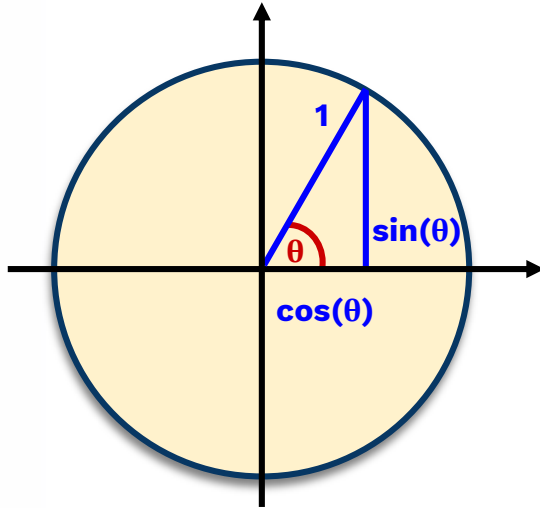


# Trigonometric Series & Product of Cosines -1

## Trigonometry

10



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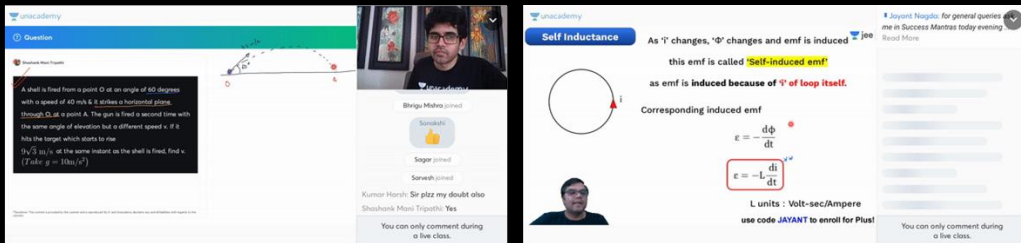
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Questions

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

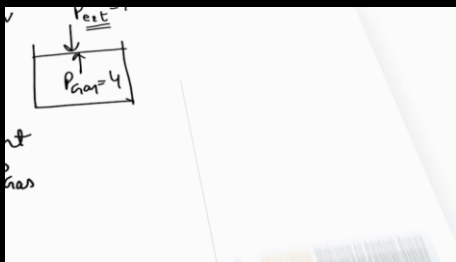
$$\mathcal{E} = -\frac{d\Phi}{dt}$$

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

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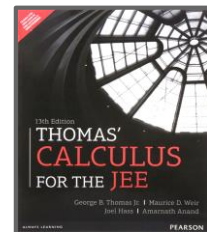
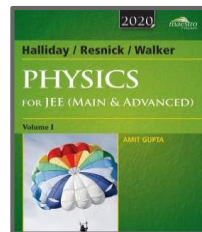
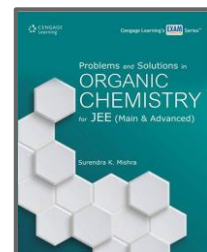
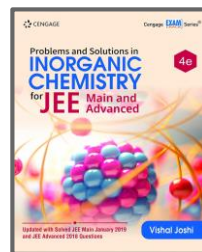
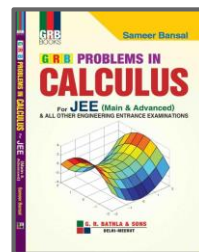
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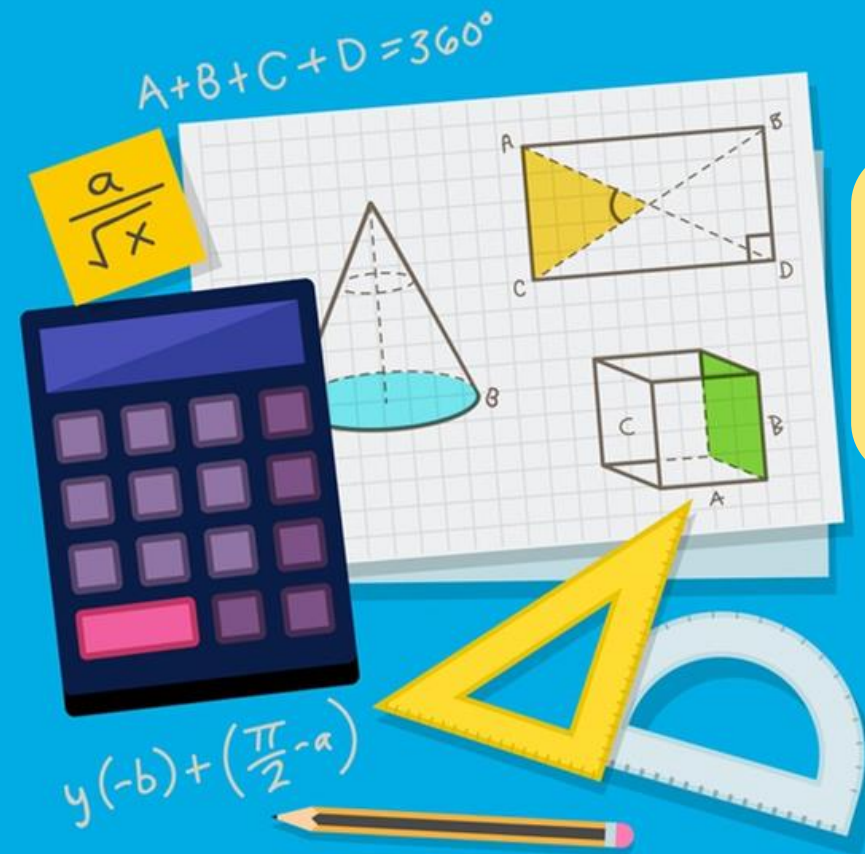
11<sup>th</sup> / 9, 10

12<sup>th</sup> / Drop





# LET'S BEGIN!!



# Homework Question



If  $\cos^3 x \sin 2x = \sum_{r=0}^n \underline{a_r} \sin(\underline{rx})$ ,  $\forall x \in \mathbb{R}$  then find  $\underline{a_3/a_1}$ :

$$= \cancel{a_0 \sin 0} + \boxed{a_1} \underline{\sin x} + a_2 \underline{\sin 2x} + \boxed{a_3} \underline{\sin 3x} + a_4 \underline{\sin 4x} + a_5 \underline{\sin 5x} + \dots$$

$$\left( \frac{\cos 3x + 3\cos x}{4} \right) \sin 2x$$

$$= \frac{1}{4} \left( \sin 2x \cos 3x + \underline{3 \sin 2x \cos x} \right)$$

$$\because \cos 3\theta = 4\cos^3 \theta - 3\cos \theta$$

$$\Rightarrow \cos^3 \theta = \left( \frac{\cos 3\theta + 3\cos \theta}{4} \right)$$

$$= \frac{1}{8} \left( \underbrace{2 \sin 2x \cos 3x}_{\text{arrow}} + 3 \left( \underbrace{2 \sin 4x \cos x}_{\text{arrow}} \right) \right)$$

$$= \frac{1}{8} \left( \left( \sin(5x) + \sin(-x) \right) + 3 \left( \sin 3x + \sin x \right) \right)$$

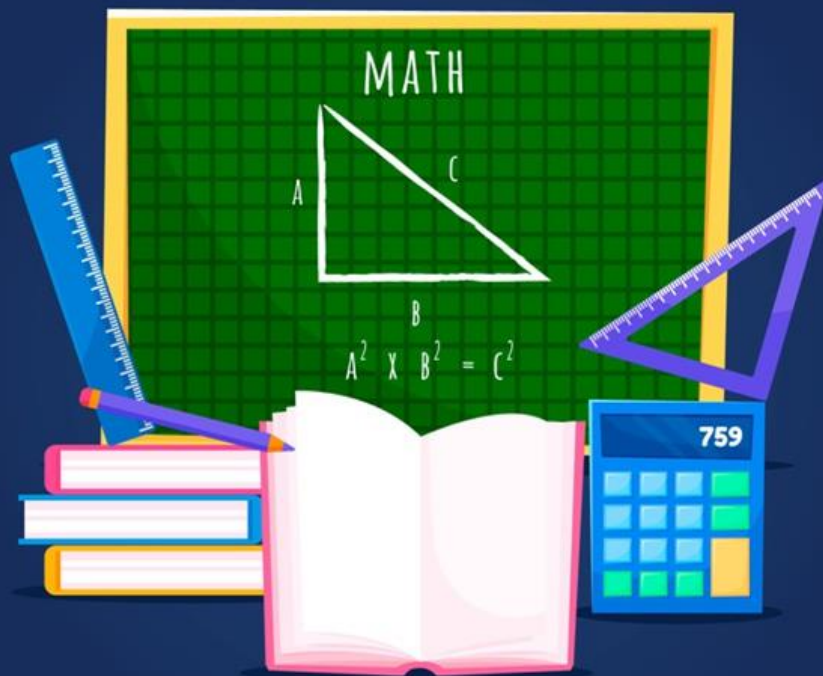
$$= \frac{1}{8} \left( \sin 5x + 3 \sin 3x + 2 \sin x \right)$$

$$= \frac{1}{8} \sin 5x + \frac{3}{8} \sin 3x + \frac{1}{4} \sin x$$

$$\left. \begin{array}{l} a_1 = \frac{1}{4} \\ a_3 = \frac{3}{8} \\ a_5 = \frac{1}{8} \end{array} \right| \begin{array}{l} a_2 = 0 \\ a_4 = 0 \end{array}$$



# Trigonometric Series of Sine & Cosine







## Trigonometric Series of Sine and Cosine

1

$$\sin \alpha + \sin(\alpha + \beta) + \sin(\alpha + 2\beta) + \dots + \sin\{\alpha + (n-1)\beta\} = \frac{\sin \frac{n\beta}{2}}{\sin \frac{\beta}{2}} \sin\left(\alpha + \frac{n-1}{2}\beta\right)$$

\* angles are in A.P.

\* total  $n$ -terms

\* first term:  $\alpha$

\* Common diff:  $\beta$

$$2 \sin A \sin B =$$

$$\cos(A-B) - \cos(A+B)$$

$$= \frac{2 \sin \beta/2}{2 \sin \beta/2} \left[ \sin \alpha + \sin(\alpha + \beta) + \sin(\alpha + 2\beta) + \dots + \sin(\alpha + (n-1)\beta) \right]$$

$$= \left( \frac{1}{2 \sin \frac{\beta}{2}} \right) \left[ 2 \sin \alpha \sin \frac{\beta}{2} + 2 \sin(\alpha + \beta) \sin \frac{\beta}{2} + 2 \sin(\alpha + 2\beta) \sin \frac{\beta}{2} + \dots + 2 \sin(\alpha + (n-1)\beta) \sin \frac{\beta}{2} \right]$$

$$= \left( \frac{1}{2 \sin \frac{\beta}{2}} \right) \left[ \left( \cos\left(\alpha - \frac{\beta}{2}\right) - \cancel{\cos\left(\alpha + \frac{\beta}{2}\right)} \right) + \left( \cancel{\cos\left(\alpha + \frac{\beta}{2}\right)} - \cancel{\cos\left(\alpha + \frac{3\beta}{2}\right)} \right) \right]$$

$$\begin{aligned}
 & + \left( \cancel{\cos\left(\alpha + \frac{3\beta}{2}\right)} - \cancel{\cos\left(\alpha + \frac{5\beta}{2}\right)} \right) \\
 & + \dots + \left( \cos\left(\alpha + \left(n-1-\frac{1}{2}\right)\beta\right) - \underbrace{\cos\left(\alpha + \left(n-1+\frac{1}{2}\right)\beta\right)} \right)
 \end{aligned}$$

$$= \left( \frac{1}{2\sin\frac{\beta}{2}} \right) \left( \cos\left(\alpha - \frac{\beta}{2}\right) - \cos\left(\alpha + \left(n-\frac{1}{2}\right)\beta\right) \right)$$

$$= \frac{1}{\cancel{2\sin\frac{\beta}{2}}} \left( \cancel{2}\sin\left(\frac{2\alpha + \left(n-1-\frac{1}{2}\right)\beta}{2}\right) \sin\left(\frac{\left(n-\frac{1}{2}+\frac{1}{2}\right)\beta}{2}\right) \right)$$

$$= \frac{\sin\left(n \frac{\beta}{2}\right)}{\sin\left(\frac{\beta}{2}\right)} \sin\left(\alpha + (n-1)\frac{\beta}{2}\right)$$



## Trigonometric Series of Sine and Cosine

2

$$\cos \alpha + \cos(\alpha + \beta) + \cos(\alpha + 2\beta) + \dots + \cos\{\alpha + (n - 1)\beta\} = \frac{\sin \frac{n\beta}{2}}{\sin \frac{\beta}{2}} \boxed{\cos} \left( \alpha + \frac{n-1}{2} \beta \right)$$







The **value of**  $\sin \frac{\pi}{18} + \sin \frac{2\pi}{18} + \sin \frac{3\pi}{18} + \dots + \sin \frac{35\pi}{18} =$

**A.** 1

**B.** 2

**C.** 0

**D.** 4

$$n = 35$$

$$\alpha = \frac{\pi}{18}$$

$$\beta = \frac{\pi}{18}$$

$$\frac{\beta}{2} = \frac{\pi}{36}$$

$$= \frac{\sin\left(n \frac{\beta}{2}\right)}{\sin\left(\frac{\beta}{2}\right)} \cdot \sin\left(\alpha + (n-1)\frac{\beta}{2}\right)$$

$$= \frac{\sin\left(35 \frac{\pi}{36}\right)}{\sin\left(\frac{\pi}{36}\right)} \sin\left(\frac{\pi}{18} + 34 \times \frac{\pi}{36}\right)$$

$\underbrace{\hspace{10em}}_{= \pi}$   
 $\underbrace{\hspace{10em}}_{\text{zero}}$



The **value of**

$$\cos \frac{\pi}{7} + \cos \frac{2\pi}{7} + \cos \frac{3\pi}{7} + \dots + \cos \frac{7\pi}{7} =$$

✓ **A.** -1

**B.** -2

**C.** 0

**D.** 2

$$\alpha = \frac{\pi}{7}$$

$$\beta = \frac{\pi}{7}$$

$$\frac{\beta}{2} = \frac{\pi}{14}$$

$$n = 7$$

$$\frac{\sin \left( 7 \cdot \frac{\pi}{14} \right)}{\sin \left( \frac{\pi}{14} \right)}$$

$$\cos \left( \frac{\pi}{7} + \frac{\pi}{14} \right)$$

$$\frac{1}{\sin \left( \frac{\pi}{14} \right)} \cdot \cos \left( \frac{4\pi}{7} \right)$$

$$\frac{\pi}{14}, \frac{8\pi}{14}$$

$$\frac{8\pi}{14} - \frac{\pi}{14} = \frac{7\pi}{14} = \frac{\pi}{2}$$

$$\frac{8\pi}{14} = \left( \frac{\pi}{2} + \frac{\pi}{14} \right)$$

$$\begin{aligned} & \frac{\cos\left(\frac{8\pi}{14}\right)}{\sin\left(\frac{\pi}{14}\right)} \\ &= \frac{\cos\left(\frac{\pi}{2} + \frac{\pi}{14}\right)}{\sin\left(\frac{\pi}{14}\right)} \\ &= \frac{-\sin\left(\frac{\pi}{14}\right)}{\sin\left(\frac{\pi}{14}\right)} = -1 \end{aligned}$$





The **value of**  $\cos \frac{2\pi}{7} + \cos \frac{4\pi}{7} + \cos \frac{8\pi}{7}$  is

**A.**  $\frac{1}{4}$

**B.**  $\frac{1}{2}$

**C.**  $-\frac{1}{2}$

**D.**  $-\frac{1}{4}$

$$\cos\left(\pi - \frac{5\pi}{7}\right) + \cos\left(\pi - \frac{3\pi}{7}\right) + \cos\left(\pi + \frac{\pi}{7}\right)$$

$$\downarrow$$
$$-\cos \frac{5\pi}{7}$$

$$\downarrow$$
$$-\cos \frac{3\pi}{7}$$

$$\downarrow$$
$$-\cos \frac{\pi}{7}$$

$$-\left[ \cos \frac{\pi}{7} + \cos \frac{3\pi}{7} + \cos \frac{5\pi}{7} \right]$$

$$\left\{ \begin{array}{l} \alpha = \frac{\pi}{7} \\ \beta = \frac{2\pi}{7} \\ \frac{\beta}{2} = \frac{\pi}{7} \\ n = 3 \end{array} \right.$$



$$= - \left[ \frac{\sin\left(3 \frac{\pi}{7}\right) \cdot \cos\left(\frac{\pi}{7} + 2 \cdot \frac{\pi}{7}\right)}{\sin\left(\frac{\pi}{7}\right)} \right]$$

$$= - \left[ \frac{2 \sin\left(\frac{3\pi}{7}\right) \cos\left(\frac{3\pi}{7}\right)}{2 \sin \frac{\pi}{7}} \right]$$

$$\frac{- \cancel{\sin \frac{6\pi}{7}}}{\cancel{2 \sin \frac{\pi}{7}}}$$

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





Find the value of:  $\sin \frac{2\pi}{7} + \sin \frac{4\pi}{7} + \sin \frac{8\pi}{7}$

H.W





Arithmetic mean of  $2 \sin 2^\circ, 4 \sin 4^\circ, 6 \sin 6^\circ, \dots$  Upto 90 terms

**A.**  $\cot 1^\circ$

**B.**  $\sec 1^\circ$

**C.**  $\operatorname{cosec} 1^\circ$

**D.**  $\tan 1^\circ$

$$\begin{aligned}
 S &= 2 \sin 2^\circ + 4 \sin 4^\circ + 6 \sin 6^\circ + \dots + 180 \sin 180^\circ \\
 &= \left( 2 \sin 2^\circ + 178 \sin 178^\circ \right) + \left( 4 \sin 4^\circ + 176 \sin 176^\circ \right) \\
 &\quad + \left( 6 \sin 6^\circ + 174 \sin 174^\circ \right) + \dots + \left( 88 \sin 88^\circ + 92 \sin 92^\circ \right) \\
 &\quad + \left( 90 \sin 90^\circ \right)
 \end{aligned}$$

$\downarrow \quad \downarrow$   
 $(180-2^\circ) \quad (180-4^\circ)$

$$\begin{array}{c}
 180 \\
 (2, 178) \\
 (4, 176) \\
 (6, 174) \\
 (8, 172) \\
 \vdots \\
 (\vdots, 96) \\
 (\vdots, 94) \\
 \checkmark (88, 92) \\
 90
 \end{array}$$

$$180 (\sin 2^\circ + \sin 4^\circ + \sin 6^\circ + \dots + \sin 88^\circ) + 90$$

$$\alpha = 2^\circ, \beta = 2^\circ; \frac{\beta}{2} = 1^\circ; n = 44$$

$$180 \left( \frac{\sin(44(1^\circ))}{\sin(1^\circ)} \sin(\underbrace{2^\circ + 43(1^\circ)}_{\text{wavy line}}) \right) + 90$$



$$180 \left( \frac{\sin 44^\circ}{\sin 1^\circ} \times \sin 45^\circ \right) + 90$$

$$= \frac{180}{\sqrt{2}} \left( \frac{\sin(45^\circ - 1^\circ)}{\sin 1^\circ} \right) + 90$$

$$= \frac{180}{\sqrt{2}} \left( \frac{\frac{1}{\sqrt{2}} \cos 1^\circ - \frac{1}{\sqrt{2}} \sin 1^\circ}{\sin 1^\circ} \right) + 90$$

$$= \boxed{90 \cot 1^\circ} - \cancel{90} + \cancel{90}$$

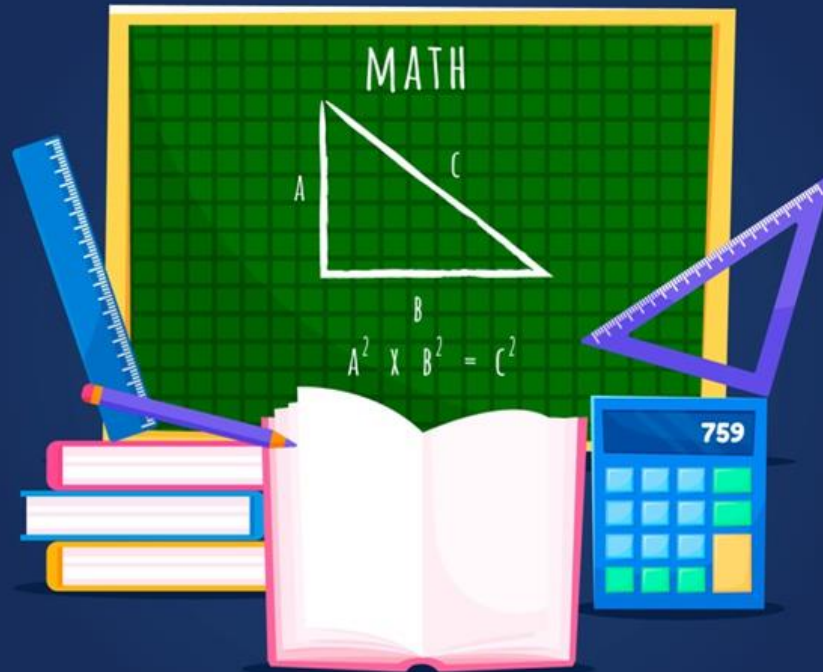
mean

$$= \frac{\text{Sum}}{90}$$

$$= \frac{\cancel{90} \cot 1^\circ}{\cancel{90}}$$

$$= \boxed{\cot 1^\circ}$$

# Product of Cosines





## Product of Cosine

$$\cos\theta \cdot \cos 2\theta \cdot \cos 2^2\theta \cdot \cos 2^3\theta \dots \cos 2^{n-1}\theta = \frac{\sin 2^n\theta}{2^n \sin\theta}$$

$$\frac{2\sin\theta}{(2\sin\theta)} \cos\theta \cos 2\theta \cos 2^2\theta \cos 2^3\theta \dots$$

$$\frac{2 \times \sin 2\theta}{2 \times 2\sin\theta} \cdot \cos 2\theta \underbrace{\cos 2^2\theta \cdot \cos 2^3\theta}$$

$$\boxed{2 \times \frac{\sin 4\theta}{(2 \times 4) \sin \theta} \cdot \cos 2^2 \theta \cos 2^3 \theta \dots}$$

$$\boxed{\frac{2}{2} \left( \frac{\sin 2^3 \theta}{2^3 \sin \theta} \right) \cos 2^3 \theta}$$

$$= \boxed{\frac{\sin 2^4 \theta}{2^4 \sin \theta}}$$



Find the **value of**

$$64 \cos \frac{\pi}{65} \cdot \cos \frac{2\pi}{65} \cdot \cos \frac{4\pi}{65} \cdot \cos \frac{8\pi}{65} \cdot \cos \frac{16\pi}{65} \cdot \cos \frac{32\pi}{65}$$

**A.** 1

**B.** 2

**C.** 3

**D.** 4

$$\theta = \frac{\pi}{65}$$

$$2^5 \left( \frac{\pi}{65} \right)$$

$$\cancel{64} \left[ \frac{\sin \left( 2^6 \frac{\pi}{65} \right)}{\cancel{2^6} \sin \pi / 65} \right]$$

$$\frac{\sin\left(\frac{64\pi}{65}\right)}{\sin\left(\frac{\pi}{65}\right)} = \frac{\sin\left(\pi - \frac{\pi}{65}\right)}{\sin\left(\pi/65\right)} = 1$$



Find the **value of**  $\cos 2^3 \frac{\pi}{10} \cos 2^4 \frac{\pi}{10} \cos 2^5 \frac{\pi}{10} \dots \cos 2^{10} \frac{\pi}{10} =$

A.  $1/128$

B.  $1/256$

C.  $\frac{1}{512} \sin \frac{\pi}{10}$

D.  $\frac{\sqrt{5}-1}{512} \sin \frac{3\pi}{10}$

$\theta = 2^3 \frac{\pi}{10}$

$2^7 \cdot \left(2^3 \frac{\pi}{10}\right)$

$\cos \theta \cos 2\theta \cos 2^2\theta \dots \cos 2^7\theta$

$$= \frac{\sin 2^8\theta}{2^8 \sin \theta} \rightarrow \frac{\sin \left(2^8 \cdot 2^3 \frac{\pi}{10}\right)}{2^8 \sin \left(2^3 \frac{\pi}{10}\right)}$$

$$= \frac{\sin\left(2^{11} \frac{\pi}{10}\right)}{2^8 \sin\left(\frac{8\pi}{10}\right)}$$

$$= \frac{\sin\left(2048 \frac{\pi}{10}\right)}{2^8 \sin\left(\frac{8\pi}{10}\right)}$$

$$= \frac{\sin\left(\cancel{2048} \frac{\pi}{\cancel{10}} + \frac{8\pi}{10}\right)}{2^8 \sin\left(\frac{8\pi}{10}\right)}$$

$$= \frac{\cancel{\sin\left(\frac{8\pi}{10}\right)}}{\cancel{2^8 \sin\left(\frac{8\pi}{10}\right)}} = \left(\frac{1}{2^8}\right)$$





Find the **value of**  $\sin \frac{\pi}{14} \sin \frac{3\pi}{14} \sin \frac{5\pi}{14} \sin \frac{7\pi}{14} \sin \frac{9\pi}{14} \sin \frac{11\pi}{14} \sin \frac{13\pi}{14}$

HW



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6:00 - 7:30 PM



Ashwani Sir | Chemistry

7:30 - 9:00 PM



Sameer Sir | Maths

9:00 - 10:30 PM

12<sup>th</sup>



Jayant Sir | Physics

1:30 - 3:00 PM



Anupam Sir | Chemistry

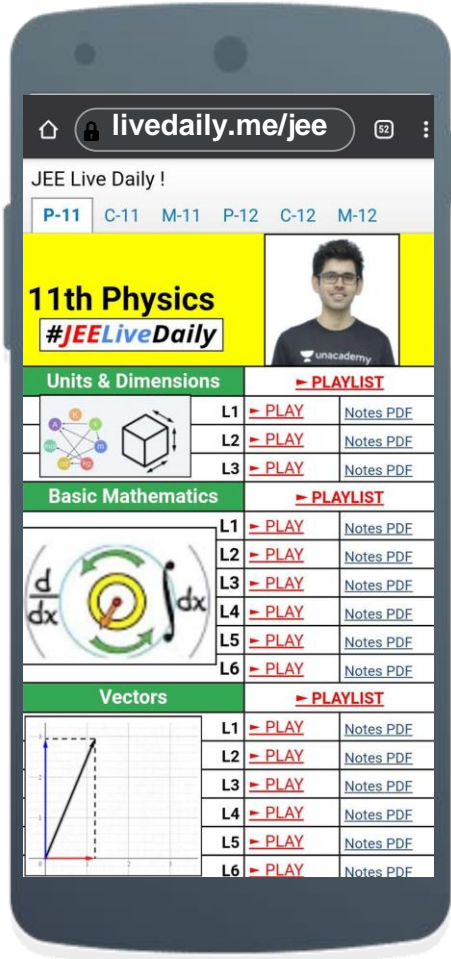
3:00 - 4:30 PM



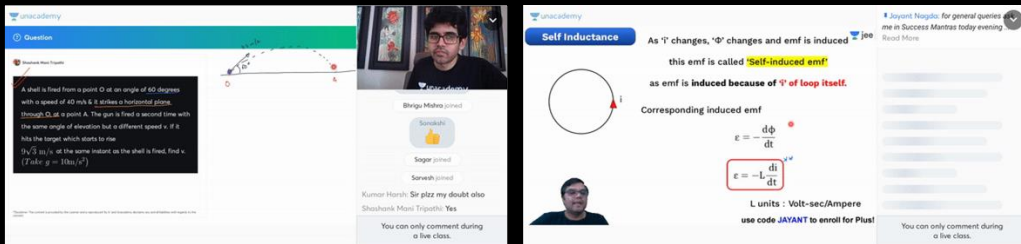
Nishant Sir | Maths

4:30 - 6:00 PM

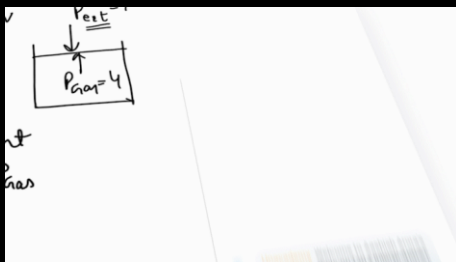
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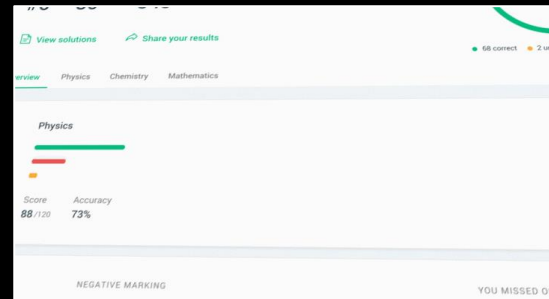
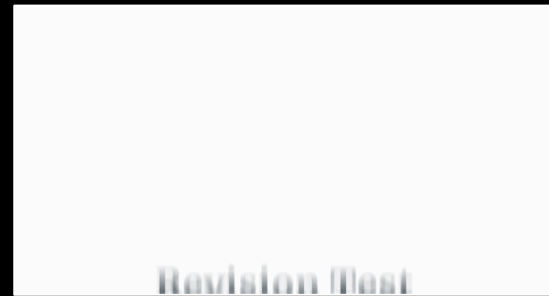


The image shows two screenshots of the Unacademy platform. The left screenshot displays a physics question: "A shell is fired from a point O at an angle of 60 degrees with a speed of 40 m/s. It strikes a horizontal plane through O at a point A. The gun is fired a second time with the same angle of elevation but a different speed  $v$ . If it hits the target which starts to rise  $(\sqrt{3}/2) \text{ m/s}^2$  at the same instant as the shell is fired, find  $v$ . (Take  $g = 10 \text{ m/s}^2$ )". The right screenshot shows a lecture on "Self Inductance" with the text: "As  $\vec{I}$  changes,  $\vec{\Phi}$  changes and emf is induced. This emf is called **Self-induced emf** as emf is induced because of  $\vec{I}$  of loop itself." It includes the formula for induced emf:  $\mathcal{E} = -\frac{d\Phi}{dt}$  and  $\mathcal{E} = -L \frac{di}{dt}$ , and mentions "L units: Volt-sec/Ampere".



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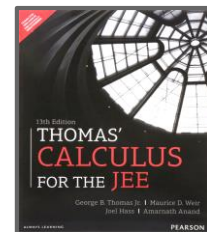
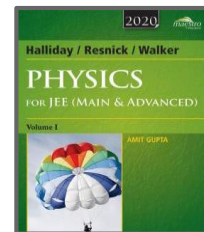
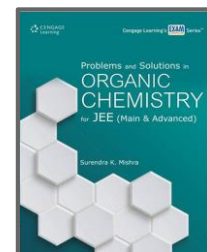
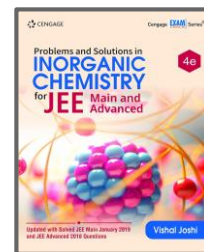
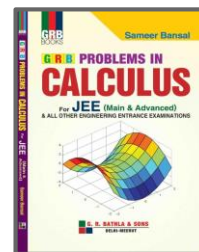
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Aravindan K  
Sundaram  
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Manas Pandey  
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Mihir Agarwal  
99.63



Akshat Tiwari  
99.60



Sarthak  
Kalankar  
99.59



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99.50



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99.48



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99.39



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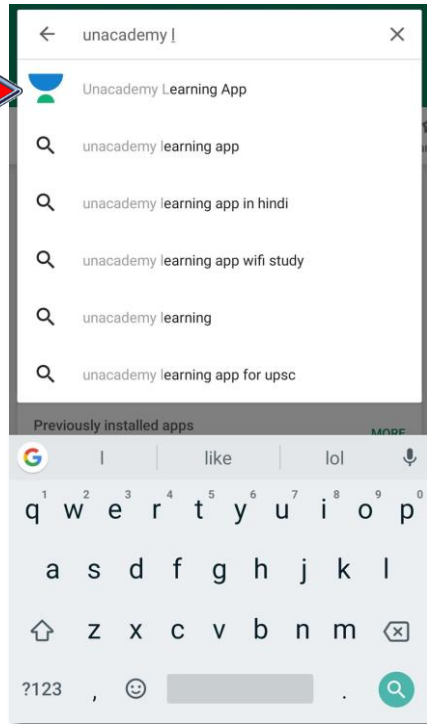


Naman Goyal  
98.48

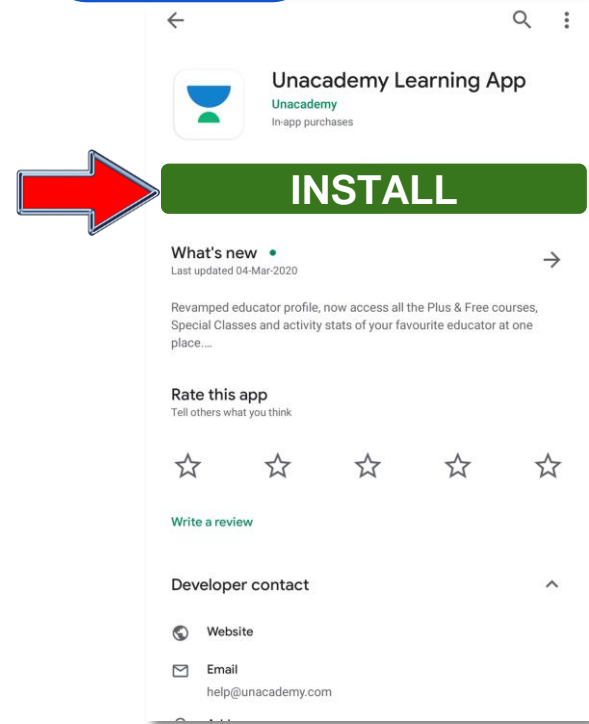


MIHIR PRAJAPATI  
98.16

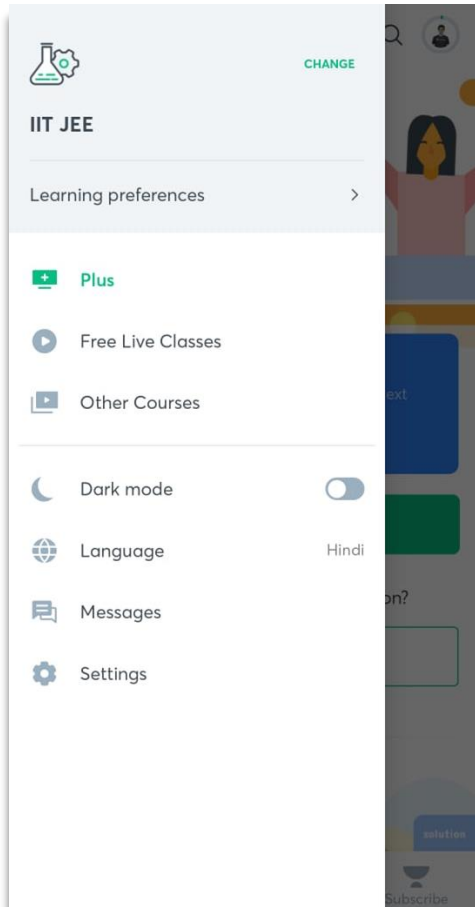
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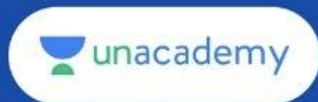
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