From this last line we see that the keys to press are:

| Scientific Calculator | Graphing Calculator |
|---|---|
| 1.6003 $\boxed{1/x}$ $\boxed{\tan^{-1}}$ | $\boxed{\tan^{-1}}$ $\boxed{(}$ 1.6003 $\boxed{x^{-1}}$ $\boxed{)}$ $\boxed{\text{ENTER}}$ |

To the nearest degree, the reference angle is $\hat{\theta} = 32°$. Since we want $\theta$ to terminate in QII, we subtract $32°$ from $180°$ to get $\theta = 148°$.

Again, we can check our result on a calculator by entering $148°$, finding its tangent, and then finding the reciprocal of the result.

| Scientific Calculator | Graphing Calculator |
|---|---|
| 148 $\boxed{\tan}$ $\boxed{1/x}$ | 1 $\boxed{\div}$ $\boxed{\tan}$ $\boxed{(}$ 148 $\boxed{)}$ $\boxed{\text{ENTER}}$ |

The calculator gives a result of $-1.6003$.

## GETTING READY FOR CLASS

After reading through the preceding section, respond in your own words and in complete sentences.

**a.** Define reference angle.

**b.** State the reference angle theorem.

**c.** What is the first step in finding the exact value of $\cos 495°$?

**d.** Explain how to find $\theta$ to the nearest tenth of a degree, if $\tan\theta = -0.8541$ and $\theta$ terminates in QIV with $0° < \theta < 360°$.

## PROBLEM SET 3.1

Draw each of the following angles in standard position and then name the reference angle.

**1.** $210°$ **2.** $150°$ **3.** $143.4°$ **4.** $253.8°$
**5.** $311.7°$ **6.** $93.2°$ **7.** $195°\ 10'$ **8.** $171°\ 40'$
**9.** $-300°$ **10.** $-330°$ **11.** $-120°$ **12.** $-150°$

Find the exact value of each of the following.

**13.** $\cos 225°$ **14.** $\cos 135°$ **15.** $\sin 120°$ **16.** $\sin 210°$
**17.** $\tan 135°$ **18.** $\tan 315°$ **19.** $\cos 240°$ **20.** $\cos 150°$
**21.** $\csc 330°$ **22.** $\sec 330°$ **23.** $\sec 300°$ **24.** $\csc 300°$
**25.** $\sin 390°$ **26.** $\cos 420°$ **27.** $\cot 480°$ **28.** $\cot 510°$

Use a calculator to find the following.

**29.** $\cos 347°$ **30.** $\cos 238°$ **31.** $\sec 101.8°$ **32.** $\csc 166.7°$
**33.** $\tan 143.4°$ **34.** $\tan 253.8°$ **35.** $\sec 311.7°$ **36.** $\csc 93.2°$
**37.** $\cot 390°$ **38.** $\cot 420°$ **39.** $\csc 575.4°$ **40.** $\sec 590.9°$
**41.** $\cos(-315°)$ **42.** $\sin(-225°)$ **43.** $\tan 195°\ 10'$ **44.** $\tan 171°\ 40'$
**45.** $\sec 314°\ 40'$ **46.** $\csc 670°\ 20'$ **47.** $\sin(-120°)$ **48.** $\cos(-150°)$

Use a calculator to find $\theta$ to the nearest tenth of a degree, if $0° < \theta < 360°$ and

First find Reference & then add 180

**49.** $\sin\theta = -0.3090$ with $\theta$ in QIII **50.** $\sin\theta = -0.3090$ with $\theta$ in QIV
**51.** $\cos\theta = -0.7660$ with $\theta$ in QII **52.** $\cos\theta = -0.7660$ with $\theta$ in QIII
**53.** $\tan\theta = 0.5890$ with $\theta$ in QIII **54.** $\tan\theta = 0.5890$ with $\theta$ in QI
**55.** $\cos\theta = 0.2644$ with $\theta$ in QI **56.** $\cos\theta = 0.2644$ with $\theta$ in QIV

57. $\sin\theta = 0.9652$ with $\theta$ in QII
58. $\sin\theta = 0.9652$ with $\theta$ in QI
59. $\sec\theta = 1.4325$ with $\theta$ in QIV
60. $\csc\theta = 1.4325$ with $\theta$ in QII
61. $\csc\theta = 2.4957$ with $\theta$ in QII
62. $\sec\theta = -3.4159$ with $\theta$ in QII
63. $\cot\theta = -0.7366$ with $\theta$ in QII
64. $\cot\theta = -0.1234$ with $\theta$ in QIV
65. $\sec\theta = -1.7876$ with $\theta$ in QIII
66. $\csc\theta = -1.7876$ with $\theta$ in QIII

Find $\theta$, if $0° < \theta < 360°$ and

67. $\sin\theta = -\dfrac{\sqrt{3}}{2}$ and $\theta$ in QIII
68. $\sin\theta = -\dfrac{1}{\sqrt{2}}$ and $\theta$ in QIII
69. $\cos\theta = -\dfrac{1}{\sqrt{2}}$ and $\theta$ in QII
70. $\cos\theta = -\dfrac{\sqrt{3}}{2}$ and $\theta$ in QIII
71. $\sin\theta = -\dfrac{\sqrt{3}}{2}$ and $\theta$ in QIV
72. $\sin\theta = \dfrac{1}{\sqrt{2}}$ and $\theta$ in QII
73. $\tan\theta = \sqrt{3}$ and $\theta$ in QIII
74. $\tan\theta = \dfrac{1}{\sqrt{3}}$ and $\theta$ in QIII
75. $\sec\theta = -2$ with $\theta$ in QII
76. $\csc\theta = 2$ with $\theta$ in QII
77. $\csc\theta = \sqrt{2}$ with $\theta$ in QII
78. $\sec\theta = \sqrt{2}$ with $\theta$ in QIV
79. $\cot\theta = -1$ with $\theta$ in QIV
80. $\cot\theta = \sqrt{3}$ with $\theta$ in QIII

### REVIEW PROBLEMS

The problems that follow review material we covered in Sections 1.1 and 2.1. Giv the complement and supplement of each angle.

81. $70°$
82. $120°$
83. $x$
84. $90° - y$

85. If the longest side in a $30°–60°–90°$ triangle is 10, find the length of the othe two sides.
86. If the two shorter sides of a $45°–45°–90°$ triangle are both $\frac{3}{4}$, find the length o the hypotenuse.

Simplify each expression by substituting values from the table of exact values an then simplifying the resulting expression.

87. $\sin 30° \cos 60°$
88. $4\sin 60° - 2\cos 30°$
89. $\sin^2 45° + \cos^2 45°$
90. $(\sin 45° + \cos 45°)^2$

## SECTION 3.2 RADIANS AND DEGREES

Although James Thomson is credited with the first printed use of the term *radian*, it is believed that the concept of radian measure was originally proposed by Roger Cotes (1682–1716), who was also the first to calculate 1 radian in degrees.

If you think back to the work you have done with functions of the form $y = f(x)$ i your algebra class, you will see that the variables $x$ and $y$ were always real number The trigonometric functions we have worked with so far have had the for $y = f(\theta)$, where $\theta$ is measured in degrees. In order to apply the knowledge we ha about functions from algebra to our trigonometric functions, we need to write o angles as real numbers, not degrees. The key to doing this is called *radian measu* Radian measure is a relatively new concept in the history of mathematics. The te *radian* was first introduced by physicist James T. Thomson in examination questio in 1873. The introduction of radian measure will allow us to do a number of usef things. For instance, in Chapter 4 we will graph the function $y = \sin x$ on a rect