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# Springboard mathematics course 3 teacher edition

1. Mathematics Learner's Material 9 Module 7: Triangle Trigonometry This instructional material was collaboratively developed and reviewed by educators from public and private schools, colleges, and/or universities. We encourage teachers and other education stakeholders to email their feedback, comments, and recommendations to the Department of Education at action@depd.gov.ph. We value your feedback and recommendations. Department of Education Republic of the Philippines 2. Math axis G a Learner's Material First Edition, 2014 ISBN: 978-971-9601-71-5 Republic Act 8293, section 176 states that: No copyright shall subsist in any work of the Government of the Philippines. However, prior approval of the government agency or office wherein the work is created shall be necessary for exploitation of such work for profit. Such agency or office may, among other things, impose as a condition the payment of royalties. Borrowed materials (i.e., songs, stories, poems, pictures, photos, brand names, trade-marks, etc.) included in this book are owned by their respective copyright holders. DepEd is represented by the Filipinas Copyright Licensing Society (FILCOLS), Inc. in seeking permission to use these materials from their respective copyright owners. The publisher and authors do not represent nor claim ownership over them. Published by the Department of Education Secretary: Br. Armin A. Luistro FSC Undersecretary: Dina S. Gonzaga, PhD Development eam of the Learner's Material Authors: Mercedes L. Bryson, Leonides E. Bulalaya, Melvin M. Callanta, Jerry D. Cruz, Richard F. De Vera, Gilda T. Garcia, Sonia E. Javier, Roselle A. Lazaro, Bernadeth J. Mesterio, and Rommel Hero A. Saladino Consultants: Rosemarie-Villena-David, PhD, Jan Isaac L. Garces, PhD, Alex C. Ocampo, PhD, and Soledad A. Ulep, PhD Editor: Debbie Marie B. Versoza, PhD Reviewers: Alma D. Angeles, Elvin S. Garcia, Guilver Eduardo L. Van Zandt, Arlene A. Pascua, PhD, and Debbie Marie B. Versoza, PhD Book Designer: Leonardo C. Rosete, Visual Communication Department, UP College of Fine Arts Management Team: Dir. Jocelyn D.R. Andaya, Jose D. Tuguinay Jr., Elizabeth G. Catao, Maribel S. Perez, and Nicamor M. San Gabriel Jr.; Printed in the Philippines by Vibal Group, nc. Department of Education-Instructional Materials Council Secretariat (DepEd-IMCS) Office Address: 5th Floor Mabini Building, DepEd Complex, Meralco Avenue, Pasig City, Philippines 1600 Telephone: 021 634-1034 / 634-1072 Fax: 021 634-1072 Email Address: imcs@deped.gov.ph 3. Table of Contents Module 7: Triangle trigonometry ..... 423 Module Map ..... 423
Secant, Cosecant, and Cotangent ..... 430 Lesson 2. Trigonometric Ratios of Special Angles ..... 447 Lesson 3. Angles of Elevation and Angles of Depression ..... 457 Lesson 4. Word Problems Involving Right Triangles ..... 467 Lesson 5. Oblique Triangles ..... 477 Lesson 5.1. The Law of Sines and Its Applications ..... 480 Lesson 5.2. The Law of Cosines and Its Applications ..... 497 Glossary of Terms ..... 506 References and Websites Links Used in this Module ..... 507 4. MODULE 7 TRIANGLE TRIGONOMETRY I. INTRODUCTION AND FOCUS QUESTIONS Have you ever wondered how towers and buildings were constructed? How do you determine the distance traveled as well as the height of an airplane as it takes off? What about determining the height of the mountain? We can do all these things even if we are not in the real place or sit-upon. These are just some of many real-world applications of triangle trigonometry. www.olx.com.ph www.nww2m.com This module will help you understand how to use the concepts on triangle trigonometry in solving different problems involving right triangles. I. LESSONS AND ENRICHMENT In this module, you will find answers to questions above by studying the following lessons: Lesson 1 • The Six Trigonometric Ratios: sine, cosine, tangent, secant, cosecant, and cotangent Lesson 2 • The Trigonometric Ratios of Special Angles Lesson 3 • Angles of Elevation and Angles of Depression Lesson 4 • Application: The Use of Trigonometry in Solving Real-Life Problems Involving Right Triangles Lesson 5 • Oblique Triangles 5.1 • Law of sines and its applications 5.2 • Law of cosines and its applications 5.3 • 4.26 In these lessons you are able to: Lesson 1 • Illustrate the six trigonometric ratios; • apply trigonometric ratios to solve right triangles given: a. the length of the hypotenuse and the length of one leg b. the length of the hypotenuse and one of the acute angles c. the length of one leg and one of the acute angles d. the length of both sides Lesson 2 • determine trigonometric ratios involving special angles; • compute the numerical values of trigonometric expressions involving special angles; Lesson 3 • illustrate angles of elevation and angles of depression; • distinguish between angle of elevation and angle of depression; • solve problems involving angles of elevation and depression; Lesson 4 • use the trigonometric ratios in solving real-life problems involving right triangles Lesson 5 • illustrate the laws of sines and cosines • solve problems involving oblique triangles Module Map 6. III. PRE-ASSESSMENT Let us find out how much you already know about this module. Answer the following questions as much as you can by writing on your answer sheet the letter that you think is the correct answer. Take note of the items that you are not able to answer correctly and then let us find out the correct answer as we go through this module. 1. With respect to the given angle, what is the ratio of the hypotenuse to the opposite side? a. sine b. cosine c. tangent d. cosecant 2. Which of the following statements is correct? 427 A. $x = 8$ , $c = \sin 60^\circ = y/4$ , $b = \tan 30^\circ = 1/x$ , $d = \cos 60^\circ = y/4$ , $y = 60^\circ$ y 4 3. Given the figure on the right, which refers to the angle of depression? A. $\angle MKN$ B. $\angle LKN$ C. $\angle MKL$ D. none of these 4. In the triangle PQR, what is the length of PQ? A. 1 cm B. 9 cm C. 5 cm D. 12 cm eye K 5. In the triangle DEF, what is m $\angle E$ to the nearest degree? A. 16 $^\circ$ B. 41 $^\circ$ C. 28 $^\circ$ D. 62 $^\circ$ 17. In the figure, $\angle P = 43^\circ$ , $\angle Q = 33^\circ$ , $\angle R = 20^\circ$ , $\angle A = 33^\circ$ , $\angle B = 32^\circ$ , $\angle C = 62^\circ$ . The expression $\sin 30^\circ = \tan 45^\circ$ is equal to 0. R. 1. C. 2. D. -1. 10. A kite held by 125 m of string makes an angle of elevation with the ground of 45°. About how high is the kite above the ground? A. 62.8 m B. 88.4 m B. 75.1 m D. 116 m 11. From the top of a barn 16.2 m high, you see a cat on the ground. The angle of depression of the cat is 30°. How many meters must the cat walk to reach the barn? A. 9.08 m B. 9.81 m B. 9.80 m D. 9.18m 12. ABCD is a parallelogram. If AB is 8 cm long, BC is 5 cm and their included angle measures 100°, how long is diagonal AC? A. 12.95 cm C. 10.40 cm B. 12.59 cm D. 14.14 cm 13. In right triangle PQR, PQ = 12 cm and QR = 5 cm. What is $\cos R$ ? A. 12/13 B. 5/13 C. 5/12 D. 12/5 45 $^\circ$ 45 $^\circ$ 40 $^\circ$ c 15 b P p r 8. 14. XYZ is a non - right triangle. If XY measures 20 cm, XZ measures 15 cm and $\angle X$ measures 35° then what is the measure of $\angle Y$ ? A. 25.84 $^\circ$ B. 24.85 $^\circ$ C. 25.48 D. 24.58 $^\circ$ 15. A balloon is 50 m high. Its angle of elevation from observer A is 40° and from observer B it is 30°. What is the maximum distance between the two observers? Express your answer to the nearest meter. A. 136 m B. 137 m C. 138 m D. 39 m 16. With the sun, a girl 1.4 m tall casts a 3.6 m shadow. Find the angle of elevation from the tip of the shadow to the sun. Express your answer to the nearest degree. A. 19 $^\circ$ B. 20 $^\circ$ C. 21 $^\circ$ D. 22 $^\circ$ 17. You are walking along a straight level path toward a mountain. At one point the angle of elevation of the top of the mountain is 40°. As you walk 250 m closer, the angle of elevation is 45°. How high is the mountain? Express your answer to the nearest tenth of a meter. A. 1304 m B. 1340 m C. 1034 m D. 1043 m 18. Two points P and Q on the same side of a river are 12 m apart. A tree on the opposite side of the river is directly opposite a point between P and Q. The lines of sight of a tree across the river make angles of 78° and 57°, respectively, with the line joining P and Q. Find the distance from point Q to the tree. Express your answer to the nearest meter. A. 14 m B. 15 m C. 16 m D. 17 m 19. A surveyor sights two signs and the angle between the two lines of sight is 100°. The distance between the signs is 100 m. The angle of depression of the nearer sign from the eye of the surveyor is 30°. How far is the nearer sign from the eye of the surveyor? Express your answer to the nearest meter. A. 124 m B. 125 m C. 126 m D. 127 m IV. LEARNING GOALS The learner demonstrates understanding of the basic concepts of trigonometry and is able to apply the concepts of trigonometric ratios to formulate and solve real-life problems with precision 429 and accuracy. 9. The Six Trigonometric Ratios: Sine, Cosine, Tangent, Secant, Cosecant, and Cotangent 430 What to Know Lesson 1 will help you recall the different concepts about triangles. This will guide you to define and illustrate the six trigonometric ratios. ► Activity 1: Triangles of Different Sizes This activity helps you recall the concepts of similar triangles. Investigate the following triangles: 1. Draw three similar right triangles ABC, DEF, and GHI in different sizes in such a way that $m \angle C = m \angle F = m \angle I = 63^\circ$ . 2. Measure the second acute angle in each of the triangles. 3. Use a ruler to measure the sides of the triangles to the nearest tenths in centimeters. Then find each of the following ratios for all the three triangles: a. the ratio of the leg opposite the 63° angle to the hypotenuse b. the ratio of the leg adjacent to the 63° angle to the hypotenuse Record your findings in the given table Measures in AABC in ADEF in AGHI leg opposite the 63° angle leg adjacent to the 63° angle hypotenuse leg opposite 63° angle hypotenuse leg adjacent to 63° angle hypotenuse leg adjacent to 63° angle hypotenuse 10. 3. Using a scientific calculator, determine the value of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 11. 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Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 62. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 63. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 64. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 65. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 66. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 67. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 68. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 69. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 70. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 71. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 72. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 73. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 74. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 75. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 76. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 77. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 78. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 79. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 80. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 81. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 82. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 83. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 84. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 85. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the approximate value of sine of 63°. The ratio _____ is the approximate value of cosine of 63°. The ratio _____ is the approximate value of tangent of 63°. 86. Using a scientific calculator, determine the values of $\sin 63^\circ$ , $\cos 63^\circ$ , and $\tan 63^\circ$ then compare them to the values obtained in step 4. What do you observe? 431 6. Complete each statement: The ratio _____ is the





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