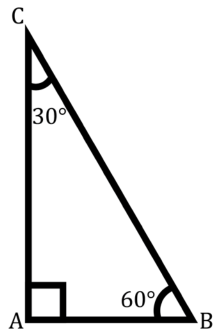
1. In the $30° - 60° - 90°$ right triangle below, $AB = 10$ cm. What is the length, in centimeters, of $\overline{BC}$?



A. 20

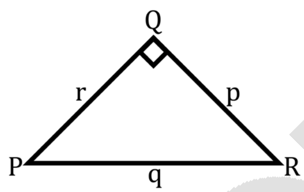
B. $10\sqrt{3}$

C. 10

D. $\frac{10\sqrt{3}}{3}$

E. 5

2. For right triangle $\triangle PQR$ shown below, what is $\cos(P)$?



A. $\frac{p}{r}$

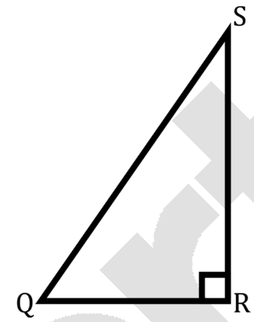
B. $\frac{p}{q}$

C. $\frac{q}{r}$

D. $\frac{r}{p}$

E. $\frac{r}{q}$

3. The hypotenuse of the right triangle $\triangle QRS$ shown below is 18 feet long. The cosine of $\angle Q$ is $\frac{2}{3}$. About how many feet long is $\overline{QR}$?



A. 9

B. 12

C. 13.4

D. 17.3

E. 27

4. A zipline is to be built so that a taut cable is at a $12°$ incline relative to the level ground. If the zipline's starting point is to be 11 meters above the ground at its starting point and end at ground-level, how far horizontally will the endpoint be from the starting point?

A. $11 \sin 12°$

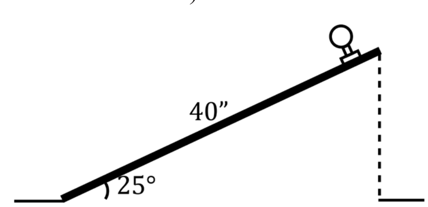
B. $11 \cos 12°$

C. $11 \tan 12°$

D. $\frac{11}{\tan 12°}$

E. $11 \cot 12°$

5. A door is propped open $25°$ with a bar as shown in the diagram below. If the door is 40 inches long, how long does the bar need to be?
(Note: $\sin 25° \approx 0.423$
$\cos 25° \approx 0.906$
$\tan 25° \approx 0.466$)



A. 17

B. 19

C. 36

D. 44

E. 95

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6. The sides of a right triangle measure 20 inches, 21 inches, and 29 inches. What is the cosine of the angle opposite the side that measures 20 inches?

A. $\frac{20}{29}$

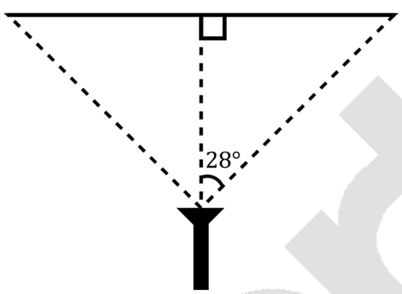
B. $\frac{29}{20}$

C. $\frac{21}{29}$

D. $\frac{29}{21}$

E. $\frac{21}{20}$

7. A flashlight emits a cone of light as shown below. If the flashlight is projecting a circle of light on the wall that is 80 cm in diameter, how far is the flashlight from the wall in centimeters?



A. $40\tan 20°$

B. $\frac{\tan 20°}{40}$

C. $\frac{40}{\tan 20°}$

D. $\frac{80}{\tan 20°}$

E. $80\tan 20°$

8. A right triangle has legs of length $49\sin\theta$ units and $49\cos\theta$ units for some angle θ that satisfies $0° \le \theta \le 90°$. What is the length, in units, of the longest side of the triangle?

A. θ

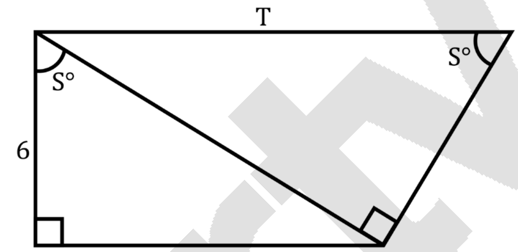
B. 1

C. 7

D. 49θ

E. 49

9. In the figure below, $\cos S = \frac{3}{5}$. What is the approximate value of T using the given information and the diagram below?



A. 10

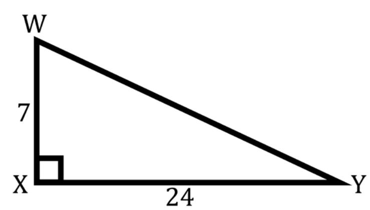
B. 13.5

C. 0.60

D. 12.5

E. 53.1

10. In the right triangle shown below, the length of $\overline{WX}$ is 7 feet and the length of $\overline{XY}$ is 24 feet. For $\angle Y$,the value of which of the following trignometric expressions is $\frac{7}{25}$?



A. $\cos Y$

B. $\sin Y$

C. $\tan Y$

D. $\sec Y$

E. $\csc Y$

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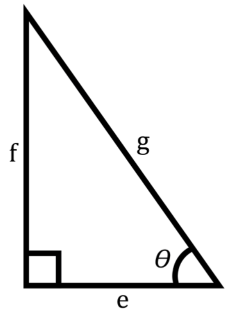
11. The dimensions of the right triangle shown below are given in meters. What is $\cos\theta$?



A. $\frac{e}{g}$

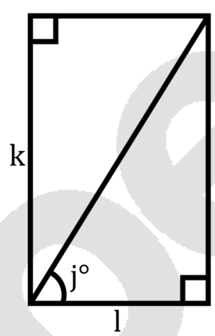
B. $\frac{f}{g}$

C. $\frac{g}{e}$

D. $\frac{g}{f}$

E. $\frac{f}{e}$

12. Which of the following trigonometric equations is valid for the measurements indicated below for the two sides and angle formed by a rectangle and its diagonal?



A. $\tan j° = \frac{l}{k}$

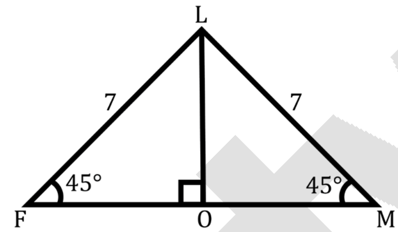
B. $\cos j° = \frac{k}{l}$

C. $\cos j° = \frac{l}{k}$

D. $\cot j° = \frac{k}{l}$

E. $\sec j° = \frac{l}{k}$

13. In right triangle $\triangle LMF$ below, distances are shown in yards. How many yards long is $\overline{LO}$?



A. $\frac{14\sqrt{2}}{2}$

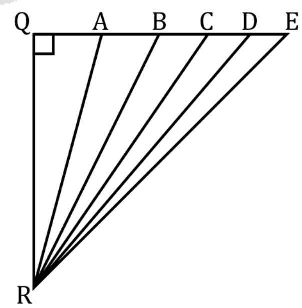
B. $14\sqrt{2}$

C. 7

D. $7\sqrt{2}$

E. $\frac{7\sqrt{2}}{2}$

14. In the figure below, A, B, C, and D are on $\overline{QE}$. Which of the following angles has the smallest cosine?



A. $\angle QRA$

B. $\angle QRB$

C. $\angle QRC$

D. $\angle QRD$

E. $\angle QRE$

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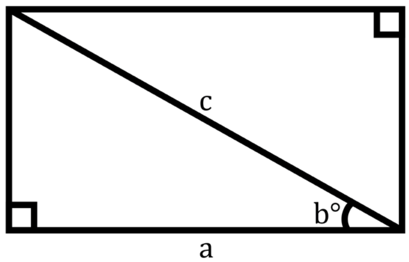
15. Which of the following trigonometric equations is valid for the side measurement a nanometers, diagonal measurement c nanometers, and angle measurement $b°$ in the rectangle shown below?



A. $\sin b° = \frac{a}{c}$

B. $\cos b° = \frac{a}{c}$

C. $\cos b° = \frac{c}{a}$

D. $\tan b° = \frac{a}{c}$

E. $\sec b° = \frac{a}{c}$

16. An angle in a right triangle has measure β. If $\cos\beta = \frac{5}{13}$ and $\tan\beta = \frac{12}{5}$, then $\sin\beta =$?

A. $\frac{12}{5}$

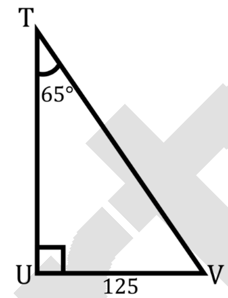
B. $\frac{12}{13}$

C. $\frac{13}{12}$

D. $\frac{12}{\sqrt{194}}$

E. $\frac{12}{\sqrt{313}}$

17. In right triangle $\triangle TUV$ below, $\overline{UV}$ is 125 yards long and $\angle T = 65°$. What is the measure of $\overline{TV}$?



A. $125\sin 65°$

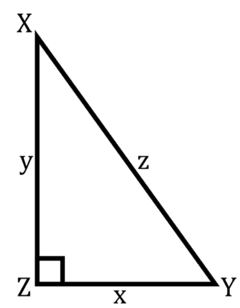
B. $\frac{125}{\sin 65°}$

C. $\frac{\sin 65°}{125}$

D. $125\cos 65°$

E. $\frac{125}{\cos 65°}$

18. For any right triangle as shown, $(\cos X)(\tan Y) =$? (All side lengths are given in meters, all angle measurements are given in degrees)



A. $\frac{y^2}{xz}$

B. $\frac{x^2}{yz}$

C. $\frac{x}{z}$

D. $\frac{y}{z}$

E. $\frac{z}{x}$

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19. An arbologist (a scientist who studies trees) comes across a tree that juts out of the ground at $12°$. When the sun is directly overhead, so that its rays are perpendicular to the ground, the tree's shadow is 8 meters long. If it can be determined, what is the length of the tree?

A. $\dfrac{8}{\cos 12°}$

B. $8\cos 12°$

C. $\dfrac{8}{\tan 12°}$

D. $8\tan 12°$

E. $\dfrac{8}{\sin 12°}$

20. In $\triangle HIJ$, $\angle J$ is a right angle and the measure of $\angle I$ is $63°$. Another triangle, $\triangle QRS$ is being constructed such that $\angle R$ is a right angle and the measure of $\angle S$ is one third the measure of $\angle I$. What is the measure of $\angle Q$?

A. 21
B. 22.5°
C. 45°
D. 69°
E. 159°

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ANSWER KEY

1. A **2. E** **3. B** **4. D** **5. A** **6. C** **7. C** **8. E** **9. D** **10. B** **11. A** **12. C** **13. E** **14. E**
15. B **16. B** **17. B** **18. A** **19. A** **20. D**

ANSWER EXPLANATIONS

1. **A.** Remember that the corresponding ratio of the sides of a $30°-60°-90°$ triangle is $1:\sqrt{3}:2$, respectively. Since 10 is opposite of $30°$, and the side we are looking for is opposite $90°$, the ratio of 10 to the side we're solving for is equal to $1:2$. $\frac{10}{n}=\frac{1}{2}$, where n is the side we are seeking. Simple algebra shows that $n=20$.

2. **E.** Remember that the cosine of an angle in a right triangle is equal to the adjacent side divided by the hypotenuse. The side adjacent to $\angle P$ is r, and the hypotenuse is q. Thus, $\cos(P)=\frac{r}{q}$.

3. **B.** The cosine is equal to the adjacent side divided by the hypotenuse. The cosine of $\angle Q=\frac{\overline{QR}}{18}=\frac{2}{3}$. Algebra shows that $\overline{QR}=12$.

4. **D.** We can sketch the triangle formed by the starting point, the ground below it, and the ending point. The zipline forms the hypotenuse, and the height of the starting point and the horizontal distance to the ending point form the two legs. The distance we are given is the height of the starting point, and we want to find the horizontal distance. The height of the starting point divided by the horizontal distance, d, will be equal to $\tan 12°$. Thus $\frac{11}{d}=\tan 12°$, so $d=\frac{11}{\tan 12°}$.

5. **A.** The relation between the length of the bar, b, and the length of the door is the relation between the side opposite the $25°$ angle and the hypotenuse. $\frac{b}{40}=\sin 25° \approx 0.423$. Thus, $b \approx 40(0.423)=16.92 \approx 17$.

6. **C.** The cosine of the angle opposite the side that measures 20 inches is the measure of the side adjacent the angle divided by the hypotenuse. We know that the hypotenuse must be the 29 because the hypotenuse is always the longest side of a right triangle. That leaves the adjacent side as 21. Thus, the cosine is $\frac{21}{29}$.

7. **C.** Recognize that the side of the right triangle opposite $20°$ is the radius of the circle, not the diameter. Thus, $\sin 20°=\frac{40}{d}$, where d is the distance from the wall, not $\frac{80}{d}$. Once you have this it is easy to rearrange it to $d=\frac{40}{\sin 20°}$.

8. **E.** The longest side of the right triangle is the hypotenuse, which we can find using the Pythagorean theorem. Plug in the the measures we are given: $\sqrt{(49\sin\theta)^2+(49\cos\theta)^2}=\sqrt{c^2}$, where c is the hypotenuse. We can simplify the right side and combine the 49's of the right to get $c=\sqrt{49^2\left(\sin\theta^2+\cos\theta^2\right)}$. We know that $\sin\theta^2+\cos\theta^2=1$, so this becomes $c=\sqrt{49^2(1)}=49$.

9. **D.** Because we know that the ratio for $\cos S=\frac{3}{5}$, and that cosine is adjacent over hypotenuse, we can set up a ratio with our side length 6: $\frac{3}{5}=\frac{6}{h}$, with h being the hypotenuse length of the bottom triangle. We also can figure out the angle of S itself with $\cos S=\frac{3}{5}$. Taking the arccos of 0.6, we solve that $S=53.1°$. Now, we can find out T by setting up this equation: $\sin 53.1=\frac{10}{T}$. Solving this, we get $T \approx 12.5$.

10. **B.** We can recognize that this triangle is a $7-24-25$ right triangle (or solve for the hypotenuse manually). For $\angle Y$, the 7 is opposite, and the 25 foot side is the hypotenuse. This makes $\frac{7}{25}$ the opposite divided by the hypotenuse, which is the sine.

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11. **A.** The cosine of an angle is the measure of the adjacent side divided by the measure of the hypotenuse. The side adjacent to $\angle\theta$ is e, and the hypotenuse is g. By plugging in these values we find that $\cos\theta = \frac{e}{g}$.

12. **C.** The side of measure l is adjacent to the angle of measure j, and the side of measure k is a hypotenuse. The trigonometric function for the relationship between an adjacent side and the hypotenuse is the cosine. The cosine is the adjacent side, l, divided by the hypotenuse, k. This is expressed as $\cos j° = \frac{l}{k}$.

13. **E.** One easy way to solve this problem is to recognize that the diagram shown depicts half of a square, cut across the diagonal. The diagonal of a square is equal to the side times $\sqrt{2}$, and since the center line of the diagram is the diagonal cut in half, it is equal to the side of the square times $\frac{\sqrt{2}}{2}$. Plugging in the side, 7, we get $\frac{7\sqrt{2}}{2}$.

14. **E.** The cosine is equal to the adjacent side divided by the hypotenuse. The smallest cosine will be the one with the smallest measure for cosine and largest measure for hypotenuse. All of the angles we can choose as answers have the same adjacent side, $\overline{QR}$, so the only difference will be in the length of the hypotenuse. The largest hypotenuse will have the smallest cosine, and we can tell just by looking at the diagram that $\angle QRE$ has the largest hypotenuse, so it is our answer.

15. **B.** The two sides we are given are the adjacent side and hypotenuse relative to the angle of measure $b°$. The relationship between these two sides is expressed in the cosine. The cosine is the adjacent side divided by the hypotenuse, which in our case is $\frac{a}{c}$. Our answer is $\cos b° = \frac{a}{c}$.

16. **B.** The sine of an angle is the opposite side divided by the hypotenuse. We can find the measure of the opposite side from the tangent we are given, $\frac{12}{5}$, which is the opposite side divided by the adjacent side. If the adjacent side is 5, the opposite side is 12. We can find the hypotenuse from the cosine we are given, $\frac{5}{13}$, which is the adjacent side divided by the hypotenuse. If the adjacent side is 5, the hypotenuse is 13. Let us assume that in our triangle the adjacent side is 5. This won't affect our answer since an angle's sine is the same no matter what the sides are. The opposite side is 12, and the hypotenuse is 13, so the sine (opposite/hypotenuse) is $\frac{12}{13}$.

17. **B.** We are given the measure of an angle, the measure of its opposite side, and we are looking for the measure of the hypotenuse. The relationship between an angle's opposite side and hypotenuse is expressed as the sine of that angle. The sine of $65°$ here is $\frac{125}{n}$ where n is the measure we are looking for. Since, $\sin 65° = \frac{125}{n}$, we can rearrange this into $n = \frac{125}{\sin 65°}$.

18. **A.** The cosine of X is the adjacent side divided by the hypotenuse: $\frac{y}{z}$. The tangent of Y is the opposite side divided by the adjacent side, $\frac{y}{x}$. Plugging these expressions in for the trigonometric functions, we are evaluating $\left(\frac{y}{z}\right)\left(\frac{y}{x}\right) = \frac{y^2}{xz}$.

19. **A.** The important thing to remember in this problem is that the length of the tree is the hypotenuse, not the side. We are given the angle made by the tree and the ground and the length of its shadow, which relative to the angle is the adjacent side. We now have enough information to solve the problem. The cosine is the adjacent side (what we are given) divided by the hypotenuse (what we are looking for). $\cos 12° = \frac{8}{n}$, where n is the length of the tree. Rearranging this, we get $n = \frac{8}{\cos 12°}$.

20. **D.** The measure of $\angle S = \frac{1}{3}\angle I = \frac{1}{3}(63°) = 21°$. We are given that $\angle R = 90°$. We know that $\angle Q + \angle R + \angle S = 180°$, since the interior angles of a triangle on a plane sum to $180°$. Substitute in the values we have: $\angle Q + 90° + 21° = 180° \rightarrow \angle Q + 111° = 180° \rightarrow \angle Q = 69°$.