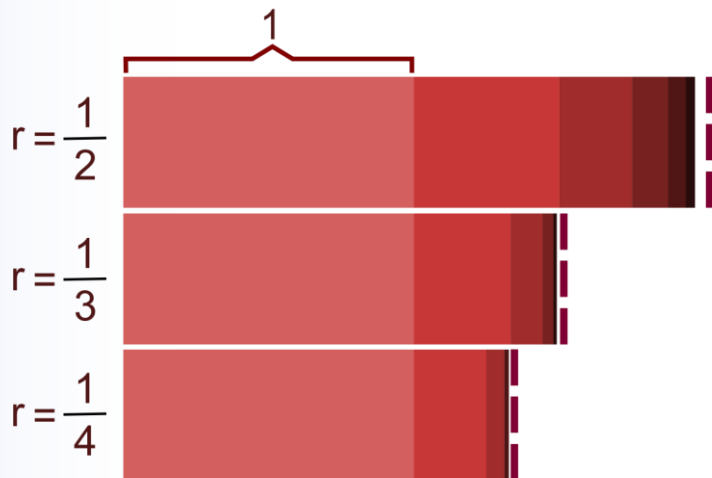


# Harmonic Progression and AGP

## Sequences & Series

5

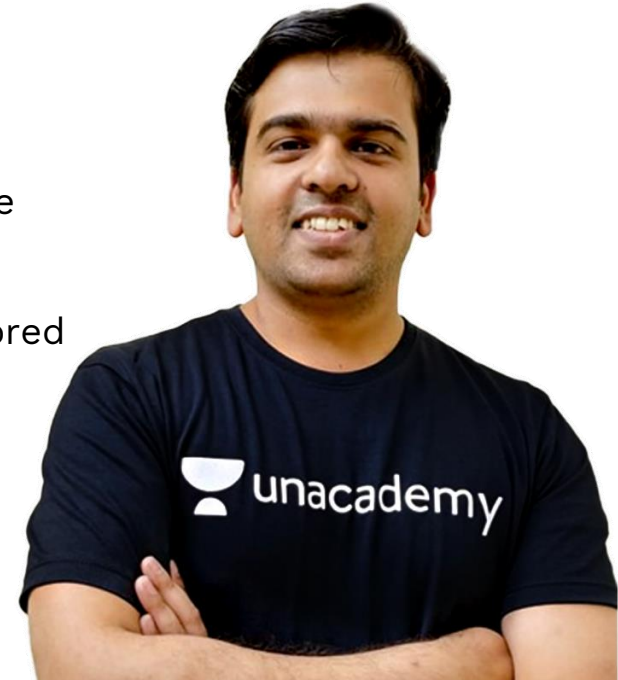


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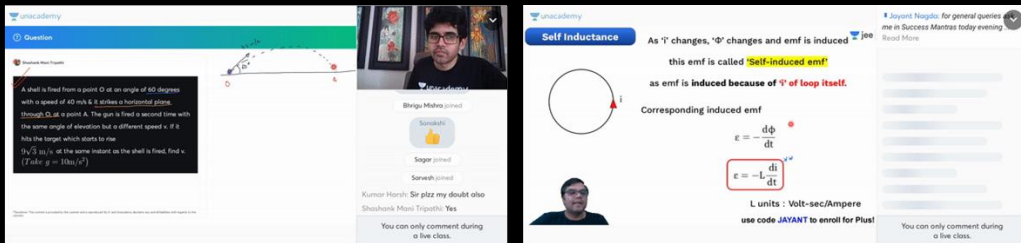
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Questions

A shell is fired from a point O at an angle of 60 degrees with a speed of 40 m/s. It strikes a horizontal plane through O at a point A. The gun is fired a second time with the same angle of elevation but a different speed  $v$ . If it hits the target which starts to rise  $(\sqrt{3}/2) \sin(\theta)$  at the same instant as the shell is fired, find  $v$ . (Take  $g = 10 \text{ m/s}^2$ )

Shreyas Mishra joined

Sagar joined

Saravali joined

Kumar Harsh: Sir plz my doubt also

Shashank Masi Tripathi: Yes

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Self Inductance

As  $\theta$  changes,  $\Phi$  changes and emf is induced

this emf is called **Self-induced emf**

as emf is induced because of  $\theta$  of loop itself.

Corresponding induced emf

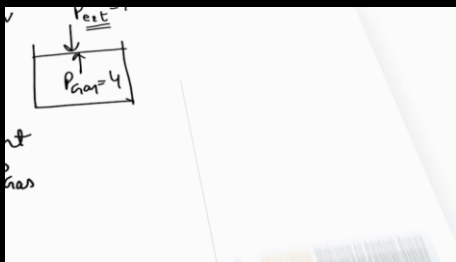
$$\mathcal{E} = -\frac{d\Phi}{dt}$$

$$\mathcal{E} = -L \frac{di}{dt}$$

L units: Volt-sec/Ampere

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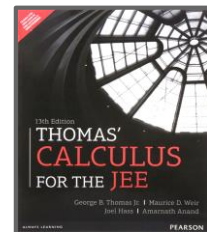
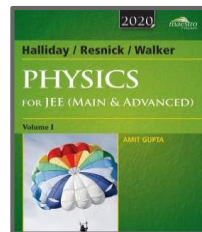
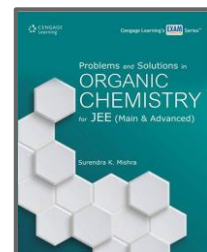
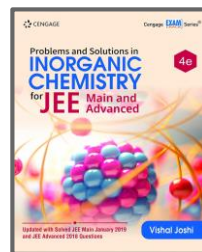
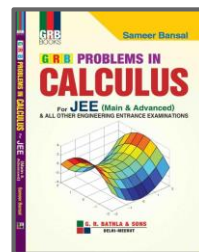
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# LET'S BEGIN!!

# Harmonic Progression





## Definition and Understanding

A sequences in which the reciprocal of the terms form an A.P. is called a Harmonic Progression (H.P.).

Eg:

$1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \dots$

H.P.

$1, 2, 3, 4, 5, \dots$

Corresponding  
A.P.





$$\text{If } x = \sum_{n=0}^{\infty} a^n, y = \sum_{n=0}^{\infty} b^n, z = \sum_{n=0}^{\infty} c^n$$

Where **a, b, c** are in A.P. and **|a| < 1, |b| < 1, |c| < 1**, then **x, y, z** are in

**A.** G.P

**B.** A.P

☒ **C.** H.P.

**D.** AGP

$$x = \sum_{n=0}^{\infty} a^n = 1 + a + a^2 + a^3 + \dots \infty$$

$$= \boxed{\frac{1}{1-a}}$$

Similarly;  $y = \frac{1}{1-b}$  &  $z = \frac{1}{1-c}$

$$x = \frac{1}{1-a}$$

$$y = \frac{1}{1-b}$$

$$z = \frac{1}{1-c}$$

Now:

$$a, b, c \longrightarrow A.P.$$

$$-a, -b, -c \longrightarrow A.P.$$

$$1-a, 1-b, 1-c \longrightarrow A.P.$$

$$\left(\frac{1}{1-a}\right) ; \left(\frac{1}{1-b}\right) ; \left(\frac{1}{1-c}\right) \longrightarrow H.P.$$

$$\Rightarrow x, y, z \longrightarrow H.P.$$







If  $a^x = b^y = c^z$  and  $a, b, c$  are in G.P. then  $x, y, z$  are in:

A. G.P

B. A.P

☒ C. H.P.

D. AGP

$$\underline{M-1} \quad a^x = b^y = c^z = K$$

$$\log a^x = \log b^y = \log c^z = \log K$$

$$x \log a = y \log b = z \log c = \log K$$

$$x = \frac{\log K}{\log a}$$

$$y = \frac{\log K}{\log b}$$

$$z = \frac{\log K}{\log c}$$

Now.

$a, b, c \rightarrow \text{G.P.}$

$\log a, \log b, \log c \rightarrow \text{A.P.}$

$\frac{\log a}{\log K}, \frac{\log b}{\log K}, \frac{\log c}{\log K} \rightarrow \text{A.P.}$

$\frac{\log K}{\log a}, \frac{\log K}{\log b}, \frac{\log K}{\log c} \rightarrow \text{H.P.}$

$$\underline{\underline{M-2}}^?$$

Shortcut:

$$a^x = b^y = c^z$$

$$2^x = 4^y = 8^z$$

$$2^x = 2^{2y} = 2^{3z}$$

$$x = 2y = 3z = K$$

$$\left. \begin{array}{l} x = K \\ y = \frac{K}{2} \\ z = \frac{K}{3} \end{array} \right\} \rightarrow \frac{1}{K}, \frac{2}{K}, \frac{3}{K} \rightarrow A.P.$$

$$\Rightarrow x, y, z \rightarrow \text{H.P.}$$

**NOTE:**

To solve the questions of H.P. we can first solve for the corresponding A.P.

$h_1, h_2, h_3, h_4, \dots$  H.P.  
 $\rightarrow \frac{1}{h_1}, \frac{1}{h_2}, \frac{1}{h_3}, \dots$  A.P.



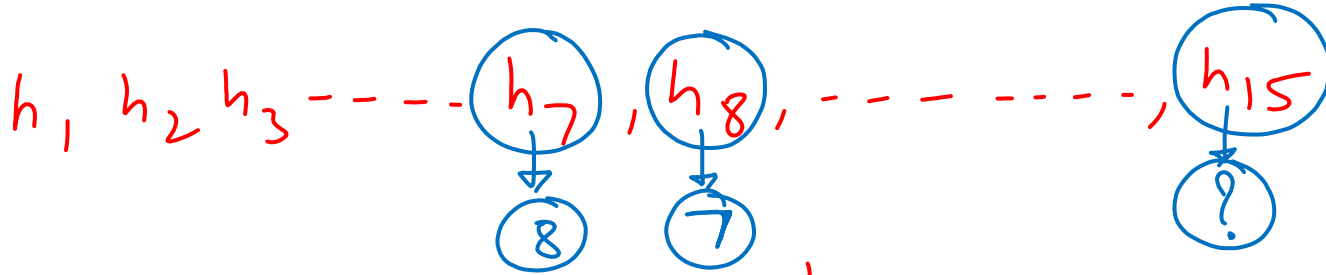
If the **7<sup>th</sup> term** of an **H.P.** is 8 and **8<sup>th</sup> term** is **7**, then its **15<sup>th</sup> term** is

**A.** 16

**B.** 14

**C.** 27/14

**D.** 56/15



For corresponding A.P.

$$T_7 = \frac{1}{8}; T_8 = \frac{1}{7}$$

$$T_7 = a + 6d = \frac{1}{8}$$

$$T_8 = a + 7d = \frac{1}{7}$$

$$\ominus \div d = \frac{1}{7} - \frac{1}{8} = \frac{1}{56}$$



$$a + 6d = \frac{1}{8}$$

$$a + 6\left(\frac{1}{56}\right) = \frac{1}{8}$$

$$a = \frac{1}{8} - \frac{6}{56}$$

$$\boxed{a = \frac{1}{56}}$$

$T_{15}$  (of corresponding AP)

$$= a + 14d$$

$$= \frac{1}{56} + 14\left(\frac{1}{56}\right)$$

$$= \boxed{\frac{15}{56}}$$

$\Rightarrow$  15<sup>th</sup> term of H.P. is  $\boxed{\frac{56}{15}}$



Let  $a_1, a_2, \dots, a_{10}$  be in **A.P.**, and  $h_1, h_2, \dots, h_{10}$  be in **H.P.**

If  $a_1 = h_1 = 2$  and  $a_{10} = h_{10} = 3$ , then  $a_4 h_7$  is

**JEE 1999****A.** 2**B.** 3**C.** 5☒ **D.** 6

Part-1 : For A.P.

$$\begin{array}{ccccccc} a_1 & a_2 & a_3 & a_4 & \dots & a_{10} \\ \downarrow & & & \downarrow & & \downarrow \\ \textcircled{2} & & & \textcircled{?} & & \textcircled{3} \end{array}$$

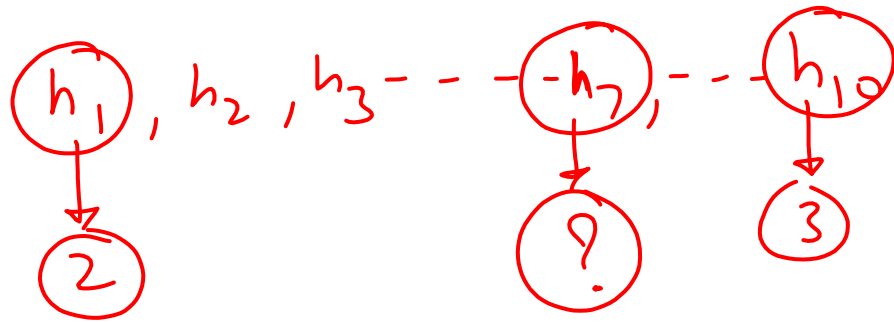
$$a_{10} = a_1 + 9d$$

$$3 = 2 + 9d$$

$$\boxed{d = \frac{1}{9}}$$

$$\Rightarrow a_4 = 2 + 3\left(\frac{1}{9}\right) = \boxed{\frac{7}{3}}$$

Part-2: For H.P



Corresponding A.P

$$a = \frac{1}{2}; T_{10} = \frac{1}{3}$$

$$T_{10} = a + 9d$$

$$\frac{1}{3} = \frac{1}{2} + 9d$$

$$-\frac{1}{6} = 9d$$

$$\boxed{d = -\frac{1}{54}}$$

Now.

$$\begin{aligned}T_7 &= a + 6d \\&= \frac{1}{2} + 6\left(-\frac{1}{54}\right) \\&= \frac{1}{2} - \frac{1}{9} \\&= \frac{7}{18}\end{aligned}$$

$\Rightarrow$  For H.P.:

$$\boxed{h_7 = \frac{18}{7}}$$

Now.

$$\begin{aligned}a_7 h_7 &= \left(\frac{7}{3}\right) \left(\frac{18}{7}\right) \\&= \textcircled{6}\end{aligned}$$

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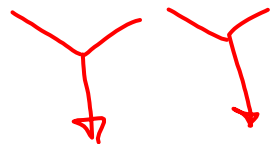


## Property of H.P.

If  $a, b, c$  are in H.P. then

$$a, b, c \rightarrow \text{H.P.}$$

$$\frac{1}{a}, \frac{1}{b}, \frac{1}{c} \rightarrow \text{A.P.}$$



$$\left(\frac{1}{b} - \frac{1}{a}\right) = \left(\frac{1}{c} - \frac{1}{b}\right)$$

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

$$b = \left(\frac{2ac}{a+c}\right)$$





If the roots of the equation  $a(b-c)x^2 + b(c-a)x + c(a-b) = 0$  are equal then **a, b, c** are in:

**A.** G.P

**B.** A.P

**C.** H.P.

**D.** AGP

$$a(b-c)x^2 + b(c-a)x + c(a-b) = 0$$

$x=1$  Satisfies the given equation  
 $\therefore$  both roots are equal

$$\left( \text{Product of roots} \right) = 1$$
$$\frac{c(a-b)}{a(b-c)} = 1$$

$$ac - bc = ab - ac$$

$$2ac = ab + bc$$

$$2ac = b(a+c)$$

$$\left( \frac{2ac}{a+c} \right) = b$$

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

 $\Rightarrow$  $a, b, c$  $\rightarrow$  H.P.





If  $a$ ,  $b$  and  $c$  are distinct numbers in A.P. and  $a^2$ ,  $b^2$  and  $c^2$  are in H.P. then which of the following is/are true:

**A.**  $a$ ,  $-b/2$ ,  $c$  are in G.P.

**B.**  $a$ ,  $2b$ ,  $c$  are in G.P.

**C.**  $a$ ,  $b$ ,  $-c/2$  are in G.P.

**D.**  $a$ ,  $b$ ,  $2c$  are in G.P.

HW-1









# Arithmetic Geometric Progression





## What is A.G.P. ?

Eg: A.P. :  $1, 2, 3, 4, 5, \dots$

G.P. :  $x, x^2, x^3, x^4, x^5, \dots$

A.G.P. :  $x, 2x^2, 3x^3, 4x^4, 5x^5, \dots$



## Sum of A.G.P.

$$|x| < 1$$

~~Eg:~~

$$S = x + 2x^2 + 3x^3 + 4x^4 + \dots \infty$$

$$xS = \quad \quad \quad x^2 + 2x^3 + 3x^4 + \dots \infty$$

$$(1-x)S = \underbrace{x + x^2 + x^3 + x^4 + \dots}_{\text{P.W.G.P.}} \infty$$

$$(1-x)S = \frac{x}{1-x}$$

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

Ans.



The sum to infinite term of the series

$$1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + \dots \text{ is}$$

A. 2

☒ B. 3

C. 4

D. 5

2009 M

S

$$S = \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + \dots$$

$$\frac{1}{3}S = \boxed{\phantom{0}} + \frac{2}{3^2} + \frac{6}{3^3} + \frac{10}{3^4} + \dots$$

$$\frac{2S}{3} = \frac{2}{3} + \frac{4}{3^2} + \frac{4}{3^3} + \frac{4}{3^4} + \dots \infty$$



$$\Rightarrow \frac{2S}{3} = \frac{2}{3} + \frac{4/9}{1 - \frac{1}{3}}$$

$$\frac{2S}{3} = \frac{2}{3} + \frac{4}{2 \times 3}$$

$$\frac{2S}{3} = \frac{2}{3} + \frac{2}{3}$$

$$\frac{2S}{\cancel{2}} = \frac{4}{\cancel{2}} \Rightarrow \boxed{S=2}$$

Answer:

$$1 + S$$

$$1 + 2$$

$$\boxed{3}$$





If  $(10)^9 + 2(11)^1(10)^8 + 3(11)^2(10)^7 + \dots + 10(11)^9 = k(10)^9$ , then  $k$  is equal to:

2014 M

☒ A. 100

☐ B. 110

☐ C. 121/10

☐ D. 441/100

$$S = (10)^9 + 2\underbrace{(11)^1(10)^8} + 3\underbrace{(11)^2(10)^7} + \dots + 10\underbrace{(11)^9} \quad \square$$

$$\frac{11}{10}S = \square + \underbrace{(11)^1(10)^8} + 2\underbrace{(11)^2(10)^7} + \dots + 9\underbrace{(11)^9}$$

$$\frac{-S}{10} = \frac{(10)^9 + \underbrace{(11)^1(10)^8 + (11)^2(10)^7 + \dots + (11)^9}_{+ (11)^{10}} - (11)^{10}}$$

$$-\frac{S}{10} = \frac{(10)^9 \left( \left( \frac{11}{10} \right)^{10} - 1 \right)}{\left( \frac{11}{10} - 1 \right)} - (11)^{10} \quad \left| \quad S_n = \frac{a(r^n - 1)}{(r - 1)} \right.$$

$$-\frac{S}{10} = 10^{10} \left( \frac{11^{10}}{10^{10}} - 1 \right) - (11)^{10}$$

$$-\frac{S}{10} = \cancel{1}^{10} - 10^{10} - \cancel{(11)^{10}}$$

$$\boxed{S = 10^{11}} \rightarrow 10^2 \cdot 10^9 \rightarrow (100) 10^9$$

$$\boxed{K = 100}$$





$2^{1/4} \cdot 4^{1/8} \cdot 8^{1/16} \cdot 16^{1/32} \dots$  is equal to

A. 1

☒ B. 2

C.  $3/2$

D.  $5/2$

2014 M

$$2^{1/4} \cdot 2^{2/8} \cdot 2^{3/16} \cdot 2^{4/32} \cdot \dots$$

$$= (2)^{\left(\frac{1}{4} + \frac{2}{8} + \frac{3}{16} + \frac{4}{32} + \dots \infty\right)}$$

$$= (2)^5$$

Now:

$$S = \frac{1}{4} + \frac{2}{8} + \frac{3}{16} + \frac{4}{32} + \dots \infty$$

$$\frac{S}{2} = \frac{1}{8} + \frac{2}{16} + \frac{3}{32} + \dots \infty$$

$$\frac{S}{2} = \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \dots \infty$$

$$\frac{S}{2} = \frac{1/4}{1 - 1/2} \Rightarrow \frac{S}{2} = \frac{1}{2} \Rightarrow \boxed{S=1}$$

Ans.

$$2^S \downarrow 2^1 \rightarrow \textcircled{2}$$







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7:30 - 9:00 PM



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12<sup>th</sup>



Jayant Sir | Physics

1:30 - 3:00 PM



Anupam Sir | Chemistry

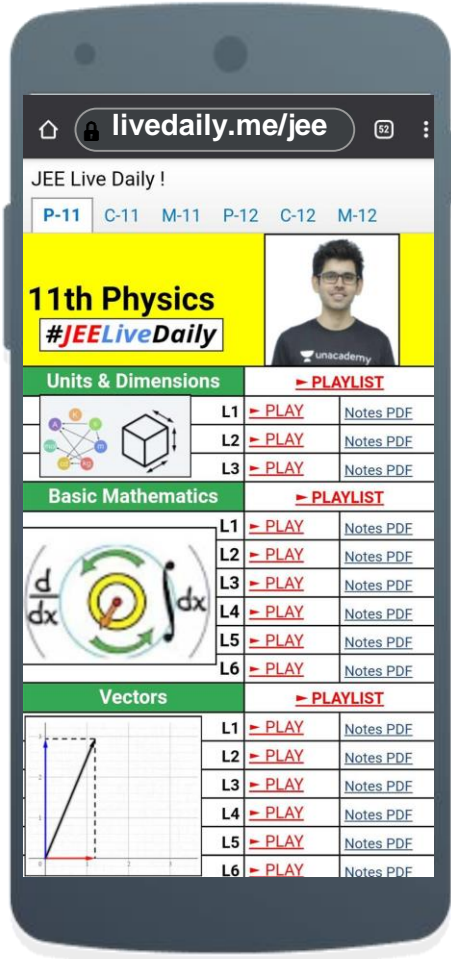
3:00 - 4:30 PM



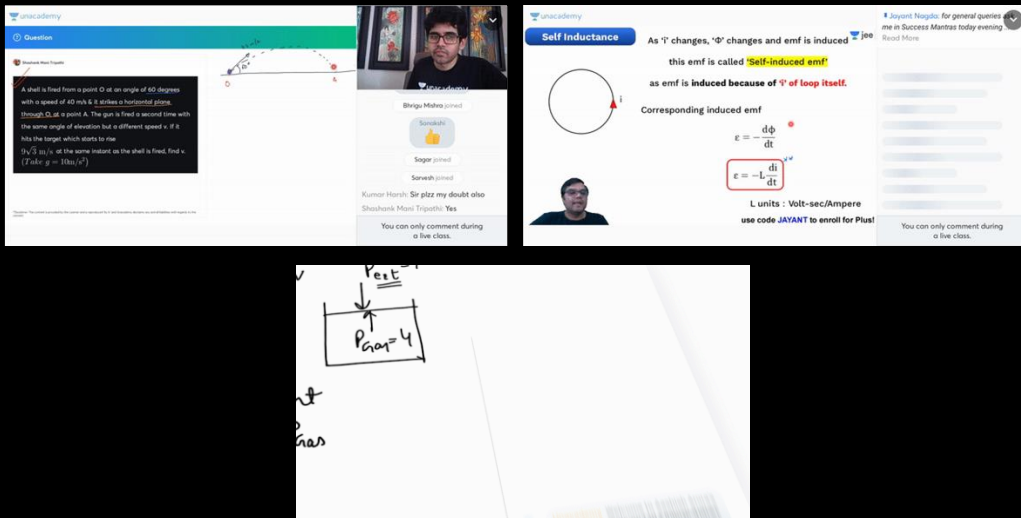
Nishant Sir | Maths

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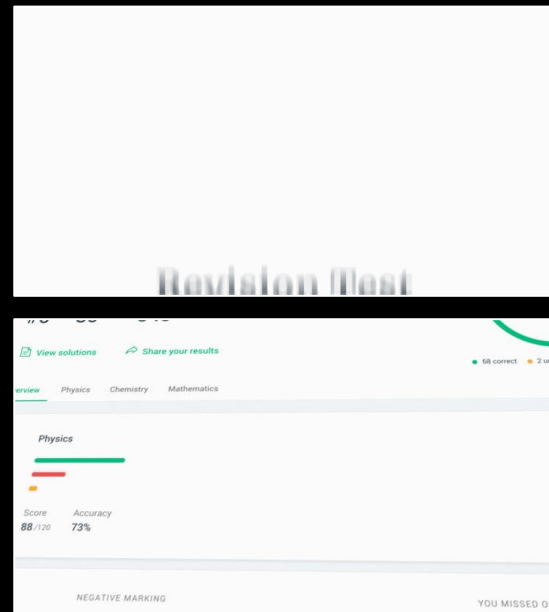
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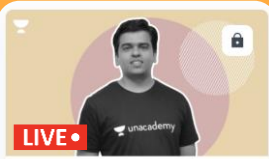


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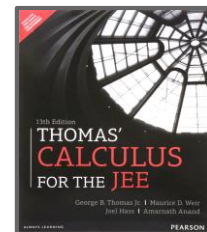
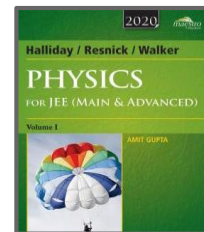
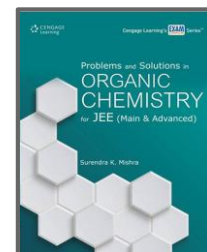
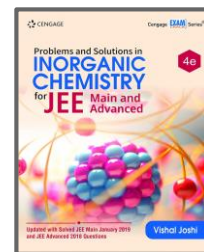
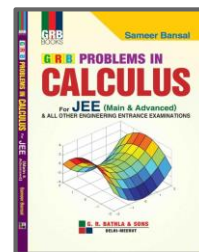
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Sundaram  
99.69



Manas Pandey  
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Mihir Agarwal  
99.63



Akshat Tiwari  
99.60



Sarthak  
Kalankar  
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99.50



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98.85



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Megh Gupta  
98.59

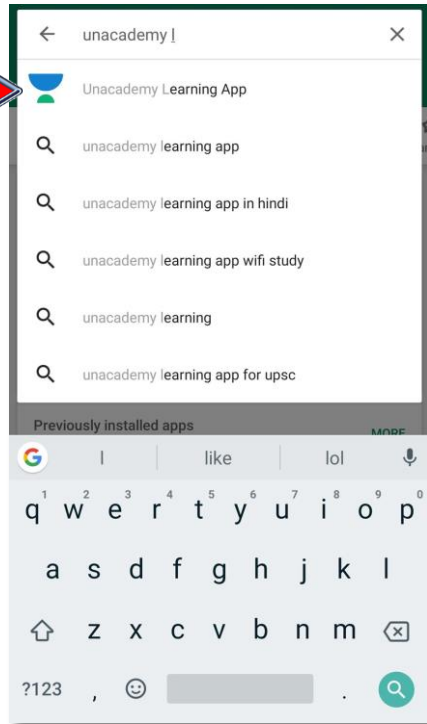


Naman Goyal  
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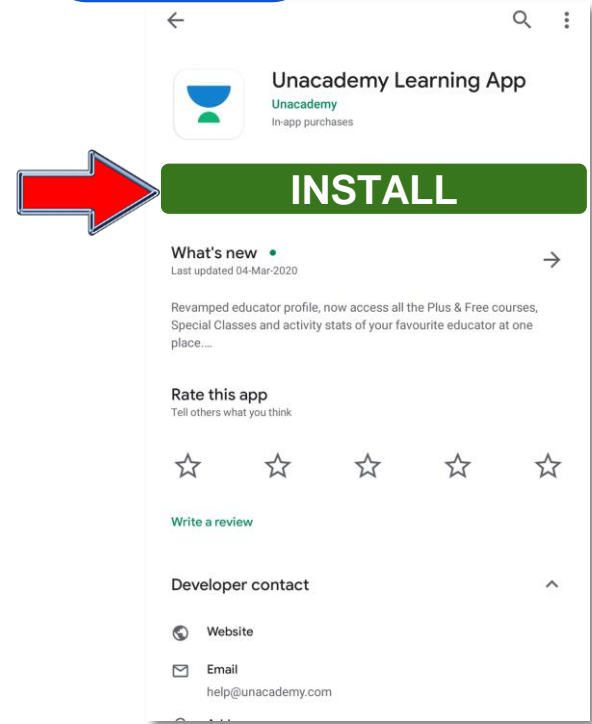


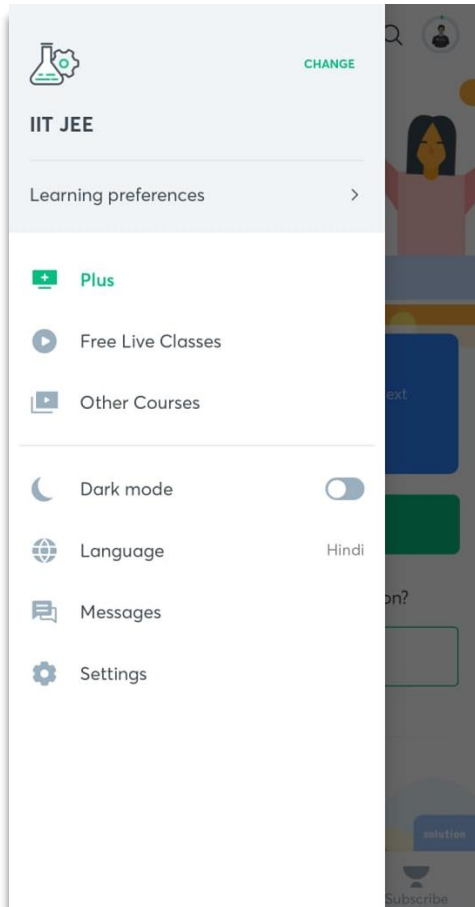
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