

Centroid, incentre  
and excentre

**Straight Lines**

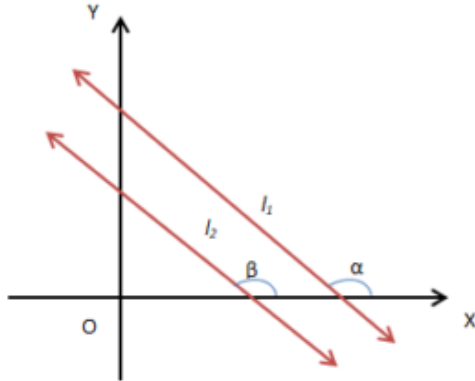


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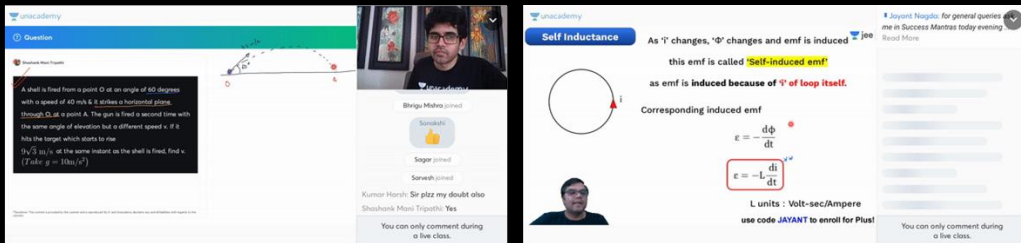
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**Question:** A shell is fired from a point O at an angle of 60 degrees with a speed of 40 m/s. It strikes a horizontal plane through O at a point A. The gun is fired a second time with the same angle of elevation but a different speed  $v$ . If it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

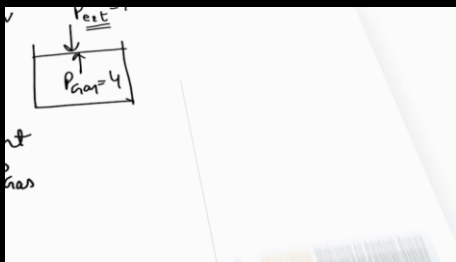
**Self Inductance:** As  $\Phi$  changes,  $\mathcal{E}$  changes and emf is induced. This emf is called **Self-induced emf** as emf is induced because of  $\Phi$  of loop itself.

Corresponding induced emf

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

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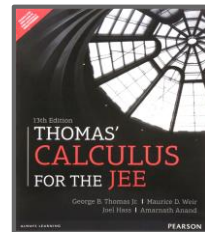
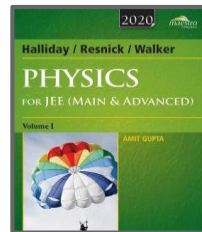
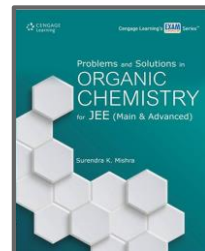
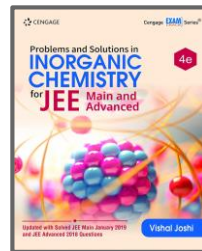
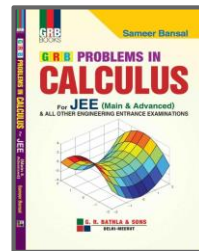
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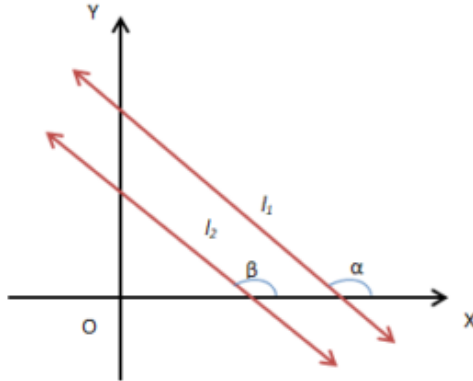


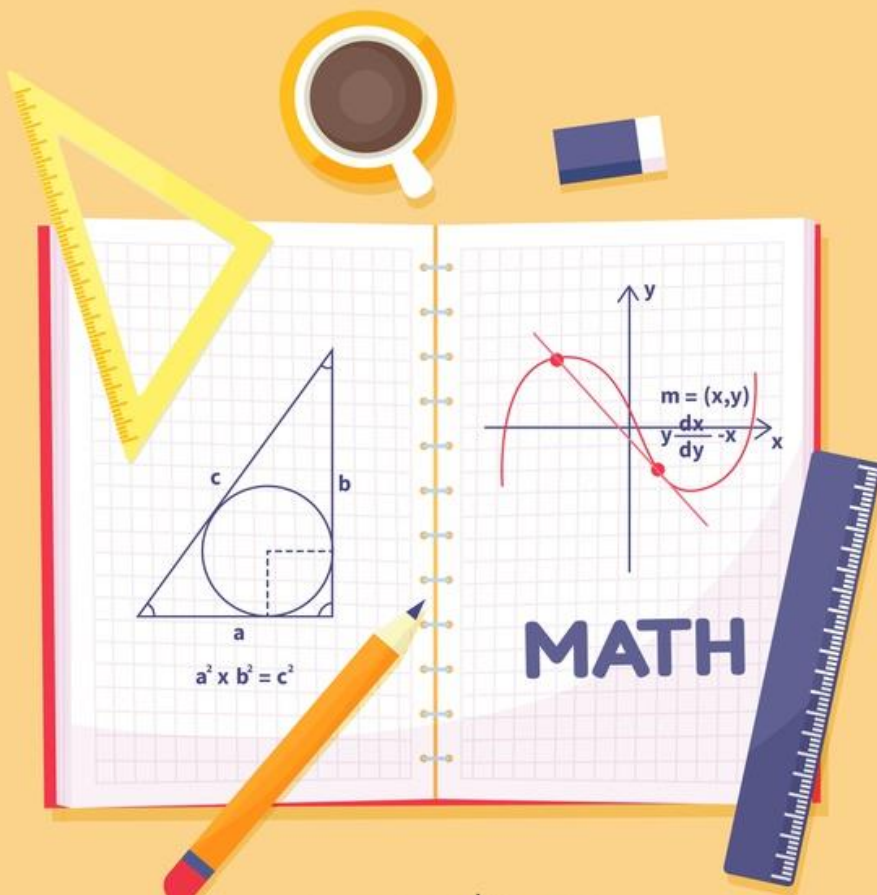
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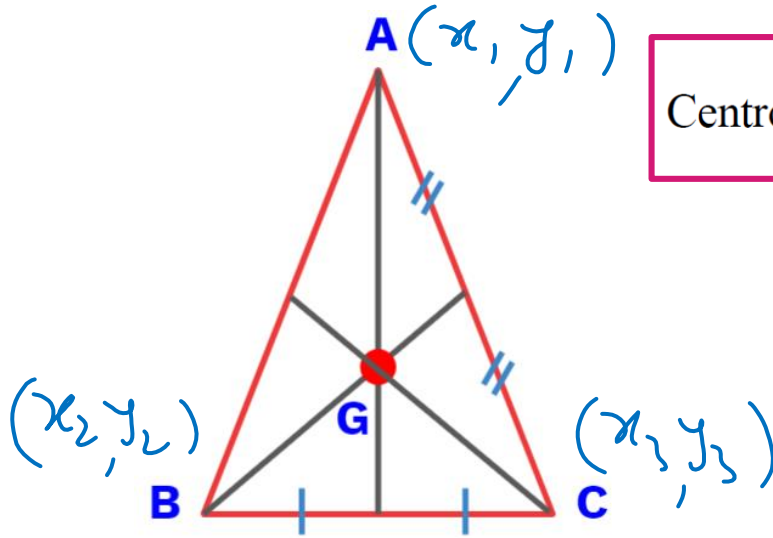


# Important Points of a Triangle



# 1. Centroid

The centroid of a triangle is the point of intersection of its medians.



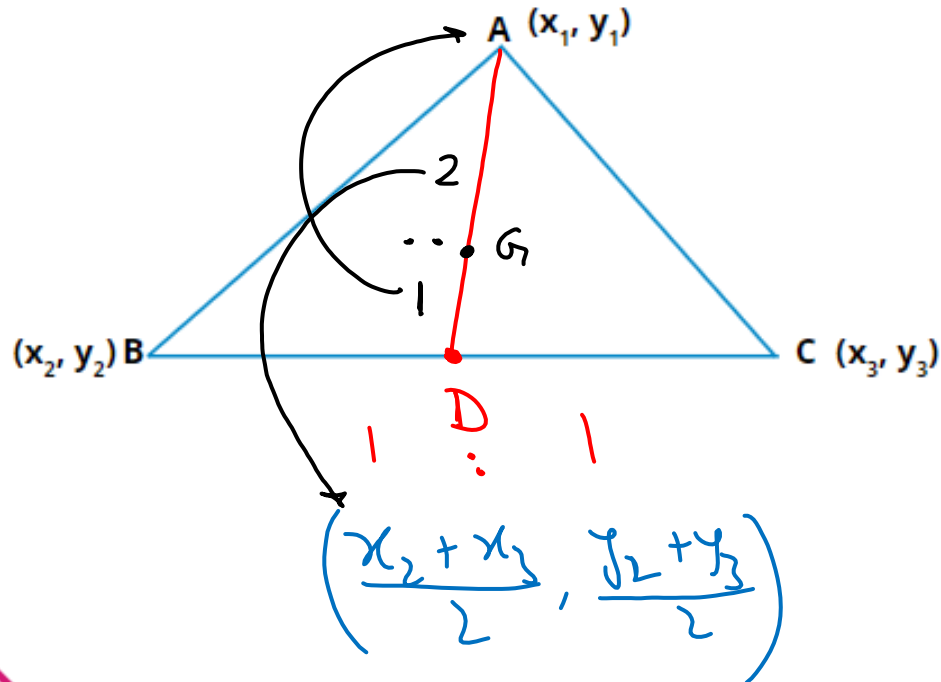
$$\text{Centroid } G \equiv \left( \frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3} \right)$$



# 1. Centroid

1. Median through A **bisects** the side BC.

2. Centroid Divides the median in the ratio **2:1**



$$\left( \frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3} \right)$$





The centroid of a triangle is  $(2, 7)$  and two of its vertices are  $(4, 8)$  and  $(-2, 6)$  the third vertex is

A.  $(0, 0)$

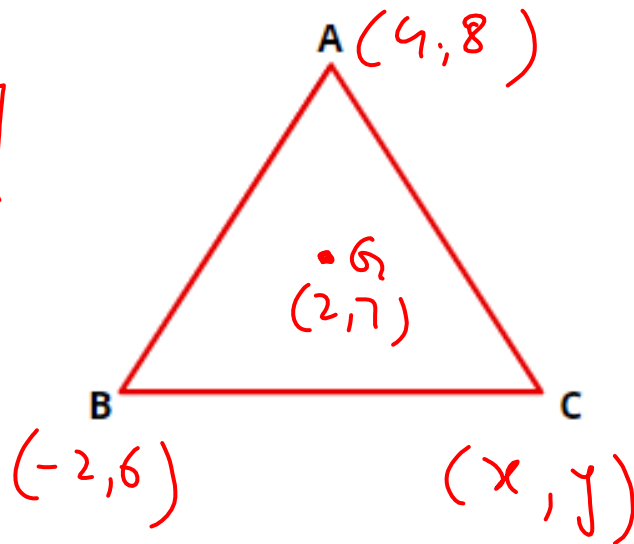
✓ B.  $(4, 7)$

C.  $(7, 4)$

D.  $(7, 7)$

$$2 = \frac{4 - 2 + x}{3} \Rightarrow \boxed{x = 4}$$

$$7 = \frac{8 + 6 + y}{3} \Rightarrow \boxed{y = 7}$$









The vertices of a triangle are  $(ab, 1/ab)$ ,  $(bc, 1/bc)$  and  $(ca, 1/ca)$  where  $a, b, c$  are the roots of the equation  $x^3 - 3x^2 + 6x + 1 = 0$ . The coordinates of its centroid are.

A.  $(1, 2)$

☒ B.  $(2, -1)$

C.  $(1, -1)$

D.  $(2, 3)$

$$a + b + c = 3$$

$$ab + bc + ca = 6$$

$$abc = -1$$

$$G \equiv$$

$$x = \frac{ab + bc + ca}{3} = \frac{6}{3} = 2$$

$$y = \frac{\left(\frac{1}{ab} + \frac{1}{bc} + \frac{1}{ca}\right)}{3}$$

$$y = \frac{a+b+c}{3abc}$$

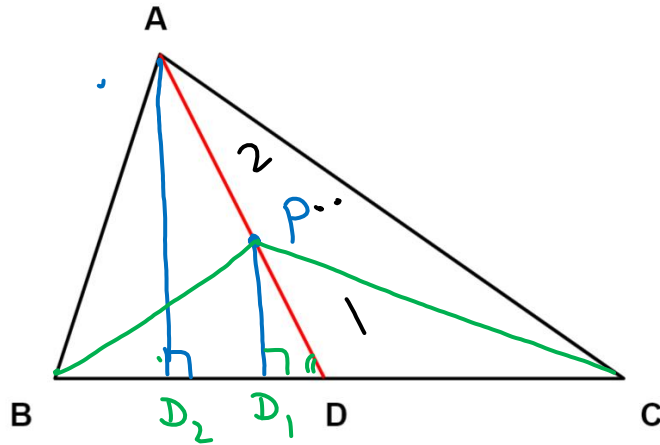
$$y = \frac{3}{3(-1)}$$

$$\boxed{y = -1}$$



Let  $A(1, 0)$ ,  $B(6, 2)$  and  $C(3/2, 6)$  be the vertices of a triangle  $ABC$ . If  $P$  is a point inside the triangle  $ABC$  such that the triangles  $APC$ ,  $APB$  and  $BPC$  have equal areas, then the length of the line segment  $PQ$ , where  $Q$  is the point  $(-7/6, -1/3)$ , is \_\_\_\_\_

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$$A(\triangle ABC) = \frac{1}{2}(BC)(AD_2)$$

$$\triangle AD_2D \sim \triangle PD_1D$$

$$\Rightarrow \frac{AD_2}{PD_1} = \frac{AD}{PD}$$
$$A(\triangle PBC) = \frac{AD}{\left(\frac{AD}{3}\right)} = \frac{3}{1}$$
$$= \frac{1}{2}(BC)\left(\frac{AD}{3}\right) = \frac{\Delta}{3}$$
$$\Rightarrow PD_1 = \frac{AD_2}{3}$$

$$A \equiv (1, 0)$$

$$B \equiv (6, 2)$$

$$C \equiv \left(\frac{3}{2}, 6\right)$$

$P \equiv \text{Centroid}$

$$\equiv \left(\frac{17/2}{3}, \frac{8}{3}\right)$$

$$\boxed{P \equiv \left(\frac{17}{6}, \frac{8}{3}\right)}$$

$$Q \equiv \left(-\frac{7}{6}, -\frac{1}{3}\right)$$

$$PQ = \sqrt{\left(\frac{17}{6} + \frac{7}{6}\right)^2 + \left(\frac{8}{3} + \frac{1}{3}\right)^2}$$

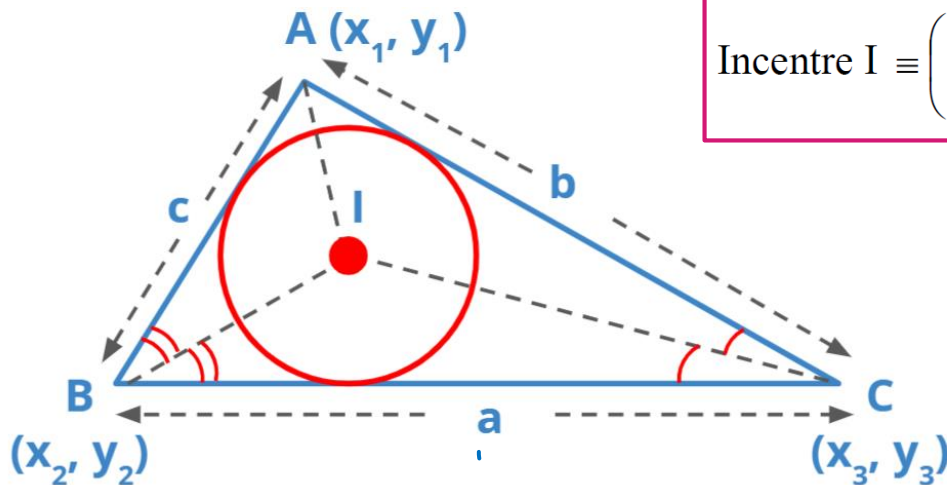
$$= \sqrt{16 + 9}$$

$$= \textcircled{5}$$



## 2. Incentre

The incentre of a triangle is the point of intersection of internal bisector of the angles.



$$\text{Incentre } I \equiv \left( \frac{ax_1 + bx_2 + cx_3}{a + b + c}, \frac{ay_1 + by_2 + cy_3}{a + b + c} \right)$$

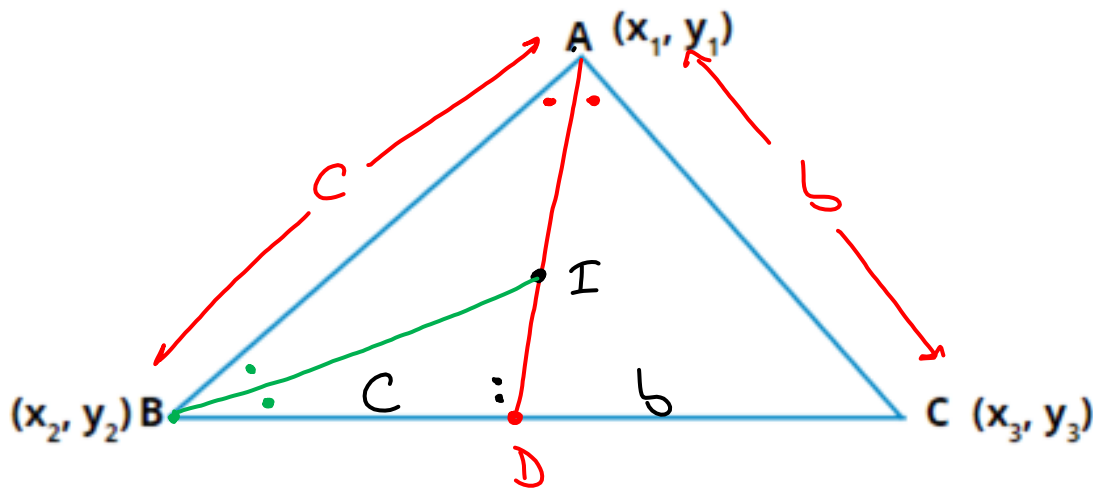




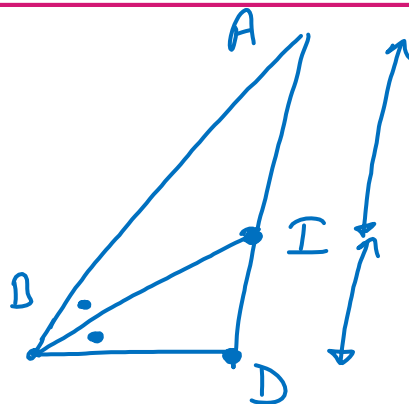
## 2. Incentre

### Angle Bisector Theorem:

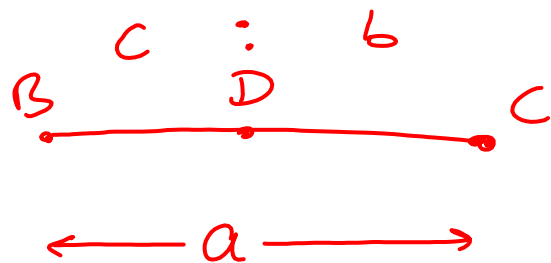
Angle Bisector divides the opposite side in the ratio of the length of containing sides.



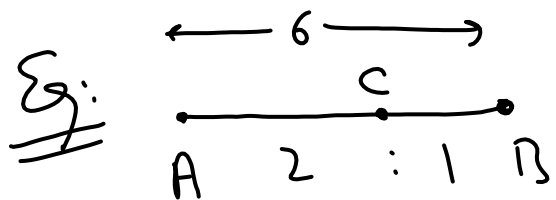
$$\left( \frac{bx_2 + cx_3}{b+c}, \frac{by_2 + cy_3}{b+c} \right)$$



$$\frac{DI}{IA} = \frac{BD}{AB}$$

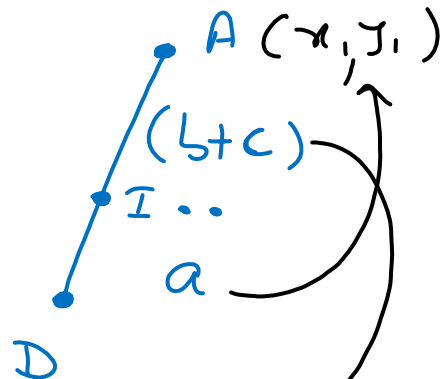


$$BD = \frac{a}{b+c} \times C$$



$$AC = \frac{6}{3} \times 2 = 4$$

$$\frac{DI}{IA} = \frac{\frac{ax}{b+c}}{x} = \frac{a}{b+c}$$



$$\left( \frac{bx_2 + cx_3}{b+c}, \frac{by_2 + cy_3}{b+c} \right)$$

$$\frac{ax_1 + bx_2 + cx_3}{a+b+c}$$





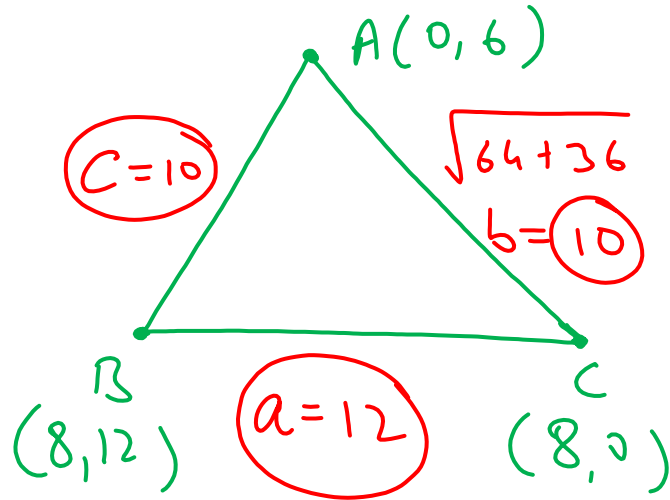
Find the coordinates of incentre of the triangle whose vertices are  $(0, 6)$ ,  $(8, 12)$  and  $(8, 0)$

A.  $(5, 2)$

☒ B.  $(5, 6)$

C.  $(7, 4)$

D.  $(6, 7)$



$$x = \frac{12(0) + 10(8) + 8(10)}{32}$$

$$= \frac{10 \times 8 \times 2}{32} = 5$$

$$y = \frac{12 \times 6 + 10 \times 12 + 10 \times 0}{32}$$
$$= 6$$









The x-coordinate of the incentre of the triangle that has the coordinates of mid points of its sides as  $(0, 1)$   $(1, 1)$  and  $(1, 0)$  is:

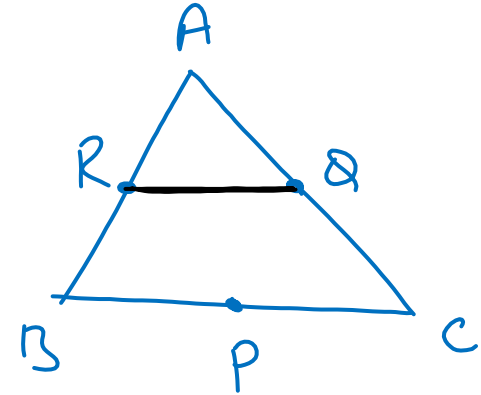
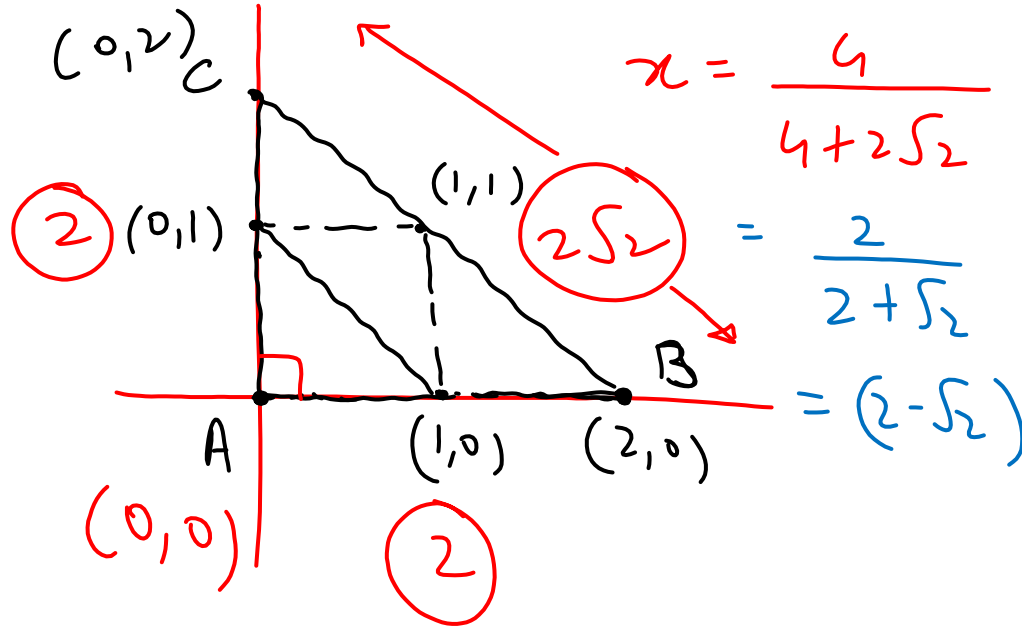
A.  $2 + \sqrt{2}$

☒ B.  $2 - \sqrt{2}$

C.  $1 - \sqrt{2}$

D.  $1 + \sqrt{2}$

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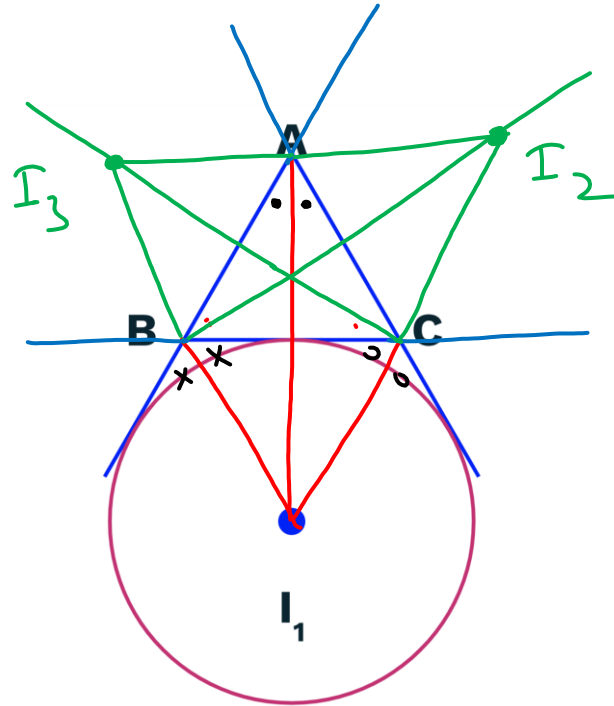






### 3. Excentre

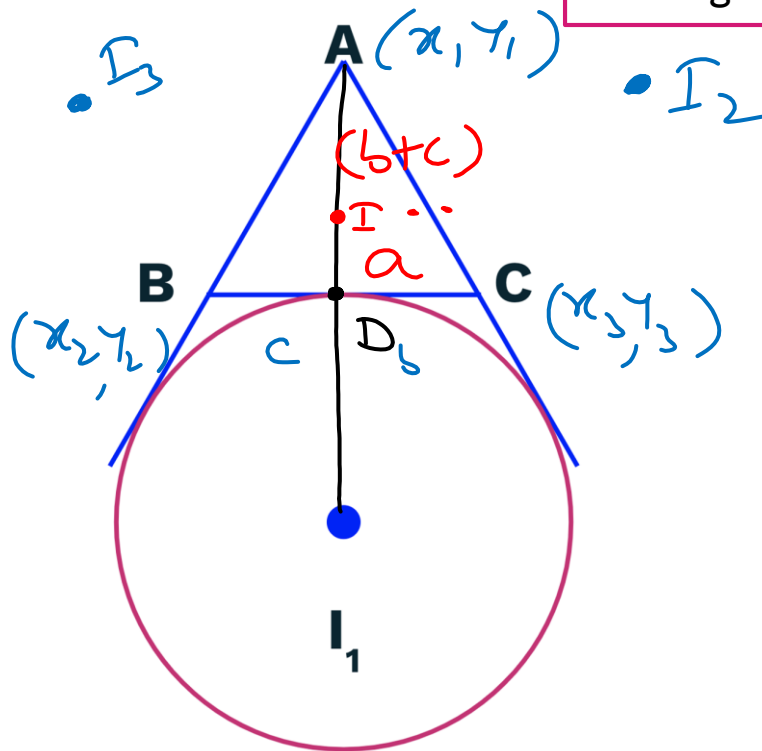
Excenter is the point of concurrency of two external angle bisectors and one internal angle bisector.





### 3. Excentre

Incenter and Excenter are **Harmonic Conjugates** of each other with respect to the angle bisector.



$$I_1 = \left( \frac{-ax_1 + bx_2 + cx_3}{-a + b + c}, \frac{-ay_1 + by_2 + cy_3}{-a + b + c} \right)$$

$$I_2 = \left( \frac{ax_1 - bx_2 + cx_3}{a - b + c}, \frac{ay_1 - by_2 + cy_3}{a - b + c} \right)$$

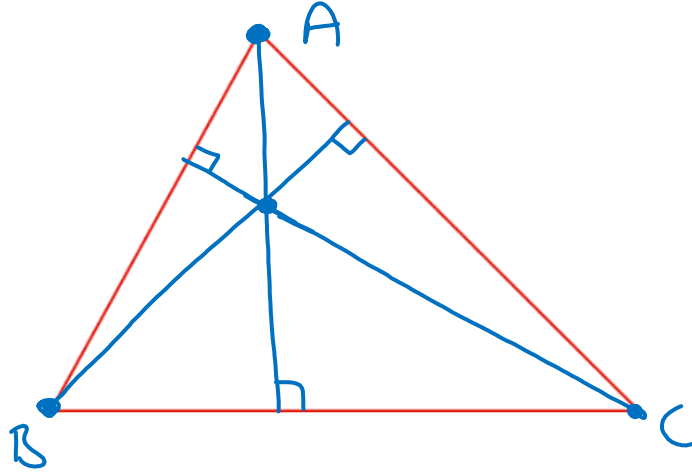
$$I_3 = \left( \frac{ax_1 + bx_2 - cx_3}{a + b - c}, \frac{ay_1 + by_2 - cy_3}{a + b - c} \right)$$





## 4. Orthocenter

It is the point of intersection of Altitudes of a Triangle

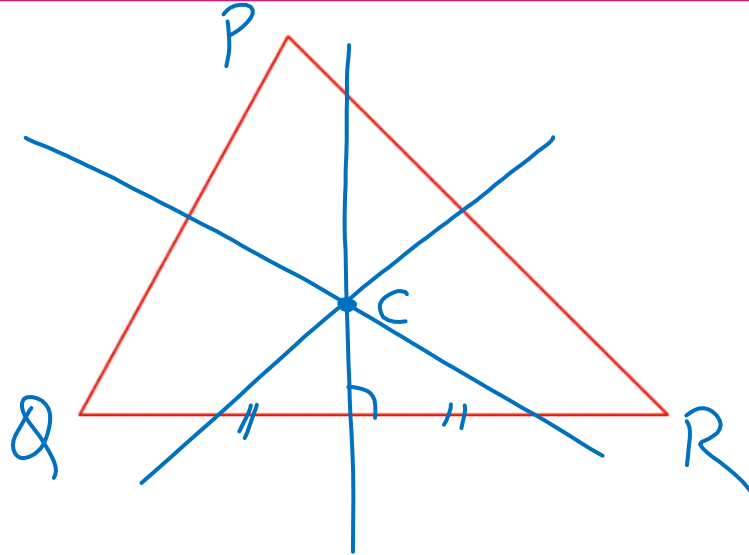






## 5. Circumcenter

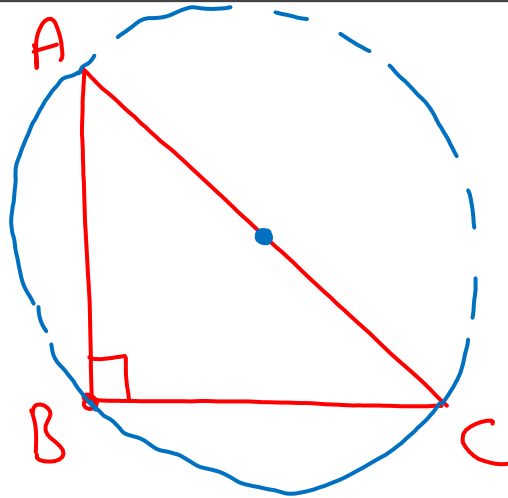
It is the point of intersection of Perpendicular Bisectors of a Triangle





## Important Results

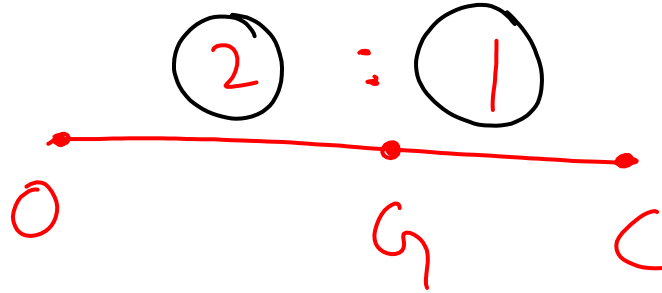
In **right angled triangle** orthocenter is at the vertex with  $90^\circ$  and circumcenter is mid point of hypotenuse.





## Important Results

Orthocentre, Centroid & Circumcentre are always collinear & centroid divides the line joining orthocentre & circumcentre in the ratio **2:1**.

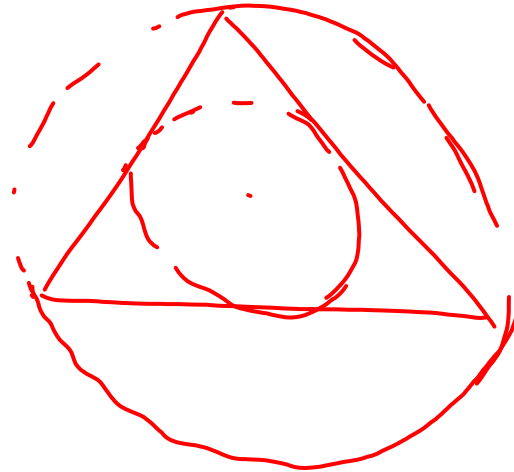
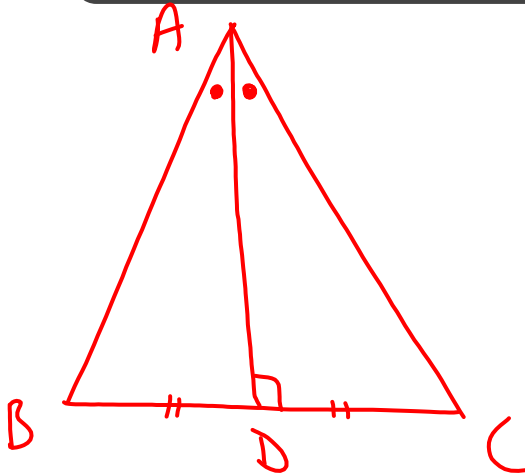


$$\overline{OG} : \overline{GC} = 2 : 1$$



## Important Results

In an **isosceles triangle** G, O, I & C lie on the same line and in an **equilateral triangle**, all these four points coincide.





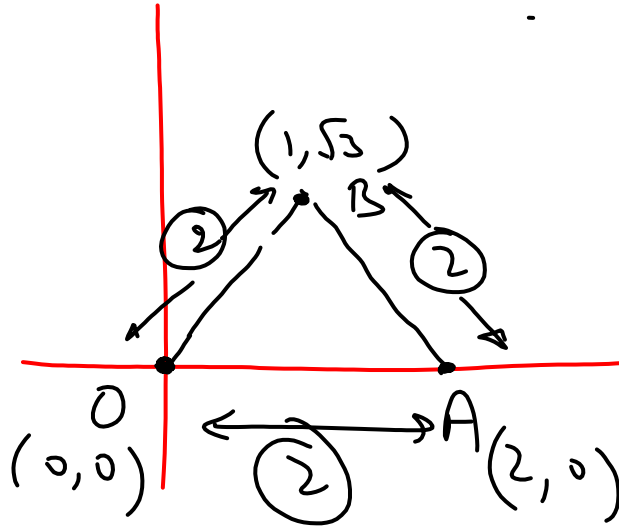
The incentre of the triangle with vertices  $(1, \sqrt{3})$ ,  $(0, 0)$  and  $(2, 0)$  is

A.  $\left(1, \frac{\sqrt{3}}{2}\right)$

B.  $\left(\frac{2}{3}, \frac{1}{\sqrt{3}}\right)$

C.  $\left(\frac{2}{3}, \frac{\sqrt{3}}{2}\right)$

☒ D.  $\left(1, \frac{1}{\sqrt{3}}\right)$



Equilateral  $\Delta$

$$I \equiv G = \left(1, \frac{\sqrt{3}}{3}\right)$$

$$= \left(1, \frac{1}{\sqrt{3}}\right)$$



Let the orthocentre and centroid of a triangle be  $A(-3, 5)$  and  $B(3, 3)$  respectively. If  $C$  is the circumcentre of this triangle, then the radius of the circle having line segment  $AC$  as diameter, is :

A.  $2\sqrt{10}$

B.

$3\sqrt{\frac{5}{2}}$

C.

$\frac{3\sqrt{5}}{2}$

D.  $\sqrt{10}$

2018 M

$A(-3, 5)$        $B(3, 3)$

$AB = \sqrt{36 + 4} = \sqrt{40}$

$$\frac{2}{3} AC = AB$$

$$AC = \frac{3}{2} \sqrt{40}$$

$$\therefore \text{radius} = \frac{AC}{2}$$

$$= \frac{3}{4} \sqrt{40}$$

$$= 3 \sqrt{\frac{40}{16}}$$

$$= 3 \sqrt{\frac{5}{2}}$$





$O(0, 0)$  is one of the vertices of triangle whose circumcentre is  $S(3, 4)$  and centroid  $G(6, 8)$ . Then, the triangle

- A.** Is right angled
- B.** Must be equilateral
- C.** Must be right-angled isosceles
- D.** Is isosceles

HW-1





If in a triangle ABC, A (1, 10), Circumcentre  $(-\frac{1}{3}, \frac{2}{3})$  and Orthocentre  $(\frac{11}{3}, \frac{4}{3})$  are given. Then find the coordinate of midpoint of side opposite to A.

**A.** (1, 6)

**B.** (1, 5)

**C.** (1, -3)

**D.** (1,  $-\frac{11}{3}$ )

HW-2







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Namo Sir | Physics

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

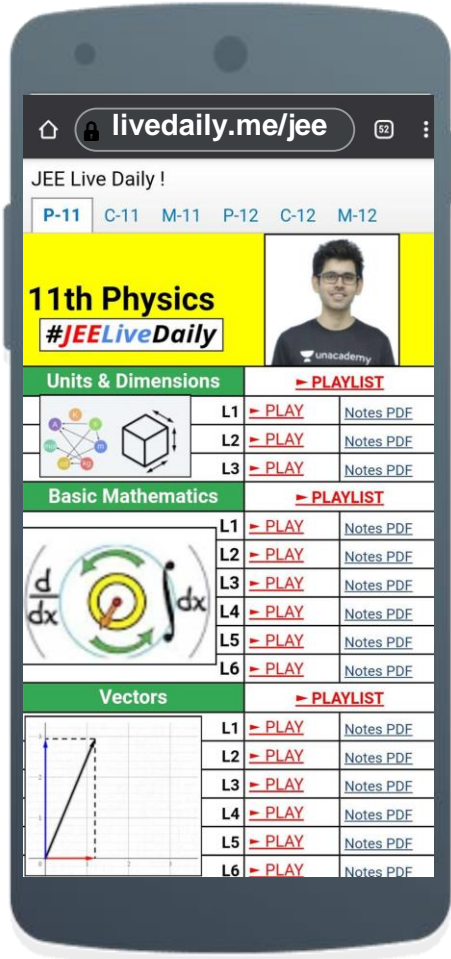
3:00 - 4:30 PM



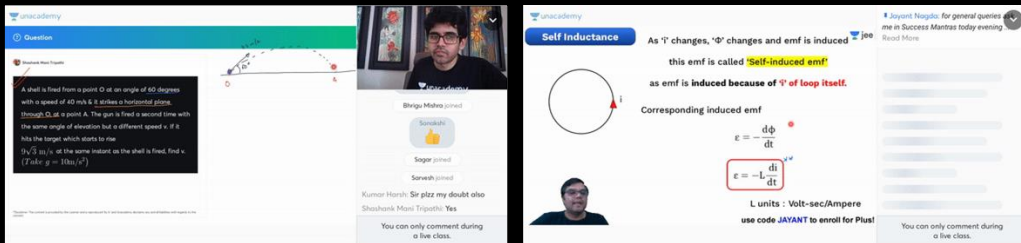
Nishant Sir | Maths

4:30 - 6:00 PM

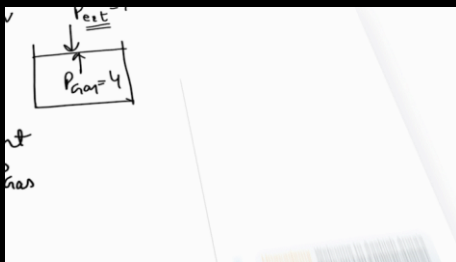
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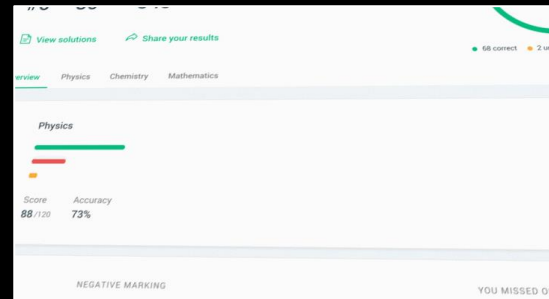
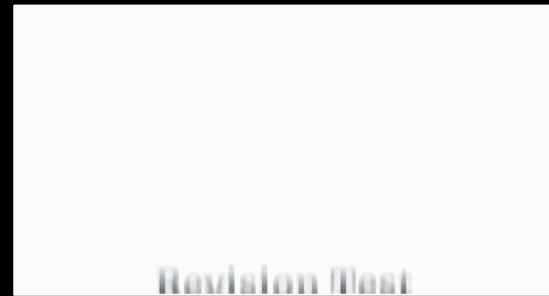


The image shows two screenshots of the Unacademy platform. The left screenshot displays a physics question: "A shell is fired from a point O at an angle of 60 degrees with a speed of 40 m/s. It strikes a horizontal plane through O at a point A. The gun is fired a second time with the same angle of elevation 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 also 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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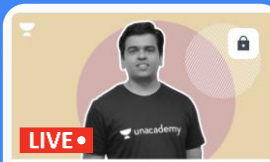
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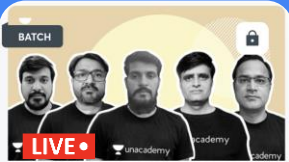
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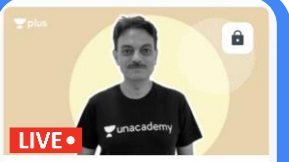
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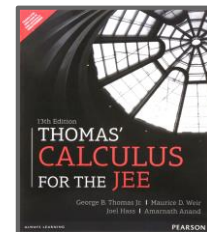
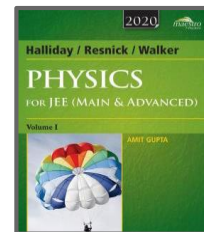
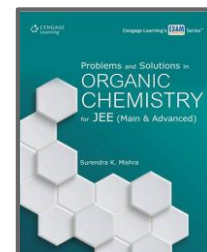
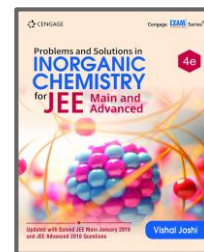
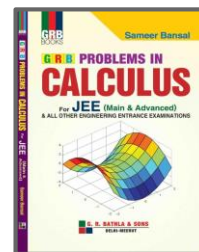
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Lesson 1 • Apr 2, 2021 12:30 PM

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99.75



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  
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Maroof  
99.50



Tarun Gupta  
99.50



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99.48



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99.39



Sahil  
99.38



Vaibhav Dhanuka  
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99.29



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Shrish  
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Ayush Kale  
98.85



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98.67



Megh Gupta  
98.59

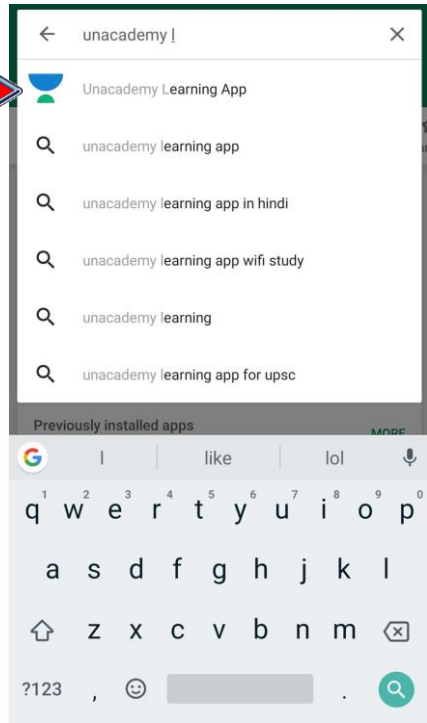


Naman Goyal  
98.48

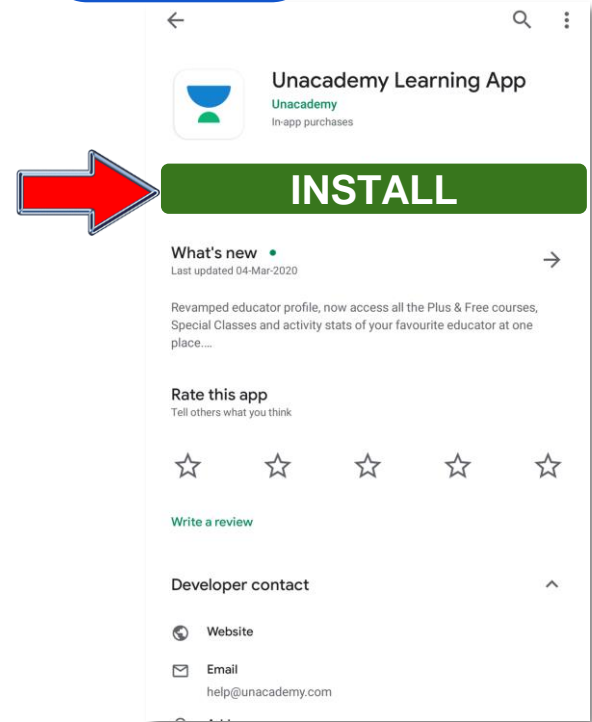


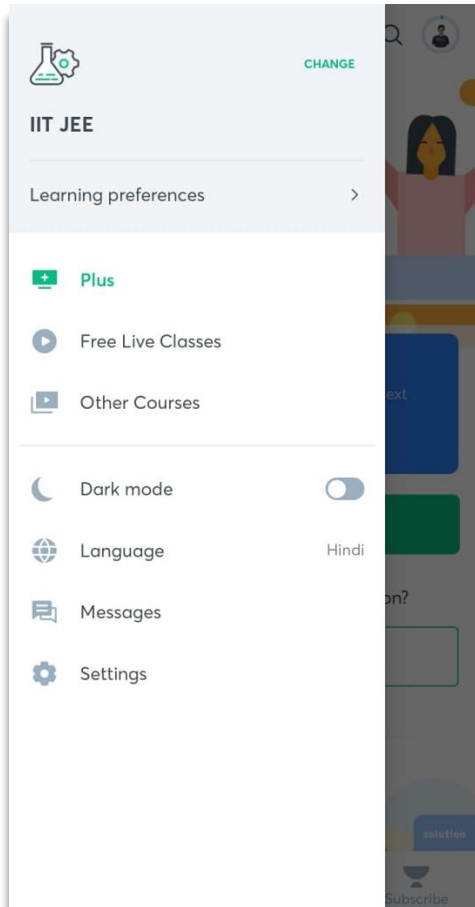
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**Evolve Batch (Class 12th) : JEE Main 2022**



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