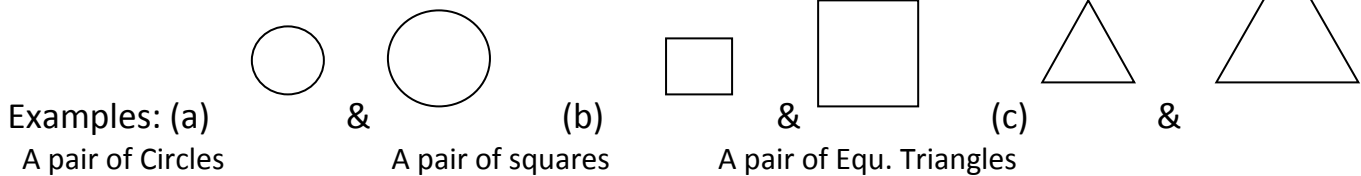


Triangles

Key Points

Similar Figures: Two figures having similar shapes (size may or may not be same), called Similar figures.



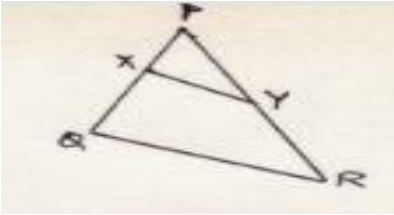
- Pairs of all regular polygons, containing equal number of sides are examples of Similar Figures.
- **Similar Triangles:** Two Triangles are said to be similar if
 - (a) Their corresponding angles are equal (also called Equiangular Triangles)
 - (b) Ratio of their corresponding sides are equal/proportional
- All congruent figures are similar but similar figures may /may not be congruent
- Conditions for similarity of two Triangles
 - (a) AAA criterion/A-A corollary
 - (b) SAS similarity criterion
 - (c) SSS similarity criterion (where 'S' stands for ratio of corresponding sides of two Triangles)

Important Theorems of the topic Triangles

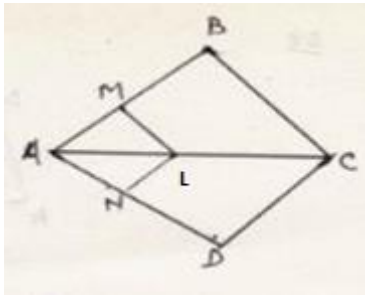
- (a) Basic Proportionality Theorem (B.P.T.)/Thale's Theorem
- (b) Converse of B.P.T.
- (c) Area related theorem of Similar Triangles
- (d) Pythagoras Theorem
- (e) Converse of Pythagoras Theorem

Level I

- (1) In the figure $XY \parallel QR$, $PQ/XQ = 7/3$ and $PR = 6.3\text{cm}$ then find YR



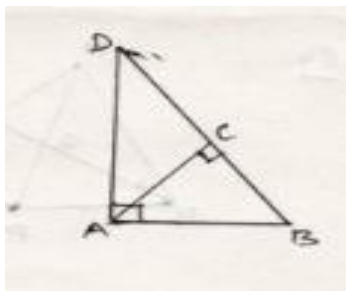
- (2) If $\triangle ABC \sim \triangle DEF$ and their areas be 64cm^2 & 121cm^2 respectively, then find BC if $EF = 15.4\text{ cm}$
- (3) ABC is an isosceles \triangle , right angled at C then prove that $AB^2 = 2AC^2$
- (4) If $\triangle ABC \sim \triangle DEF$, $\angle A = 46^\circ$, $\angle E = 62^\circ$ then the measure of $\angle C = 72^\circ$. Is it true? Give reason.
- (5) The ratio of the corresponding sides of two similar triangles is $16:25$ then find the ratio of their perimeters.
- (6) A man goes 24 km in due east and then He goes 10 km in due north. How far is He from the starting Point?
- (7) The length of the diagonals of a rhombus is 16cm & 12cm respectively then find the perimeter of the rhombus.
- (8) In the figure $LM \parallel CB$ and $LN \parallel CD$ then prove that $AM/AB = AN/AD$



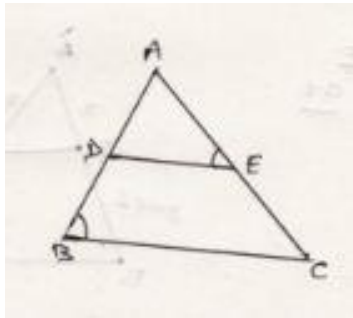
- (9) Which one is the sides of a right angled triangles among the following (a) $6\text{cm}, 8\text{cm}$ & 11cm (b) $3\text{cm}, 4\text{cm}$ & 6cm (c) 5cm , 12cm & 13cm

Level II

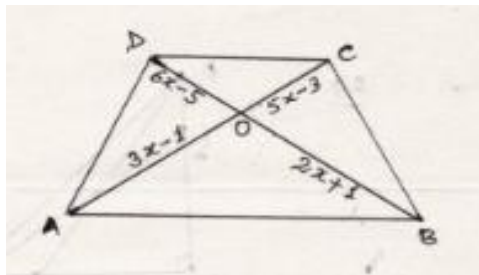
- (1) In the figure ABD is a triangle right angled at A and AC is perpendicular to BD then show that $AC^2 = BC \times DC$



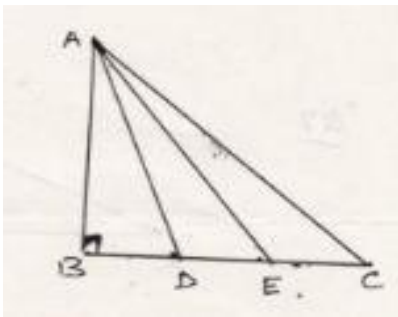
- (2) Two poles of height 10m & 15 m stand vertically on a plane ground. If the distance between their feet is $5\sqrt{3}$ m then find the distance between their tops.
- (3) D & E are the points on the sides AB & AC of $\triangle ABC$, as shown in the figure. If $\angle B = \angle AED$ then show that $\triangle ABC \sim \triangle AED$



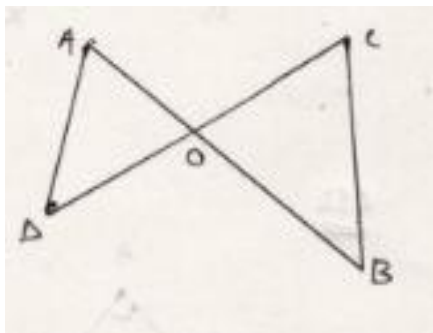
- (4) In the adjoining figure $AB \parallel DC$ and diagonal AC & BD intersect at point O. If $AO = (3x-1)$ cm, $OB = (2x+1)$ cm, $OC = (5x-3)$ cm and $OD = (6x-5)$ cm then find the value of x.



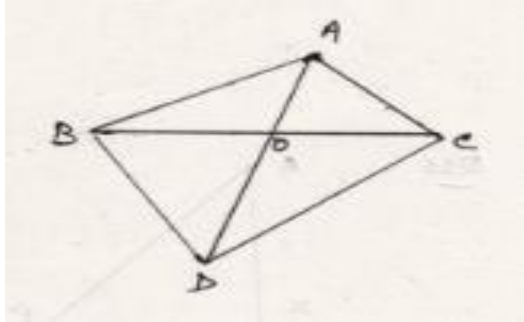
- (5) In the figure D & E trisect BC. Prove that $8AE^2 = 3AC^2 + 5AD^2$



- (6) In the figure $OA/OC = OD/OB$ then prove that $\angle A = \angle C$

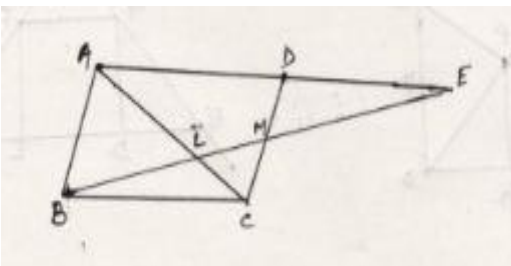


- (7) Using converse of B.P.T. prove that the line joining the mid points of any two sides of a triangle is parallel to the third side of the triangle.
- (8) In the given figure $\triangle ABC$ & $\triangle DBC$ are on the same base BC . if AD intersect BC at O then prove that $\frac{\text{ar}(\triangle ABC)}{\text{ar}(\triangle DBC)} = \frac{AO}{DO}$

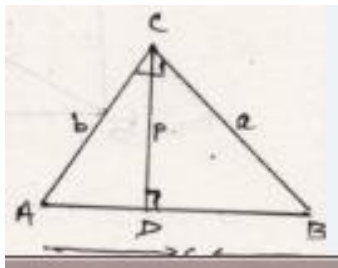


Level III

- (1) A point O is in the interior of a rectangle $ABCD$, is joined with each of the vertices A, B, C & D . Prove that $OA^2 + OC^2 = OB^2 + OD^2$
- (2) In an equilateral triangle ABC , D is a point on the base BC such that $BD = \frac{1}{3} BC$, then show that $9AD^2 = 7AB^2$
- (3) Prove that in a rhombus, sum of squares of the sides is equal to the sum of the squares of its diagonals
- (4) In the adjoining figure $ABCD$ is a parallelogram. Through the midpoint M of the side CD , a line is drawn which cuts diagonal AC at L and AD produced at E . Prove that $EL = 2BL$

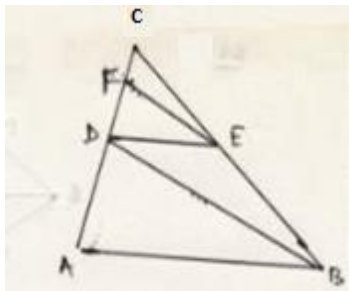


- (5) $\triangle ABC$ & $\triangle DBC$ are two triangles on the same base BC and on the same side of BC with $\angle A = \angle D = 90^\circ$. If CA & BD meet each other at E then show that $AE \times EC = BE \times ED$
- (6) $\triangle ABC$ is a Triangle, right angle at C and p is the length of the perpendicular drawn from C to AB . By expressing the area of the triangle in two ways show that (i) $pc = ab$ (ii) $\frac{1}{p^2} = \frac{1}{a^2} + \frac{1}{b^2}$



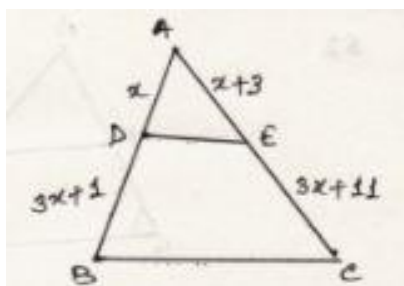
(7) Prove that the ratio of the areas of two similar triangles is equal to the ratio of their corresponding sides.

(8) In the figure $AB \parallel DE$ and $BD \parallel EF$. Prove that $DC^2 = CF \times AC$



Self-Evaluation Questions including Board Questions & Value Based Questions

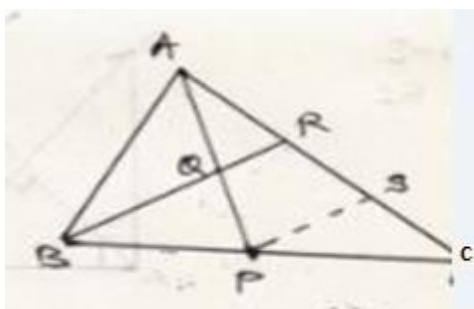
(1) Find the value of x for which $DE \parallel BC$ in the adjoining figure



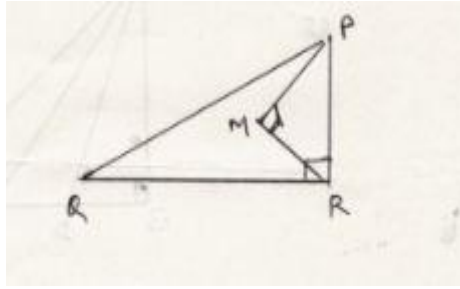
(2) In an equilateral triangle prove that three times the square of one side is equal to four times the square of one of its altitude.

(3) The perpendicular from A on the side BC of a triangle ABC intersect BC at D such that $DB = 3CD$. Prove that $2AB^2 = 2AC^2 + BC^2$

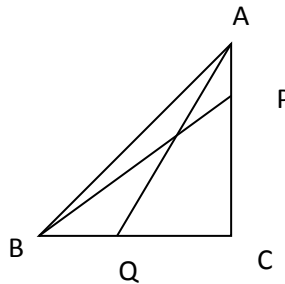
(4) In the adjoining figure P is the midpoint of BC and Q is the midpoint of AP. If BQ when produced meets AC at R, then prove that $RA = \frac{1}{3} CA$



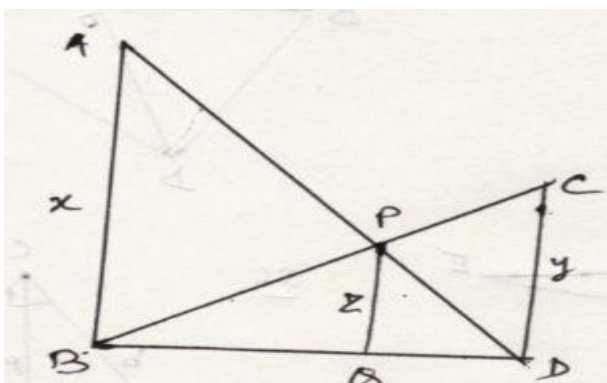
- (5) BL and CM are medians of triangle ABC, right angled at A then prove that $4(BL^2 + CM^2) = 5BC^2$
- (6) In $\triangle ABC$ if $AB = 6\sqrt{3}\text{cm}$, $AC = 12\text{cm}$ and $BC = 6\text{cm}$ then show that $\angle B = 90^\circ$
- (7) In the adjoining figure $\angle QRP = 90^\circ$, $\angle PMR = 90^\circ$, $QR = 26\text{cm}$, $PM = 8\text{cm}$ and $MR = 6\text{cm}$ then find the area of $\triangle PQR$



- (8) If the ratio of the corresponding sides of two similar triangles is 2:3 then find the ratio of their corresponding altitudes.
- (9) In the adjoining figure ABC is a \triangle right angled at C. P & Q are the points on the sides CA & CB respectively which divides these sides in the ratio 2:1, then prove that $9(AQ^2 + BP^2) = 13 AB^2$

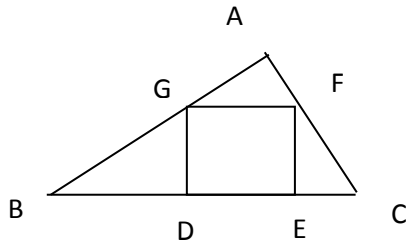


- (10) In the adjoining figure $AB \parallel PQ \parallel CD$, $AB = x$ unit, $CD = y$ unit & $PQ = z$ unit then prove that $\frac{1}{x} + \frac{1}{y} = \frac{1}{z}$



- (11) State and prove Pythagoras theorem. Using this theorem find the distance between the tops of two vertical poles of height 12m & 18m respectively fixed at a distance of 8m apart from each other.

(12) in the adjoining figure DEFG is a square & $\angle BAC = 90^\circ$ then prove that (a) $\triangle AGF \sim \triangle DBG$
 (B) $\triangle AGF \sim \triangle EFC$ (C) $\triangle DBG \sim \triangle EFC$ (D) $DE^2 = BD \times EC$



- (13) A man steadily goes 4 m due east and then 3m due north .Find
 (a) Distance from initial point to last point.
 (b) What mathematical concept is used in this problem?
 (c) What is its value?

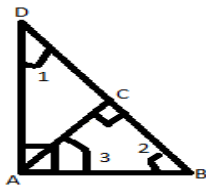
Solutions

Level I

- (1) By B.P.T. $PQ/XQ=PR/YR \Rightarrow 7/3=6.3/YR \Rightarrow YR= 3 \times 6.3/7=2.7$
 So $YR=2.7\text{cm}$
- (2) By theorem $\text{Ar of } \triangle ABC/\text{Ar of } \triangle DEF= BC^2/15.4^2$
 $\Rightarrow 64/121 = BC^2/15.4^2 \Rightarrow \text{solving } BC = 11.2 \text{ cm}$
- (3) By Pythagoras theorem $AB^2= AC^2+BC^2 \Rightarrow AB^2= AC^2+AC^2$ (given that $AC=BC$)
 So $AB^2=2AC^2$
- (4) $\triangle ABC \sim \triangle DEF \Rightarrow \angle A=\angle D=46^\circ, \angle B=\angle E=62^\circ$ so $\angle C =180-(46+62)=72^\circ$
 So it is true.
- (5) Let $\triangle ABC \sim \triangle DEF$
 then $AB/DE= BC/EF=AC/DF= \text{perimeter of } \triangle ABC/\text{Perimeter of } \triangle DEF$
 $\Rightarrow AB/DE=\text{perimeter of } \triangle ABC/\text{Perimeter of } \triangle DEF$
 So $\text{perimeter of } \triangle ABC/\text{Perimeter of } \triangle DEF=16:25$
- (6) By Pythagoras theorem , $\text{Distance} = \sqrt{24^2+10^2}$
 On Solving , $\text{distance} =26\text{km}$
- (7) In $\triangle AOD$, by Pythagoras theorem $AD=\sqrt{6^2+8^2}$
 $\Rightarrow AD= 10\text{cm}$
 So $\text{perimeter of Rhombus} = 4 \times 10\text{cm}$
 $= 40\text{cm}$
- (8) In $\triangle ABC$, $LM \parallel BC$ so by BPT $AM/AB=AL/AC$ -----(i)
 Similarly in $\triangle ACD$, $LN \parallel DC$, so by BPT $AN/AD = AL/AC$ ------(ii)
 Comparing results i & ii we get $AM/AB= AN/AD$

Using Pythagoras thermo ,finding the value of p^2+b^2 & h^2 separately in each case , it comes equal in case of c where p^2+b^2 comes equal to h^2
 So sides given in question c is the sides of right triangle

Level II



- (1) In $\triangle ABC$ $\angle 2 + \angle 3 = 90^\circ$
 $\Rightarrow \angle 1 + \angle 2 = \angle 2 + \angle 3$
 $\Rightarrow \angle 1 = \angle 3$
 $\triangle ACD \sim \triangle BCA$
 $\Rightarrow AC/BC = CD/AC$
 So $AC^2 = BC \times CD$

(2) Using Pythagoras theorem

$$\text{Distance between their tops} = \sqrt{5^2 + (5\sqrt{3})^2}$$

$$\sqrt{25 + 75}$$

Distance between their tops = 10m

(3) In $\triangle AED$ & $\triangle ABC$

$$\angle AED = \angle ABC \text{ (given)}$$

$$\angle A = \angle A \text{ (common)}$$

By AA corollary $\triangle ABC \sim \triangle AED$

(4) Diagonals of a trapezium divide each proportionally

$$\text{So } AO/OC = BO/OD$$

$$3x-1/5x-3 = 2x+1/6x-5$$

$$\Rightarrow 8x^2 - 20x + 8 = 0$$

Solving we get $x = 2 \text{ \& } 1/2$ (na)

So $x = 2$

(5) $BD = DE = EC = P$ (let)

$$BE = 2P \text{ \& } BC = 3P$$

$$\text{In Rt } \triangle ABD, AD^2 = AB^2 + BD^2$$

$$= AB^2 + p^2$$

$$\text{In Rt } \triangle ABE, AE^2 = AB^2 + BE^2$$

$$= AB^2 + (2p)^2$$

$$= AB^2 + 4p^2$$

$$\text{In Rt } \triangle ABC, AC^2 = AB^2 + BC^2$$

$$= AB^2 + (3p)^2$$

$$= AB^2 + 9p^2$$

$$\text{Now taking RHS } 3AC^2 + 5AD^2$$

$$= 3(AB^2 + 9p^2) + 5(AB^2 + p^2)$$

$$= 8AB^2 + 32p^2$$

$$= 8(AB^2 + 4p^2)$$

$$= 8AE^2$$

$$= \text{LHS}$$

(6) $OA/OC = OD/OB$ (given)

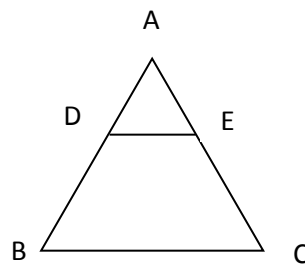
$$\Rightarrow OA/OD = OC/OB$$

$$\text{\& } \angle AOD = \angle BOC \text{ (v.o. } \angle^s)$$

By SAS similarity condition $\triangle AOD \sim \triangle COB$

$$\Rightarrow \angle A = \angle C$$

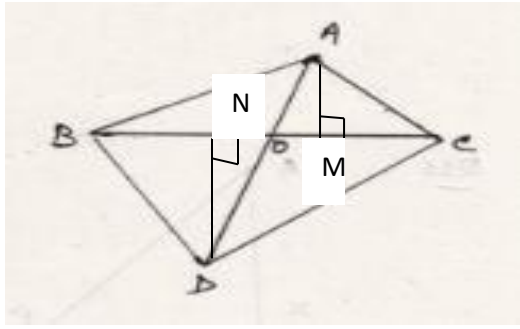
(7)



Given that $AD/DE = 1$ & $AE/EC = 1$ (as D & E are mid points of the sides AB & AC)

$$\Rightarrow AD/DB = AE/EC$$

By converse of BPT $DE \parallel BC$



(8)

We draw perpendiculars AM & DN as shown. $\triangle DON \sim \triangle AOM$ (by AA corollary)

$$DN/AM = OD/OA \Rightarrow AM/DN = OA/OD \text{-----(i)}$$

$$\text{Ar of } \triangle ABC / \text{Ar of } \triangle DBC = (1/2 \times BC \times AM) / (1/2 \times BC \times DN) \\ = AM/DN$$

$$\text{Ar of } \triangle ABC / \text{Ar of } \triangle DBC = AO/OD \text{ (from (i))}$$

Level III

(1) We draw $PQ \parallel BC$ through Pt. O \Rightarrow BPQC & APQD are rectangles.

$$\text{In Rt } \triangle OPB, \text{ by Pythagoras theorem } OB^2 = BP^2 + OP^2 \text{-----(i)}$$

$$\text{In Rt } \triangle OQD, OD^2 = OQ^2 + DQ^2 \text{----- (ii)}$$

$$\text{In Rt } \triangle OQC, OC^2 = OQ^2 + CQ^2 \text{----- (iii)}$$

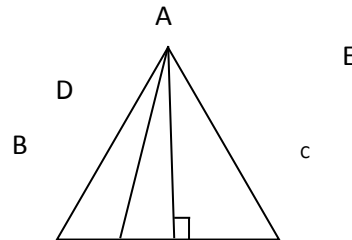
$$\text{In Rt } \triangle OAP, OA^2 = AP^2 + OP^2 \text{----- (iv)}$$

On adding (i) & (ii)

$$OB^2 + OD^2 = BP^2 + OP^2 + OQ^2 + PQ^2 \\ = CQ^2 + OP^2 + OQ^2 + AP^2 \text{ (BP=CQ \& DA=AP)} \\ = CQ^2 + OQ^2 + OP^2 + AP^2$$

$$\text{So } OB^2 + OD^2 = OC^2 + OD^2$$

(2)



We draw AE perpendicular to BC & AD is joined.

Then $BD = BC/3$, $DC = 2BC/3$ & $BE = EC = BC/2$

$$\text{In Rt. } \triangle ADE, AD^2 = AE^2 + DE^2 \\ = AE^2 + (BE - BD)^2 \\ = AE^2 + BE^2 + BD^2 - 2 \cdot BE \cdot BD \\ = AB^2 + (BC/3)^2 - 2 \cdot BC/2 \cdot BC/3 \\ = AB^2 + BC^2/9 - BC^2/3 \\ = (9AB^2 + BC^2 - 3BC^2)/9 \\ = (9AB^2 + AB^2 - 3AB^2)/9 \text{ (Given } AB=BC=AC) \\ = 7AB^2/9 \\ \Rightarrow 9AD^2 = 7AB^2$$

$$(3) \text{In Rt. } \triangle AOB, AB^2 = OA^2 + OB^2$$

$$= (AC/2)^2 + (BD/2)^2$$

$$4AB^2 = AC^2 + BD^2 \text{-----(I)}$$

$$\text{Similarly } 4BC^2 = AC^2 + BD^2 \text{----- (II)}$$

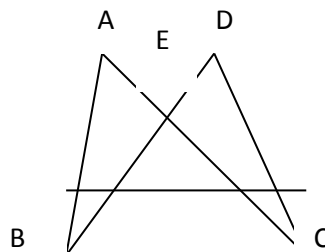
$$4CD^2 = AC^2 + BD^2 \text{----- (III)}$$

$$4AD^2 = AC^2 + BD^2 \text{----- (IV)}$$

$$\text{Adding these results } 4(AB^2 + BC^2 + CD^2 + AD^2) = 4(AC^2 + BD^2)$$

$$\Rightarrow (AB^2 + BC^2 + CD^2 + AD^2) = (AC^2 + BD^2)$$

(4) $\triangle BMC \cong \triangle EDM$ (by ASA criterion)
 \Rightarrow by cpct $DE=BC$ & $AD=BC$ (opp. sides of \parallel gm)
 Adding above results $AD+DE=BC+BC$
 $\Rightarrow AE=2BC$
 Now $\triangle AEL \sim \triangle CBL$ (By AA corollary)
 $EL/BL=AE/BC \Rightarrow EL/BL=2BC/BC \Rightarrow EL=2BL$



(5) $\triangle AEB \sim \triangle DEC$ (AA corollary)
 $AE/DE=EB/EC$
 $\Rightarrow AE \times EC=BE \times ED$

(6) Ar of $\triangle ABC = \frac{1}{2} \times AB \times DC$
 $= \frac{1}{2} \times c \times p$
 $= pc/2$
 Again Ar of $\triangle ABC = \frac{1}{2} \times AC \times BC$
 $= \frac{1}{2} \times b \times a$
 $= ab/2$

Comparing above two areas

$$ab/2 = pc/2$$

$$\Rightarrow ab=pc$$

Now in Rt $\triangle ABC$, $AB^2=BC^2+AC^2$

$$c^2=a^2+b^2$$

$$(ab/p)^2 = a^2+b^2 \quad (ab=pc \Rightarrow c=ab/p)$$

$$a^2b^2/p^2 = a^2+b^2$$

$$1/p^2 = a^2+b^2/a^2b^2$$

$$1/p^2 = 1/a^2 + 1/b^2$$

(7) Theorem question, as proved

(8) In $\triangle ABC$, $AB \parallel DE$, by BPT $AC/DC = BC/CE$ -----(i)

In $\triangle BDC$, $EF \parallel BD$, by BPT $DC/CF = BC/EC$ -----(ii)

Comparing (i) & (ii) $AC/DC = DC/CF$

$$\Rightarrow DC^2 = AC \times CF$$

Self-Evaluation Questions

(1) A/Q $AD/DB = AE/EC$ (by BPT)

$$\Rightarrow x/3x+1 = x+3/3x+11$$

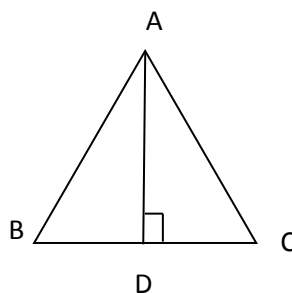
$$\Rightarrow 3x^2+11=3x^2+9x+x+3$$

$$\text{So } x=3$$

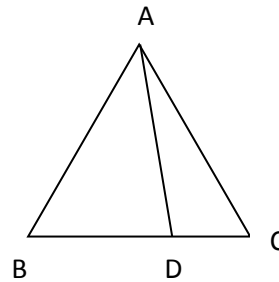
(2)

In $\triangle ABD$, $AB^2=AD^2+BD^2$

$$= AD^2+(BC/2)^2 \quad (AB=BC=AC)$$

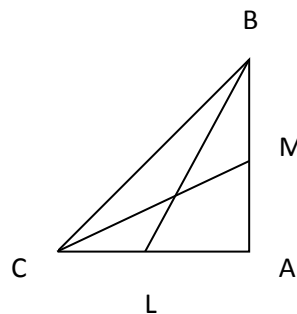


$$\begin{aligned}
 &= AD^2 + AB^2/4 \\
 4AB^2 &= 4AD^2 + AB^2 \\
 4AB^2 - AB^2 &= 4AD^2 \\
 3AB^2 &= 4AD^2
 \end{aligned}$$



$$\begin{aligned}
 (3), BC &= 4CD \Rightarrow CD = BC/4 \\
 \Rightarrow BD &= 3CD = 3BC/4 \quad \text{-----(i)} \\
 \text{In } \triangle ABD, AB^2 &= AD^2 + BD^2 \quad \text{-----(ii)} \\
 \text{In } \triangle ACD, AC^2 &= AD^2 + CD^2 \quad \text{-----(iii)} \\
 \text{Now } AB^2 - AC^2 &= BD^2 - CD^2 \\
 &= 9BC^2/16 - BC^2/16 = BC^2/2 \\
 2(AB^2 - AC^2) &= BC^2 \\
 2AB^2 &= 2AC^2 + BC^2
 \end{aligned}$$

(4) we draw $PS \parallel BR$
 In triangle RBC, P is the mid point of BC and $PS \parallel BR$
 $RS = CS$ [Mid point theorem](1)
 In $\triangle APS$, $PS \parallel BR$ ie $PS \parallel QR$ and Q is the mid point of AP
 So $AR = RS$ [II] (Mid point theorem)
 From results (I) & (II) $AR = RS = CS$
 So $AR = 1/3 AC$



$$\begin{aligned}
 (5) \\
 \text{In } \triangle ABL, BL^2 &= AB^2 + AL^2 \\
 4BL^2 &= 4AB^2 + 4AL^2 \\
 &= 4AB^2 + (2AL)^2 \\
 4BL^2 &= 4AB^2 + AC^2 \quad \text{-----(i)} \\
 \text{In } \triangle ACM \\
 4CM^2 &= 4AC^2 + AB^2 \quad \text{-----(ii)} \\
 \text{On adding} \\
 4BL^2 + 4CM^2 &= 4AB^2 + AC^2 + 4AC^2 + AB^2 \\
 &= 5AB^2 + 5AC^2 \\
 &= 5(AC^2 + AB^2) \\
 &= 5BC^2
 \end{aligned}$$

$$\begin{aligned}
 \text{ie } 4BL^2 + 4CM^2 &= 5BC^2 \\
 (6) AC^2 &= 12^2 = 144 \quad \text{-----(i)} \\
 AB^2 + BC^2 &= (6\sqrt{3})^2 + 6^2 \\
 &= 108 + 36 \\
 AB^2 + BC^2 &= 144 \quad \text{-----(ii)}
 \end{aligned}$$

From (i) & (ii)
 $AC^2 = AB^2 + BC^2$ (converse of Pythagoras theorem)
 $\angle B = 90^\circ$

$$\begin{aligned}
 (7) \text{ In } \triangle PMR \\
 PR^2 &= PM^2 + MR^2 \\
 &= 6^2 + 8^2 \\
 &= 36 + 64
 \end{aligned}$$

$$= 100$$

$$PR = 10\text{cm}$$

$$\text{In } \Delta PQR \quad PQ^2 = QR^2 - PR^2$$

$$= 26^2 - 10^2$$

$$= 676 - 100$$

$$= 576$$

$$PQ = 24\text{cm}$$

$$\text{Now Area of } \Delta PQR = \frac{1}{2} \times PR \times PQ$$

$$= \frac{1}{2} \times 10 \times 24$$

$$= 120 \text{ cm}^2$$

8. Ratio of areas of two similar Δ^s is equal to the ratio of squares of corresponding sides

$$\text{So Ratio of areas of two similar } \Delta^s = (2x/3x)^2 = 4/9$$

So Ratio of areas of two similar Δ^s = ratio of squares of their corresponding altitudes = $4/9$

So, Ratio of corresponding altitudes = $4/9$

9. P divide CA in the ratio 2 :1 Therefore

$$CP = \frac{2}{3} AC \dots\dots\dots(i)$$

$$QC = \frac{2}{3} BC \dots\dots\dots(ii)$$

In Right Triangle ACQ:

$$AQ^2 = QC^2 + AC^2$$

$$\text{Or, } AQ^2 = \frac{4}{9} BC^2 + AC^2 \quad (QC = \frac{2}{3} BC)$$

$$\text{Or, } 9 AQ^2 = 4 BC^2 + 9 AC^2 \dots\dots\dots(iii)$$

Similarly, In Right Triangle BCP

$$9BP^2 = 9BC^2 + 4 AC^2 \dots\dots\dots(iv)$$

Adding eq. (iii) & (iv)

$$9(AQ^2 + BQ^2) = 13(BC^2 + AC^2)$$

$$9(AQ^2 + BQ^2) = 13AB^2$$

10. In triangle ABD,

PQ || AB

$$PQ/AB = DQ/BD$$

$$\text{Or, } Z/X = DQ/BD \dots\dots\dots(i)$$

In triangle BCD,

PQ || CD

$$PQ/CD = BQ/BD$$

$$\text{Or, } Z/Y = BQ/BD \dots\dots\dots(ii)$$

Adding eq. (i) & (ii)

$$Z/X + Z/Y = DQ/BD + BQ/BD = DQ + BQ/BD$$

$$\text{Or, } Z/X + Z/Y = BD/BD = 1$$

$$\text{Or, } 1/X + 1/Y = 1/Z$$

11. State and Prove Pythagoras Theorem

$$AP = AB - PB = (18 - 12) \text{ m} = 6 \text{ m}$$

$$[PB = CD = 6 \text{ m}]$$

$$PC = BD = 8 \text{ m}$$

In ΔACP

$$AC = \sqrt{AP^2 + PC^2}$$

$$= \sqrt{(6)^2 + (8)^2}$$

$$= \sqrt{36 + 64} = \sqrt{100} = 10$$

$$AC = 10 \text{ m}$$

(12) DE // GF & AC cuts them

$\Rightarrow \angle DAG = \angle FGC$ (corres. \angle^s)
 $\angle GDE = 90^\circ \Rightarrow \angle GDA = 90^\circ$
 $\triangle ADG \sim \triangle GCF$ (By AA corollary, shown above)
(ii) similarly $\triangle FEB \sim \triangle GCF$
Since $\triangle ADG$ & $\triangle FEB$ are both similar to $\triangle GCF$
 $\Rightarrow \triangle ADG \sim \triangle FEB$
(iii) $\triangle ADG \sim \triangle FEB$
 $AD/FE = DG/FB$
 $\Rightarrow AD/DG = EF/EB$
(iv) $\triangle ADG \sim \triangle FEB$
 $AD/FE = DG/FB$
 $\Rightarrow AD/DE = DE/EB$ ($FE = DG = DE$)
 $DE^2 = AD \times EB$

(13)(i) distance from the initial point $= \sqrt{3^2 + 4^2}$
 $= \sqrt{25}$
 $= 5\text{m}$

(ii) Pythagoras theorem
(iii) To save time & energy