SAMPLE CONTENT

PERFECT

MATHEMATICS PART - II

BASED ON LATEST BOARD PAPER PATTERN

Application of Co-ordinate Geometry:

Slope of a line is used to determine the length of conveyor belt. If the slope of the belt is more, the material will slide down instead of being carried up.

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STD. X
(Eng. Med.)

Target Publications® Pvt. Ltd.

Based on the **Latest Paper Pattern** prescribed by the Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04

PERFECT

Mathematics Part – II

STD. X

Salient Features

- Written as per the **Latest Textbook and Board Paper Pattern**
- Complete coverage of the entire syllabus, which includes:
  - Solutions to all Practice Sets and Problem Sets
  - Intext and Activity/Project based questions from the textbook
- Exclusive Practice includes:
  - Additional problems, Activities, Multiple Choice Questions (MCQs) and One mark questions
  - 'Chapter Assessment' at the end of each chapter
- Tentative marks allocation for all problems
- Constructions drawn with accurate measurements
- Relevant Previous Years' Board Questions till **July 2023**
- At the end of the book:
  - A separate section of 'Challenging Questions' is provided
  - 'Important Theorems and Formulae' for quick reference are provided
  - 'Model Question Paper' in accordance with the latest paper pattern
- Includes Important Features for holistic learning:
  - ***Illustrative Example***
  - ***Smart Check***
- Q.R. codes provide:
  - Answer Keys of Chapter Assessment
  - Solution of Model Question Paper
- Includes Board Question Paper of March 2024 (Solution in pdf format through QR code)

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PREFACE

Creation of the **'Perfect Mathematics Part – II, Std. X'** book was a rollercoaster ride. We had a plethora of ideas, suggestions and decisions to ponder over. However, our primary objective was to align book with the latest syllabus and provide students with ample practice material.

This book covers several topics including Similarity of Triangles, Pythagoras Theorem, Circles, Geometric Constructions, Co-ordinate Geometry, Trigonometry and Mensuration. The study of these topics requires a deep and intrinsic understanding of concepts, terms and formulae. Hence, to ease this task, we present **'Perfect Mathematics Part – II, Std. X'** a complete and thorough guide, extensively drafted to boost the confidence of students.

Before each Practice Set, a short and easy explanation of various concepts with the help of 'Illustrative Examples' is provided. A detailed problem solving process is explained step by step in 'Illustrative Examples'. Detailed solution of the problems has been provided for student's understanding and is not expected in the examination. We have also included Solutions and Answers to Textual Questions and Examples in an extremely lucid manner.

Moreover, the inclusion of **'Smart Check'** enables students to verify their answers. **'Textual Activities'** covers all the Textual Activities along with their answers. **'Additional Problems for Practice'** include multiple problems to help students revise and enhance their problem solving skills. **'Solved Examples'** from textbook are also a part of this book. **'Activities for Practice'** includes additional activities along with their answers for students to practice. **'One Mark Questions'** include **'Type A:** Multiple Choice Questions', **'Type B:** Solve the Following Questions' along with their answers. Every chapter ends with a **'Chapter Assessment'**. This test stands as a testimony to the fact that the child has understood the chapter thoroughly. **'Challenging Questions'** include questions that are not a part of the textbook, yet are core to the concerned subject. These questions would provide students enough practice to tackle Challenging Questions in their examination.

Questions from Board papers of March 2019, July 2019, March 2020, November 2020, March 2022, July 2022, March 2023 and July 2023 have been included as that would help students to prepare better for board exam.

We have provided a tentative mark allocation for the problems in this book. However, marks mentioned are indicative and are subject to change as per the Maharashtra State Board's discretion.

'Model Question Paper' based on latest paper pattern is provided along with solution which can be accessed through QR code to help students assess their preparedness for final board examination.

A book affects eternity; one can never tell where its influence stops.

Best of luck to all the aspirants!

Publisher

Edition: Fourth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us on : mail@targetpublications.org

KEY FEATURES

Illustrative Example: Illustrative Example provides a detailed approach towards solving a problem.

Smart Check: Smart Check is a technique to verify the answers. This is our attempt to cross-check the accuracy of the answer. Smart check is indicated by ✓ symbol.

Activities for Practice: In this section we have provided multiple activities for practice in accordance with the latest paper pattern.

One Mark Questions: **Type A** consists of Multiple Choice Questions (which either require short solutions or direct application of mathematical concepts).
Type B consists of questions that require very short solutions with direct application of mathematical concepts.

Additional Problems for Practice: In this section we have provided ample practice problems for students. It also has Solved examples from the textbook, which are indicated by "+".

***Chapter Assessment*:** This section covers questions from the chapter for self-evaluation purpose. This is our attempt to offer students with revision and help them assess their knowledge of each chapter.

Challenging Questions: In light of the importance of specific questions in board examination, we have created a separate section of Challenging Questions for additional practice to boost the exam score

***Important Theorems and Formulae*:** Important Theorems and Formulae given at the end of the book include all the key formulae and theorems in the chapter. It offers students a handy tool to solve problems and ace the last minute revision.

Question Paper: Model Question Paper is provided for the students to know about the types of questions that are asked in the Board Examinations.

QR Codes:
- Answer Keys of Chapter Assessment
- Solution of Model Question Paper.
- Solution to Board Question Paper of March 2024

Evaluation Scheme

Academic year 2019 - 2020 and onwards

Mathematics - Part I	40 Marks	Written Examination	Time: 2 hours
Mathematics - Part II	40 Marks	Written Examination	Time: 2 hours
Internal Evaluation	20 Marks		
Total	**100 Marks**		

The scheme of internal evaluation will be as follows:

- 2 Homework assignments [one based on Mathematics Part – I and one based on Mathematics Part – II (5 Marks each) – 10 Marks]
- Practical Exam / MCQ Test (Part I – 10 Marks and Part II – 10 Marks) - These 20 marks are to be converted into 10 Marks.

PAPER PATTERN

Question No.	Type of Questions	Total Marks	Marks with option
1.	(A) Solve 4 out of 4 MCQ (1 mark each)	04	04
	(B) Solve 4 out of 4 subquestions (1 mark each)	04	04
2.	(A) Solve 2 activity based subquestions out of 3 (2 marks each)	04	06
	(B) Solve any 4 out of 5 subquestions (2 marks each)	08	10
3.	(A) Solve 1 activity based subquestion out of 2 (3 marks each)	03	06
	(B) Solve any 2 out of 4 subquestions (3 marks each)	06	12
4.	Solve any 2 out of 3 subquestions (4 marks each) [Out of textbook]	08	12
5.	Solve any 1 out of 2 subquestions (3 marks each)	03	06
	Total Marks	**40**	**60**

The division of marks in question papers as per objectives will be as follows:

Distribution of Marks	
Easy Questions	40%
Medium Questions	40%
Difficult Questions	20%

Objectives	Maths – II
Knowledge	20%
Understanding	30%
Application	40%
Skill	10%

[Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04]

Topic-wise weightage of marks

S. No.	Topic Name	Marks with option
1	Similarity	10
2	Pythagoras Theorem	07
3	Circle	12
4	Geometric Constructions	07
5	Co-ordinate Geometry	07
6	Trigonometry	07
7	Mensuration	10
	Total	**60**

Note: In the topic-wise weightage of marks given in the above table, flexibility of maximum 2 marks is permissible.

CONTENTS

Note:
- ***Smart check is indicated by ✓ symbol.***
- ***Solved examples from textbook are indicated by "+".***
- ***Intext and Activity/Project based questions from the textbook are indicated by "#".***
- ***Steps of construction are provided in Chapters for the students' understanding.***

Page no. **1** to **29** are purposely left blank.

To see complete chapter buy **Target Notes** or **Target E-Notes**

2 Pythagoras Theorem

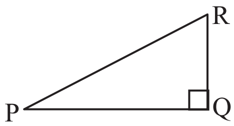
Let's Study

- Pythagorean triplet
- Similarity and right angled triangles
- Theorem of geometric mean
- Pythagoras theorem
- Application of Pythagoras theorem
- Apollonius theorem

Let's Recall

Pythagoras theorem:

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



In ΔPQR, $\angle PQR = 90°$

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

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 a Pythagorean triplet.

\# **Example: Verify that (3, 4, 5), (5, 12, 13), (8, 15, 17), (24, 25, 7) are Pythagorean triplets.**

(Textbook pg. no. 30)

Solution:

i. Here, $5^2 = 25$

$3^2 + 4^2 = 9 + 16 = 25$

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

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

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

---

ii. Here, $13^2 = 169$

$5^2 + 12^2 = 25 + 144 = 169$

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

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

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

---

iii. Here, $17^2 = 289$

$8^2 + 15^2 = 64 + 225 = 289$

$\therefore$ $17^2 = 8^2 + 15^2$

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

$\therefore$ **8, 15, 17 is a Pythagorean triplet.**

iv. Here, $25^2 = 625$

$7^2 + 24^2 = 49 + 576 = 625$

$\therefore$ $25^2 = 7^2 + 24^2$

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

$\therefore$ **24, 25, 7 is a Pythagorean triplet.**

Something More

Formula for Pythagorean triplet:

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

Proof:

$(a^2 + b^2)^2 = a^4 + 2a^2b^2 + b^4$ ...(i)

$(a^2 - b^2)^2 = a^4 - 2a^2b^2 + b^4$ ...(ii)

$(2ab)^2 = 4a^2b^2$ ...(iii)

Now, $(a^4 + 2a^2b^2 + b^4) = (a^4 - 2a^2b^2 + b^4) + 4a^2b^2$

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

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

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

The above formula can be used to get various Pythagorean triplets.

\# **Assign different values to a and b and obtain 5 Pythagorean triplets.**

(Textbook pg. no. 31)

Solution:

i. Let a = 2, b = 1

$a^2 + b^2 = 2^2 + 1^2 = 4 + 1 = 5$

$a^2 - b^2 = 2^2 - 1^2 = 4 - 1 = 3$

$2ab = 2 \times 2 \times 1 = 4$

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

---

ii. Let a = 4, b = 3

$a^2 + b^2 = 4^2 + 3^2 = 16 + 9 = 25$

$a^2 - b^2 = 4^2 - 3^2 = 16 - 9 = 7$

$2ab = 2 \times 4 \times 3 = 24$

$\therefore$ **(25, 7, 24) is a Pythagorean triplet.**

iii. Let a = 5, b = 2

$a^2 + b^2 = 5^2 + 2^2 = 25 + 4 = 29$

$a^2 - b^2 = 5^2 - 2^2 = 25 - 4 = 21$

$2ab = 2 \times 5 \times 2 = 20$

$\therefore$ **(29, 21, 20) is a Pythagorean triplet.**

---

iv. Let a = 4, b = 1

$a^2 + b^2 = 4^2 + 1^2 = 16 + 1 = 17$

$a^2 - b^2 = 4^2 - 1^2 = 16 - 1 = 15$

$2ab = 2 \times 4 \times 1 = 8$

$\therefore$ **(17, 15, 8) is a Pythagorean triplet.**

---

v. Let a = 9, b = 7

$a^2 + b^2 = 9^2 + 7^2 = 81 + 49 = 130$

$a^2 - b^2 = 9^2 - 7^2 = 81 - 49 = 32$

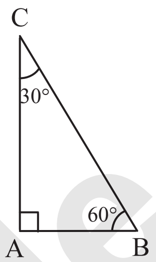
$2ab = 2 \times 9 \times 7 = 126$

$\therefore$ **(130, 32, 126) is a Pythagorean triplet.**

[**Note:** Numbers in Pythagorean triplet can be written in any order.]

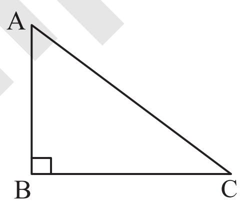
Let's Recall

- **Theorem of 30° – 60° – 90° triangle:**
  If the acute angles of a right angled triangle are 30° and 60°, then the side opposite to 30° angle is half of the hypotenuse and the side opposite to 60° angle is $\frac{\sqrt{3}}{2}$ times the hypotenuse.



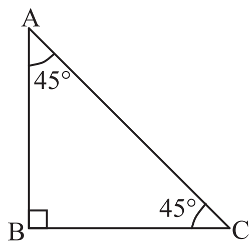
  If in ΔABC, ∠A = 90°, ∠B = 60°, ∠C = 30°, then $AB = \frac{1}{2} BC$ and $AC = \frac{\sqrt{3}}{2} BC$.

- **Converse of 30° – 60° – 90° theorem:**
  In a right angled triangle, if one side is half of the hypotenuse, then the angle opposite to that side is 30°.



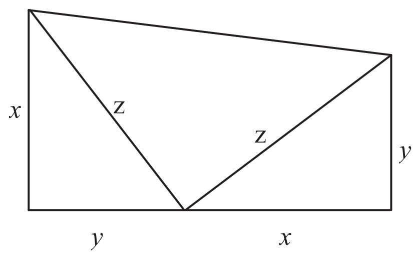
  If in ΔABC, ∠ABC = 90°, $AB = \frac{1}{2} AC$, then ∠ACB = 30°

- **Theorem of 45° – 45° – 90° triangle:**
  If the acute angles of a right angled triangle are 45° and 45°, then each of the perpendicular sides is $\frac{1}{\sqrt{2}}$ times the hypotenuse.



  If in ΔABC, ∠B = 90°, ∠A = ∠C = 45°, then $AB = BC = \frac{1}{\sqrt{2}} AC$.

Activity:

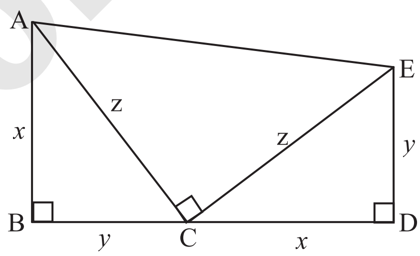


Take two congruent right angled triangles. Take another isosceles right angled triangle whose congruent sides are equal to the hypotenuse of the two congruent right angled triangles. Join these triangles to form a trapezium.

Area of the trapezium = $\frac{1}{2}$ × (sum of the lengths of parallel sides) × height

Using this formula, equating the area of trapezium with the sum of areas of the three right angled triangles prove the theorem of Pythagoras. (Textbook pg. no. 32)

Proof:



In ΔABC, ∠B = 90°

$\therefore$ $A(\Delta ABC) = \frac{1}{2} \times y \times x$

$\therefore$ $A(\Delta ABC) = \frac{1}{2} xy$ …(i)

Similarly, $A(\Delta EDC) = \frac{1}{2} xy$ …(ii)

In ΔACE, ∠C = 90°

$\therefore$ $A(\Delta ACE) = \frac{1}{2} \times z \times z$

$\therefore$ $A(\Delta ACE) = \frac{1}{2} z^2$ …(iii)

□ABDE is a trapezium.

$\therefore$ $A(\square ABDE) = \frac{1}{2} \times (AB + ED) \times (BD)$

$= \frac{1}{2} \times (x + y) \times (x + y)$

$\therefore$ $A(\square ABDE) = \frac{1}{2} (x + y)^2$ …(iv)

But, A(□ABDE)

= A(ΔABC) + A(ΔEDC) + A(ΔACE)

$\therefore$ $\frac{1}{2} (x + y)^2 = \frac{1}{2} xy + \frac{1}{2} xy + \frac{1}{2} z^2$

…[From (i), (ii), (iii) and (iv)]

$\therefore$ $(x+y)^2 = xy + xy + z^2$

$\therefore$ $x^2 + 2xy + y^2 = 2xy + z^2$

$\therefore$ $x^2 + y^2 = z^2$

$\therefore$ **The theorem of Pythagoras is proved.**

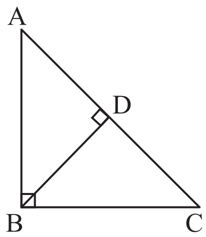
Let's Learn

Similarity and right angled triangle

Theorem: In a right angled triangle, if an altitude is drawn to the hypotenuse, then the two triangles formed will be similar to the original triangle and to each other. **[Mar 2013]**

Given: In ΔABC, $\angle$ABC = 90°, seg BD $\perp$ hypotenuse AC, A–D–C.

To prove: ΔABC ~ ΔADB, ΔABC ~ ΔBDC, ΔADB ~ ΔBDC,



Proof:

In ΔABC and ΔADB,

$\angle$ABC $\cong$ $\angle$ADB ...[Each angle is of measure 90°]

$\angle$BAC $\cong$ $\angle$DAB ...[Common angle]

$\therefore$ **ΔABC ~ ΔADB** ...(i)[AA test of similarity]

In ΔABC and ΔBDC,

$\angle$ABC $\cong$ $\angle$BDC ...[Each angle is of measure 90°]

$\angle$ACB $\cong$ $\angle$BCD ...[Common angle]

$\therefore$ **ΔABC ~ ΔBDC** ...(ii) [AA test of similarity]

$\therefore$ **ΔADB ~ ΔBDC** ...(iii)[From (i) and (ii)]

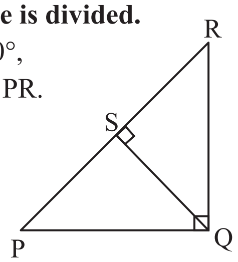
$\therefore$ ΔABC ~ ΔADB ~ ΔBDC ...[From (i), (ii) and (iii)] [Transitivity]

Theorem of geometric mean

Theorem: In a right angled triangle, the perpendicular segment to the hypotenuse from the opposite vertex is the geometric mean of the segments into which the hypotenuse is divided.

Given: In ΔPQR, $\angle$PQR = 90°, seg QS $\perp$ hypotenuse PR.

To prove: $QS^2 = PS \times SR$



Proof:

In ΔPQR, $\angle$ PQR = 90°, seg QS $\perp$ hypotenuse PR } ...[Given]

$\therefore$ ΔRSQ ~ ΔQSP ...[Similarity of right angled triangles]

$\therefore$ $\frac{QS}{PS} = \frac{RS}{QS}$ ...[Corresponding sides of similar triangles]

$\therefore$ $QS^2 = PS \times SR$

$\therefore$ seg QS is the geometric mean of seg PS and seg SR.

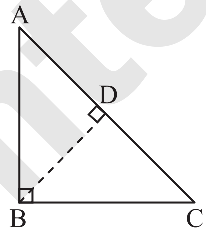
Pythagoras Theorem

Theorem: In a right angled triangle, the square of the hypotenuse is equal to the sum of the squares of the remaining two sides. **[Mar 2013, 2018; July 2023]**

Given: In ΔABC, $\angle$ABC = 90°.

To prove: $AC^2 = AB^2 + BC^2$

Construction: Draw seg BD $\perp$ hypotenuse AC, A–D–C.



Proof:

In ΔABC, $\angle$ABC = 90° ...[Given]

seg BD $\perp$ hypotenuse AC ...[Construction]

$\therefore$ ΔABC ~ ΔADB ...[Similarity of right angled triangles]

$\therefore$ $\frac{AB}{AD} = \frac{AC}{AB}$ ...[Corresponding sides of similar triangles]

$\therefore$ $AB^2 = AD \times AC$ ...(i)

Also, ΔABC ~ ΔBDC ...[Similarity of right angled triangles]

$\therefore$ $\frac{BC}{DC} = \frac{AC}{BC}$ ...[Corresponding sides of similar triangles]

$\therefore$ $BC^2 = DC \times AC$ ...(ii)

$AB^2 + BC^2 = AD \times AC + DC \times AC$ ...[Adding (i) and (ii)]

$= AC\ (AD + DC)$

$= AC \times AC$ ...[A–D–C]

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

i.e. $AC^2 = AB^2 + BC^2$

Converse of Pythagoras theorem

Theorem: In a triangle, if the square of one side is equal to the sum of the squares of the remaining two sides, then the triangle is a right angled triangle.

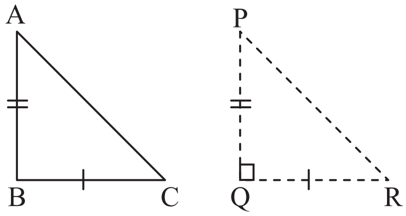
Given: In ΔABC, $AC^2 = AB^2 + BC^2$.

To prove: $\angle$ABC = 90°

Construction: Draw ΔPQR such that,

$PQ = AB$, $QR = BC$ and $\angle PQR = 90°$.

Proof:



In ΔPQR, $\angle PQR = 90°$ …[Construction]

∴ $PR^2 = PQ^2 + QR^2$ …(i)[Pythagoras theorem]

But, $PQ = AB$ and $QR = BC$ …(ii)[Construction]

∴ $PR^2 = AB^2 + BC^2$ …(iii)[From (i) and (ii)]

But, $AC^2 = AB^2 + BC^2$ …(iv) [Given]

∴ $AC^2 = PR^2$ …[From (iii) and (iv)]

∴ $AC = PR$ …(v)[Taking square root of both sides]

In ΔABC and ΔPQR,

seg $AB \cong$ seg PQ
seg $BC \cong$ seg QR } …[Construction]

seg $AC \cong$ seg PR …[From (v)]

∴ $\Delta ABC \cong \Delta PQR$ …[SSS test of congruency]

∴ $\angle ABC \cong \angle PQR$ …[c.a.c.t]

But, $\angle PQR = 90°$ …[Construction]

∴ $\angle ABC = 90°$

Practice Set 2.1

1. Identify, with reason, which of the following are Pythagorean triplets. [1 Mark each]

i. (3, 5, 4) ii. (4, 9, 12)
iii. (5, 12, 13) iv. (24, 70, 74)
v. (10, 24, 27) vi. (11, 60, 61)

***Solution*:**

i. Here, $5^2 = 25$

$3^2 + 4^2 = 9 + 16 = 25$

∴ $5^2 = 3^2 + 4^2$

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

∴ **(3, 5, 4) is a Pythagorean triplet.**

ii. Here, $12^2 = 144$

$4^2 + 9^2 = 16 + 81 = 97$

∴ $12^2 \neq 4^2 + 9^2$

The square of the largest number is not equal to the sum of the squares of the other two numbers.

∴ **(4, 9, 12) is not a Pythagorean triplet.**

iii. Here, $13^2 = 169$

$5^2 + 12^2 = 25 + 144 = 169$

∴ $13^2 = 5^2 + 12^2$

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

∴ **(5, 12, 13) is a Pythagorean triplet.**

iv. Here, $74^2 = 5476$

$24^2 + 70^2 = 576 + 4900 = 5476$

∴ $74^2 = 24^2 + 70^2$

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

∴ **(24, 70, 74) is a Pythagorean triplet.**

v. Here, $27^2 = 729$

$10^2 + 24^2 = 100 + 576 = 676$

∴ $27^2 \neq 10^2 + 24^2$

The square of the largest number is not equal to the sum of the squares of the other two numbers.

∴ **(10, 24, 27) is not a Pythagorean triplet.**

vi. Here, $61^2 = 3721$

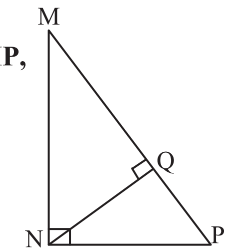
$11^2 + 60^2 = 121 + 3600 = 3721$

∴ $61^2 = 11^2 + 60^2$

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

∴ **(11, 60, 61) is a Pythagorean triplet.**

2. In the adjoining figure, $\angle MNP = 90°$, seg $NQ \perp$ seg MP, $MQ = 9$, $QP = 4$, find NQ.



[Mar 2020; July 2023][2 Marks]

***Solution*:**

In ΔMNP, $\angle MNP = 90°$ and

seg $NQ \perp$ seg MP …[Given]

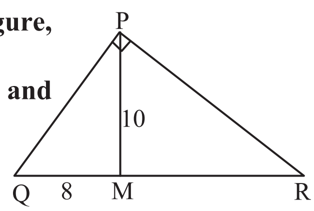
∴ $NQ^2 = MQ \times QP$ …[Theorem of geometric mean]

∴ $NQ = \sqrt{MQ \times QP}$ …[Taking square root of both sides]

$= \sqrt{9 \times 4} = 3 \times 2$

∴ **NQ = 6 units**

3. In the adjoining figure, $\angle QPR = 90°$, seg $PM \perp$ seg QR and Q–M–R, $PM = 10$, $QM = 8$, find QR.



[3 Marks]

***Solution*:**

In ΔPQR, $\angle QPR = 90°$ and seg $PM \perp$ seg QR …[Given]

∴ $PM^2 = QM \times MR$ …[Theorem of geometric mean]

∴ $10^2 = 8 \times MR$

∴ $MR = \frac{100}{8} = 12.5$ units

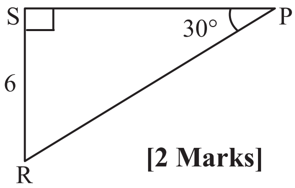
Now, QR = QM + MR ...[Q–M–R]

= 8 + 12.5

$\therefore$ **QR = 20.5 units**

---

4. See adjoining figure. Find RP and PS using the information given in ΔPSR.



[2 Marks]

***Solution*:**

In ΔPSR, ∠S = 90°, ∠P = 30° ...[Given]

$\therefore$ ∠R = 60° ...[Remaining angle of a triangle]

$\therefore$ ΔPSR is a 30° – 60° – 90° triangle.

RS = $\frac{1}{2}$ RP ...[Side opposite to 30°]

$\therefore$ 6 = $\frac{1}{2}$ RP

$\therefore$ RP = 6 × 2 = 12 units

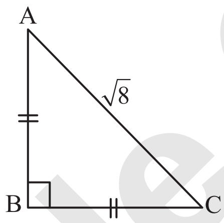
Also, PS = $\frac{\sqrt{3}}{2}$ RP ...[Side opposite to 60°]

= $\frac{\sqrt{3}}{2} \times 12 = 6\sqrt{3}$ units

$\therefore$ **RP = 12 units, PS = $6\sqrt{3}$ units**

---

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



[3 Marks]

***Solution*:**

AB = BC ... **[Given]**

$\therefore$ ∠BAC = ∠BCA ...[Isosceles triangle theorem]

Let ∠BAC = ∠BCA = x ...(i)

In ΔABC, ∠A + ∠B + ∠C = 180°

...[Sum of the measures of the angles of a triangle is 180°]

$\therefore$ x + 90° + x = 180° ...[From (i)]

$\therefore$ 2x = 90°

$\therefore$ $x = \frac{90°}{2}$ ...[From (i)]

$\therefore$ x = 45°

$\therefore$ ∠BAC = ∠BCA = **45°**

$\therefore$ ΔABC is a 45° – 45° – 90° triangle.

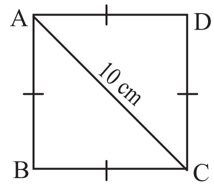
$\therefore$ AB = BC = $\boxed{\frac{1}{\sqrt{2}}}$ × AC ...[Side opposite to 45°]

= $\boxed{\frac{1}{\sqrt{2}}} \times \sqrt{8}$

= $\boxed{\frac{1}{\sqrt{2}}} \times 2\sqrt{2}$ = **2 units**

6. Find the side and perimeter of a square whose diagonal is 10 cm. [2 Marks]

***Solution*:**



Let □ABCD be the given square.

l(diagonal AC) = 10 cm

Let the side of the square be 'x' cm.

In ΔABC,

∠B = 90° ...[Angle of a square]

$\therefore$ $AC^2 = AB^2 + BC^2$ ...[Pythagoras theorem]

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

$\therefore$ $100 = 2x^2$

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

$\therefore$ $x^2 = 50$

$\therefore$ $x = \sqrt{50}$ ...[Taking square root of both sides]

= $\sqrt{25 \times 2} = 5\sqrt{2}$

$\therefore$ **Side of square is $5\sqrt{2}$ cm.**

Perimeter of square = 4 × side = 4 × $5\sqrt{2}$

$\therefore$ **Perimeter of square = $20\sqrt{2}$ cm**

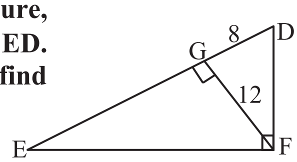
---

7. In the adjoining figure, ∠DFE = 90°, FG ⊥ ED. If GD = 8, FG = 12, find

i. EG

ii. FD, and

iii. EF



[3 Marks]

***Solution*:**

i. In ΔDEF, ∠DFE = 90° and FG ⊥ ED ...[Given]

$\therefore$ FG^2 = GD × EG ...[Theorem of geometric mean]

$\therefore$ 12^2 = 8 × EG

$\therefore$ EG = $\frac{144}{8}$

$\therefore$ **EG = 18 units**

---

ii. In ΔFGD, ∠FGD = 90° ...[Given]

$\therefore$ $FD^2 = FG^2 + GD^2$ ...[Pythagoras theorem]

= $12^2 + 8^2$ = 144 + 64= 208

$\therefore$ FD = $\sqrt{208}$ ...[Taking square root of both sides]

$\therefore$ **FD = $4\sqrt{13}$ units**

---

iii. In ΔEGF, ∠EGF = 90° ...[Given]

$\therefore$ $EF^2 = EG^2 + FG^2$ ...[Pythagoras theorem]

= $18^2 + 12^2$ = 324 + 144 = 468

$\therefore$ EF = $\sqrt{468}$ ...[Taking square root of both sides]

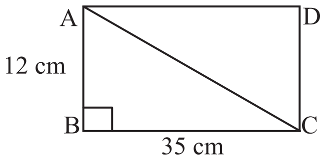
$\therefore$ **EF = $6\sqrt{13}$ units**

8. Find the diagonal of a rectangle whose length is 35 cm and breadth is 12 cm.

[Mar 2023][2 Marks]

***Solution*:**

Let □ABCD be the given rectangle.



AB = 12 cm,

BC = 35 cm

In ΔABC, ∠B = 90° …[Angle of a rectangle]

∴ $AC^2 = AB^2 + BC^2$ …[Pythagoras theorem]

$= 12^2 + 35^2$

$= 144 + 1225$

$= 1369$

∴ $AC = \sqrt{1369}$ …[Taking square root of both sides]

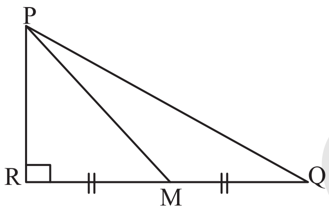
$= 37$ cm

∴ **The diagonal of the rectangle is 37 cm.**

---

9. In the adjoining figure, M is the midpoint of QR. ∠PRQ = 90°.

Prove that, $PQ^2 = 4\ PM^2 - 3\ PR^2$.



[3 Marks]

***Proof*:**

$RM = \frac{1}{2}QR$ …[M is the midpoint of QR]

∴ $2RM = QR$ …(i)

In ΔPQR, ∠PRQ = 90° …[Given]

∴ $PQ^2 = PR^2 + QR^2$ …[Pythagoras theorem]

∴ $PQ^2 = PR^2 + (2RM)^2$ …[From (i)]

∴ $PQ^2 = PR^2 + 4RM^2$ …(ii)

Now, in ΔPRM, ∠PRM = 90° …[Given]

∴ $PM^2 = PR^2 + RM^2$ …[Pythagoras theorem]

∴ $RM^2 = PM^2 - PR^2$ …(iii)

∴ $PQ^2 = PR^2 + 4\ (PM^2 - PR^2)$ …[From (ii) and (iii)]

∴ $PQ^2 = PR^2 + 4\ PM^2 - 4\ PR^2$

∴ $\mathbf{PQ^2 = 4\ PM^2 - 3\ PR^2}$

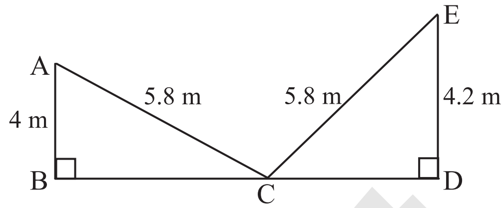
---

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 of 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 AC and CE represent the ladder of length 5.8 m, and A and E represent windows of the buildings on the opposite sides of the street. BD is the width of the street.



AB = 4 m and ED = 4.2 m

In ΔABC, ∠B = 90° …[Given]

$AC^2 = AB^2 + BC^2$ …[Pythagoras theorem]

∴ $5.8^2 = 4^2 + BC^2$

∴ $5.8^2 - 4^2 = BC^2$

∴ $(5.8 - 4)\ (5.8 + 4) = BC^2$

∴ $1.8 \times 9.8 = BC^2$

∴ $\frac{18 \times 98}{100} = BC^2$

∴ $\frac{9 \times 2 \times 49 \times 2}{100} = BC^2$

∴ $\frac{9 \times 4 \times 49}{100} = BC^2$

∴ $BC = \frac{3 \times 2 \times 7}{10}$ …[Taking square root of both sides]

∴ $BC = \frac{42}{10} = 4.2$ cm …(i)

In ΔCDE, ∠CDE = 90° …[Given]

$CE^2 = CD^2 + DE^2$ …[Pythagoras theorem]

∴ $5.8^2 = CD^2 + 4.2^2$

∴ $5.8^2 - 4.2^2 = CD^2$

∴ $(5.8 - 4.2)\ (5.8 + 4.2) = CD^2$

∴ $1.6 \times 10 = CD^2$

∴ $CD^2 = 16$

∴ $CD = 4$ m …(ii) [Taking square root of both sides]

Now, BD = BC + CD …[B–C–D]

= 4.2 + 4 …[From (i) and (ii)]

= 8.2 m

∴ **The width of the street is 8.2 metres.**

Let's Learn

Application of Pythagoras theorem

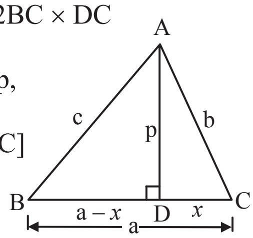
In a triangle, relation between the side opposite to acute angle and remaining two sides, and relation between the side opposite to obtuse angle and the remaining two sides can be determined with the help of Pythagoras theorem.

Pythagoras theorem can be applied to acute angled triangle and obtuse angled triangle as shown below:

\# **Example: In ΔABC, ∠C is an acute angle, seg AD ⊥ seg BC.**
Prove that: $AB^2 = BC^2 + AC^2 - 2\ BC \times DC$.

(Textbook pg. no. 40)

Given: ∠C is an acute angle, seg AD ⊥ seg BC.
To prove: $AB^2 = BC^2 + AC^2 - 2BC \times DC$
Proof:



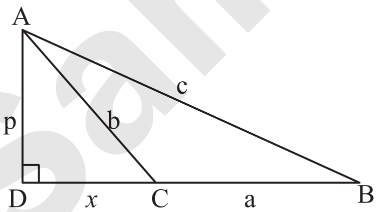
Let AB = c, AC = b, AD = p,
BC = a, DC = x
BD + DC = BC …[B–D–C]
∴ BD = BC – DC
∴ BD = a – x

In ΔABD, ∠D = 90° …[Given]
$AB^2 = BD^2 + AD^2$ …[Pythagoras theorem]
∴ $c^2 = (a - x)^2 + \boxed{p^2}$
∴ $c^2 = a^2 - 2ax + x^2 + \boxed{p^2}$ …(i)
In ΔADC, ∠D = 90° …[Given]
$AC^2 = AD^2 + CD^2$ …[Pythagoras theorem]
∴ $b^2 = p^2 + \boxed{x^2}$
∴ $p^2 = b^2 - \boxed{x^2}$ …(ii)
∴ $c^2 = a^2 - 2ax + x^2 + b^2 - x^2$
…[Substituting (ii) in (i)]
∴ $c^2 = a^2 + b^2 - 2ax$
∴ $\mathbf{AB^2 = BC^2 + AC^2 - 2\ BC \times DC}$

\# **Example: In ΔABC, ∠ACB is an obtuse angle, seg AD ⊥ seg BC. Prove that:**
$AB^2 = BC^2 + AC^2 + 2\ BC \times CD$.

(Textbook pg. no. 40 and 41)

Given: ∠ACB is an obtuse angle, seg AD ⊥ seg BC.
To prove: $AB^2 = BC^2 + AC^2 + 2BC \times CD$
Proof:



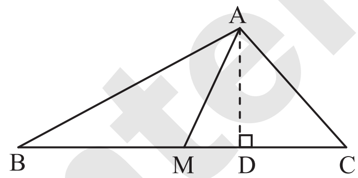
Let AD = p, AC = b, AB = c,
BC = a, DC = x
BD = BC + DC …[B–C–D]
∴ BD = a + x
In ΔADB, ∠D = 90° …[Given]
$AB^2 = BD^2 + AD^2$ …[Pythagoras theorem]
∴ $c^2 = (a + x)^2 + p^2$
∴ $c^2 = a^2 + 2ax + x^2 + p^2$ …(i)
Also, in ΔADC, ∠D = 90° …[Given]
$AC^2 = CD^2 + AD^2$ …[Pythagoras theorem]
∴ $b^2 = x^2 + p^2$
∴ $p^2 = b^2 - x^2$ …(ii)
∴ $c^2 = a^2 + 2ax + x^2 + b^2 - x^2$
…[Substituting (ii) in (i)]
∴ $c^2 = a^2 + b^2 + 2ax$
∴ $\mathbf{AB^2 = BC^2 + AC^2 + 2\ BC \times CD}$

Apollonius theorem

Apollonius theorem shows relation between median and sides of a triangle.

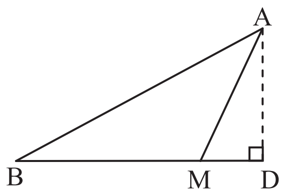
In ΔABC, if M is the midpoint of side BC, then $AB^2 + AC^2 = 2\ AM^2 + 2\ BM^2$.

Given: In ΔABC, M is the midpoint of side BC.
To prove: $AB^2 + AC^2 = 2\ AM^2 + 2\ BM^2$
Construction: Draw seg AD ⊥ seg BC, B–D–C.

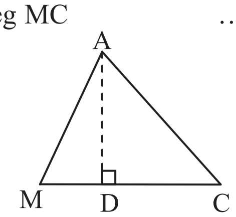


Proof:

Lets consider seg AM is not perpendicular to side BC, then out of ∠AMB and ∠AMC one is obtuse and other is acute. In the figure, ∠AMB is obtuse and ∠AMC is acute.
In ΔAMB,
∠AMB is an obtuse angle, …[Given]
seg AD ⊥ seg BC …[Construction]



∴ $AB^2 = AM^2 + BM^2 + 2\ BM{\cdot}MD$
…(i)[Application of Pythagoras theorem]
In ΔAMC,
∠AMC is an acute angle, …[Given]
seg AD ⊥ seg MC …[Construction]



∴ $AC^2 = AM^2 + MC^2 - 2\ MC.MD$
…(ii)[Application of Pythagoras theorem]
$AB^2 + AC^2 = AM^2 + BM^2 + 2\ BM.MD + AM^2 + MC^2 - 2\ MC\ .\ MD$
…[Adding (i) and (ii)]
∴ $AB^2 + AC^2 = 2AM^2 + BM^2 + BM^2 + 2\ BM.MD - 2\ BM.MD$
…[∵ BM = MC (M is the midpoint of BC)]
∴ $\mathbf{AB^2 + AC^2 = 2\ AM^2 + 2\ BM^2}$

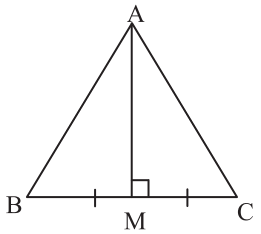
 # Apollonius theorem: In ΔABC, if M is the midpoint of side BC and seg AM ⊥ seg BC, then prove that $AB^2 + AC^2 = 2\ AM^2 + 2\ BM^2$.

(Textbook pg. no. 41)

Given: In ΔABC, M is the midpoint of side BC and seg AM ⊥ seg BC.

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

Proof:



In ΔAMB, $\angle M = 90°$ ...[seg AM ⊥ seg BC]

∴ $AB^2 = AM^2 + BM^2$ ...(i)[Pythagoras theorem]

Also, in ΔAMC,

$\angle M = 90°$ ...[seg AM ⊥ seg BC]

∴ $AC^2 = AM^2 + MC^2$ ...(ii) [Pythagoras theorem]

∴ $AB^2 + AC^2 = AM^2 + BM^2 + AM^2 + MC^2$

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

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

...[∵ BM = MC (M is the midpoint of BC)]

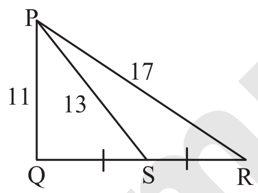
∴ $\mathbf{AB^2 + AC^2 = 2\ AM^2 + 2\ BM^2}$

Practice Set 2.2

1. In ΔPQR, point S is the midpoint of side QR. If PQ = 11, PR = 17, PS = 13, find QR.

[Mar 2020] [3 Marks]

***Solution*:**



In ΔPQR, point S is the midpoint of side QR.

...[Given]

∴ seg PS is the median.

∴ $PQ^2 + PR^2 = 2\ PS^2 + 2\ SR^2$

...[Apollonius theorem]

∴ $11^2 + 17^2 = 2\ (13)^2 + 2\ SR^2$

∴ $121 + 289 = 2\ (169) + 2\ SR^2$

∴ $410 = 338 + 2\ SR^2$

∴ $2\ SR^2 = 410 - 338$

∴ $2\ SR^2 = 72$

∴ $SR^2 = \frac{72}{2} = 36$

∴ $SR = \sqrt{36}$ ...[Taking square root of both sides]

= 6 units

Now, QR = 2 SR ...[S is the midpoint of QR]

$= 2 \times 6$

∴ **QR = 12 units**

2. In ΔABC, AB = 10, AC = 7, BC = 9, then find the length of the median drawn from point C to side AB. [2 Marks]

***Solution*:**

Let CD be the median drawn from the vertex C to side AB.

$BD = \frac{1}{2}\ AB$ ...[D is the midpoint of AB]

$= \frac{1}{2} \times 10 = 5$ units

In ΔABC, seg CD is the median. ...[Given]

∴ $AC^2 + BC^2 = 2\ CD^2 + 2\ BD^2$

...[Apollonius theorem]

∴ $7^2 + 9^2 = 2\ CD^2 + 2\ (5)^2$

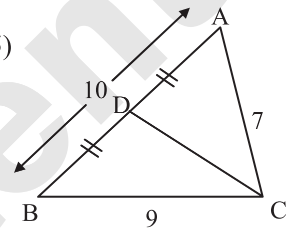
∴ $49 + 81 = 2\ CD^2 + 2\ (25)$

∴ $130 = 2\ CD^2 + 50$

∴ $2\ CD^2 = 130 - 50$

∴ $2\ CD^2 = 80$

∴ $CD^2 = \frac{80}{2} = 40$



∴ $CD = \sqrt{40}$ ...[Taking square root of both sides]

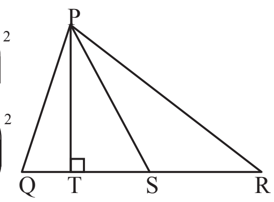
$= 2\sqrt{10}$ units

∴ **The length of the median drawn from point C to side AB is $2\sqrt{10}$ units.**

3. In the adjoining figure, seg PS is the median of ΔPQR and PT ⊥ QR.
Prove that,

i. $PR^2 = PS^2 + QR \times ST + \left(\frac{QR}{2}\right)^2$

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



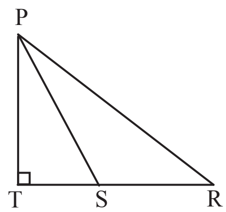
[4 Marks]

***Proof*:**

i. $QS = SR = \frac{1}{2}\ QR$ ...(i) $\left[\begin{array}{l}\text{S is the midpoint} \\ \text{of side QR}\end{array}\right]$

In ΔPSR, ∠PSR is an obtuse angle and PT ⊥ SR

...[Given, Q–S–R]



∴ $PR^2 = SR^2 + PS^2 + 2\ SR \times ST$

...(ii)[Application of Pythagoras theorem]

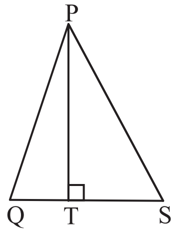
∴ $PR^2 = \left(\frac{1}{2}QR\right)^2 + PS^2 + 2\left(\frac{1}{2}QR\right) \times ST$

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

∴ $PR^2 = \left(\frac{QR}{2}\right)^2 + PS^2 + QR \times ST$

∴ $\mathbf{PR^2 = PS^2 + QR \times ST + \left(\frac{QR}{2}\right)^2}$

ii. In ΔPQS, $\angle PSQ$ is an acute angle and $PT \perp QS$ …[Given, Q–S–R]



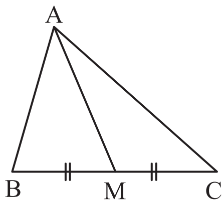
$\therefore$ $PQ^2 = QS^2 + PS^2 - 2\ QS \times ST$ …(iii)[Application of Pythagoras theorem]

$\therefore$ $PQ^2 = \left(\frac{1}{2}QR\right)^2 + PS^2 - 2\left(\frac{1}{2}QR\right) \times ST$ …[From (i) and (iii)]

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

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

4. In ΔABC, point M is the midpoint of side BC. If $AB^2 + AC^2 = 290$ cm, AM = 8 cm, find BC.



[2 Marks]

***Solution*:**

In ΔABC, point M is the midpoint of side BC. …[Given]

$\therefore$ seg AM is the median.

$\therefore$ $AB^2 + AC^2 = 2\ AM^2 + 2\ MC^2$ …[Apollonius theorem]

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

$\therefore$ $145 = 64 + MC^2$ …[Dividing both sides by 2]

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

$\therefore$ $MC^2 = 81$

$\therefore$ $MC = \sqrt{81}$ …[Taking square root of both sides]

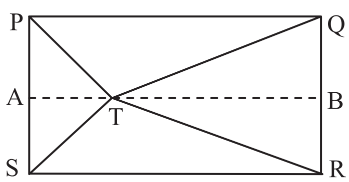
$\therefore$ MC = 9 cm

Now, BC $= 2$ MC …[M is the midpoint of BC]

$= 2 \times 9$

$\therefore$ **BC = 18 cm**

5. In the given figure, point T is in the interior of rectangle PQRS. Prove that, $TS^2 + TQ^2 = TP^2 + TR^2$. (As shown in the figure, draw seg AB || side SR and A–T–B)



[4 Marks]

Given: □PQRS is a rectangle.
Point T is in the interior of □PQRS.

To prove: $TS^2 + TQ^2 = TP^2 + TR^2$

Construction: Draw seg AB || side SR such that A – T – B.

***Proof*:**

□PQRS is a rectangle. …[Given]

$\therefore$ PS = QR …(i) [Opposite sides of a rectangle]

In □ASRB,

$\angle S = \angle R = 90°$ …(ii) [Angles of rectangle PQRS]

side AB || side SR …[Construction]

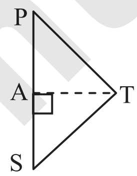
Also $\angle A = \angle S = 90°$, $\angle B = \angle R = 90°$ …[Interior angle theorem, from (ii)]

$\therefore$ $\angle A = \angle B = \angle S = \angle R = 90°$ …(iii)

$\therefore$ □ASRB is a rectangle.

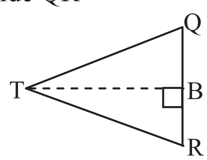
$\therefore$ AS = BR …(iv)[Opposite sides of a rectangle]

In ΔPTS, $\angle PST$ is an acute angle and seg AT $\perp$ side PS …[From (iii)]



$\therefore$ $TP^2 = PS^2 + TS^2 - 2\ PS.AS$ …(v) [Application of Pythagoras theorem]

In ΔTQR, $\angle TRQ$ is an acute angle and seg BT $\perp$ side QR …[From (iii)]



$\therefore$ $TQ^2 = RQ^2 + TR^2 - 2\ RQ.BR$ …(vi) [Application of Pythagoras theorem]

$TP^2 - TQ^2 = PS^2 + TS^2 - 2\ PS.AS - RQ^2 - TR^2 + 2\ RQ.BR$ …[Subtracting (vi) from (v)]

$\therefore$ $TP^2 - TQ^2 = TS^2 - TR^2 + PS^2 - RQ^2 - 2\ PS.AS + 2\ RQ.BR$

$\therefore$ $TP^2 - TQ^2 = TS^2 - TR^2 + PS^2 - PS^2 - 2\ PS.BR + 2\ PS.BR$ …[From (i) and (iv)]

$\therefore$ $TP^2 - TQ^2 = TS^2 - TR^2$

$\therefore$ $\mathbf{TS^2 + TQ^2 = TP^2 + TR^2}$

Problem Set – 2

1. Some questions and their alternative answers are given. Select the correct alternative. **[1 Mark each]**

i. Out of the following which is the Pythagorean triplet? **[Mar 2020]**

(A) (1, 5, 10) (B) (3, 4, 5)
(C) (2, 2, 2) (D) (5, 5, 2)

ii. 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

iii. Out of the dates given below which date constitutes a Pythagorean triplet?
(A) 15/08/17 (B) 16/08/16
(C) 3/5/17 (D) 4/9/15

iv. If a, b, c are sides of a triangle and $a^2 + b^2 = c^2$, name the type of the triangle. **[Mar 2023]**
(A) Obtuse angled triangle
(B) Acute angled triangle
(C) Right angled triangle
(D) Equilateral triangle

v. Find perimeter of a square if its diagonal is $10\sqrt{2}$ cm. **[July 2023]**
(A) 10 cm (B) $40\sqrt{2}$ cm
(C) 20 cm (D) 40 cm

vi. Altitude on the hypotenuse of a right angled 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) $2\sqrt{6}$ cm

vii. 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

viii. In ΔABC, AB = $6\sqrt{3}$ cm, AC = 12 cm, BC = 6 cm. Find measure of $\angle$A.
(A) 30° (B) 60°
(C) 90° (D) 45°

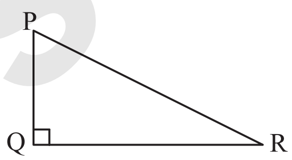
Answers:

i.	(B)	ii.	(B)	iii.	(A)	iv.	(C)
v.	(D)	vi.	(C)	vii.	(B)	viii.	(A)

Hints:

i. *Refer Practice Set 2.1 Q.1 (i)*

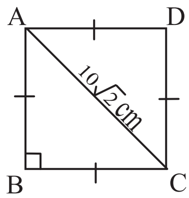
ii.



In ΔPQR, $\angle$Q = 90°
$\therefore$ $PR^2 = PQ^2 + QR^2$ …[Pythagoras theorem]
$\therefore$ $PR^2 = 169$
$\therefore$ PR = $\sqrt{169}$ = 13

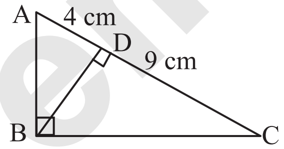
iii. Consider Option A.
Here, $15^2 + 8^2 = 225 + 64 = 289$, and $17^2 = 289$
$\therefore$ $15^2 + 8^2 = 17^2$

v. In ΔABC, $\angle$B = 90°, and $\angle$BAC = $\angle$BCA = 45°



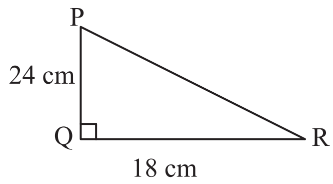
$\therefore$ AB = $\frac{1}{\sqrt{2}}$ AC …[Theorem of 45°– 45°– 90° triangle]
= $\frac{1}{\sqrt{2}} \times 10\sqrt{2}$
$\therefore$ AB = 10 cm
$\therefore$ Perimeter of square = 4 (AB) = 4 × 10 = 40 cm

vi. In ΔABC,
BD^2 = AD × DC …[Theorem of geometric mean]



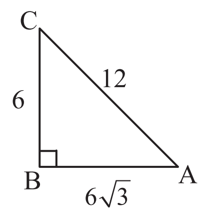
$\therefore$ BD^2 = 4 × 9
$\therefore$ BD = $\sqrt{36}$
= 6 cm

vii. In ΔPQR, $\angle$Q = 90°
$\therefore$ $PR^2 = PQ^2 + QR^2$ …[Pythagoras theorem]
$= 24^2 + 18^2$
= 576 + 324
= 900



$\therefore$ PR = $\sqrt{900}$
= 30 cm

viii. We know that, 6 = $\frac{1}{2}$(12) and
$6\sqrt{3} = \frac{\sqrt{3}}{2}(12)$



$\therefore$ BC = $\frac{1}{2}$ AC and AB = $\frac{\sqrt{3}}{2}$ AC
$\therefore$ $\angle$A = 30°
…[Converse of 30° – 60° – 90° theorem]

2. Solve the following examples.
[2 Marks each]

i. Find the height of an equilateral triangle having side 2a.

ii. Do sides 7 cm, 24 cm, 25 cm form a right angled triangle? Give reason. **[July 2017]**

iii. Find the length of a diagonal of a rectangle having sides 11 cm and 60 cm. **[July 2022]**

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

v. A side of an isosceles right angled triangle is *x*. Find its hypotenuse.

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

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To see complete chapter buy **Target Notes** or **Target E-Notes**

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

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

$\therefore$ $3364 = 2\,(841) + 2\,MR^2$

$\therefore$ $1682 = 841 + MR^2$ …[Dividing both sides by 2]

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

$\therefore$ $MR^2 = 841$

$\therefore$ $MR = \sqrt{841}$ …[Taking square root of both sides]

$= 29$ units

Now, QR = 2 MR …[M is the midpoint of QR]

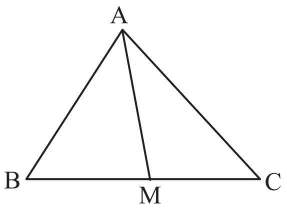
$= 2 \times 29$

$\therefore$ **QR = 58 units**

18. Seg AM is a median of ΔABC. If AB = 22, AC = 34, BC = 24, find AM.

[2 Marks]

***Solution*:**



In ΔABC, seg AM is the median. …[Given]

$\therefore$ M is the midpoint of side BC.

$\therefore$ $MC = \frac{1}{2}\ BC$

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

$= 12$ units

Now, $AB^2 + AC^2 = 2\,AM^2 + 2\,MC^2$

…[Apollonius theorem]

$\therefore$ $22^2 + 34^2 = 2\,AM^2 + 2\,(12)^2$

$\therefore$ $484 + 1156 = 2\,AM^2 + 2\,(144)$

$\therefore$ $1640 = 2\,AM^2 + 2\,(144)$

$\therefore$ $820 = AM^2 + 144$ …[Dividing both sides by 2]

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

$\therefore$ $AM^2 = 676$

$\therefore$ $AM = \sqrt{676}$

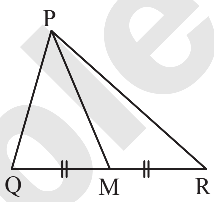
…[Taking square root of both sides]

$\therefore$ **AM = 26 units**

Activities for Practice

1. In ΔPQR, point M is the midpoint of side QR. If $PQ^2 + PR^2 = 362$ cm, PM = 9 cm, find QR.

[2 Marks]



In ΔPQR, point M is the midpoint of side QR.

…[Given]

$\therefore$ ☐ $+ PR^2 =$ ☐ $+ 2\,MR^2$

…[Apollonius theorem]

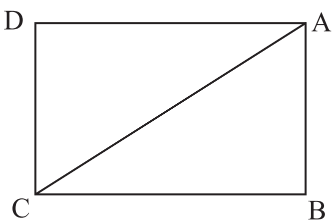
$\therefore$ $362 = 2\,(9)^2 + 2\,MR^2$

$\therefore$ MR = ☐

Now, QR = 2 MR …[M is the midpoint of QR]

$\therefore$ QR = ☐

2. In the given figure, ☐ABCD is a rectangle. If AB = 5, AC = 13, then complete the following activity to find BC.



[Mar 2022][2 Marks]

Activity:

ΔABC is ☐ triangle.

$\therefore$ By Pythagoras theorem,

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

$\therefore$ $25 + BC^2 =$ ☐

$\therefore$ $BC^2 =$ ☐

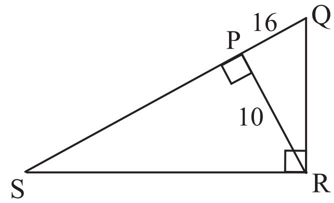
$\therefore$ BC = ☐

3. In the given figure, ∠QRS = 90°, RP ⊥ SQ. If PQ = 16, RP = 10, find

i. SP

ii. RQ and

iii. SR



[3 Marks]

i. In ΔQSR, ∠QRS = 90°

and RP ⊥ SQ …[Given]

$\therefore$ $RP^2 =$ ☐ $\times$ SP

…[Theorem of geometric mean]

$\therefore$ SP = ☐

ii. In ΔRPQ, $\angle RPQ = 90°$

$\therefore$ $RQ^2 = RP^2 + PQ^2$ …[$\square$]

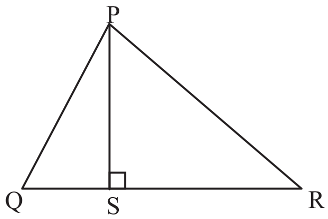
$\therefore$ $RQ =$ $\square$

iii. In ΔSPR, $\angle SPR = 90°$

$\therefore$ $SR^2 =$ $\square$ …[Pythagoras theorem]

$\therefore$ $SR =$ $\square$

4.



In ΔPQR, seg $PS \perp$ side QR, then complete the activity to prove $PQ^2 + RS^2 = PR^2 + QS^2$.

[Nov 2020] [3 Marks]

In ΔPSQ, $\angle PSQ = 90°$

$\therefore$ $PS^2 + QS^2 = PQ^2$ …[Pythagoras theorem]

$\therefore$ $PS^2 = PQ^2 -$ $\square$ …(i)

Similarly,

In ΔPSR, $\angle PSR = 90°$

$\therefore$ $PS^2 +$ $\square$ $= PR^2$ …[Pythagoras theorem]

$\therefore$ $PS^2 = PR^2 -$ $\square$ …(ii)

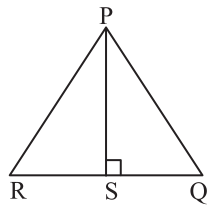
$\therefore$ $PQ^2 -$ $\square$ $=$ $\square$ $- RS^2$ …[From (i) and (ii)]

$\therefore$ $PQ^2 +$ $\square$ $= PR^2 + QS^2$

5. In ΔPQR, seg $PS \perp$ seg QR and $SQ = 3RS$.

Prove that : $2PQ^2 = 2PR^2 + QR^2$ **[3 Marks]**

***Proof*:**



In ΔPSR, $\angle PSR = 90°$ …[Given]

$\therefore$ $PR^2 = PS^2 + RS^2$ …[Pythagoras theorem]

$\therefore$ $PS^2 = PR^2 - RS^2$ …(i)

Also, in ΔPSQ, $\angle PSQ = 90°$ …[Given]

$\therefore$ $PQ^2 = PS^2 +$ $\square$ …[$\square$]

$\therefore$ $PQ^2 = PS^2 + (3RS)^2$

$\therefore$ $PQ^2 = PS^2 + 9RS^2$

$\therefore$ $PQ^2 =$ $\square$ $- RS^2 + 9RS^2$ …[From (i)]

$\therefore$ $PQ^2 = PR^2 + 8RS^2$ …(ii)

But, $QR = QS + RS$ …[Q – S – R]

$\therefore$ $QR = 3RS + RS$ …[Given]

$\therefore$ $QR = 4RS$

$\therefore$ $RS =$ $\square$ QR …(iii)

$\therefore$ $PQ^2 = PR^2 + 8\left(\frac{1}{4}QR\right)^2$ …[From (ii) and (iii)]

$\therefore$ $PQ^2 = PR^2 + 8 \times \frac{QR^2}{16}$

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

$\therefore$ $2PQ^2 = 2PR^2 + QR^2$ …[$\square$]

One Mark Questions

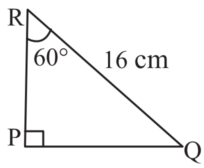
Type A: Multiple Choice Questions

1. Out of the following which is a Pythagorean triplet? **[Mar 2019]**
   (A) (5, 12, 14) (B) (3, 4, 2)
   (C) (8, 15, 17) (D) (5, 5, 2)

2. Which of the following triplets will not form a right angled triangle?
   (A) 50, 30, 40
   (B) 15, 20, 25
   (C) 20, 29, 21
   (D) 12, 16, 11

3. If in ΔABC, AB = 15 cm, BC = 17 cm and AC = 8 cm, then which of the following will be a right angle?
   (A) $\angle A$ (B) $\angle B$
   (C) $\angle C$ (D) none of these

4. From the figure given below, the lengths of PQ and PR are ________ and ________ respectively.
   (A) 8 cm, $8\sqrt{2}$ cm
   (B) $8\sqrt{2}$ cm, 8 cm
   (C) 8 cm, $8\sqrt{3}$ cm
   (D) $8\sqrt{3}$ cm, 8 cm



5. The length of the longest segment which can be drawn in a rectangle of length 84 cm and breadth 13 cm is ________.
   (A) 84 cm (B) 85 cm
   (C) 86 cm (D) 97 cm

6. If the diagonal of a square is $25\sqrt{2}$ cm, then the length of its side is ________.
   (A) 50 cm (B) 25 cm
   (C) 5 cm (D) $5\sqrt{2}$ cm

7. If the length of the hypotenuse of an isosceles right angled triangle is 10 cm, then the length of the equal sides will be ________.
   (A) 10 cm (B) $10\sqrt{2}$ cm
   (C) 5 cm (D) $5\sqrt{2}$ cm

8. If the lengths of the diagonals of a rhombus are 12 cm and 16 cm, then what is the length of its side?
   (A) 10 cm (B) 20 cm
   (C) $10\sqrt{2}$ cm (D) $20\sqrt{2}$ cm

9. The diagonal of a square of side 8 cm is
   (A) 8 cm (B) $4\sqrt{2}$ cm
   (C) $8\sqrt{2}$ cm (D) $8\sqrt{3}$ cm

10. In an isosceles triangle ABC, if AC = BC and $AB^2 = 2AC^2$, then ∠ACB =
   (A) 30° (B) 45°
   (C) 60° (D) 90°

11. ABC is an isosceles triangle in which ∠ACB = 90°. If AC = 2 cm, then the value of AB is
   (A) $\sqrt{2}$ cm (B) $2\sqrt{2}$ cm
   (C) $3\sqrt{2}$ cm (D) $4\sqrt{2}$ cm

12. In an equilateral triangle ABC, if AD ⊥ BC, B–D–C and AB = 12 cm, then the value of AD is
   (A) 6 cm (B) $6\sqrt{3}$ cm
   (C) 4 cm (D) $4\sqrt{3}$ cm

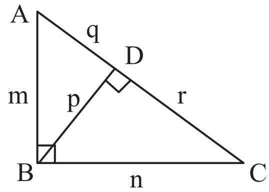
13. A man goes 9 m due east and then 40 m due north. How far is he from the starting point?
   (A) 35 m (B) 39 m
   (C) 41 m (D) 45 m

14. A ladder 25 m long reaches a window of a building 20 m above the ground. The distance of foot of the ladder from the building is
   (A) 10 m (B) 12 m
   (C) 15 m (D) 18 m

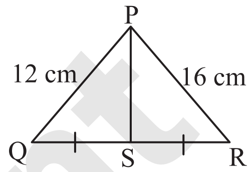
15. In ΔPQR, ∠PQR = 90° and seg QS ⊥ hypotenuse PR, P–S–R, then
   (A) $PR^2 = PQ \times PR$
   (B) $QS^2 = PS \times SR$
   (C) $PR^2 = PS \times SR$
   (D) $QS^2 = PQ \times QR$

16. In ΔABC, ∠B = 90°, BD ⊥ AC, A–D–C. If CD = 2 cm and AD = 8 cm, then BD is equal to
   (A) 2 cm (B) 4 cm
   (C) 6 cm (D) 8 cm

17. For the figure given below, which of the following relations is correct?
   (A) $p^2 = qr$
   (B) $m^2 + n^2 = q^2 + r^2$
   (C) $p^2 = q^2 + r^2$
   (D) $p^2 = mn$



18. In ΔPQR, PS is the median. If PQ = 12 cm, PR = 16 cm, PS = 10 cm, then QR = ________.



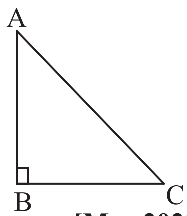
   (A) 10 cm (B) $10\sqrt{2}$ cm
   (C) 20 cm (D) $20\sqrt{2}$ cm

19. In ΔABC, seg CD is the median.
   If $AC^2 + BC^2 = 416$ and CD = 12, then AD =
   (A) 6 (B) 7
   (C) 8 (D) 9

Type B: Solve the Following Questions

1. Find the diagonal of a square whose side is 10 cm. **[Mar 2015, 2020]**

2. In Δ ABC, ∠ABC = 90°, ∠BAC = ∠BCA = 45°. If AC = $9\sqrt{2}$, then find the value of AB.



[Mar 2022]

3. In a right angled triangle, if sum of the squares of the sides making right angle is 289, then what is the length of the hypotenuse?

4. If the lengths of the diagonals of a rhombus are 6 cm and 8 cm, then what is the length of its side?

5. If the sides of a triangle are 12 cm, 35 cm and 37 cm respectively, determine whether the triangle is right angle triangle or not.

6. Is (10, 10, 20) the Pythagorean triplet?

7. A man goes 30 m due east and then 40 m due north. How far is he from the starting point?

8. In an isosceles triangle PQR, if PR = QR and $PQ^2 = 2\ PR^2$, then ∠PRQ = ?

9. A ladder 29 m long reaches a window of a building 21 m above the ground then what is the distance of foot of the ladder from the building?

10. Find the side of a square whose diagonal is $35\sqrt{2}$ cm.

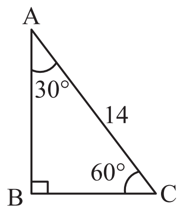
Additional Problems for Practice

Based on Practice Set 2.1

1. Identify the Pythagorean triplets from the following: **[1 Mark each]**

i.	(15, 10, 35)	ii.	(28, 45, 53)
iii.	(10, 10, 20)	iv.	(16, 63, 65)
v.	(20, 21, 29)	vi.	(9, 20, 21)

+2. See the given figure. In ΔABC, $\angle B = 90°$, $\angle A = 30°$, AC = 14, then find
i. AB and
ii. BC **[July 2022]**

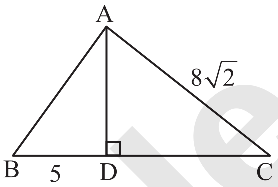


[2 Marks]

3. In ΔPQR, $\angle P = 30°$, $\angle Q = 60°$, $\angle R = 90°$ and PQ = 12 cm, then find PR and QR. **[July 2017] [2 Marks]**

4. In ΔPQR, $\angle P = 60°$, $\angle Q = 90°$ and QR = $6\sqrt{3}$ cm, then find the values of PR and PQ. **[Nov 2020] [2 Marks]**

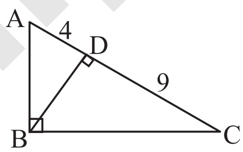
+5. See the given figure, In ΔABC, seg AD $\perp$ seg BC, $\angle C = 45°$, BD = 5 and AC = $8\sqrt{2}$, then find AD and BC.



[2 Marks]

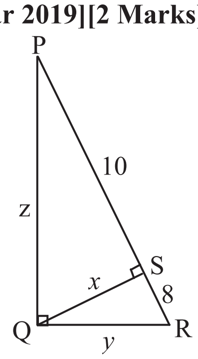
6. Find the length of the altitude of an equilateral triangle with side 6 cm. **[Mar 2017, 2018] [2 Marks]**

7. In right-angled ΔABC, BD $\perp$ AC. If AD = 4, DC = 9, then find BD.



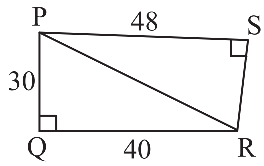
[Mar 2019][2 Marks]

+8. See the given figure. In ΔPQR, $\angle PQR = 90°$, seg QS $\perp$ seg PR, then find x, y, z. **[3 Marks]**



+9. In the right angled triangle, sides making right angle are 9 cm and 12 cm. Find the length of the hypotenuse. **[2 Marks]**

10. In the adjoining figure, if $\angle PQR = 90°$, and $\angle PSR = 90°$, then find PR and RS. **[2 Marks]**



11. Find the diagonal of a square whose side is 14 cm. **[1 Mark]**

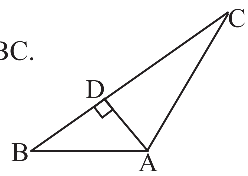
12. Find the side of a square whose diagonal is $16\sqrt{2}$ cm long. **[Mar 2012; July 2017] [1 Mark]**

+13. In ΔLMN, l = 5, m = 13, n = 12. State whether ΔLMN is a right angled triangle or not. **[2 Marks]**

14. In ΔABC, AB = 9 cm, BC = 40 cm, AC = 41 cm. State whether ΔABC is a right-angled triangle or not? Write reason. **[Mar 2022] [2 Marks]**

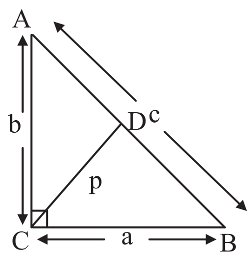
15. A ladder 10 m long reaches a window 8 m above the ground. Find the distance of the foot of the ladder from the base of the wall. **[Mar 2013] [2 Marks]**

+16. See the given figure. In ΔABC, seg AD $\perp$ seg BC. Prove that: $AB^2 + CD^2 = BD^2 + AC^2$



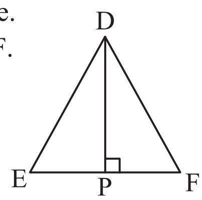
[2 Marks]

17. In ΔABC, $\angle C = 90°$. If BC = a, CA = b, AB = c and the length of the altitude from vertex C on side AB is p, then show that
i. cp = ab
ii. $\frac{1}{p^2} = \frac{1}{a^2} + \frac{1}{b^2}$



[Mar 2014] [4 Marks]

18. ΔDEF is an equilateral triangle. seg DP $\perp$ side EF, and E–P–F. Prove that: $DP^2 = 3\ EP^2$



[Oct 2008] [4 Marks]

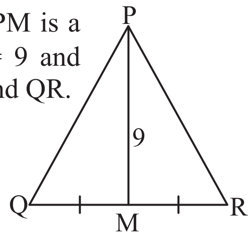
19. Prove that three times the square of any side of an equilateral triangle is equal to four times the square of an altitude. **[4 Marks]**

20. In an isosceles triangle PQR, PQ = PR and S is any point on side QR. Then prove that:
$PQ^2 - PS^2 = QS \times SR$. **[3 Marks]**

21. If a and b are natural numbers and a > b. If $(a^2 + b^2)$, $(a^2 - b^2)$ and 2ab are the sides of the triangle, then prove that the triangle is right angled.
Find out two Pythagorean triplets by taking suitable values of a and b.
[Mar 2022][3 Marks]

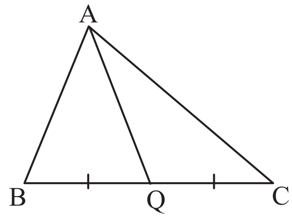
Based on Practice Set 2.2

+1. In the given figure, seg PM is a median of ΔPQR. PM = 9 and $PQ^2 + PR^2 = 290$, then find QR.



[2 Marks]

2. In the figure below, if $AB^2 + AC^2 = 122$, BC = 10, then find the length of median drawn to side BC.



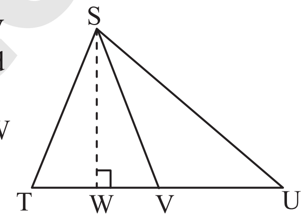
[Oct 2012; July 2015] [2 Marks]

3. In ΔABC, ∠ABC = 90°, AB = 12, BC = 16 and seg BP is a median. Find BP. **[2 Marks]**

4. Adjacent sides of a parallelogram are 11 cm and 17 cm. If one of its diagonal is 26 cm, then find length of its other diagonal.
[Mar 2016] [3 Marks]

+5. Prove that the sum of the squares of the diagonals of a rhombus is equal to the sum of the squares of the sides. **[4 Marks]**

6. In the given figure, SV is the median and SW ⊥ TU. Prove that, $SU^2 - ST^2 = 2TU \times VW$



[4 Marks]

Chapter Assessment

Total Marks: 25

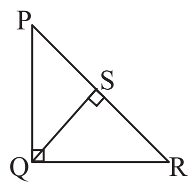
Q.1. A. Choose the correct alternative. **[4]**

i. Which of the following triplets will not form a right angled triangle?
(A) (5, 12, 13) (B) (8, 15, 17) (C) (20, 10, 11) (D) (9, 40, 41)

ii. In ΔPQR, ∠Q = 30°, ∠R = 90° and the length of the hypotenuse is 20 cm. What will be length of QR?
(A) 10 cm (B) $10\sqrt{3}$ cm (C) $10\sqrt{2}$ cm (D) $5\sqrt{2}$ cm

iii. If the length of the diagonal of a square is 16 cm, then its perimeter will be
(A) 32 cm (B) $32\sqrt{2}$ cm (C) 64 cm (D) $64\sqrt{2}$ cm

iv. In ΔPQR, ∠Q = 90° and QS ⊥ PR. If PS = 32 cm, SR = 8 cm, then QS =
(A) 8 cm
(B) $2\sqrt{10}$ cm
(C) 16 cm
(D) 40 cm



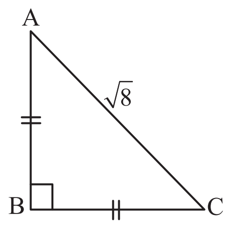
Q.1. B. Solve the following questions. **[2]**

i. Find the diagonal of a rectangle having length and breadth 8 cm and 6 cm respectively.

ii. Is (7, 40, 42) the Pythagorean triplet?

Q.2. A. Complete the following activities. (Any one) **[2]**

i. For finding AB and BC with the help of information given in the adjoining figure, complete the following activity.



Solution:

AB = BC ...[Given]

∴ ∠BAC = ∠BCA ...[Isosceles triangle theorem]

∴ ∠BAC = ☐

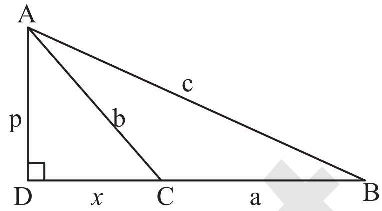
∴ AB = BC = $\square$ × AC ...[Side opposite to 45°]

= $\square \times \sqrt{8}$

∴ AB = BC = $\square$

ii. In ΔABC, ∠ACB is an obtuse angle, seg AD ⊥ seg BC.
Prove that: $AB^2 = BC^2 + AC^2 + 2\,BC \times CD$.

Complete the proof by filling the blanks.



Proof:

BD = BC + DC ...[B–C–D]

∴ BD = a + x

In ΔADB, ∠D = 90°

∴ $c^2 = (a + x)^2 + \square$ ...[Pythagoras theorem]

∴ $c^2 = a^2 + 2ax + x^2 + \square$ ...(i)

Also, in ΔADC, ∠D = 90°

∴ $b^2 = \square + p^2$ ...[Pythagoras theorem]

∴ $p^2 = b^2 - \square$ ...(ii)

∴ $c^2 = a^2 + 2ax + x^2 + b^2 - x^2$ ...[Substituting (ii) in (i)]

∴ $c^2 = a^2 + b^2 + 2ax$

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

Q.2. B. Solve the following questions. (Any two) **[4]**

i. A 50 m long ladder reaches a window 14 m above the ground. Find the distance of the foot of the ladder from the base of the wall.

ii. In ΔABC, seg AP is a median. If BC = 18, $AB^2 + AC^2 = 260$, find AP.

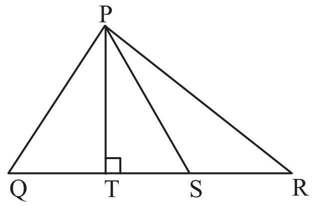
iii. Find the height of an equilateral triangle having side 12 cm.

Q.3. A. Complete the following activities. (Any one) **[3]**

i. In the given figure, seg PS is the median of ΔPQR and PT ⊥ QR. Prove that,

a. $PR^2 = PS^2 + QR \times ST + \left(\frac{QR}{2}\right)^2$

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



Proof:

a. seg PS is the median of ΔPQR.

∴ S is the midpoint of side QR.

∴ QS = $\square$ = $\frac{1}{2}$QR ...(i)

In ΔPSR, ∠PSR is an obtuse angle and PT ⊥ QR

∴ $PR^2 = SR^2 + PS^2 + 2SR \times ST$ ...[$\square$]

$PR^2 = \square + PS^2 + 2\left(\frac{1}{2}QR\right) \times ST$ ...[From (i)]

$PR^2 = \left(\frac{QR}{2}\right)^2 + PS^2 + \square \times ST$

∴ $PR^2 = PS^2 + QR \times ST + \left(\frac{QR}{2}\right)^2$

b. In ΔPQS, ∠PSQ is an acute angle and PT ⊥ QR

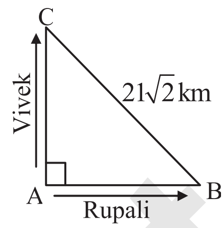
∴ $PQ^2 = QS^2 + PS^2 - 2QS \times ST$ ...[Application of Pythagoras theorem]

∴ $PQ^2 = \left(\frac{1}{2}QR\right)^2 + PS^2 - 2\,\square \times ST$ ...[From (i)]

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

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

ii. Rupali and Vivek started walking to the East and to the North respectively, from the same point and at the same speed. After 3 hours distance between them was $21\sqrt{2}$ km. Find their speed per hour.



Suppose Rupali and Vivek started Vivek walking from point A, and reached points B and C respectively after 3 hours.

Distance between them = BC = $\boxed{}$ km

since, their speed is same, both travel the same distance in the given time.

∴ AB = AC

Let AB = AC = x km …(i)

Now, In ΔABC, ∠A = $\boxed{}$

∴ $BC^2 = AB^2 + AC^2$ …[Pythagoras theorem]

∴ $(21\sqrt{2})^2 = x^2 + x^2$ …[From (i)]

∴ $\boxed{} \times 2 = 2x^2$

∴ $x^2 = 441$

∴ $x = \sqrt{441}$ …[Taking square root of both sides]

∴ $x = \boxed{}$

∴ AB = AC = 21 km

Now, speed = $\frac{\text{distance}}{\text{time}} = \boxed{}$

∴ The speed of Rupali and Vivek is $\boxed{}$

Q.3. B. Solve the following questions. (Any One) **[3]**

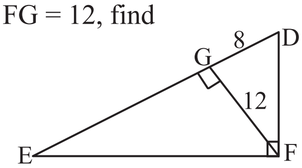
i. ΔABC is an equilateral triangle. Point P is on base BC such that PC = $\frac{1}{3}$ BC, if AB = 6 cm find AP.

ii. In the adjoining figure, ∠DFE = 90°, FG ⊥ ED. If GD = 8, FG = 12, find

a. EG

b. FD, and

c. EF



Q.4. Solve the following questions. (Any one) **[4]**

i. The length of one side of a parallelogram is 17 cm. If the length of its diagonals are 12 cm and 26 cm, then find the length of the other side of the parallelogram.

ii. ABC is a triangle in which AB = AC and D is a point on BC. Prove that $AB^2 - AD^2 = BD.CD$.

Q.5. Solve the following question. (Any one) **[3]**

i. If a and b are natural numbers and a > b, then show that $(a^2 + b^2)$, $(a^2 - b^2)$, (2ab) is a Pythagorean triplet. Find two Pythagorean triplets using any convenient values of a and b.

ii. In an isosceles triangle, length of the congruent side is 13 cm and its base is 10 cm. Find the distance between the vertex opposite to the base and the centroid.

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