

# Angles and Angle Measure

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 29

## Q Quick Review

Angles come in two flavors here: **degrees** and **radians**. A full rotation is  $360^\circ$  or  $2\pi$  radians – same physical sweep, different units. The bridge between them is  $180^\circ = \pi$  radians.

**Converting.** Multiply by whatever conversion factor cancels the unit you've got:

Degrees  $\rightarrow$  radians: multiply by  $\frac{\pi}{180}$ .

Radians  $\rightarrow$  degrees: multiply by  $\frac{180}{\pi}$ .

For example,  $60^\circ \cdot \frac{\pi}{180} = \frac{\pi}{3}$ , and  $\frac{3\pi}{4} \cdot \frac{180}{\pi} = 135^\circ$ .

**What is a radian really?** One radian is the central angle that sweeps out an arc equal in length to the radius. That makes radians a *ratio* of arc length to radius – a pure number, with no units to track. (One radian is about  $57.30^\circ$ .)

**Memorize the family.** The common conversions show up over and over:  $30^\circ = \frac{\pi}{6}$ ,  $45^\circ = \frac{\pi}{4}$ ,  $60^\circ = \frac{\pi}{3}$ ,  $90^\circ = \frac{\pi}{2}$ ,  $180^\circ = \pi$ ,  $270^\circ = \frac{3\pi}{2}$ ,  $360^\circ = 2\pi$ . Knowing these by sight saves seconds on every problem.

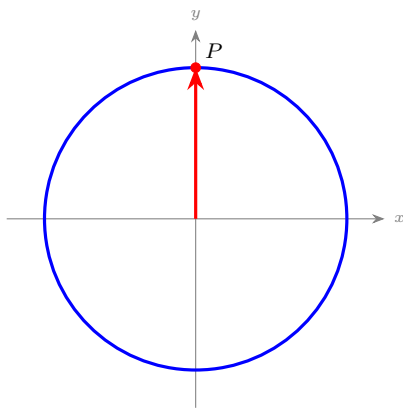
**Negative angles work the same way.** The sign rides along through the conversion:  $-\frac{\pi}{6} \cdot \frac{180}{\pi} = -30^\circ$ .

**Common slips.** Multiplying by  $\frac{180}{\pi}$  when you meant  $\frac{\pi}{180}$  (the units won't cancel). Forgetting to simplify the fraction at the end –  $\frac{315\pi}{180}$  should reduce to  $\frac{7\pi}{4}$ .

## PRACTICE

Convert between degrees and radians. Simplify radian answers to lowest terms.

1. Convert the drawn angle ( $90^\circ$ ) to radians. \_\_\_\_\_



2. Convert  $\frac{\pi}{3}$  radians to degrees. \_\_\_\_\_

3. Convert  $135^\circ$  to radians. \_\_\_\_\_

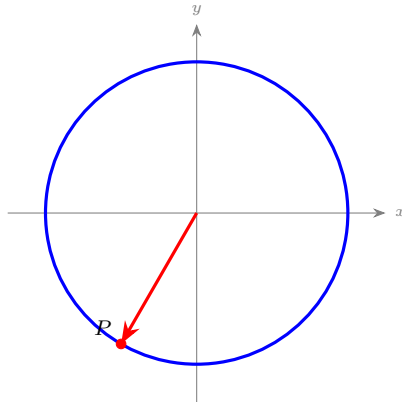
4. Convert  $-\frac{\pi}{6}$  to degrees. \_\_\_\_\_

5. Convert  $315^\circ$  to radians. \_\_\_\_\_

6. Convert  $\frac{5\pi}{6}$  to degrees. \_\_\_\_\_



7. Convert the drawn angle ( $240^\circ$ ) to radians. \_\_\_\_\_



8. Convert  $\frac{7\pi}{6}$  to degrees. \_\_\_\_\_

9. Convert  $30^\circ$  to radians. \_\_\_\_\_

10. Convert  $45^\circ$  to radians. \_\_\_\_\_

11. Convert 1 radian to degrees (round to two decimals). \_\_\_\_\_

12. Convert  $-\frac{5\pi}{4}$  to degrees. \_\_\_\_\_

13. Convert  $720^\circ$  to radians. \_\_\_\_\_

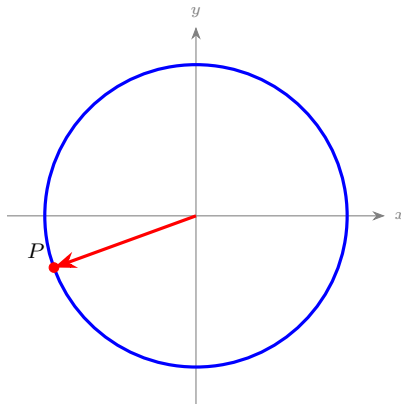
14. Convert  $\frac{\pi}{12}$  to degrees. \_\_\_\_\_

15. Convert  $750^\circ$  to a positive coterminal radian angle in  $[0, 2\pi)$ . \_\_\_\_\_

16. Convert  $-60^\circ$  to radians. \_\_\_\_\_

17. Convert  $\frac{11\pi}{6}$  to degrees. \_\_\_\_\_

18. Convert the drawn angle ( $200^\circ$ ) to radians. \_\_\_\_\_



19. Convert  $\frac{3\pi}{2}$  to degrees. \_\_\_\_\_

20. Convert 2 radians to degrees (round to two decimals). \_\_\_\_\_



**◆ Word Problems**

21. A protractor measures a swing-set arc as  $108^\circ$ . Express this in radians as a simplified fraction of  $\pi$ . \_\_\_\_\_
22. A bike wheel rotates through  $\frac{7\pi}{2}$  radians. How many degrees is that? (Don't reduce coterminally – keep the full rotation count.) \_\_\_\_\_
23. An ant walks  $\frac{\pi}{4}$  radian of arc on a circular track. Convert this to degrees, and decide whether it's less than, equal to, or greater than a  $50^\circ$  arc. \_\_\_\_\_
24. A clock's minute hand sweeps 25 minutes. In what radian measure (as a simplified fraction of  $\pi$ ) did it sweep? Express your answer as a positive angle. \_\_\_\_\_

**Additional Practice**

25. Find  $\sin \theta$  if opposite = 5, hypotenuse = 13. \_\_\_\_\_
26. Find  $\cos \theta$  if adjacent = 12, hypotenuse = 13. \_\_\_\_\_
27. Find  $\tan \theta$  if opposite = 7, adjacent = 4. \_\_\_\_\_
28. Find  $\sin 30^\circ$ . \_\_\_\_\_
29. Find  $\cos 60^\circ$ . \_\_\_\_\_



Answer Keys

1. $\frac{\pi}{2}$	13. $4\pi$
2. $60^\circ$	14. $15^\circ$
3. $\frac{3\pi}{4}$	15. $\frac{\pi}{6}$
4. $-30^\circ$	16. $-\frac{\pi}{3}$
5. $\frac{7\pi}{4}$	17. $330^\circ$
6. $150^\circ$	18. $\frac{10\pi}{9}$
7. $\frac{4\pi}{3}$	19. $270^\circ$
8. $210^\circ$	20. $\approx 114.59^\circ$
9. $\frac{\pi}{6}$	21. $\frac{3\pi}{5}$
10. $\frac{\pi}{4}$	22. $630^\circ$
11. $\approx 57.30^\circ$	23. $45^\circ$ ; less than $50^\circ$
12. $-225^\circ$	24. $\frac{5\pi}{6}$
<b>Additional Practice Answers</b>	
25. $\frac{5}{13}$	28. $\frac{1}{2}$
26. $\frac{12}{13}$	29. $\frac{1}{2}$
27. $\frac{7}{4}$	

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

- To go from degrees to radians, multiply by  $\frac{\pi}{180}$  so the degree unit cancels:  
 $90^\circ \cdot \frac{\pi}{180} = \frac{90\pi}{180} = \frac{\pi}{2}$ . A quarter turn is  $\frac{\pi}{2}$  – a value worth knowing on sight.
- Keep the rule visible:  $\frac{\pi}{3} \cdot \frac{180}{\pi} = \frac{180}{3} = 60^\circ$ . The  $\pi$ 's cancel cleanly. This is the part to check before moving on, because it keeps the answer tied to the original question.
- One steady path is:  $135^\circ \cdot \frac{\pi}{180} = \frac{135\pi}{180} = \frac{3\pi}{4}$  (divide top and bottom by 45). That gives a quick check on the answer.
- Start with the key idea: The negative sign rides along:  $-\frac{\pi}{6} \cdot \frac{180}{\pi} = -30^\circ$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $315^\circ \cdot \frac{\pi}{180} = \frac{315\pi}{180} = \frac{7\pi}{4}$  (divide both by 45). This is the part to check before moving on, because it keeps the answer tied to the original question.
- Keep the rule visible:  $\frac{5\pi}{6} \cdot \frac{180}{\pi} = \frac{5 \cdot 180}{6} = 150^\circ$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Multiply by  $\frac{\pi}{180}$ :  $240^\circ \cdot \frac{\pi}{180} = \frac{240\pi}{180}$ . Divide top and bottom by their common factor 60 to land on  $\frac{4\pi}{3}$ . Always reduce the fraction at the end.
- Start with the key idea:  $\frac{7\pi}{6} \cdot \frac{180}{\pi} = \frac{7 \cdot 180}{6} = 7 \cdot 30 = 210^\circ$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $30^\circ \cdot \frac{\pi}{180} = \frac{\pi}{6}$ . (Worth memorizing – this one shows up constantly.) That gives a quick check on the answer.
- Keep the rule visible:  $45^\circ \cdot \frac{\pi}{180} = \frac{45\pi}{180} = \frac{\pi}{4}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- One steady path is:  $1 \cdot \frac{180}{\pi} = \frac{180}{\pi} \approx 57.30^\circ$ . Useful sanity-check number: one radian is a bit less than  $60^\circ$ . That gives a quick check on the answer.

- Start with the key idea: Keep the sign:  $-\frac{5\pi}{4} \cdot \frac{180}{\pi} = -\frac{5 \cdot 180}{4} = -225^\circ$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $720^\circ \cdot \frac{\pi}{180} = \frac{720\pi}{180} = 4\pi$ . Two full rotations =  $4\pi$  radians. This is the part to check before moving on, because it keeps the answer tied to the original question.
- Keep the rule visible:  $\frac{\pi}{12} \cdot \frac{180}{\pi} = \frac{180}{12} = 15^\circ$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- First convert:  $750^\circ \cdot \frac{\pi}{180} = \frac{25\pi}{6}$ . Now subtract full rotations of  $2\pi = \frac{12\pi}{6}$ :  
 $\frac{25\pi}{6} - \frac{24\pi}{6} = \frac{\pi}{6}$ .
- Start with the key idea:  $-60^\circ \cdot \frac{\pi}{180} = -\frac{60\pi}{180} = -\frac{\pi}{3}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $\frac{11\pi}{6} \cdot \frac{180}{\pi} = \frac{11 \cdot 180}{6} = 11 \cdot 30 = 330^\circ$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Multiply by  $\frac{\pi}{180}$ :  $200^\circ \cdot \frac{\pi}{180} = \frac{200\pi}{180}$ . The greatest common factor of 200 and 180 is 20, so divide both by 20 to get  $\frac{10\pi}{9}$  (it does not reduce to a  $\pi/n$  form – that's fine).
- One steady path is:  $\frac{3\pi}{2} \cdot \frac{180}{\pi} = \frac{3 \cdot 180}{2} = 270^\circ$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- The input is unitless, so use the radians-to-degrees factor:  $2 \cdot \frac{180}{\pi} = \frac{360}{\pi} \approx 114.59^\circ$ . (Quick sanity check: one radian is about  $57.3^\circ$ , so two radians is about  $2 \cdot 57.3 = 114.6^\circ$  – just under  $120^\circ$ , which matches.)
- A careful way to see it:  $108^\circ \cdot \frac{\pi}{180} = \frac{108\pi}{180} = \frac{3\pi}{5}$  (divide both by 36). The arc covers  $3/5$  of a half-circle. That gives a quick check on the answer.
- Keep the rule visible:  $\frac{7\pi}{2} \cdot \frac{180}{\pi} = \frac{7 \cdot 180}{2} = 630^\circ$ . The wheel made one full



turn ( $360^\circ$ ) plus another  $270^\circ$  – so it's now pointing where  $270^\circ$  would, after one extra revolution. That gives a quick check on the answer.

**23.** One steady path is:  $\frac{\pi}{4} \cdot \frac{180}{\pi} = 45^\circ$ . That's  $5^\circ$  less than  $50^\circ$ , so the ant's arc is smaller. (Sanity check:  $45^\circ$  is half of a right angle.) That gives a quick check on

the answer.

**24.** A full hour is  $360^\circ$  over 60 minutes, so each minute is  $6^\circ$ . Twenty-five minutes is  $25 \cdot 6 = 150^\circ$ . Convert:  $150^\circ \cdot \frac{\pi}{180} = \frac{150\pi}{180} = \frac{5\pi}{6}$ . (Reality check: 25 min is just under half an hour, and  $\frac{5\pi}{6}$  is just under  $\pi$  – matches.)



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