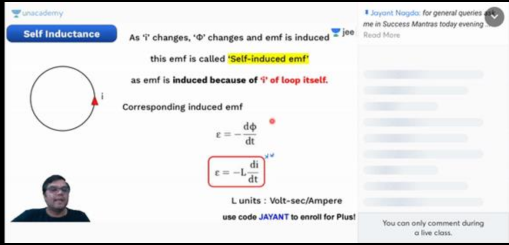

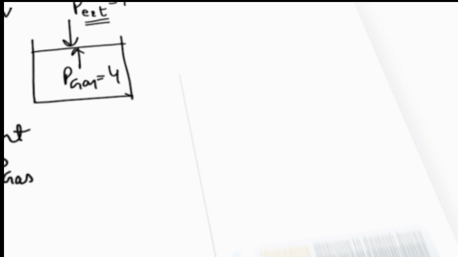

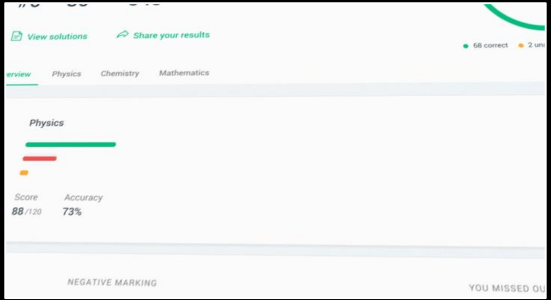

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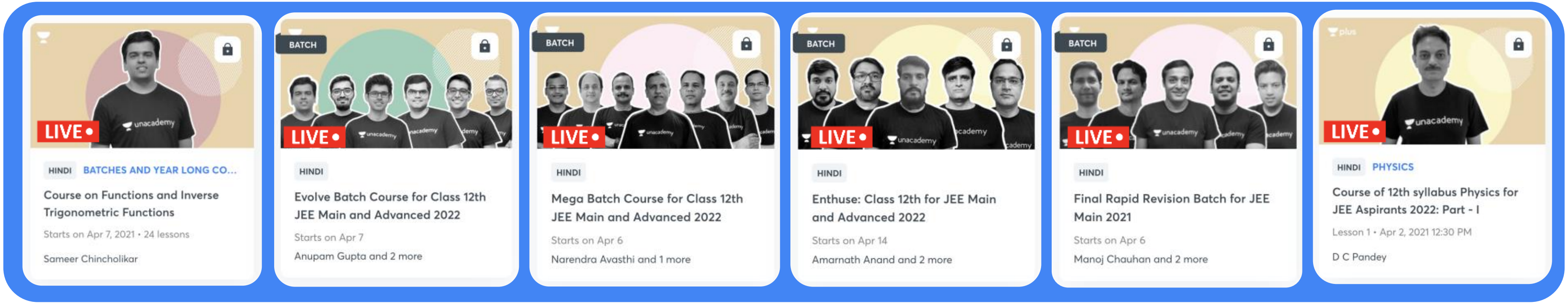

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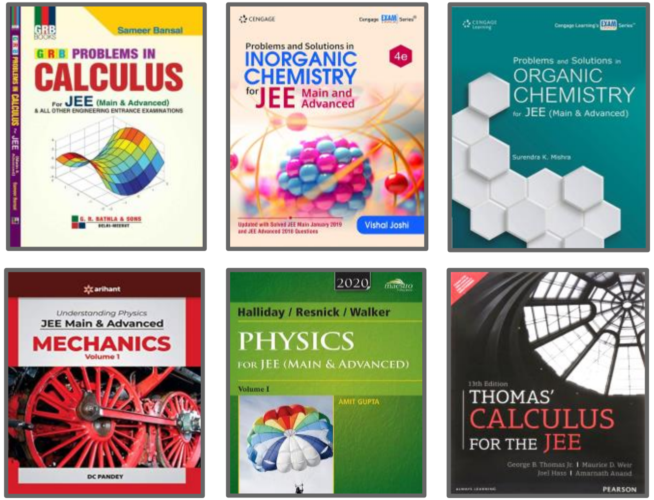

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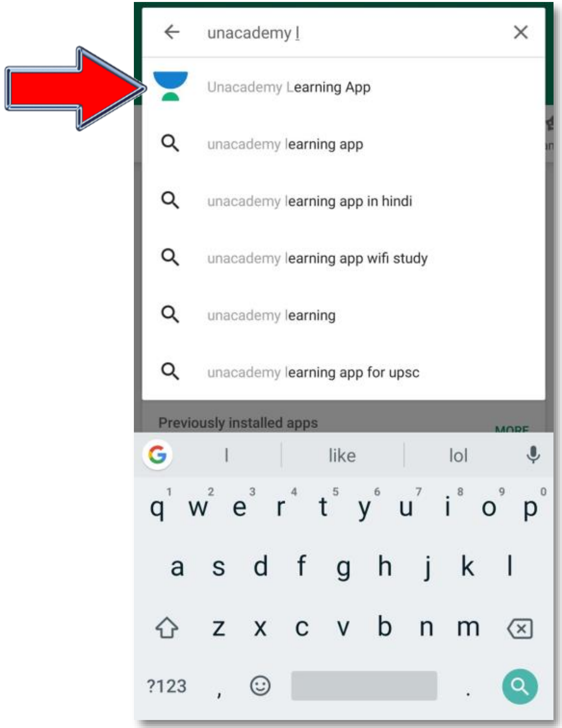

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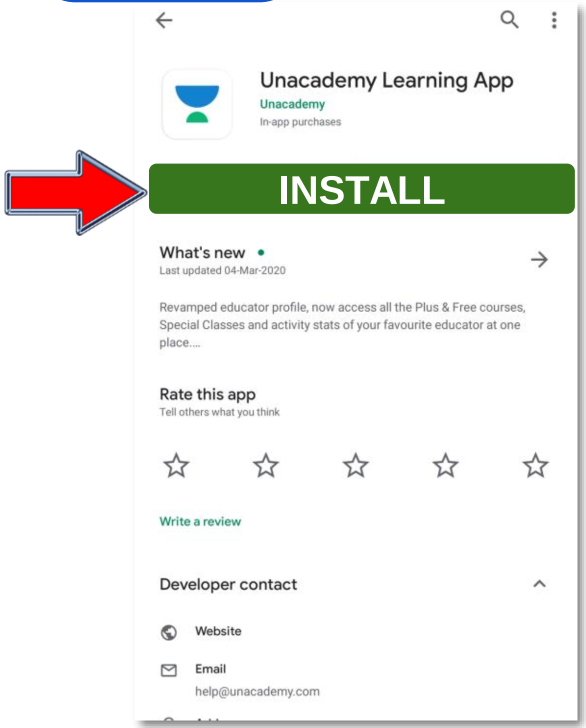

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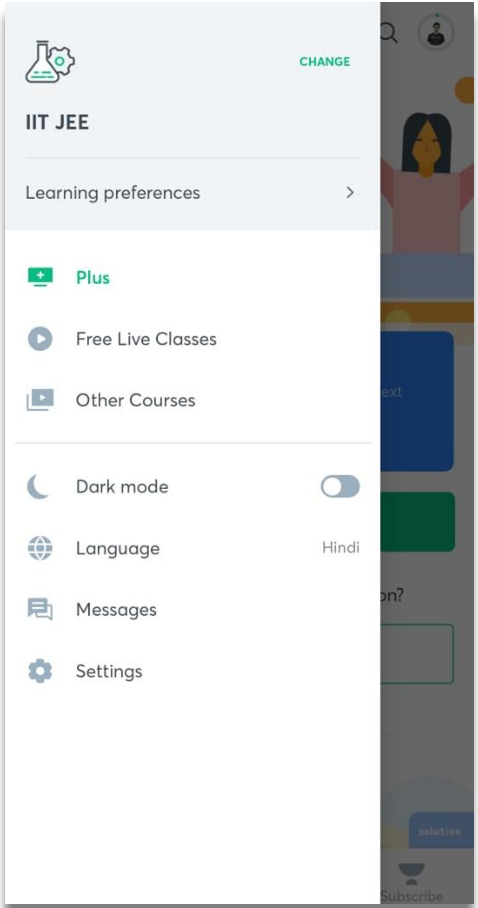
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