Answer Key

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Consider the vertices,

$$\mathbf{A} = \begin{pmatrix} -5 \\ 4 \end{pmatrix} \qquad \mathbf{B} = \begin{pmatrix} 5 \\ -1 \end{pmatrix} \qquad \mathbf{C} = \begin{pmatrix} -1 \\ -3 \end{pmatrix} \tag{1}$$

I. VECTORS

Parameter	Value	Description
$\mathbf{m_1}$	$\begin{pmatrix} -1 \\ -11 \end{pmatrix}$	$\mathbf{A} - \mathbf{B}$
$\mathbf{m_2}$	$\begin{pmatrix} 8 \\ 1 \end{pmatrix}$	$\mathbf{B} - \mathbf{C}$
$\mathbf{m_3}$	$\begin{pmatrix} -7 \\ 10 \end{pmatrix}$	$\mathbf{A} - \mathbf{C}$
$\|\mathbf{B} - \mathbf{A}\|$	11.045	AB
$\|\mathbf{C} - \mathbf{B}\|$	8.062	BC
$\|\mathbf{A} - \mathbf{C}\|$	12.206	AC
$\text{rank}\begin{pmatrix} 1 & 1 & 1 \\ \mathbf{A} & \mathbf{B} & \mathbf{C} \end{pmatrix}$	3	points are not collinear
$\mathbf{n_1}^\top$	$\begin{pmatrix} -11 & 1 \end{pmatrix}$	AB
c_1	49	
$\mathbf{n_2}^\top$	$\begin{pmatrix} 1 & -8 \end{pmatrix}$	BC
c_2	43	
$\mathbf{n_3}^\top$	$\begin{pmatrix} 10 & 7 \end{pmatrix}$	AC
c_3	-5	
area	43.5	area of triangle
$\angle A$	40.186°	Angle
$\angle B$	77.680°	
$\angle C$	62.134°	

TABLE I.1
VECTORS

II. MEDIANS

Parameter	Value	Description
D	$\begin{pmatrix} -1 \\ -5.5 \end{pmatrix}$	midpoint of line BC
E	$\begin{pmatrix} -3.0 \\ 0.5 \end{pmatrix}$	midpoint of line AC
F	$\begin{pmatrix} -0.5 \\ 0 \end{pmatrix}$	midpoint of line AB
$\mathbf{n_4^\top}$	$\begin{pmatrix} -10.5 & -3 \end{pmatrix}$	AD
c_4	27	
$\mathbf{n_5^\top}$	$\begin{pmatrix} 6 & -4.5 \end{pmatrix}$	BE
c_5	3	
$\mathbf{n_6^\top}$	$\begin{pmatrix} 4.5 & 7.5 \end{pmatrix}$	CF
c_6	-24	
G	$\begin{pmatrix} -2 \\ -2 \end{pmatrix}$	centroid of triangle

TABLE II.1
MEDIAN

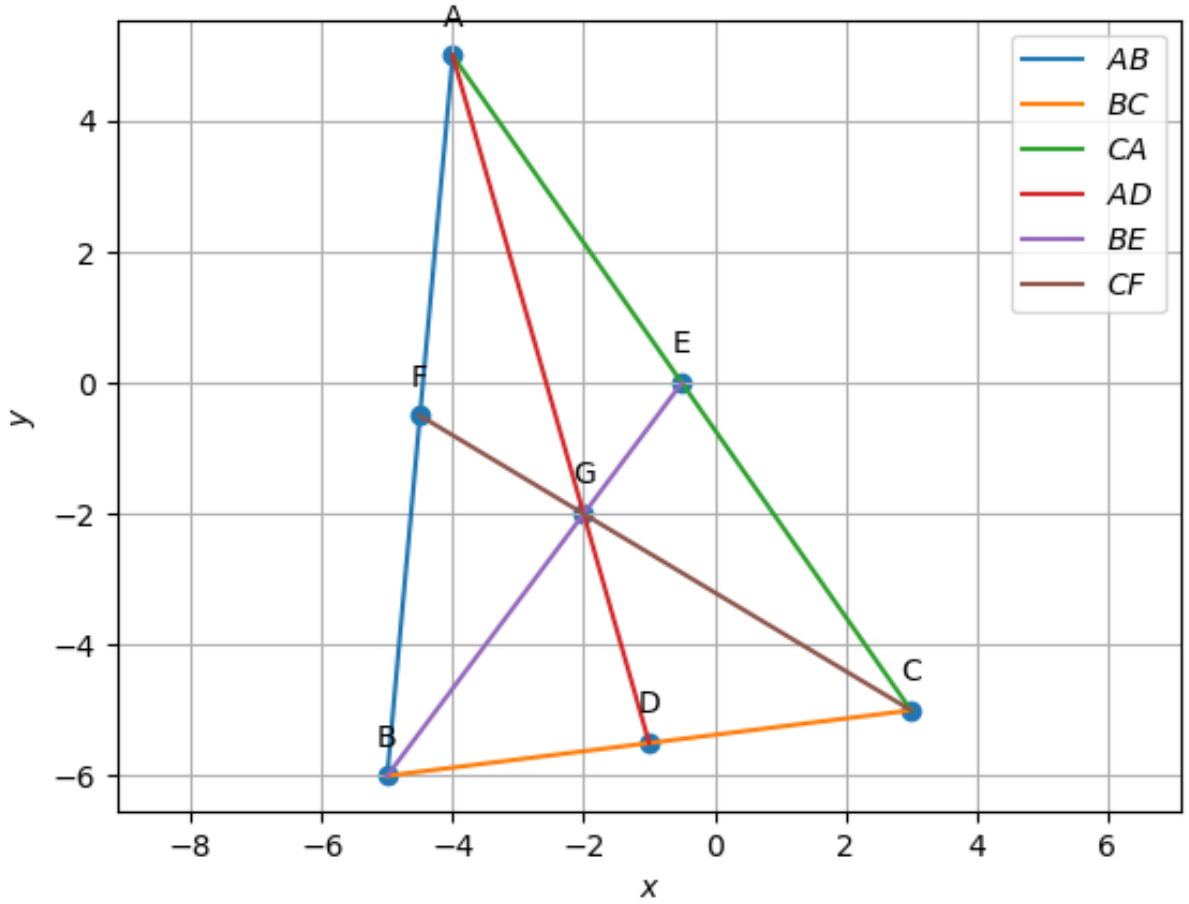

Fig. II.1. Triangle ABC with medians AD, BE and CF

III. ALTITUDES

Parameter	Value	Description
$\mathbf{n_7}^\top$	$\begin{pmatrix}8 & 1\end{pmatrix}$	AD_1
c_7	-27	
$\mathbf{n_8}^\top$	$\begin{pmatrix}-7 & 10\end{pmatrix}$	BE_1
c_8	-25	
$\mathbf{n_9}^\top$	$\begin{pmatrix}-1 & -11\end{pmatrix}$	CF_1
c_9	52	
H	$\begin{pmatrix}-2.817\\-4.471\end{pmatrix}$	Orthocentre of triangle

TABLE III.1
ALTITUDES

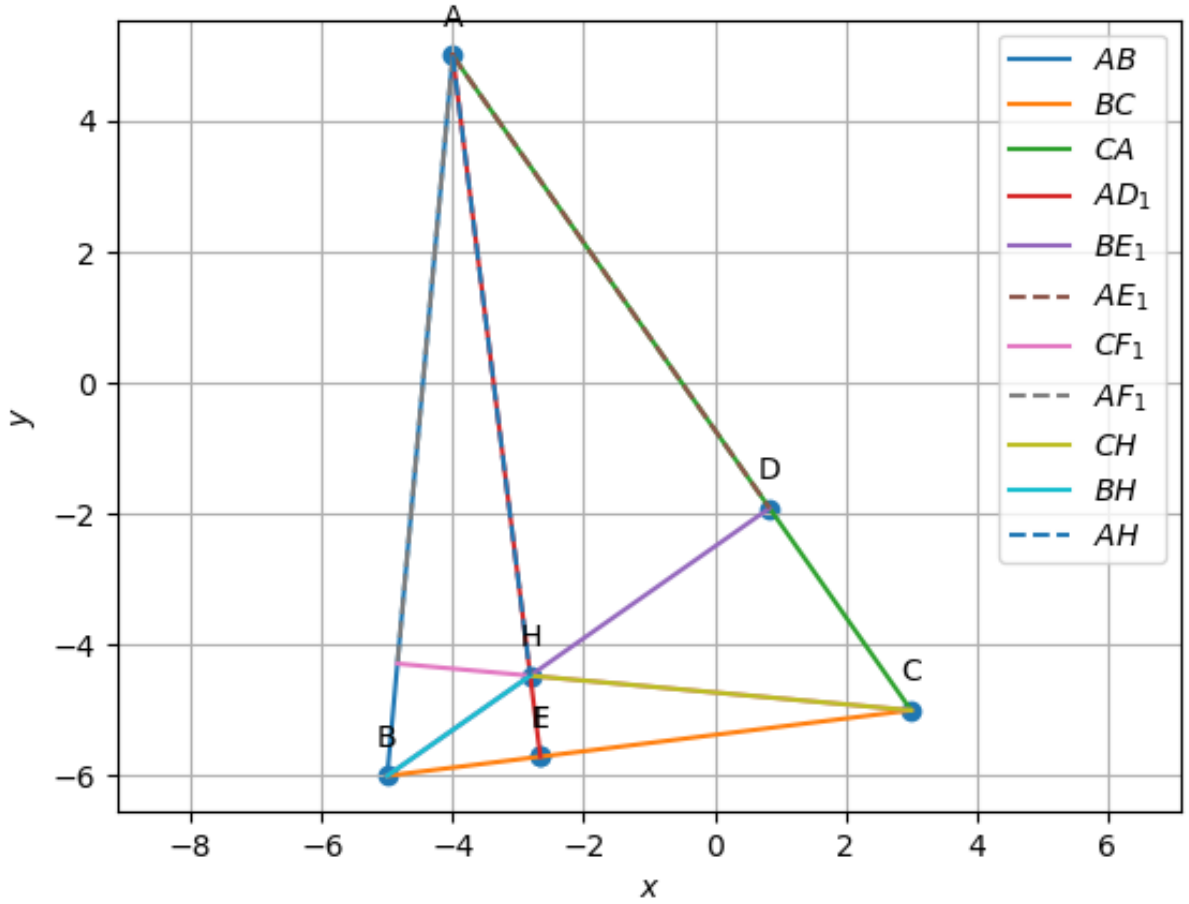

Fig. III.1. Triangle ABC with altitudes AD_1, BE_1 and CF_1

IV. PERPENDICULAR BISECTOR

Parameter	Value	Description
$\mathbf{n}_{10}^{\top}$	$\begin{pmatrix}1 & 11\end{pmatrix}$	Perpendicular bisector of AB
c_{10}	-10	
$\mathbf{n}_{11}^{\top}$	$\begin{pmatrix}-8 & -1\end{pmatrix}$	Perpendicular bisector of BC
c_{11}	13.5	
$\mathbf{n}_{12}^{\top}$	$\begin{pmatrix}7 & -10\end{pmatrix}$	Perpendicular bisector of CA
c_{12}	-3.5	
O	$\begin{pmatrix}-1.592\\-0.764\end{pmatrix}$	Circumcircle
radius	6.247	

TABLE IV.1
PERPENDICULAR BISECTOR

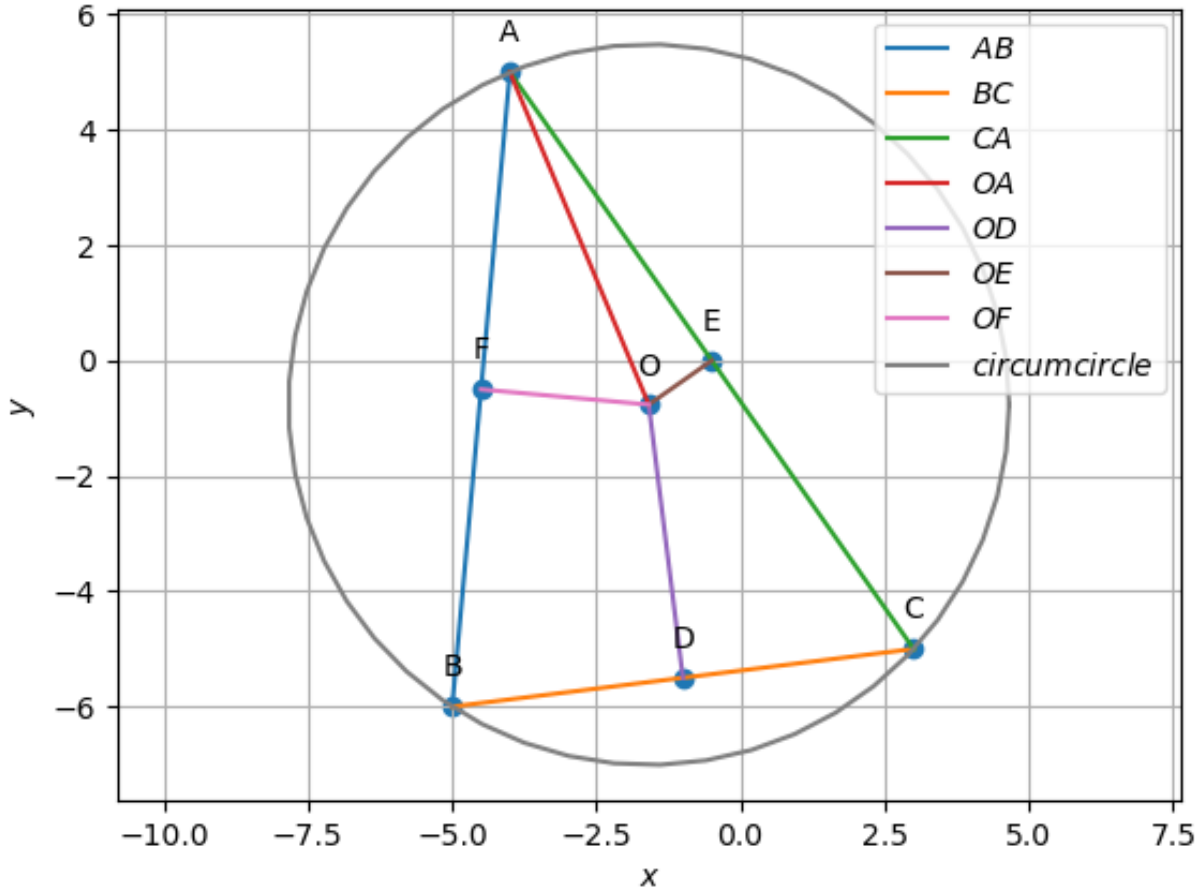

Fig. IV.1. circumcircle of triangle ABC with circumcentre O

V. ANGULAR BISECTOR

Parameter	Value	Description
$\mathbf{n}_{13}^{\top}$	$\begin{pmatrix}-1.815 & -0.483\end{pmatrix}$	Angular bisector of A
c_{13}	4.846	
$\mathbf{n}_{14}^{\top}$	$\begin{pmatrix}1.112 & -1.082\end{pmatrix}$	Angular bisector of B
c_{14}	0.897	
$\mathbf{n}_{15}^{\top}$	$\begin{pmatrix}0.695 & 1.566\end{pmatrix}$	Angular bisector of C
c_{15}	5.048	
$\mathbf{I}$	$\begin{pmatrix}-1.920\\-2.815\end{pmatrix}$	Incircle
radius	2.778	

TABLE V.1
ANGULAR BISECTOR

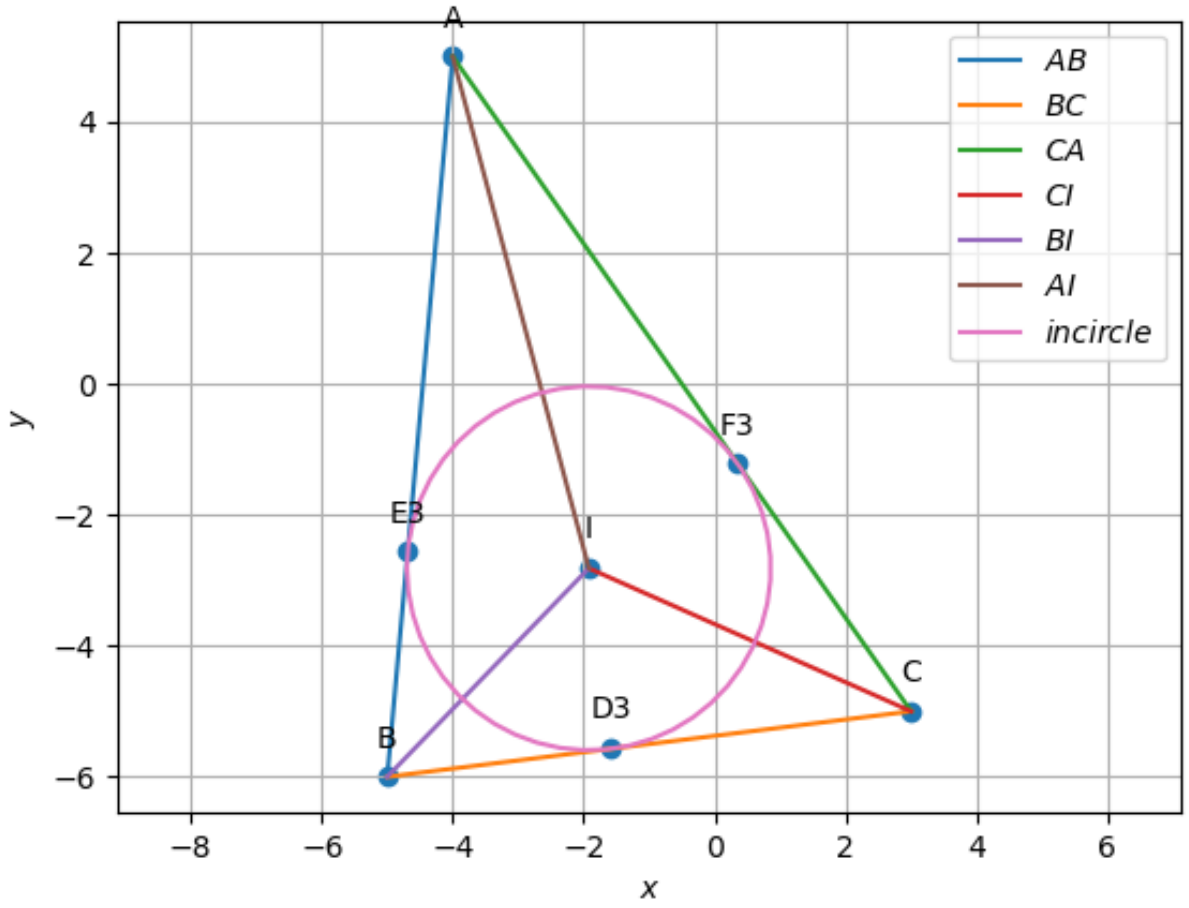

Fig. V.1. incircle of triangle ABC with incentre I