To convert from degrees → radians we multiply degrees by $\frac{\pi \text{ rad}}{180^\circ}$

To convert from radians → degrees we multiply radians by $\frac{180^\circ}{\pi \text{ rad}}$

Ex 1: Convert the following to radians, sketch the angle and find two coterminal angles (one positive and one negative).

a) $30^\circ = (30\,\text{deg})\left(\frac{\pi \text{ rad}}{180\,\text{deg}}\right) = \frac{\pi}{6}\,\text{rad}$

b) $-210^\circ = (-210\,\text{deg})\left(\frac{\pi \text{ rad}}{180\,\text{deg}}\right) = -\frac{7\pi}{6}\,\text{rad}$

Ex 2: Convert the following to degrees, sketch the angle and find two coterminal angles (one positive and one negative).

a) $\frac{\pi}{4}\,\text{rad} = \left(\frac{\pi}{4}\,\text{rad}\right)\left(\frac{180\,\text{deg}}{\pi \text{ rad}}\right) = 45\,\text{deg}$

b) $-\frac{5\pi}{6}\,\text{rad} = \left(-\frac{5\pi}{6}\,\text{rad}\right)\left(\frac{180\,\text{deg}}{\pi \text{ rad}}\right) = -150\,\text{deg}$

Coterminal angles: are angles in standard position (angles with the initial side on the positive *x*-axis) that have a common terminal side. For example, the angles 30°, –330° and 390° are all coterminal (see figure 2.1 below).

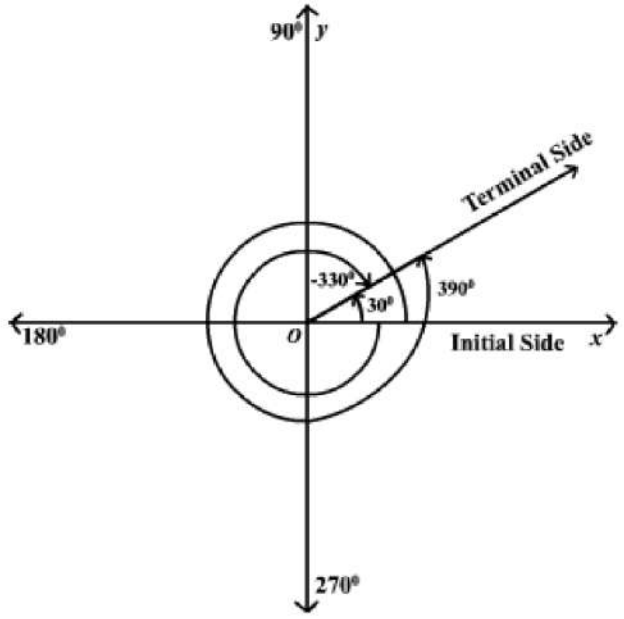


Fig. 2.1

In general, if θ is any angle, then **θ + n(360)** is coterminal angle with θ, for all nonzero integer **n**. For **positive** angle θ, **the coterminal angle** can be found by: θ + 360°

It can also be found by theta minus 360 degrees.

In radians it is theta plus 2pi or theta minus 2pi

Example 2.1: Find three positive angles that are coterminal with

30°

-55°

Solution: Use the formula **θ + n(360)** as follows:

30° + 360° = **390°**
30° + 2(360°)= **750°**
30° + 3(360°)= **1110°**

30 – 360 = -330 deg which is also coterminal

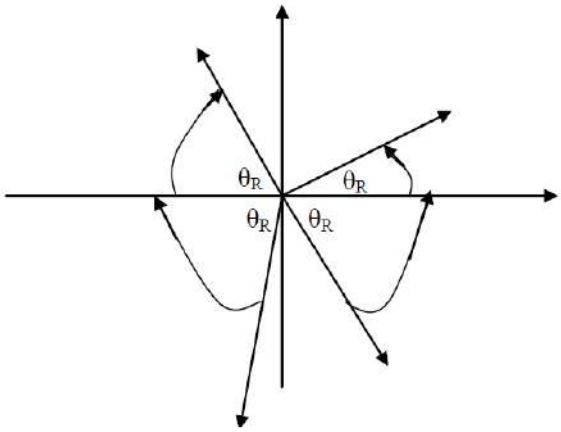
Note: There are an infinite number of angles coterminal with 30°.

-55° + 360°= **305°**
-55° + 2(360°)= **665°**
-55° + 3(360°)= **1025°**

Definition of Reference Angle: Let θ be a non-quadrantal angle in standard position. The reference angle of θ is the **acute angle** θ_R that the terminal side of θ **makes with the *x*-axis**.

If θ is in QI, $\theta_R = \theta$
If θ is in QII, $\theta_R = 180° - \theta$ or $\pi - \theta$
If θ is in QIII, $\theta_R = \theta - 180°$ or $\theta - \pi$
If θ is in QIV, $\theta_R = 360° - \theta$ or $2\pi - \theta$

Don't try to 'memorize' these. Use logic. Always find the difference between the angle and the positive or negative *x*-axis.



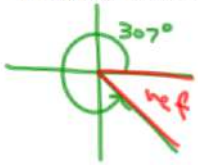
Example 4(a) **FINDING REFERENCE ANGLES**

Find the reference angle for an angle of 218° .

218 - 180 = 38°

Example 4(b) **FINDING REFERENCE ANGLES**

Find the reference angle for an angle of 1387° .



360
-307
53°

-360
-360
-360
307

Degrees & Radians Conversion Practice

Convert each degree measure into radians.

1) -290°

2) 345°

3) 970°

4) -510°

5) 510°

6) 150°

7) 210°

8) -240°

Convert each radian measure into degrees.

21) $\frac{\pi}{18}$

22) $-\frac{25\pi}{12}$

23) $\frac{35\pi}{18}$

24) $\frac{41\pi}{36}$

25) $-\frac{3\pi}{2}$

26) $\frac{107\pi}{36}$

27) $\frac{\pi}{3}$

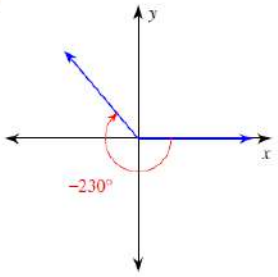
28) $-\frac{17\pi}{9}$

Coterminal Angles and Reference Angles

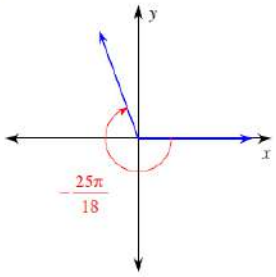
Date_____ Period____

Find the reference angle.

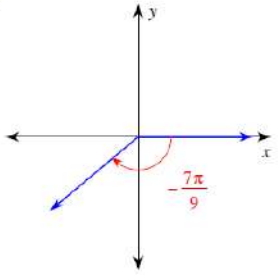
1)



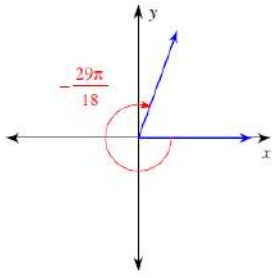
2)



3)



4)



7) -510°

8) $-\frac{19\pi}{18}$

9) $-\frac{13\pi}{12}$

10) -250°

State if the given angles are coterminal.

11) $185^\circ,\ -545^\circ$

12) $\frac{17\pi}{36},\ \frac{161\pi}{36}$

Find a coterminal angle between 0° and 360°.

13) -330°

14) -435°

15) 640°

16) -442°

Find a coterminal angle between 0 and 2π for each given angle.

17) $\frac{11\pi}{3}$

18) $-\frac{35\pi}{18}$

19) $\frac{15\pi}{4}$

20) $-\frac{19\pi}{12}$

Find a positive and a negative coterminal angle for each given angle.

21) $\frac{5\pi}{4}$

22) $\frac{25\pi}{36}$

Summary Assignment Week 2

Name: _____ Date: _____ Pd: _____

Convert the following from degrees to Radians:

1. 160^o	2. -200°

Convert the following from Radians to Degrees:

3. $\frac{9\pi}{4}$	4. $-\frac{11\pi}{12}$

Name a positive and negative angle that is co-terminal to the given:

5. $\frac{7\pi}{4}$	6. -200°

What is the reference angle for the following?

7. 223°	8. -269°
9. $\frac{13\pi}{3}$	10. $\frac{17\pi}{12}$