

2

Pythagoras Theorem

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Points to Remember:

Theorem : 1

• Similarity and Right Angled Triangles :

'In a right angled triangle, if the altitude is drawn from the vertex of the right angle to the hypotenuse, then the two triangles formed are similar to the original triangle and to each other'.

Given :

- (1) In $\triangle ABC$, $\angle ABC = 90^\circ$
- (2) seg $BD \perp$ hypotenuse AC ,
A - D - C

To Prove :

$$\triangle ABC \sim \triangle ADB \sim \triangle BDC$$

Proof :

In $\triangle ABC$ and $\triangle ADB$,
 $\angle ABC \cong \angle ADB$... (Each is a right angle)

$\angle A \cong \angle A$... (Common angle)

$\therefore \triangle ABC \sim \triangle ADB$... (i) (By AA Test of similarity)

In $\triangle ABC$ and $\triangle BDC$,
 $\angle ABC \cong \angle BDC$... (Each is a right angle)

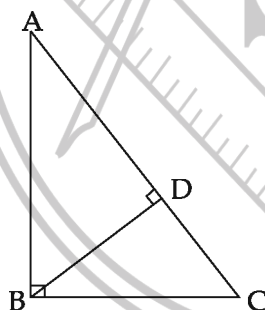
$\angle C \cong \angle C$... (Common angle)

$\therefore \triangle ABC \sim \triangle BDC$... (ii) (By AA Test of similarity)

$\therefore \triangle ABC \sim \triangle ADB \sim \triangle BDC$... [From (i) and (ii)]

• Theorem of Geometric Mean :

'In a right angled triangle, the length of perpendicular segment drawn on the hypotenuse from the opposite vertex, is the geometric mean of the segments into which the hypotenuse is divided'.



Given :

- (1) In $\triangle ABC$, $\angle ABC = 90^\circ$
- (2) seg $BD \perp$ hypotenuse AC ,
A - D - C

To Prove :

$$BD^2 = AD \times CD$$

Proof :

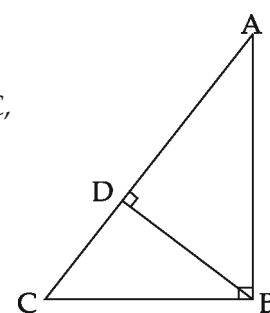
In $\triangle ABC$, $\angle ABC = 90^\circ$
 ... (Given)

seg $BD \perp$ hypotenuse AC ... (Given)

$\therefore \triangle ADB \sim \triangle BDC$... (Similarity in right angled triangles)

$$\therefore \frac{AD}{BD} = \frac{BD}{CD} \quad \dots \text{(c.s.s.t)}$$

$$\therefore BD^2 = AD \times CD$$



MASTER KEY QUESTION SET - 2

Practice Set - 2.1 (Textbook Page No. 38)

- (2) In the adjoining figure, $\angle MNP = 90^\circ$
 seg $NQ \perp$ seg MP ,
 $MQ = 9$, $QP = 4$.

Find NQ . (2 marks)

Solution :

In $\triangle MNP$, $\angle MNP = 90^\circ$

... (Given)

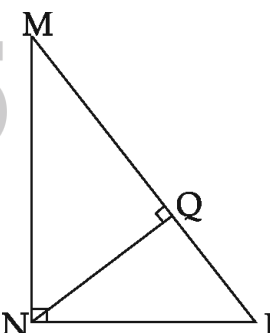
seg $NQ \perp$ hypotenuse MP ... (Given)

$$\therefore NQ^2 = MQ \times PQ \quad \dots \text{(Theorem of Geometric mean)}$$

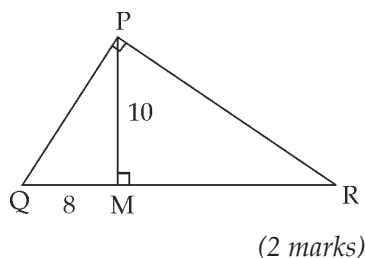
$$\therefore NQ^2 = 9 \times 4$$

$$\therefore NQ^2 = 36$$

$$\therefore NQ = 6 \text{ units} \quad \dots \text{(Taking square roots)}$$



- (3) In the adjoining figure, $\angle QPR = 90^\circ$, seg $PM \perp$ hypotenuse QR , $Q - M - R$. If $PM = 10$, $QM = 8$ then find QR .



(2 marks)

Solution :

- In $\triangle QPR$, $\angle QPR = 90^\circ$... (Given)
 seg $PM \perp$ hypotenuse QR ... (Given)
 $\therefore PM^2 = QM \times RM$... (Theorem of Geometric mean)
 $\therefore 10^2 = 8 \times RM$
 $\therefore RM = \frac{100}{8}$
 $\therefore RM = 12.5$ units
 $QR = QM + RM$... (Q - M - R)
 $\therefore QR = 8 + 12.5$
 $\therefore \boxed{QR = 20.5 \text{ units}}$



Points to Remember:

Theorem : 2

Theorem of Pythagoras :

Statement : 'In a right angled triangle, the square of the hypotenuse is equal to the sum of the squares of the remaining two sides'.

Given :

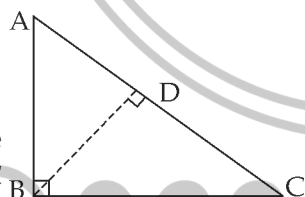
In $\triangle ABC$, $m\angle ABC = 90^\circ$

To Prove :

$$AC^2 = AB^2 + BC^2$$

Construction :

Draw seg $BD \perp$ side AC such that $A - D - C$


Proof :

- In $\triangle ABC$, $\angle ABC = 90^\circ$... (Given)
 seg $BD \perp$ hypotenuse AC ... (Construction)
 $\therefore \triangle ABC \sim \triangle ADB \sim \triangle BDC$... (i) (Similarity in right angled triangles)
 $\triangle ABC \sim \triangle ADB$... (From (i))
 $\therefore \frac{AB}{AD} = \frac{AC}{AB}$... (c.s.s.t)
 $\therefore AB^2 = AC \times AD$... (ii)
 $\triangle ABC \sim \triangle BDC$... (From (i))
 $\therefore \frac{BC}{DC} = \frac{AC}{BC}$... (c.s.s.t)
 $\therefore BC^2 = AC \times DC$... (iii)

Adding (ii) and (iii) we get,

$$AB^2 + BC^2 = AC \times AD + AC \times DC$$

$$\therefore AB^2 + BC^2 = AC (AD + DC)$$

$$\therefore AB^2 + BC^2 = AC \times AC [\because A - D - C]$$

$$\therefore AB^2 + BC^2 = AC^2$$

$$\therefore \boxed{AC^2 = AB^2 + BC^2}$$

Practice Set - 2.1 (Textbook Page No. 39)

- (6) Find the side and perimeter of a square whose diagonal is 10 cm. (2 marks)

Given :

(1) $\square PQRS$ is a square

(2) $PR = 10$ cm

To Find :

(a) Side PQ

(b) Perimeter of $\square PQRS$

Solution :

$\square PQRS$ is a square

$$\therefore PQ = QR \quad \dots (i)$$

In $\triangle PQR$, $\angle Q = 90^\circ$

$$\therefore PR^2 = PQ^2 + QR^2$$

$$\therefore 10^2 = PQ^2 + PQ^2$$

$$\therefore 2PQ^2 = 100$$

$$\therefore PQ^2 = \frac{100}{2}$$

$$\therefore PQ^2 = 50$$

$$\therefore PQ = \sqrt{25 \times 2}$$

$$\therefore \boxed{PQ = 5\sqrt{2} \text{ cm}}$$

$$\therefore \text{Perimeter of } \square PQRS = 4 \times \text{side}$$

$$= 4 \times PQ$$

$$= 4 \times 5\sqrt{2}$$

$$\therefore \boxed{\text{Perimeter of } \square PQRS = 20\sqrt{2} \text{ cm}}$$

- (8) Length and breadth of a rectangle are 35 cm and 12 cm respectively. Find length of its diagonal. (2 marks)

Given :

(1) $\square ABCD$ is a rectangle

(2) $AB = 35$ cm,

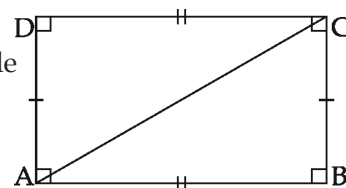
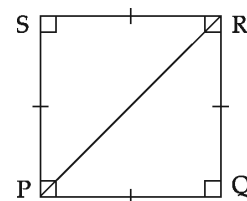
$BC = 12$ cm

To Find :

diagonal AC

Solution :

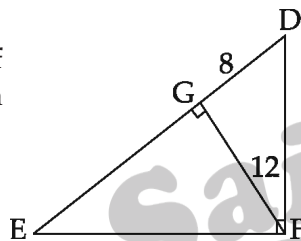
In $\triangle ABC$, $\angle ABC = 90^\circ$... (Angle of a rectangle)



$$\begin{aligned}\therefore AC^2 &= AB^2 + BC^2 && \dots(\text{By Pythagoras theorem}) \\ \therefore &= 35^2 + 12^2 \\ \therefore &= 1225 + 144 \\ \therefore &= 1369 \\ \therefore AC &= 37 \text{ cm} && \dots(\text{Taking square roots})\end{aligned}$$

Length of the diagonal of the rectangle is 37 cm

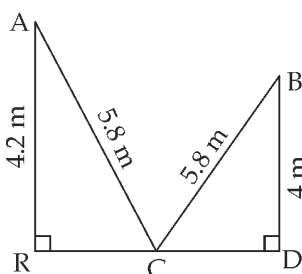
- (7) In the adjoining figure, $\angle DFE = 90^\circ$, $FG \perp ED$ if $GD = 8$, $FG = 12$ then find (i) EG (ii) FD (iii) EF. (3 marks)



Solution :

- (i) In $\triangle DFE$, $\angle DFE = 90^\circ$... (Given)
 $\therefore$ seg $FG \perp$ hypotenuse DE ... (Given)
 $FG^2 = DG \times EG$... (Theorem of Geometric mean)
 $\therefore 12^2 = 8 \times EG$
 $\therefore EG = \frac{12 \times 12}{8}$
 $\therefore$ **EG = 18 units** ... (i)
- (ii) In $\triangle FGD$, $\angle FGD = 90^\circ$... (Given)
 $\therefore FD^2 = FG^2 + GD^2$... (By Pythagoras theorem)
 $\therefore = 12^2 + 8^2$
 $\therefore = 144 + 64$
 $\therefore FD^2 = 208$
 $\therefore FD = \sqrt{208}$... (Taking square roots)
 $\therefore FD = \sqrt{16 \times 13}$
 $\therefore$ **FD = $4\sqrt{13}$ units**
- (iii) In $\triangle FGE$, $m\angle FGE = 90^\circ$... (Given)
 $\therefore EF^2 = EG^2 + FG^2$... (By Pythagoras theorem)
 $\therefore = 18^2 + 12^2$... [From (i)]
 $\therefore = 324 + 144$
 $\therefore EF^2 = 468$
 $\therefore EF = \sqrt{468}$ (Taking square roots)
 $\therefore EF = \sqrt{36 \times 13}$
 $\therefore$ **EF = $6\sqrt{13}$ units**

- * (10) Walls of two buildings on either side of a street are parallel to each other. A ladder 5.8 m long is placed on the street such that its top just reaches the window of a building at the height if 4 m. On turning the ladder over to the other side of the



street, its top touches the window of the other building at a height 4.2 m. Find the width of the street. (3 marks)

Solution :

Let RD represents the width of the street.

BD represents the first building.

AR represents the second building

CA and CB are two different positions of the same ladder from point C.

AR = 4.2 m, BD = 4 m, AC = BC = 5.8 m, RD = ?

In $\triangle ARC$, $\angle R = 90^\circ$... (Given)

$$\therefore AC^2 = AR^2 + CR^2 \quad \dots(\text{By Pythagoras theorem})$$

$$\therefore (5.8)^2 = (4.2)^2 + CR^2$$

$$\therefore CR^2 = (5.8)^2 - (4.2)^2$$

$$\therefore CR^2 = (5.8 + 4.2)(5.8 - 4.2)$$

$$\therefore CR^2 = 10 \times 1.6$$

$$\therefore CR^2 = 16$$

$$\therefore CR = 4 \text{ m} \quad \dots(\text{Taking square root})$$

In $\triangle BDC$, $\angle D = 90^\circ$... (Given)

$$\therefore BC^2 = CD^2 + BD^2 \quad \dots(\text{By Pythagoras theorem})$$

$$\therefore 5.8^2 = CD^2 + 4^2$$

$$\therefore CD^2 = (5.8)^2 - 4^2$$

$$\therefore CD^2 = (5.8 + 4)(5.8 - 4)$$

$$\therefore CD^2 = 9.8 \times 1.8$$

$$\therefore CD^2 = \frac{98}{10} \times \frac{18}{10}$$

$$\therefore CD^2 = \frac{98 \times 18}{100}$$

$$\therefore CD^2 = \frac{98 \times 2 \times 9}{100}$$

$$\therefore CD^2 = \frac{196 \times 9}{100}$$

$$\therefore CD = \frac{14 \times 3}{10} \quad \dots(\text{Taking square roots})$$

$$\therefore CD = \frac{42}{10}$$

$$\therefore CD = 4.2 \text{ m}$$

$$RD = RC + CD \quad \dots(R - C - D)$$

$$= 4 + 4.2$$

$$RD = 8.2 \text{ m}$$

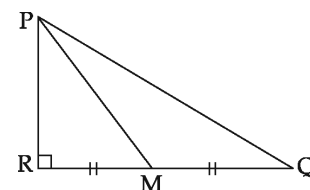
$$\therefore \text{Width of the street is 8.2 m}$$

- * (9) In the adjoining figure, M is the midpoint of QR. $\angle PRQ = 90^\circ$.

Prove that,

$$PQ^2 = 4PM^2 - 3PR^2$$

(4 marks)

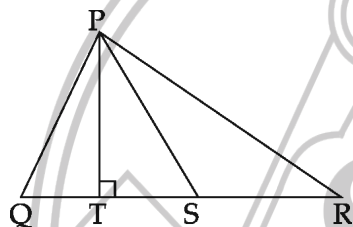


Proof :

$$\begin{aligned}
 &\text{In } \triangle PRQ, \angle PRQ = 90^\circ \quad \dots(\text{Given}) \\
 \therefore &PQ^2 = PR^2 + QR^2 \quad \dots(i) \text{ (By Pythagoras theorem)} \\
 \therefore &QR = 2RM \quad \dots(ii) \text{ (M is the midpoint of seg QR)} \\
 \therefore &PQ^2 = PR^2 + (2RM)^2 \quad \dots[\text{From (i) and (ii)}] \\
 \therefore &PQ^2 = PR^2 + 4RM^2 \quad \dots(iii) \\
 &\text{In } \triangle PRM, \angle PRM = 90^\circ \\
 \therefore &PM^2 = PR^2 + RM^2 \quad \dots(\text{Pythagoras theorem}) \\
 \therefore &RM^2 = PM^2 - PR^2 \quad \dots(iv) \\
 \therefore &PQ^2 = PR^2 + 4(PM^2 - PR^2) \quad \dots[\text{From (iii) and (iv)}] \\
 \therefore &PQ^2 = PR^2 + 4PM^2 - 4PR^2 \\
 \therefore &\boxed{PQ^2 = 4PM^2 - 3PR^2}
 \end{aligned}$$

Practice Set - 2.2 (Textbook Page No. 43)

- (3) In $\triangle PQR$ seg PS is median of $\triangle PQR$.
and $PT \perp QR$,
(4 marks)


Prove that :

$$\begin{aligned}
 (i) \quad &PR^2 = PS^2 + QR \times ST + \left(\frac{QR}{2}\right)^2 \\
 (ii) \quad &PQ^2 = PS^2 - QR \times ST + \left(\frac{QR}{2}\right)^2
 \end{aligned}$$

Proof :

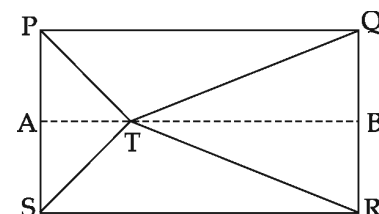
$$\begin{aligned}
 &QS = RS = \frac{QR}{2} \quad \dots(i) \text{ (S is the midpoint of seg QR)} \\
 &\text{In } \triangle PTS, \angle PTS = 90^\circ \quad \dots(\text{Given}) \\
 \therefore &PS^2 = PT^2 + ST^2 \quad \dots(\text{Pythagoras theorem}) \\
 \therefore &PT^2 = PS^2 - ST^2 \quad \dots(ii) \\
 (i) \quad &\text{In } \triangle PTR, \angle PTR = 90^\circ \quad \dots(\text{Given}) \\
 \therefore &PR^2 = PT^2 + TR^2 \quad \dots(\text{By Pythagoras theorem}) \\
 \therefore &PR^2 = PS^2 - ST^2 + (RS + ST)^2 \quad \dots[\text{From (ii), } R - S - T] \\
 &= PS^2 - ST^2 + RS^2 + 2 \times RS \times ST + ST^2 \\
 &= PS^2 + 2RS \times ST + RS^2 \\
 &= PS^2 + 2 \times \frac{QR}{2} \times ST + \left(\frac{QR}{2}\right)^2 \quad \dots[\text{From (i)}] \\
 \therefore &\boxed{PR^2 = PS^2 + QR \times ST + \left(\frac{QR}{2}\right)^2} \\
 (ii) \quad &\text{In } \triangle PTQ, \angle PTQ = 90^\circ \quad \dots(\text{Given}) \\
 \therefore &PQ^2 = PT^2 + QT^2 \quad \dots(\text{By Pythagoras theorem}) \\
 \therefore &PQ^2 = PS^2 - ST^2 + (QS - ST)^2 \quad \dots[\text{From (ii), } Q - T - S] \\
 &PQ^2 = PS^2 - ST^2 + QS^2 - 2QS \times ST + ST^2 \\
 &PQ^2 = PS^2 - 2QS \times ST + QS^2
 \end{aligned}$$

$$PQ^2 = PS^2 - 2 \times \frac{QR}{2} \times ST + \left(\frac{QR}{2}\right)^2 \quad \dots[\text{From (i)}]$$

$$\therefore \boxed{PQ^2 = PS^2 - QR \times ST + \left(\frac{QR}{2}\right)^2}$$

- * (5) In adjoining figure, point T is in the interior of rectangle PQRS.

Prove that, $TS^2 + TQ^2 = TP^2 + TR^2$ (5 marks)


To Prove :

$$TS^2 + TQ^2 = TP^2 + TR^2$$

Construction :

Draw a line parallel to side SR, through point T, intersecting sides PS and QR at point A and B respectively.

Proof :

$$\begin{aligned}
 &\square PQRS \text{ is a rectangle} \quad \dots(\text{Given}) \\
 \therefore &\angle SPQ = \angle PSR = \angle SRQ = \angle PQR = 90^\circ \quad \dots(i) \text{ (Angles of a rectangle)} \\
 &\text{seg } PQ \parallel \text{seg } SR \quad \dots(ii) \text{ (Opposite sides of rectangle are parallel)} \\
 &\text{But, seg } AB \parallel \text{seg } SR \quad \dots(iii) \text{ [Construction]} \\
 \therefore &\text{seg } PQ \parallel \text{seg } SR \parallel \text{seg } AB \quad \dots(iv) \text{ [From (i), (ii) \& (iii)]} \\
 &\text{In } \square ABRS, \text{seg } AB \parallel \text{seg } SR \quad \dots[\text{From (iii)}] \\
 &\text{seg } AS \parallel \text{seg } BR \quad \dots(\text{Opposite sides of rectangle are parallel and } P - A - S, Q - B - R) \\
 &\text{In } \square ABRS \text{ is parallelogram} \quad \dots(\text{By definition}) \\
 \therefore &AS = BR \quad \dots(v) \text{ (Opposite sides of parallelogram are equal)} \\
 &\text{Similarly by proving } \square ABQP \text{ is a parallelogram we get,} \\
 &AP = BQ \quad \dots(vi) \\
 &\text{seg } PQ \parallel \text{seg } AB \quad \dots[\text{From (ii)}] \\
 &\text{on transversal PS,} \\
 &\angle QPS = \angle BAS = 90^\circ \quad \dots(vii) \\
 &\text{Similarly we can prove,} \\
 &\text{seg } BA \perp \text{seg } PS \quad \dots(viii) \\
 \therefore &\text{In } \triangle TAS, \angle TAS = 90^\circ \quad \dots[\text{From (vii)}] \\
 \therefore &TS^2 = TA^2 + AS^2 = 90^\circ \quad \dots(ix) \text{ (By Pythagoras theorem)}
 \end{aligned}$$

- $\therefore$ In $\triangle TBQ$, $\angle TBQ = 90^\circ$...[From (viii)]
 $\therefore TQ^2 = TB^2 + BQ^2 = 90^\circ$... (x) (By Pythagoras theorem)

Adding (ix) and (x),

$$TS^2 + TQ^2 = TA^2 + AS^2 + TB^2 + BQ^2 \quad \dots (xi)$$

In $\triangle TAP$, $\angle TAP = 90^\circ$...[From (vii)]

$$\therefore TP^2 = TA^2 + AP^2 \quad \dots (xii) \text{ (By Pythagoras theorem)}$$

In $\triangle TBR$, $\angle TBR = 90^\circ$

$$\therefore TR^2 = TB^2 + BR^2 \quad \dots (xiii) \text{ (By Pythagoras theorem)}$$

Adding (xii) and (xiii),

$$TP^2 + TR^2 = TA^2 + AP^2 + TB^2 + BR^2$$

$$TP^2 + TR^2 = TA^2 + BQ^2 + TB^2 + AS^2 \quad \dots (xiv) \quad \dots [\text{From (vi) and (v)}]$$

$$\therefore TS^2 + TQ^2 = TP^2 + TR^2 \quad \dots [\text{From (xi) and (xiv)}]$$

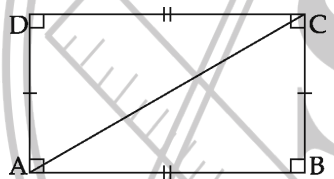
Problem Set - 2 (Textbook Pg No. 44)

(2) Solve the following:

(iii) Find the length a diagonal of a rectangle having side 11 cm and 60 cm. (2 marks)

Solution :

In rectangle ABCD,
AB = 60 cm, BC = 11 cm.



In $\triangle ABC$, $\angle ABC = 90^\circ$... (Angle of a rectangle)

$$\therefore AC^2 = AB^2 + BC^2 \quad \dots (\text{By Pythagoras theorem})$$

$$AC^2 = (60)^2 + (11)^2$$

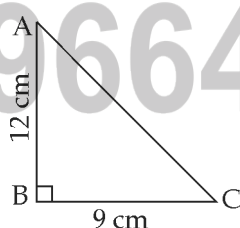
$$= 3600 + 121$$

$$AC^2 = 3721$$

$$\therefore AC = 61 \text{ cm} \quad \dots (\text{Taking square roots})$$

$$\therefore \text{The length of the diagonal of the rectangle is 61 cm}$$

(iv) Find the length of the hypotenuse of a right angled triangle if remaining sides are 9 cm and 12 cm. (2 marks)



Solution :

In $\triangle ABC$, $\angle ABC = 90^\circ$... (Given)

$$\therefore AC^2 = AB^2 + BC^2 \quad \dots (\text{By Pythagoras theorem})$$

$$AC^2 = (9)^2 + (12)^2$$

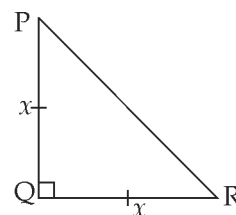
$$= 81 + 144$$

$$AC^2 = 225$$

$$\therefore AC = 15 \text{ cm} \quad \dots (\text{Taking square roots})$$

$$\therefore \text{length of the hypotenuse is 15 cm}$$

(v) A side of and isosceles right angled triangle is x. Find its hypotenuse.. (2 marks)



Solution :

In $\triangle PQR$, $\angle PQR = 90^\circ$... (Given)

$$\therefore PR^2 = PQ^2 + QR^2 \quad \dots (\text{By Pythagoras theorem})$$

$$PR^2 = x^2 + x^2$$

$$= 2x^2$$

$$\therefore PR = \sqrt{2}x \quad \dots (\text{Taking square roots})$$

$$\therefore \text{The length of the hypotenuse is } \sqrt{2}x \text{ units}$$

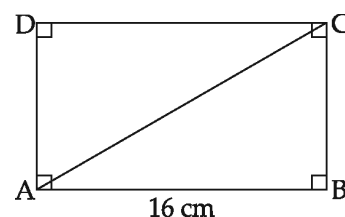
(4) Find the diagonal of a rectangle whose length is 16 cm and area is 192 sq.cm. (3 marks)

Given :

(1) $\square ABCD$ is a rectangle

(2) AB = 16 cm

(3) $A(\square ABCD) = 192 \text{ sq. cm.}$



To find :

AC

Solution :

$\square ABCD$ is a rectangle

$A(\square ABCD) = \text{length} \times \text{breadth}$

$$\therefore 192 = AB \times BC$$

$$\therefore 192 = 16 \times BC$$

$$\frac{192}{16} = BC$$

$$\therefore BC = 12 \text{ cm}$$

In $\triangle ABC$, $\angle ABC = 90^\circ$... (Angle of a rectangle)

$$\therefore AC^2 = AB^2 + BC^2 \quad \dots (\text{By Pythagoras theorem})$$

$$AC^2 = (16)^2 + (12)^2$$

$$= 256 + 144$$

$$\therefore AC^2 = 400$$

$$\therefore AC = 20 \text{ cm} \quad \dots (\text{Taking square roots})$$

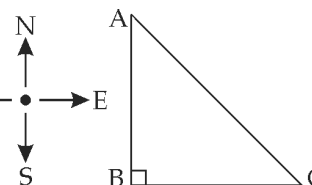
$$\therefore \text{length of the diagonal is 20 cm}$$

(10) Pranali and Prasad started walking to the East and to the North respectively, from the same point and at the same speed. After 2 hours distance between them was $15\sqrt{2} \text{ km}$. Find their speed per hour. (3 marks)

Solution :

B represents starting point of journey.

BA is the distance



travelled by Prasad in North direction.

BC is the distance travelled by Pranali in east direction.

AC is the distance between Pranali and Prasad after two hours.

Let the speed of each one be x km/hr.

∴ Distance travelled by each one hour is $2x$ km.

i.e. $AB = BC = 2x$ km

In $\triangle ABC$, $\angle B = 90^\circ$... (Line joining adjacent direction are $\perp$ to each other)

∴ $AB^2 + BC^2 = AC^2$... (By Pythagoras theorem)

∴ $(2x)^2 + (2x)^2 = (15\sqrt{2})^2$

∴ $4x^2 + 4x^2 = 225 \times 2$

∴ $8x^2 = 225 \times 2$

∴ $x^2 = \frac{225 \times 2}{8}$

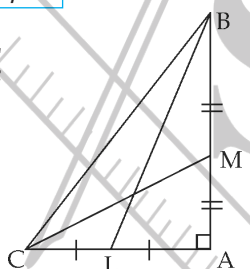
∴ $x^2 = \frac{225}{4}$

∴ $x = \frac{15}{2}$... (Taking square roots)

∴ $x = 7.5$

Speed of each one is 7.5 km / hr

- * (11) In $\triangle ABC$, $\angle BAC = 90^\circ$, seg BL and seg CM are medians of $\triangle ABC$, prove that $4(BL^2 + CM^2) = 5 BC^2$. (5 marks)**



To Prove :

$$4(BL^2 + CM^2) = 5BC^2$$

Proof :

In $\triangle BAC$, $\angle BAC = 90^\circ$... (Given)

∴ $BC^2 = AB^2 + AC^2$... (i) (By Pythagoras theorem)

In $\triangle BAL$, $\angle BAC = 90^\circ$... (Given)

∴ $BL^2 = AB^2 + AL^2$... (ii) (By Pythagoras theorem)

In $\triangle CAM$, $\angle CAM = 90^\circ$... (Given)

∴ $CM^2 = AC^2 + AM^2$... (iii) (By Pythagoras theorem)

Adding (ii) and (iii),

$$BL^2 + CM^2 = AB^2 + AL^2 + AC^2 + AM^2$$

$$\therefore BL^2 + CM^2 = AB^2 + AC^2 + AL^2 + AM^2$$

$$\therefore BL^2 + CM^2 = BC^2 + AL^2 + AM^2 \quad [\text{From (i)}]$$

$$\therefore BL^2 + CM^2 = BC^2 + \left(\frac{1}{2}AC\right)^2 + \left(\frac{1}{2}AB\right)^2 \quad [\because L \text{ and } M \text{ are the midpoint of sides AC and AB respectively}]$$

M are the midpoint of sides AC and AB respectively]

$$\therefore BL^2 + CM^2 = BC^2 + \frac{AC^2}{4} + \frac{AB^2}{4}$$

$$\therefore 4(BL^2 + CM^2) = 4BC^2 + AC^2 + AB^2 \quad (\text{Multiplying throughout by 4})$$

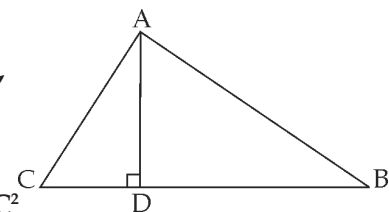
$$\therefore 4(BL^2 + CM^2) = 4BC^2 + BC^2 \quad \dots [\text{From (i)}]$$

$$\therefore \boxed{4(BL^2 + CM^2) = 5BC^2}$$

- (13) In $\triangle ABC$,
seg $AD \perp$ seg BC ,
 $DB = 3CD$.**

Prove that :

$$2AB^2 = 2AC^2 + BC^2$$



(4 marks)

To Prove :

$$2AB^2 = 2AC^2 + BC^2$$

Proof :

$DB = 3CD$... (i) (Given)

In $\triangle ADB$, $\angle ADB = 90^\circ$ (Given)

∴ $AB^2 = AD^2 + DB^2$ (By Pythagoras theorem)

∴ $AB^2 = AD^2 + (3CD)^2$ [From (i)]

∴ $AB^2 = AD^2 + 9CD^2$... (ii)

In $\triangle ADC$, $\angle ADC = 90^\circ$... (Given)

∴ $AC^2 = AD^2 + CD^2$ (By Pythagoras theorem)

∴ $AD^2 = AC^2 - CD^2$... (iii)

$AB^2 = AC^2 - CD^2 + 9CD^2$ [From (ii) and (iii)]

∴ $AB^2 = AC^2 + 8CD^2$... (iv)

But $BC = CD + DB$... [C - D - B]

∴ $BC = CD + 3CD$... [From (i)]

∴ $BC = 4CD$

∴ $CD = \frac{BC}{4}$... (v)

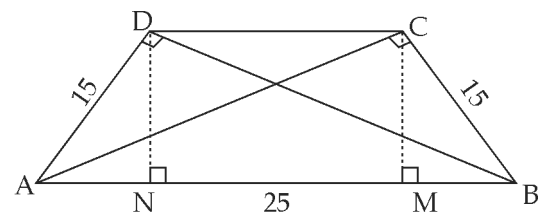
∴ $AB^2 = AC^2 + 8 \left(\frac{BC}{4}\right)^2$... [From (iv) and (v)]

∴ $AB^2 = AC^2 + 8 \times \frac{BC^2}{16}$

∴ $AB^2 = AC^2 + \frac{BC^2}{2}$... [From (iv) and (v)]

∴ $\boxed{2AB^2 = 2AC^2 + BC^2}$ (Multiplying throughout by 2)

- (15) In trapezium ABCD, seg $AB \parallel$ seg DC . seg $BD \perp$ seg AD , seg $AC \perp$ seg BC . If $AD = 15$, $BC = 15$ and $AB = 25$, then find A ($\square ABCD$) (5 marks)**



Construction :

Draw seg CM $\perp$ side AB, (A - M - B)

Draw seg DN $\perp$ side AB, (A - N - B)

Solution :

In $\triangle ABC$, $\angle ACB = 90^\circ$... (Given)

$$\therefore AC^2 + BC^2 = AB^2 \quad \dots (\text{By Pythagoras theorem})$$

$$\therefore AC^2 + (15)^2 = (25)^2$$

$$AC^2 + (25)^2 - (15)^2$$

$$AC^2 = 625 - 225 = 400$$

$$AC = 20 \text{ units} \quad \dots (\text{Taking square roots})$$

$$A(\triangle ABC) = \frac{1}{2} \times AB \times CM \quad \dots (i)$$

$$\text{Also, } A(\triangle ABC) = \frac{1}{2} \times AC \times BC \quad \dots (ii)$$

$$\therefore \frac{1}{2} \times AB \times CM = \frac{1}{2} \times AC \times BC$$

$$\therefore 25 \times CM = 20 \times 15$$

$$\therefore CM = \frac{20 \times 15}{25}$$

$$\therefore CM = 12 \text{ units} \quad \dots (iii)$$

In $\triangle BMC$, $\angle BMC = 90^\circ$... (Construction)

$$\therefore BC^2 = CM^2 + BM^2 \quad \dots (\text{By Pythagoras theorem})$$

$$\therefore 15^2 = 12^2 + BM^2$$

$$BM^2 = 15^2 - 12^2$$

$$\therefore BM^2 = 225 - 144$$

$$\therefore BM^2 = 81$$

$$\therefore BM = 9 \text{ units} \quad \dots (iv) \quad (\text{Taking square roots})$$

$$\therefore CM = DN \quad \dots (v) \quad (\text{Perpendicular distance between the same two parallel lines are equal})$$

In $\triangle BMC$ and $\triangle AND$

$$\angle BMC \cong \angle AND \quad \dots (\text{Each } 90^\circ)$$

$$\text{Hyp. } BC \cong \text{Hyp. } AD \quad \dots (\text{Given})$$

$$\text{seg } CM \cong \text{seg } DN \quad \dots [\text{From (v)}]$$

$$\therefore \triangle BMC \cong \triangle AND \quad \dots (\text{Hypotenuse side test})$$

$$\therefore \text{seg } BM \cong \text{seg } AN \quad \dots (vi) \quad \dots (\text{c.s.s.t.})$$

$$\therefore AN = 9 \text{ units} \quad \dots (vii) \quad \dots [\text{From (iv) and (vi)}]$$

$$AB = AN + MN + BM \quad \dots (A - N - M - B)$$

$$\therefore 25 = 9 + MN + 9$$

$$MN = 25 - 18 = 7 \text{ units} \quad \dots (viii)$$

In $\square CMND$, seg MN $\parallel$ seg CD

$$\dots (\text{Given, } A - N - M - B)$$

$$\text{seg } CM \parallel \text{seg } DN$$

$\dots$ (Perpendiculars drawn to the same line are parallel)

$$\therefore \square CMND \text{ is a parallelogram} \quad \dots (\text{Definition})$$

$$\therefore CD = MN \quad \dots (\text{Opposite sides of parallelogram are equal})$$

$$\therefore CD = 7 \text{ units} \quad \dots [\text{From (viii)}]$$

$$\therefore A(\text{trapezium } ABCD) = \frac{1}{2} (AB + CD) \times CM$$

$$= \frac{1}{2} (25 + 7) \times 12$$

$$= \frac{1}{2} (32) \times 12 = 192$$

$$\therefore A(\text{trapezium } ABCD) = 192 \text{ square units}$$



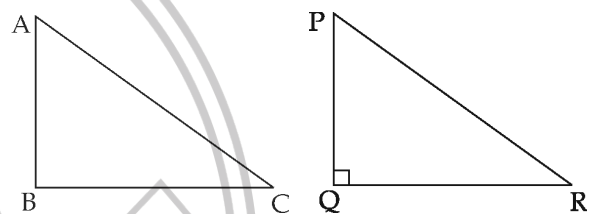
Points to Remember:

Converse of Pythagoras theorem :

Statement : In a triangle, if the square of one side is equal to the sum of the squares of remaining two sides, then the angle opposite to the first side is a right angle and the triangle is right angled triangle.

Given : In $\triangle ABC$, $AC^2 = AB^2 + BC^2$

To prove : $\angle ABC = 90^\circ$



Construction: Draw $\triangle PQR$ such that

$$AB = PQ, BC = QR \text{ and } \angle PQR = 90^\circ$$

Proof : In $\triangle ABC$ and $\triangle PQR$

$$PR^2 = PQ^2 + QR^2 \quad \dots (\text{By Pythagoras theorem})$$

$$= AB^2 + BC^2 \quad \dots (\text{Construction})$$

$$= AC^2 \quad \dots (\text{Given})$$

$$\therefore PR^2 = AC^2$$

$$PR = AC \quad \dots (\text{taking square roots})$$

$$\triangle ABC \cong \triangle PQR \quad \dots (\text{SSS test})$$

$$\angle ABC = \angle PQR = 90^\circ$$

Pythagorean Triplet:

In a triplet of natural numbers, if the square of the largest number is equal to the sum of the squares of the remaining two numbers. Then the triplet is called Pythagorean triplet.

Example: In the triplet (11, 60, 61)

$$11^2 = 121 ; 60^2 = 3600 ; 61^2 = 3721$$

$$121 + 3600 = 3721$$

The square of the largest number is equal of the sum of the squares of the other two number.

Formula for the Pythagorean triplet:

If a, b, c are natural numbers and $a > b$, then $[(a^2 + b^2), (a^2 - b^2), 2ab]$ is pythagorean triplet.

$$\therefore (a^2 + b^2)^2 = a^4 + 2a^2b^2 + b^4 \quad \dots (i)$$

$$(a^2 - b^2)^2 = a^4 - 2a^2b^2 + b^4 \quad \dots(ii)$$

$$(2ab)^2 = 4a^2b^2 \quad \dots(iii)$$

by (i), (ii) and (iii),

$$(a^2 + b^2)^2 = (a^2 - b^2)^2 + (2ab)^2$$

$\therefore [(a^2 + b^2), (a^2 - b^2), (2ab)]$ is a Pythagorean triplet.

Example: For $a = 5$ and $b = 3$

$$a^2 + b^2 = 25 + 9 = 34$$

$$a^2 - b^2 = 25 - 9 = 16$$

$$2ab = 30$$

$\therefore (16, 30, 34)$ is a Pythagorean triplet

Practice Set - 2.1 (Textbook Page No. 38)

(1) Which of the following are Pythagorean triplets? Justify.

(i) 3, 5, 4 (1 mark)

$$5^2 = 25$$

$$3^2 + 4^2 = 9 + 16$$

$$\therefore 3^2 + 4^2 = 25$$

From (i) and (ii)

$$5^2 = 3^2 + 4^2$$

$\therefore$ 3, 5, 4 is a Pythagorean triplet.

(ii) 4, 9, 12 (1 mark)

$$12^2 = 144$$

$$4^2 + 9^2 = 16 + 81$$

$$\therefore 4^2 + 9^2 = 97$$

From (i) and (ii)

$$12^2 \neq 4^2 + 9^2$$

$\therefore$ 4, 9, 12 is not a Pythagorean triplet.

(iii) 5, 12, 13 (1 mark)

$$13^2 = 169$$

$$5^2 + 12^2 = 25 + 144$$

$$\therefore 5^2 + 12^2 = 169$$

$$13^2 = 5^2 + 12^2$$

...[From (i) and (ii)]

$\therefore$ 5, 12, 13 is a Pythagorean triplet.

(iv) 24, 70, 74 (1 mark)

$$74^2 = 5476$$

$$24^2 + 70^2 = 576 + 4900$$

$$\therefore 24^2 + 70^2 = 5476$$

$$74^2 = 24^2 + 70^2$$

...[From (i) and (ii)]

$\therefore$ 24, 70, 74 is a Pythagorean triplet.

(v) 10, 24, 27 (1 mark)

$$27^2 = 729$$

$$10^2 + 24^2 = 100 + 576$$

$$\therefore 10^2 + 24^2 = 676$$

From (i) and (ii)

$$27^2 \neq 10^2 + 24^2$$

$\therefore$ 10, 24, 27 is not a Pythagorean triplet.

(vi) 11, 60, 61 (1 mark)

$$61^2 = 3721$$

$$60^2 + 11^2 = 3600 + 121$$

$$\therefore 60^2 + 11^2 = 3721$$

From (i) and (ii)

$$61^2 = 60^2 + 11^2$$

$\therefore$ 11, 60, 61 is a Pythagorean triplet.

Problem Set - 2 (Textbook Pg No. 44)

(2) Solve the following

(ii) Do sides 7 cm, 24 cm, 25 cm form a right angled triangle? Give reason. (1 mark)

Solution :

$$25^2 = 625$$

$$7^2 + 24^2 = 49 + 576$$

$$7^2 + 24^2 = 625$$

$$\therefore 25^2 = 7^2 + 4^2$$

...[From (i) and (ii)]

By converse of Pythagoras theorem, given triangle is a right angled triangle.

(vi) In ΔPQR , $PQ = \sqrt{8}$, $QR = \sqrt{5}$, $PR = \sqrt{3}$. Is ΔPQR a right angle? If yes, which angle is of 90° ?

(1 mark)

Solution :

$$PQ^2 = (\sqrt{8})^2 = 8 \quad \dots(i)$$

$$PR^2 + QR^2 = (\sqrt{3})^2 + (\sqrt{5})^2$$

$$\therefore PR^2 + QR^2 = 3 + 5$$

$$\therefore PR^2 + QR^2 = 8 \quad \dots(ii)$$

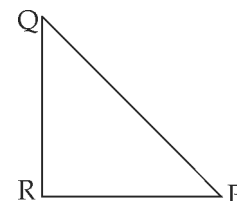
$$\therefore PQ^2 = PR^2 + QR^2$$

...[From (i) and (ii)]

Yes, ΔPQR is a right angled triangle.

$$\therefore \angle R = 90^\circ \quad \dots(\text{Converse of Pythagoras theorem})$$

$$\therefore \angle R = 90^\circ$$



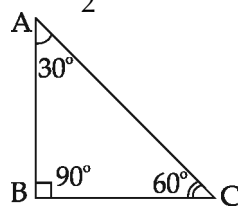
Points to Remember:

• **Theorem of $30^\circ - 60^\circ - 90^\circ$ triangle.**

If the angles of a triangle are 30° , 60° and 90° , then the side opposite to 30° is half of the hypotenuse

and the side opposite to 60° is $\frac{\sqrt{3}}{2}$ times the hypotenuse.

In $\triangle ABC$,
 $m\angle A = 30^\circ$
 $m\angle C = 60^\circ$ and
 $m\angle B = 90^\circ$

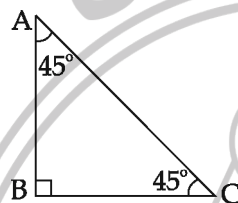


$$\therefore BC = \frac{1}{2} AC \text{ and } AB = \frac{\sqrt{3}}{2} AC$$

• **Theorem of 45° - 45° - 90° triangle.**

If the angles of a triangle are 45° , 45° and 90° , then the length of the perpendicular sides are $\frac{1}{\sqrt{2}}$ times the hypotenuse.

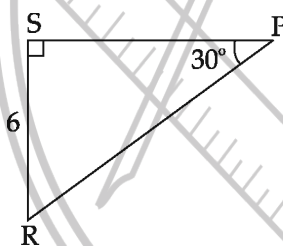
In $\triangle ABC$,
 $m\angle A = 45^\circ$
 $m\angle C = 45^\circ$ and
 $m\angle B = 90^\circ$



$$\therefore AB = BC = \frac{1}{\sqrt{2}} AC.$$

Practice Set - 2.1 (Textbook Page No. 39)

- (4) In adjoining figure, find RP and PS using the information given in $\triangle PSR$, find RP and PS. (2 marks)



Solution :

In $\triangle PSR$, $\angle S = 90^\circ$... (Given)
 $\angle P = 30^\circ$... (Given)
 $\therefore \angle R = 60^\circ$... (Sum of all angles of a triangle is 180°)

$\therefore \triangle PSR$ is $30^\circ - 60^\circ - 90^\circ$ triangle
 By $30^\circ - 60^\circ - 90^\circ$ triangle theorem,
 $RS = \frac{1}{2} PR$... (side opposite to 30°)

$$\therefore 6 = \frac{1}{2} \times PR$$

$$\therefore \boxed{PR = 12 \text{ units}}$$

$$PS = \frac{\sqrt{3}}{2} \times PR \quad \dots (\text{side opposite to } 60^\circ)$$

$$PS = \frac{\sqrt{3}}{2} \times 12$$

$$\therefore \boxed{PS = 6\sqrt{3} \text{ units}}$$

Problem Set - 2 (Textbook Pg No. 44)

- (2) Solve the following

- (i) Find the height of an equilateral triangle having side $2a$. (2 marks)

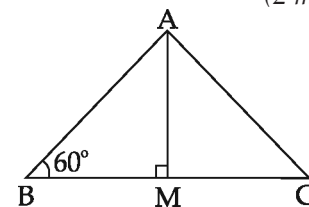
Given :

(i) $\triangle ABC$ is an equilateral triangle.

(ii) $AB = 2a$

Construction: seg $AM \perp$ side BC , $B - M - C$

To find : AM .



Solution :

In $\triangle AMB$, $\angle AMB = 90^\circ$... (Given)
 $\angle B = 60^\circ$... (angle of an equilateral triangle)
 $\angle BAM = 30^\circ$... (Sum of all angles of a triangle is 180°)

$\therefore \triangle AMB$ is $30^\circ - 60^\circ - 90^\circ$ triangle
 By $30^\circ - 60^\circ - 90^\circ$ triangle theorem,

$$AM = \frac{\sqrt{3}}{2} \times AB \quad \dots (\text{Side opposite to } 60^\circ)$$

$$\therefore AM = \frac{\sqrt{3}}{2} \times 2a$$

$$\therefore \boxed{AM = \sqrt{3} a}$$

- (3) In $\triangle RST$, $\angle S = 90^\circ$, $\angle T = 30^\circ$, $RT = 12$ cm. Find RS and ST. (2 marks)

Solution :

In $\triangle PSR$, $\angle S = 90^\circ$... (Given)
 $\angle T = 30^\circ$... (Given)
 $\therefore \angle R = 60^\circ$... (Sum of all angles of a triangle is 180°)

$\therefore \triangle PSR$ is $30^\circ - 60^\circ - 90^\circ$ triangle
 By $30^\circ - 60^\circ - 90^\circ$ triangle theorem,

$$RS = \frac{1}{2} \times RT$$

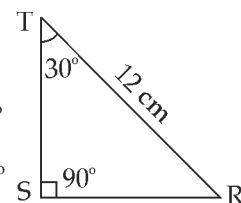
$$\therefore RS = \frac{1}{2} \times 12 \quad \dots (\text{side opposite to } 30^\circ)$$

$$\therefore \boxed{RS = 6 \text{ cm}}$$

$$ST = \frac{\sqrt{3}}{2} \times RT \quad \dots (\text{side opposite to } 60^\circ)$$

$$ST = \frac{\sqrt{3}}{2} \times 12$$

$$\therefore \boxed{ST = 6\sqrt{3} \text{ cm}}$$



- * (5) Find the length if the side and perimeter of an equilateral triangle whose height is $\sqrt{3}$ cm. (2 marks)**

Given :

(i) $\triangle ABC$ is an equilateral triangle.

(ii) seg $AM \perp$ side BC , $B - M - C$

(iii) $AM = \sqrt{3}$ cm

To find : (i) AB (ii) Perimeter of $\triangle ABC$.

Solution :

In $\triangle AMB$, $\angle AMB = 90^\circ$... (Given)

$\angle B = 60^\circ$... (Angle of an equilateral triangle)

$\therefore \angle BAM = 30^\circ$... (Sum of all angles of a triangle is 180°)

$\therefore \triangle AMB$ is $30^\circ - 60^\circ - 90^\circ$ triangle
By $30^\circ - 60^\circ - 90^\circ$ triangle theorem,

$AM = \frac{\sqrt{3}}{2} \times AB$... (Side opposite to 60°)

$\therefore AB = \frac{2}{\sqrt{3}} \times AM$

$\therefore AB = \sqrt{3} \times \frac{2}{\sqrt{3}}$

$\therefore \boxed{AB = 2 \text{ cm}}$

$\therefore$ Perimeter of $ABC = 3 \times AB$
 $= 3 \times 2 = 6 \text{ cm}$

$\therefore \boxed{\text{Perimeter of } \triangle ABC = 6 \text{ cm}}$

- (7) $\triangle ABC$ is an equilateral triangle. Point P is on base BC such that $PC = \frac{1}{3} BC$, if $AB = 6$ cm, find AP . (5 marks)**

Given :

(i) $\triangle ABC$ is an equilateral triangle.

(ii) $AB = 6$ cm

(iii) $PC = \frac{1}{3} BC$

To find : AP

Construction : Draw seg $AM \perp BC$, $C - M - B$

Solution :

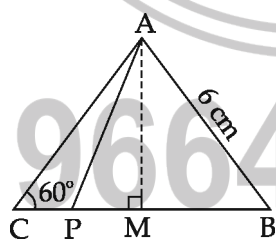
$AB = BC = AC$... (Side of an equilateral triangle)

$\therefore BC = AC = 6 \text{ cm}$... (i) ($\because AB = 6 \text{ cm}$, given)

$PC = \frac{1}{3} BC$... (Given)

$\therefore PC = \frac{1}{3} \times 6 = 2 \text{ cm}$... (ii)

In $\triangle AMC$, $\angle C = 60^\circ$... (Angle of an equilateral triangle)



$\angle AMC = 90^\circ$... (Construction)
 $\therefore \angle CAM = 30^\circ$... (Sum of all angles of a triangle is 180°)

$\therefore \triangle AMC$ is $30^\circ - 60^\circ - 90^\circ$ triangle

By $30^\circ - 60^\circ - 90^\circ$ triangle theorem,

$\therefore CM = \frac{1}{2} AC$... (side opposite to 30°)

$\therefore CM = \frac{1}{2} \times 6 \text{ cm} = 3 \text{ cm}$... (iii)

$AM = \frac{\sqrt{3}}{2} \times AC$... (side opposite to 60°)

$\therefore AM = \frac{\sqrt{3}}{2} \times 6 = 3\sqrt{3}$... (iv)

$PM = CM - CP$... (C - P - M)

$\therefore PM = 3 - 2$

$\therefore PM = 1 \text{ cm}$

$\therefore$ In $\triangle AMP$, $\angle AMP = 90^\circ$ triangle ... (Construction)

$AP^2 = AM^2 + PM^2$... (By Pythagoras theorem)
 $= (3\sqrt{3})^2 + 1$

$AP^2 = 27 + 1$

$\therefore AP^2 = 28$

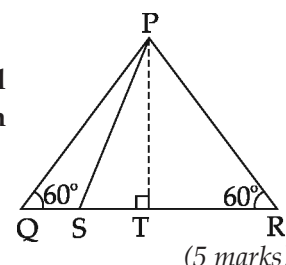
$\therefore AP = \sqrt{4 \times 7}$

$\therefore AP = 2\sqrt{7}$

... (Taking square roots)

$\therefore \boxed{AP = 2\sqrt{7} \text{ cm}}$

- * (16) In the adjoining figure, $\triangle PQR$ is an equilateral triangle. Point S is on seg QR such that $QS = \frac{1}{3} QR$. Prove that $9PS^2 = 7PQ^2$**



To prove : $9PS^2 = 7PQ^2$

Construction :

Draw seg $PT \perp$ side QR , (Q - S - T - R)

Proof : $\triangle PQR$ is an equilateral triangle (Given)

Solution :

$PQ = QR = PR$... (i) [sides of an equilateral triangle]

In $\triangle PTS$, $\angle PTS = 90^\circ$... (Construction)

$\therefore PS^2 = PT^2 + ST^2$... (ii) (By Pythagoras theorem)

In $\triangle PTQ$,

$\angle PTQ = 90^\circ$... (Construction)

$\angle PQT = 60^\circ$... (angle of an equilateral triangle)

$\angle QPT = 30^\circ$... (remaining angle)

$\therefore \triangle PTQ$ is a $30^\circ - 60^\circ - 90^\circ$ triangle

By $30^\circ - 60^\circ - 90^\circ$ triangle theorem,

$$\therefore PT = \frac{\sqrt{3}}{2} PQ \quad \dots(\text{iii}) \text{ (side opposite to } 60^\circ)$$

$$\therefore QT = \frac{1}{2} PQ \quad \dots(\text{iv}) \text{ (Side opposite to } 30^\circ)$$

$$ST = QT - QS \quad \dots(Q - S - T)$$

$$\therefore ST = \frac{1}{2} PQ - \frac{1}{3} QR \quad \dots[\text{From (iv) and given}]$$

$$\therefore ST = \frac{1}{2} PQ - \frac{1}{3} PQ \quad \dots[\text{From (i)}]$$

$$\therefore ST = \frac{3PQ - 2PQ}{6}$$

$$\therefore ST = \frac{1}{6} PQ \quad \dots(\text{v})$$

$$\therefore PS^2 = \left(\frac{\sqrt{3}}{2} PQ\right)^2 + \left(\frac{1}{6} PQ\right)^2 \quad \dots[\text{From (ii) (iii) and (v)}]$$

$$\therefore PS^2 = \frac{3PQ^2}{4} + \frac{PQ^2}{36}$$

$$\therefore PS^2 = \frac{27PQ^2 + PQ^2}{36}$$

$$\therefore PS^2 = \frac{28PQ^2}{36}$$

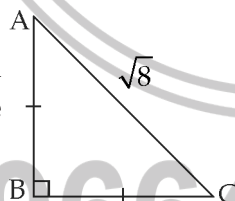
$$\therefore PS^2 = \frac{7}{9} PQ^2$$

$$\therefore \boxed{9 PS^2 = 7 PQ^2}$$

Practice Set - 2.1 (Textbook Page No. 39)

- (5) For finding AB and BC with the help of information in adjoining figure, complete the following activity.

(2 marks)



Solution :

$$AB = BC \quad \dots(\text{Side opposite to congruent angle})$$

$$\therefore \angle BAC = 45^\circ$$

$$\begin{aligned} \therefore AB = BC &= \frac{1}{\sqrt{2}} \times AC \\ &= \frac{1}{\sqrt{2}} \times \sqrt{8} \\ &= \frac{1}{\sqrt{2}} \times 2\sqrt{2} \end{aligned}$$

$$\therefore \boxed{AB = BC = 2 \text{ units}}$$



Points to Remember:

Application of Pythagoras Theorem

(1)

In acute angled $\triangle ABC$, $\angle C$ is an acute angle, seg $AD \perp$ side BC ,

$B - D - C$.

Prove that :

$$AB^2 = BC^2 + AC^2 - 2BC \cdot BD$$

Proof :

In $AB = c$, $AC = b$, $AD = p$, $BC = a$ and $DC = x$

$$\therefore BD = a - x$$

In $\triangle ADB$,

$$c^2 = (a - x)^2 + p^2 \quad \dots(\text{By Pythagoras theorem})$$

$$\therefore c^2 = a^2 - 2ax + x^2 + p^2 \quad \dots(\text{i})$$

In $\triangle ADC$,

$$b^2 = p^2 + x^2 \quad \dots(\text{By Pythagoras theorem})$$

$$\therefore p^2 = b^2 - x^2 \quad \dots(\text{ii})$$

Substituting

$$c^2 = a^2 - 2ax + x^2 + b^2 - x^2$$

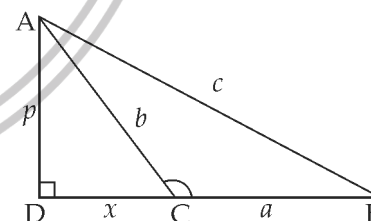
$$\therefore c^2 = a^2 + b^2 - 2ax$$

$$\therefore AB^2 = BC^2 + AC^2 - 2BC \times DC$$

- (2) In $\triangle ABC$, $\angle ACB > 90^\circ$, seg $AD \perp$ seg BC

Prove that :

$$AB^2 = BC^2 + AC^2 + 2BC \times CD$$



Proof :

Let $AD = p$, $AC = b$, $AB = c$, $BC = a$ and $DC = x$

$$\therefore DB = a + x$$

In $\triangle ADB$,

$$c^2 = (a + x)^2 + p^2 \quad \dots(\text{By Pythagoras theorem})$$

$$\therefore c^2 = a^2 + 2ax + x^2 + p^2 \quad \dots(\text{i})$$

Similarly, In $\triangle ADC$,

$$b^2 = x^2 + p^2$$

$$\therefore p^2 = b^2 - x^2 \quad \dots(\text{ii})$$

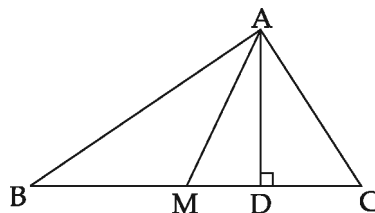
Substituting (ii) in (i),

$$c^2 = a^2 + 2ax + x^2 + b^2 - x^2$$

$$\therefore = a^2 + 2ax + b^2$$

$$\therefore AB^2 = BC^2 + AC^2 + 2BC \times CD$$

(3) The Apollonius Theorem.



Theorem : In $\triangle ABC$, if M is a midpoint of BC, then $AB^2 + AC^2 = 2AM^2 + 2BM^2$.

Given : In $\triangle ABC$, M is midpoint of side BC.

To prove : $AB^2 + AC^2 = 2AM^2 + 2BM^2$

Construction : Draw seg $AD \perp$ seg BC

Proof : If seg AM is not perpendicular to side BC. Then $\angle AMB$ and $\angle AMC$ are either acute angle or obtuse angle.

According to figure, $\angle AMB$ is an obtuse angle and $\angle AMC$ is an acute angle. According to examples (1) and (2) above.

$$AB^2 = AM^2 + MB^2 + 2BM \times MD \quad \dots(i)$$

$$\text{and } AC^2 = AM^2 + MC^2 - 2MC \times MD$$

$$\therefore AC^2 = AM^2 + MB^2 - 2BM \times MD \quad \dots(ii)$$

$$(\because BM = MC)$$

adding (i) and (ii) we get,

$$AB^2 + AC^2 = 2AM^2 + 2MB^2$$

This is called Apollonius theorem.

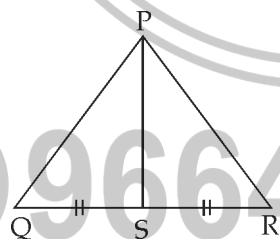
Practice Set - 2.2 (Textbook Page No. 43)

- (1) In $\triangle PQR$, point S is the midpoint of side QR.

If $PQ = 11$, $PR = 17$,

$PS = 13$ then find QR.

(2 marks)



Solution :

In $\triangle PQR$, PS is the median $\dots$ (By Definition)

$$\therefore PQ^2 + PR^2 = 2PS^2 + 2QS^2 \quad \dots(\text{Apollonius theorem})$$

$$\therefore 11^2 + 17^2 = 2 \times (13^2 + QS^2)$$

$$\therefore 121 + 289 = 2(169 + QS^2)$$

$$\therefore \frac{410}{2} = 169 + QS^2$$

$$\therefore 205 - 169 = QS^2$$

$$\therefore QS^2 = 36$$

$$\therefore QS = 6 \text{ units} \quad \dots(\text{Taking square roots})$$

$$QR = 2QS$$

$\dots(\because S$ is the midpoint of seg QR, given)

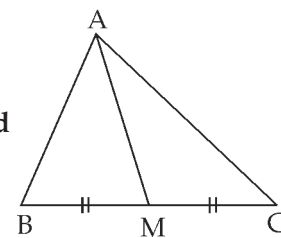
$$\therefore QR = 2 \times 6$$

$$\therefore \boxed{QR = 12 \text{ units}}$$

- (4) In $\triangle ABC$, point M is midpoint of side BC.

If $AB^2 + AC^2 = 290 \text{ cm}^2$ and $AM = 8 \text{ cm}$, find BC.

(2 marks)



Solution :

In $\triangle ABC$, seg AM is median

$\dots(\text{Given})$

$$\therefore AB^2 + AC^2 = 2AM^2 + 2BM^2$$

$\dots(\text{Apollonius theorem})$

$$\therefore 290 = 2(8^2 + BM^2)$$

$$\therefore \frac{290}{2} = 64 + BM^2$$

$$\therefore 145 - 64 = BM^2$$

$$\therefore BM^2 = 81$$

$$\therefore BM = 9 \text{ units} \quad \dots(\text{Taking square roots})$$

$$BC = 2BM$$

$\dots(\because M$ is the midpoint of seg BC)

$$\therefore BC = 2 \times 9$$

$$\therefore \boxed{BC = 18 \text{ cm}}$$

Problem Set - 2 (Textbook Pg No. 44)

- (6) In $\triangle ABC$, seg AP is a median. If $BC = 18$, $AB^2 + AC^2 = 260$. Find AP.

(3 marks)

Solution :

In $\triangle ABC$, seg AP is the median on side BC

$$\therefore BP = \frac{1}{2} \times BC$$

$$\therefore BP = \frac{1}{2} \times 18$$

$$\therefore BP = 9 \text{ units} \quad \dots(i)$$

In $\triangle ABC$, seg AP is median

$\dots(\text{Given})$

$$\therefore AB^2 + AC^2 = 2BP^2 + 2AP^2$$

$\dots(\text{Apollonius theorem})$

$$\therefore 260 = 2(9^2 + AP^2)$$

$\dots[\text{From (i)}]$

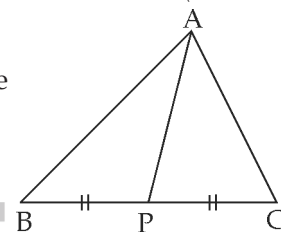
$$\therefore \frac{260}{2} = 81 + AP^2$$

$$\therefore AP^2 = 130 - 81$$

$$\therefore AP^2 = 49$$

$$\therefore \boxed{AP = 7 \text{ units}}$$

$\dots(\text{Taking square roots})$



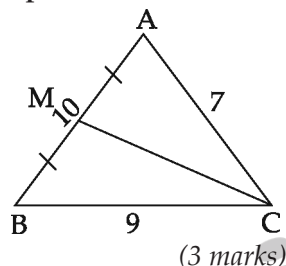
Practice Set - 2.2 (Textbook Page No. 43)

- (2) In $\triangle ABC$, $AB = 10$, $AC = 7$, $BC = 9$. Find the length of the median drawn from point C to side AB .

Given :

- (i) In $\triangle ABC$,
seg CM is a median
(ii) $AB = 10$, $AC = 7$,
 $BC = 9$

To Find : CM .

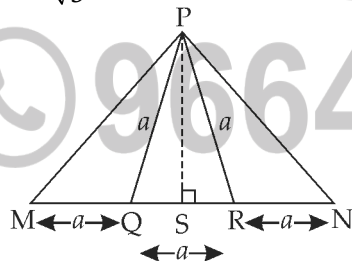


Solution :

$$\begin{aligned} \therefore BM &= \frac{1}{2} \times AB \quad \dots (M \text{ is the midpoint of seg } AB) \\ \therefore BM &= \frac{1}{2} \times 10 \\ \therefore BM &= 5 \text{ units} \quad \dots (i) \\ \text{In } \triangle ABC, CM &\text{ is the median} \quad \dots (\text{Given}) \\ \therefore AC^2 + BC^2 &= 2CM^2 + 2BM^2 \quad \dots (\text{Apollonius theorem}) \\ \therefore 7^2 + 9^2 &= 2(CM^2 + 5^2) \\ \therefore 49 + 81 &= 2(CM^2 + 25) \\ \therefore \frac{130}{2} &= CM^2 + 25 \\ \therefore CM^2 &= 65 - 25 \\ \therefore CM^2 &= 40 \\ \therefore CM &= \sqrt{40} \quad \dots (\text{Taking square roots}) \\ \therefore CM &= \sqrt{4 \times 10} \\ \therefore CM &= 2\sqrt{10} \text{ units} \end{aligned}$$

Problem Set - 2 (Textbook Pg No. 44)

- (8) From the information given in the figure, Prove that : $PM = PN = \sqrt{3} \times a$ (4 marks)



Proof :

$$\begin{aligned} MQ &= QR = RN = a \quad \dots (\text{Given}) \\ \text{Point } Q &\text{ is the midpoint of seg } MR \quad \dots (i) \\ \therefore \text{In } \triangle PMR, \text{ seg } PQ &\text{ is a median} \quad \dots [\text{From (i), Definition}] \\ \therefore PM^2 + PR^2 &= 2PQ^2 + 2QM^2 \quad \dots (\text{Apollonius theorem}) \\ \therefore PM^2 + a^2 &= 2a^2 + 2a^2 \\ \therefore PM^2 &= 4a^2 - a^2 \end{aligned}$$

$$\therefore PM^2 = 3a^2$$

$$\therefore PM = \sqrt{3}a \quad \dots (\text{Taking square roots})$$

Similarly we can prove, $PN = \sqrt{3}a$

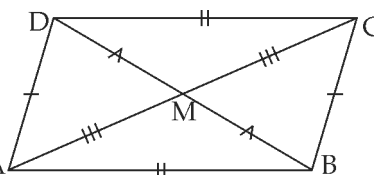
$$\therefore PM = PN = \sqrt{3}a$$

- (9) Prove that the sum of the squares of the diagonals of a parallelogram is equal to the sum of the squares of its sides.

Given :

In $\square ABCD$, is a parallelogram

Diagonals AC and BD intersect each other at point M .



To Prove :

$$AC^2 + BD^2 = AB^2 + BC^2 + CD^2 + AD^2 \quad (5 \text{ mark})$$

Proof :

$\square ABCD$ is a parallelogram $\dots (\text{Given})$

$$\left. \begin{aligned} AM &= CM = \frac{1}{2} AC \quad \dots (i) \\ BM &= DM = \frac{1}{2} BD \quad \dots (ii) \end{aligned} \right\} \begin{array}{l} \text{[Diagonals of a} \\ \text{parallelogram bisect} \\ \text{each other]} \end{array}$$

$\therefore$ In $\triangle ABC$, seg BM is a median $\dots [\text{From (i)}]$

$$\therefore AB^2 + BC^2 = 2BM^2 + 2AM^2 \quad \dots (iii) \quad (\text{By Apollonius theorem})$$

$\therefore$ In $\triangle ADC$, seg DM is a median $\dots [\text{From (i)}]$

$$\therefore CD^2 + AD^2 = 2DM^2 + 2AM^2 \quad \dots (iv) \quad (\text{By Apollonius theorem})$$

Adding (iii) and (iv)

$$\therefore AB^2 + BC^2 + CD^2 + AD^2 = 2BM^2 + 2AM^2 + 2DM^2 + 2AM^2$$

$$\therefore AB^2 + BC^2 + CD^2 + AD^2 = 2BM^2 + 2DM^2 + 4AM^2$$

$$\therefore AB^2 + BC^2 + CD^2 + AD^2 = 2BM^2 + 2BM^2 + 4AM^2 \quad \dots [\text{From (ii)}]$$

$$\therefore AB^2 + BC^2 + CD^2 + AD^2 = 4BM^2 + 4AM^2$$

$$\therefore AB^2 + BC^2 + CD^2 + AD^2 = 4 [BM^2 + AM^2]$$

$$\therefore AB^2 + BC^2 + CD^2 + AD^2 = 4 \left[\left(\frac{1}{2} BD \right)^2 + \left(\frac{1}{2} AC \right)^2 \right] \quad \dots [\text{From (i) and (ii)}]$$

$$\begin{aligned} \therefore AB^2 + BC^2 + CD^2 + AD^2 &= 4 \left[\frac{1}{4} BD^2 + \frac{1}{4} AC^2 \right] \\ &= 4 \times \frac{1}{4} [BD^2 + AC^2] \end{aligned}$$

$$\therefore AB^2 + BC^2 + CD^2 + AD^2 = BD^2 + AC^2$$

$$\therefore BD^2 + AC^2 = AB^2 + BC^2 + CD^2 + AD^2$$

- (12) Sum of squares of adjacent sides of a parallelogram is 130 cm² and length of one of its diagonal is 14 cm. Find length of the other diagonal.**

Given :

(i) □ABCD is a parallelogram

(ii) $AB^2 + BC^2 = 130 \text{ cm}^2$

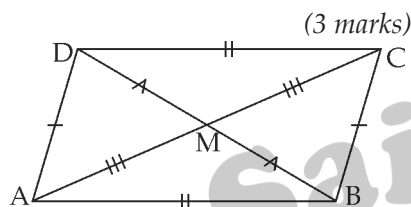
(iii) $AC = 14 \text{ cm}$

To find : BD

Solution :

□ABCD is a parallelogram

...(Given)



$$\begin{aligned} \therefore BM &= \frac{1}{2} BD \quad \dots(i) \\ \therefore AM &= \frac{1}{2} AC \quad \dots(ii) \end{aligned} \quad \left. \begin{array}{l} \text{[Diagonals of a} \\ \text{parallelogram bisect} \\ \text{each other]} \end{array} \right\}$$

$$\therefore AM = \frac{1}{2} \times 14 = 7 \text{ cm}$$

In $\triangle ABC$, seg BM is the a median

...[From (ii) and Definition]

$$\therefore AB^2 + BC^2 = 2AM^2 + 2BM^2 \dots(\text{Apollonius theorem})$$

$$130 = 2(7^2 + BM^2)$$

$$\therefore \frac{130}{2} = 49 + BM^2$$

$$\therefore 65 - 49 = BM^2$$

$$\therefore BM^2 = 16$$

$$\therefore BM = 4 \text{ cm}$$

...(Taking square roots)

$$\therefore \frac{1}{2} BD = 4 \text{ cm}$$

...[From (i)]

$$\therefore \boxed{BD = 8 \text{ cm}}$$

- * (14) In an isosceles triangle, length of each congruent side is 13 cm and length of the base is 10 cm. Find the distance between vertex opposite to base and centroid.**

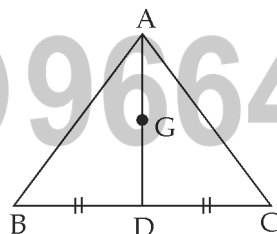
Given :

(i) In $\triangle ABC$, is an isosceles triangle

(ii) $AB = AC = 13 \text{ cm}$,
 $BC = 10 \text{ cm}$

(iii) seg AD is the median

(iv) G is the centroid of $\triangle ABC$



To find : AG

(3 marks)

Solution :

$$BD = \frac{1}{2} BC \quad \dots(\text{Median bisects opposite side})$$

$$\therefore BD = \frac{1}{2} \times 10 = 5 \text{ cm} \quad \dots(i)$$

In $\triangle ABC$, seg AD is a median ... (Definition)

$$\therefore AB^2 + AC^2 = 2AD^2 + 2BD^2 \dots(\text{Apollonius theorem})$$

$$\therefore 13^2 + 13^2 = 2(AD^2 + 5^2) \quad \dots[\text{From (i) and given}]$$

$$\therefore 169 + 169 = 2(AD^2 + 25)$$

$$\therefore \frac{338}{2} = AD^2 + 25$$

$$\therefore 169 - 25 = AD^2$$

$$\therefore 144 = AD^2$$

$$\therefore AD = 12 \text{ cm}$$

...(Taking square roots)

$$AG = \frac{2}{3} AD \quad \dots(\text{Centroid divides each median in the ratio } 3 : 1)$$

$$\therefore AG = \frac{2}{3} \times 12$$

$$\therefore \boxed{AG = 8 \text{ cm}}$$

- * (17) Seg PM is a median of $\triangle PQR$. If $PQ = 40$, $PR = 42$ and $PM = 29$, find QR.** (3 marks)

Solution :

In $\triangle PQR$, seg PM is the median ... (Given)

$$\therefore PQ^2 + PR^2 = 2PM^2 + 2QM^2$$

...(Appollonius theorem)

$$\therefore 40^2 + 42^2 = 2(29)^2 + 2(QM)^2$$

$$\therefore (40)^2 + (42)^2 = 2(29^2 + QM^2)$$

$$\therefore 1600 + 1764 = 2(841 + QM^2)$$

$$\therefore \frac{3364}{2} = 841 + QM^2$$

$$\therefore 1682 - 841 = QM^2$$

$$\therefore QM^2 = 841$$

$$\therefore QM = 29$$

...(Taking square roots)

$$QR = 2QM$$

...(M is midpoint of seg QR)

$$\therefore QR = 2 \times 29$$

$$\therefore \boxed{QR = 58 \text{ units}}$$

- (18) Seg AM is a median of $\triangle ABC$. If $AB = 22$, $AC = 34$, $BC = 24$, find AM.** (3 marks)

Solution :

In $\triangle ABC$

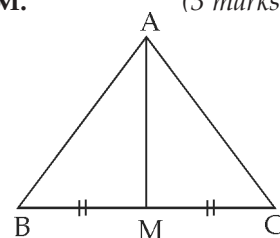
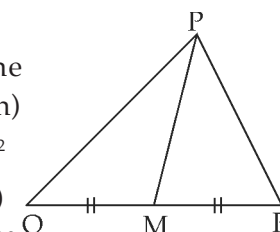
$$\therefore BM = \frac{1}{2} BC \quad \dots(\text{M is the midpoint of BC})$$

$$\therefore BM = \frac{1}{2} \times 24 = 12 \text{ units} \quad \dots(i)$$

In $\triangle ABC$, seg AM is the median ... (Given)

$$\therefore AB^2 + AC^2 = 2AM^2 + 2BM^2 \quad \dots(\text{By Apollonius theorem})$$

$$\therefore 22^2 + 34^2 = 2(AM^2 + BM^2)$$



$$\therefore 484 + 1156 = 2 (AM^2 + 12^2)$$

$$\therefore \frac{1640}{2} = AM^2 + 144$$

$$\therefore 820 - 144 = AM^2$$

$$AM^2 = 676$$

$$\therefore \boxed{AM = 26 \text{ units}} \quad \dots(\text{Taking square roots})$$

Problem Set - 2 (Textbook Page No. 43)

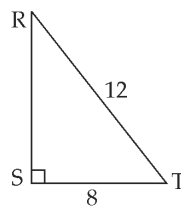
MCQ's

Choose the correct alternative for each of the following. (1 mark each)

- (1) Out of the following which is the Pythagorean triplet?
(A) (1, 5, 10) (B) (3, 4, 5) (C) (2, 2, 2) (D) (5, 5, 2)
- (2) In a right angled triangle, if sum of the squares of the sides making right angle is 169 then what is the length of the hypotenuse?
(A) 15 (B) 13 (C) 5 (D) 12
- (3) Out of the dates given below which date constitutes a Pythagorean triplet?
(A) 15/08/17 (B) 16/08/16
(C) 03/05/17 (D) 04/09/15
- (4) If a, b, c are sides of a triangle and $a^2 + b^2 = c^2$, name the type of triangle.
(A) Obtuse angled triangle
(B) Acute angled triangle
(C) Right angled triangle
(D) Equilateral triangle
- (5) Find perimeter of a square if its diagonal is $10\sqrt{2}$ cm.
(A) 10 cm (B) $40\sqrt{2}$ (C) 20 cm (D) 40 cm
- (6) Altitude on the hypotenuse of a right angle triangle divides it in two parts of lengths 4 cm and 9 cm. Find the length of the altitude.
(A) 9 cm (B) 4 cm (C) 6 cm (D) 18 cm
- (7) Height and base of a right angled triangle are 24 cm and 18 cm, find the length of its hypotenuse.
(A) 24 cm (B) 30 cm (C) 15 cm (D) 18 cm
- (8) In $\triangle ABC$ $AB = 6\sqrt{3}$ cm, $AC = 12$ cm, $BC = 6$ cm. Find measure of $\angle A$.
(A) 30° (B) 60° (C) 90° (D) 45°

Additional MCQ's

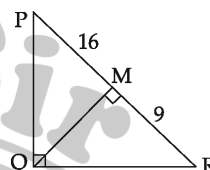
(9)



In $\triangle RST$, $\angle S = 90^\circ$, $RT = 12$ m, $ST = 8$ m then $RS = \dots\dots\dots$

- (A) $10\sqrt{8}$ m (B) $5\sqrt{4}$ m (C) $4\sqrt{5}$ m (D) 5m

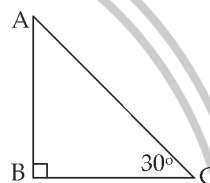
(10)



In $\triangle PQR$, $\angle PQR = 90^\circ$, seg $QM \perp$ hyp PR , $PM = 16$ and $RM = 9$ then $QM = \dots\dots\dots$

- (A) 12 (B) 25 (C) 7 (D) 16×9

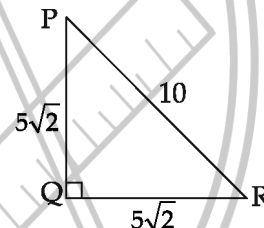
(11)



In $\triangle ABC$, $\angle B = 90^\circ$, $\angle C = 30^\circ$, $AB = 6$ cm then $AC = \dots\dots\dots$

- (A) $3\sqrt{3}$ cm (B) $2\sqrt{3}$ cm (C) $12\sqrt{3}$ cm (D) 12cm

(12)



In $\triangle PQR$, $\angle Q = 90^\circ$, $PQ = QR = 5\sqrt{2}$, $PR = 10$ then $\angle P = \dots\dots\dots$

- (A) 30° (B) 45°
(C) 60° (D) Data not sufficient

(13) Which of the following is a Pythagorean triplet?

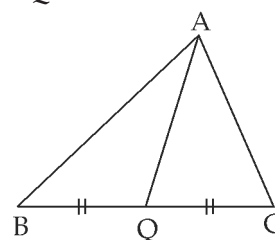
- (a) 60, 61, 11 (b) 40, 41, 42
(c) 11, 12, 15 (d) 9, 15, 17

(14) In $\triangle QSR$, $m\angle Q = 45^\circ$, $m\angle S = 90^\circ$ and $SR = 4$, find QS .

- (A) 3 (B) 4 (C) 5 (D) 6

(15) Appollonius theorem is a theorem relating the length of of a triangle.

- (A) Altitude (B) Angle bisector
(C) Perpendicular bisector (D) Median and sides

(16) In the adjoining figure, $AB^2 + AC^2 = 122$, $BC = 10$, then find AQ


- (A) 3 (B) 6 (C) 12 (D) 36

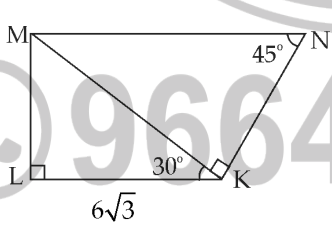
- (17) In ΔPQR , $m\angle PQR = 90^\circ$, seg $QS \perp$ hyp PR then.
 (A) $QS^2 = PS \times RS$ (B) $PS^2 = QS \times PR$
 (C) $PR^2 = QS \times PS$ (D) $PR^2 = QS^2 \times PS^2$
- (18) In which of the following quadrilateral sum of squares of all sides is equal to the sum of squares of diagonals?
 (A) Parallelogram (B) Rhombus
 (C) Square (D) (A), (B) and (C)

ANSWERS

- (1) (B) (3, 4, 5) (2) (B) 13
 (3) (A) 15/08/17 (4) (C) Right angled
 (5) (D) 40cm (6) (C) 6cm
 (7) (B) 30cm (8) (A) 30°
 (9) (C) $4\sqrt{5}$ m (10) (A) 12
 (11) (D) 12 cm (12) (B) 45°
 (13) (A) (60, 61, 11) (14) (B) 4
 (15) (D) Median and sides (16) (B) 6
 (17) (A) $QS^2 = PS \times RS$ (18) (D) A, B and C

PROBLEMS FOR PRACTICE

Based on Practice Set 2.1

- (1) In ΔXYZ , $\angle Y = 90^\circ$, $\angle Z = a^\circ$, $\angle X = (a + 30^\circ)$.
 If $XZ = 24$, find XY and YZ . (3 marks)
- (2) In the adjoining figure, $\angle L = \angle MKN = 90^\circ$, $\angle MKL = 30^\circ$ and $\angle MNK = 45^\circ$. If $KL = 6\sqrt{3}$, then find MK , ML , KN , MN and perimeter of $\square MNKL$. (3 marks)
- 
- (3) Sides of triangles are given below. Determine which of them are right angled triangle. (2 marks)
 (i) 8, 15, 17 (ii) 20, 30, 40
 (iii) 11, 12, 15 (iv) 20, 16, 12
- (4) A ladder 10 m long reaches a window 8 m above the ground. Find the distance of the foot of the ladder from the base of the wall. (2 marks)
- (5) E is a point on hypotenuse DF of ΔDFH , such that seg $HE \perp$ seg DE , seg $EG \perp$ seg FH and

seg $EK \perp$ seg DH . Prove that,

(i) $EG^2 = FG \times EK$

(ii) $EK^2 = DK \times EG$

(3 marks)

Based on Practice Set 2.2

- (11) In ΔPQR , M is the midpoint of side QR . If $PQ = 11$, $PR = 17$ and $QR = 12$, then find PM . (2 marks)

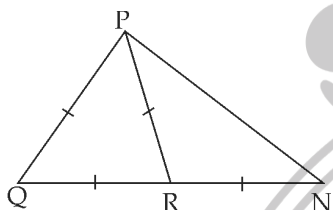
- (12) In $\triangle ABC$, AP is a median. If $AP = 7$, $AB^2 + AC^2 = 260$, find BC. (2 marks)

- (13) In $\triangle ABC$, $AB^2 + AC^2 = 122$ and $BC = 10$. Find the length of the median on side BC. (2 marks)

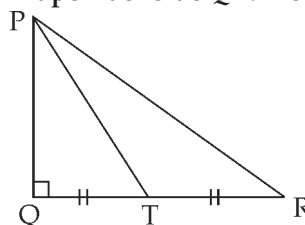
- (14) Adjacent sides of a parallelogram are 11 cm and 17 cm. If the length of one of its diagonals is 26 cm, find the length of the other. (3 marks)

- (15) If 'O' is any point in the interior of rectangle ABCD, then prove that : $OB^2 + OD^2 = OA^2 + OC^2$

- (16) In the adjoining figure, $\triangle PQR$ is an equilateral triangle. $QR = RN$. Prove that $PN^2 = 3PR^2$ (3 marks)



- (17) In the adjoining figure, $\angle PQR = 90^\circ$. T is the midpoint of side QR. Prove that $PR^2 = 4PT^2 - 3PQ^2$. (3 marks)



ANSWERS

- (1) $XY = 12$, $YZ = 12\sqrt{3}$
 (2) $MK = 12$, $ML = 6$, $KN = 12$, $MN = 12\sqrt{2}$, Perimeter of $\square MNKL = 6(3 + 2\sqrt{2} + \sqrt{3})$
 (3) (i) and (iv) are right angled triangle
 (4) $6m$ (7) $x = 5$, $y = 2\sqrt{5}$, $z = 3\sqrt{5}$ (11) 13
 (12) 18 (13) 6 (14) 12 cm

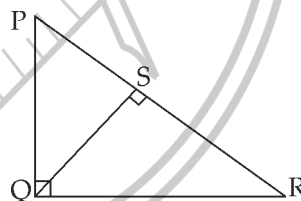
ASSIGNMENT - 2

Time : 1 Hr.

Marks : 20

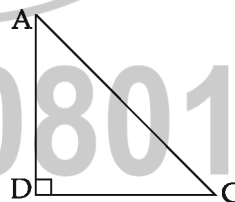
Q.1. (A) Solve the following sub questions:

- (1) Is 28, 21 and 35 a pythagorean triplet?
 (2) In $\triangle PQR$, $\angle PQR = 90^\circ$ seg $QS \perp$ hypotenuse PR, $PS = 16$, $RS = 9$. Find QS



Q.1. (B) Solve any one of the following questions:

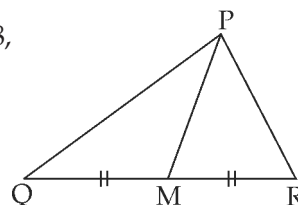
- (1) In $\triangle ADC$, $\angle ADC = 90^\circ$
 $\angle C = 45^\circ$, $AC = 8\sqrt{2}$ cm.
 Find AD.



- (2) In $\triangle XYZ$, $\angle Y = 90^\circ$, $\angle Z = a^\circ$, $\angle X = (a + 30)^\circ$. Find $\angle X$

Q.2. Solve the any one of following sub questions:

- (1) In $\triangle PQR$, seg PM is a median. $PM = 10$ and $PQ^2 + PR^2 = 328$, then find QR

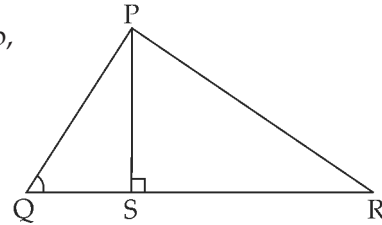


- (2) In m and n are two distinct numbers then prove that $m^2 - n^2$, $2mn$ and $m^2 + n^2$ is a pythagorean triplet.

Q.3. Solve the following sub questions: (any two)

(6)

- (1) In the adjoining figure, seg $PS \perp$ side QR . If $PQ = a$, $PR = b$, $QS = c$ and $RS = d$ then complete the following activity to prove that $(a + b)(a - b) = (c + d)(c - d)$



Proof: In $\triangle PSQ$, $\angle PSQ = 90^\circ$

...(Given)

$$\therefore \boxed{}^2 = PS^2 + \boxed{}^2$$

...(Pythagoras theorem)

$$\therefore PS^2 = \boxed{}^2 - \boxed{}^2$$

...(i)

In $\triangle PSR$, $\angle PSR = 90^\circ$

...(Given)

$$\therefore \boxed{}^2 = PS^2 + \boxed{}^2$$

...(Pythagoras theorem)

$$\therefore PS^2 = \boxed{}^2 - \boxed{}^2$$

...(ii)

$$\therefore \boxed{}^2 - \boxed{}^2 = \boxed{}^2 - \boxed{}^2$$

...[From (i) and (ii)]

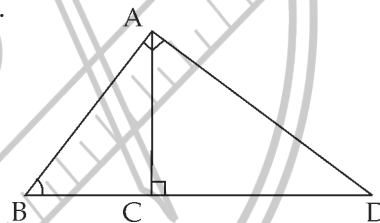
$$\therefore a^2 - c^2 = b^2 - d^2$$

...(Substitution)

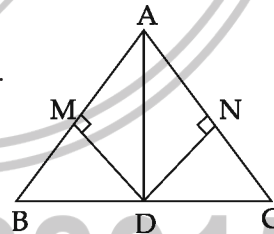
$$\therefore a^2 - b^2 = c^2 - d^2$$

$$\boxed{} \times \boxed{} = \boxed{} \times \boxed{}$$

- (2) In $\triangle ABD$, $\angle BAD = 90^\circ$ seg $AC \perp$ hypo BD , $B - C - D$.
Show that (i) $AB^2 = BC \cdot BD$ (ii) $AD^2 = BD \cdot CD$



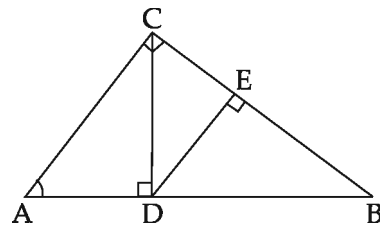
- (3) In the adjoining figure AD bisects $\angle BAC$, $B - D - C$.
 $AD \perp BC$, $DM \perp AB$, $A - M - B$. $DN \perp AC$, $A - N - C$.
Proove that $AM \times MB = AN \times NC$



Q.4. Solve the following sub questions: (any 2)

(8)

- (1) State and prove 'Pythagoras theorem'
(2) In $\triangle ACB$, $\angle ACB = 90^\circ$ seg $CD \perp$ side AB , $A - D - B$,
seg $DE \perp$ side CB .
Show that $CD^2 \times AC = AD \times AB \times DE$.



- (3) In an equilateral triangle ABC , the side BC is trisected at D . Prove that: $9 AD^2 = 7 AB^2$

