

## 4.1 Angles

unit circle,  $r=1$   $C=2\pi r$  becomes  $C=2\pi$



$2\pi = 360^\circ$   
 $\pi = 180^\circ$   
↑                      ↑  
radian measure      degree meas

converting to radians (multiply by  $1 \left(\frac{\pi}{180^\circ}\right)$ )

$$0^\circ \cdot \frac{\pi}{180^\circ} = 0$$

$$30^\circ \cdot \frac{\pi}{180^\circ} = \frac{30\pi}{180} = \frac{\pi}{6}$$

$$45^\circ \cdot \frac{\pi}{180^\circ} = \frac{45\pi}{180} = \frac{\pi}{4}$$

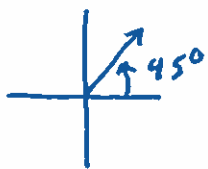
$$90^\circ \cdot \frac{\pi}{180^\circ} = \frac{90\pi}{180} = \frac{\pi}{2}$$

converting to degrees (multiply by  $1 \left(\frac{180^\circ}{\pi}\right)$ )

$$\frac{\pi}{3} \cdot \frac{180^\circ}{\pi} = \frac{180^\circ}{3} = 60^\circ$$

$$\frac{5\pi}{12} \cdot \frac{180^\circ}{\pi} = \frac{900^\circ}{12} = 75^\circ$$

\* example 1 pg 168



coterminal an

\* example 2 pg 170

all angles coterminal to  $45^\circ$  would be:

$$45^\circ + 360^\circ, 45^\circ + 2(360^\circ), 45^\circ + 3(360^\circ) \dots$$

$$45^\circ - 360^\circ, 45^\circ - 2(360^\circ) \dots$$

$$45^\circ + 360^\circ k, k \in \mathbb{I}$$

all angles coterminal to  $\pi/3$

$$\pi/3 + 2\pi k, k \in \mathbb{Z}$$

\* ex 3 pg 172



$$\theta \text{ (in radians)} = \frac{a}{r}$$

\* most texts use  $s$  for arc

\* ex 4 pg 173

$$130^\circ \cdot \frac{\pi}{180^\circ} = \frac{13\pi}{18}$$

$$\theta = \frac{a}{r}$$

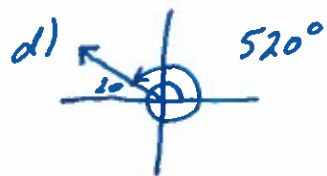
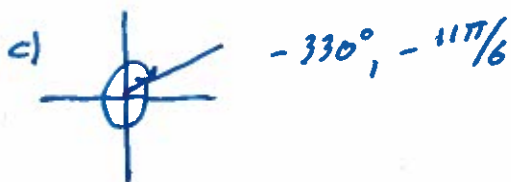
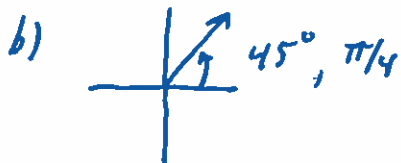
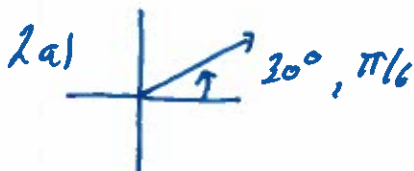
$$\frac{13\pi}{18} = \frac{a}{6.7}$$

$$a = 6.7 \left( \frac{13\pi}{18} \right)$$

$$a = 15.2 \text{ mm}$$

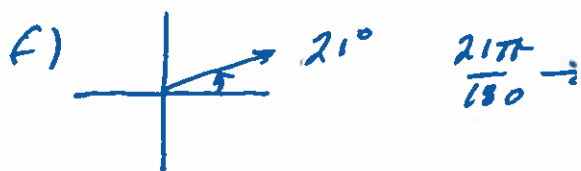
pgs 175-177 1-14, 17, 19

1.  a, c clockwise  
b, d counter-clockwise



$$\frac{520\pi}{180}$$

$$\frac{26\pi}{9}$$



3a)  $60^\circ = \pi/3$

b)  $150^\circ = 5\pi/6$

c)  $-270^\circ = -3\pi/2$

d)  $72^\circ = \frac{72\pi}{180} = \frac{2\pi}{5}$

e)  $-14.8^\circ = -\frac{14.8\pi}{180} \approx -0.26$

f)  $540^\circ = 3\pi$

4. a)  $\pi/6 = 30^\circ$

b)  $\frac{2\pi}{3} = 120^\circ$

c)  $-\frac{3\pi}{8} = -\frac{540}{8} = -67.5^\circ$

d)  $-\frac{5\pi}{2} = -450^\circ$

e)  $1 \cdot \frac{180^\circ}{\pi} \approx 57.3^\circ$

f)  $2.75 \times \frac{180}{\pi} \approx 157.6^\circ$

5. a)  $\frac{2\pi}{7} \cdot \frac{180^\circ}{\pi} = \frac{360}{7} \approx 51.429^\circ$

b)  $\frac{7\pi}{13} \cdot \frac{180}{\pi} \approx 96.923$

c)  $\frac{2}{3} \cdot \frac{180}{\pi} = \frac{120}{\pi} \approx 38.197^\circ$

d)  $3.66 \cdot \frac{180}{\pi} \approx 209.70$

6e)  $-\frac{2\pi}{3} = -120^\circ$

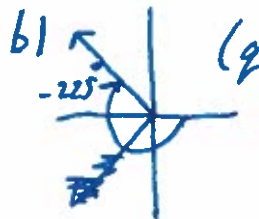
f)  $-20 \cdot \frac{180}{\pi} \approx -1145.916^\circ$

5e)  $-6.14 \cdot \frac{180}{\pi} \approx -351.796^\circ$

6a)  $1 \approx 57.3^\circ$

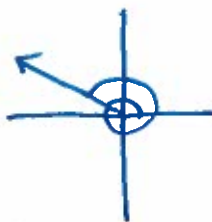


(quad I)



(q)

$$c) \frac{17\pi}{6} \cdot \frac{180}{\pi} = 510^\circ$$



quad 3

$$d) 650^\circ$$

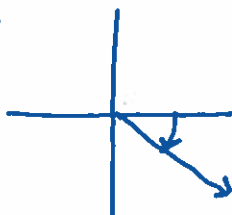


quad 4

$$e) -\frac{2\pi}{3}, -120^\circ$$



$$f) -42^\circ$$



quad 4

$$7. a) 72^\circ + 360^\circ = 432^\circ$$

$$72^\circ - 360^\circ = -288^\circ$$

$$b) \frac{3\pi}{4} + 2\pi = \frac{11\pi}{4}$$

$$\frac{3\pi}{4} - 2\pi = -\frac{5\pi}{4}$$

$$c) -120^\circ + 360^\circ = 240^\circ$$

$$-120^\circ - 360^\circ = -480^\circ$$

$$d) \frac{11\pi}{2} + 2\pi = \frac{15\pi}{2}$$

$$\frac{11\pi}{2} - 2\pi - 2\pi - 2\pi = -\pi$$

$$e) -205^\circ + 360^\circ = 155^\circ$$

$$-205^\circ - 360^\circ = -565^\circ$$

$$f) 7.8 - 2\pi \approx 1.51$$

$$-2\pi \approx -4.77$$

8 a) coterminal, differ by  $\frac{12\pi}{6} (2\pi)$

b) not coterminal, differ by  $\frac{14\pi}{2} (7\pi \rightarrow$  not multiple

c) not, differ by  $820^\circ$  (not multiple of  $360^\circ$ )

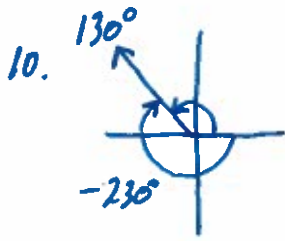
d) coterminal, differ by  $720^\circ (2 \cdot 360^\circ)$

$$9 a) 135^\circ + 360^\circ K, K \in \mathbb{I}$$

$$b) -\frac{\pi}{2} + 2\pi K, K \in \mathbb{I}$$

$$c) -200^\circ + 360^\circ K, K \in \mathbb{I}$$

$$d) 10 + 2\pi K, K \in \mathbb{I}$$



$$-230^\circ + 360^\circ = 130^\circ \quad (\text{repeat if negative})$$

11. a)  $65^\circ, 425^\circ$   
 b)  $-40^\circ, 320^\circ$   
 c)  $-40^\circ, -400^\circ, 320^\circ, 680^\circ$   
 d)  $\frac{3\pi}{4}, -\frac{5\pi}{4}$

$$2\pi = \frac{8\pi}{4}$$

$$2\pi = \frac{12\pi}{6}$$

- e)  $-\frac{11\pi}{6}, -\frac{23\pi}{6}, \frac{\pi}{6}, \frac{13\pi}{6}$

$$2\pi = \frac{6\pi}{3}$$

- f)  $\frac{7\pi}{3}, \frac{\pi}{3}, -\frac{5\pi}{3}$

$$-6.28, 6.28$$

- g)  $2.4, -3.88$

$$-12.6, 6.28$$

- h)  $-7.2, -0.92, 5.37$

- 12  $\theta = \frac{a}{r}$      $a = \theta r$
- a)  $1.4(9.5) = 13.3 \text{ cm}$   
 b)  $1.37(3.5) = 4.795 \text{ cm}$   
 c)  $\frac{13\pi}{18}(7) = 15.88 \text{ cm}$   
 d)  $282^\circ \cdot \frac{\pi}{180}(6.25) = 30.76 \text{ cm}$

13. a)  $\theta = \frac{9}{4}$  or  $2.25$     b)  $a = 1.22(9) = 10.98 \text{ ft}$

- c)  $r = \frac{15}{3.93} = 3.82 \text{ cm}$     d)  $\frac{14\pi}{18}(7) = 17.1 \text{ m}$

- 14 a)  $a = \frac{5\pi}{3}(5) = \frac{25\pi}{3}$  or  $26.18 \text{ m}$

- b) circle  $A = \pi r^2$      $\frac{5\pi}{3} = \frac{5}{6}$  of a circle  
 $2\pi \rightarrow \frac{6\pi}{3}$   
 $A = \frac{5}{6} \pi (5)^2 = 65.4 \text{ m}^2$

$$14 \text{ d) } \frac{1 \text{ rev}}{x} = \frac{15 \text{ sec}}{120}$$

$$15x = 120$$

$$x = 8 \text{ rev}$$

$$8 \cdot 360^\circ$$

$$2880^\circ$$

$$\text{or } 8 \cdot 2\pi$$

$$16\pi$$

rev	degree	radian
a) 1	$360^\circ$	$2\pi$
b) 0.75	$270^\circ$	$3\pi/2$
c) $5/12$	$150^\circ$	$5\pi/6$
d) 0.27	$97.4^\circ$	-1.7
e) -0.11	$-40^\circ$	$-2\pi/9$
f) 0.7	$252^\circ$	$7\pi/5$
g) -3.25	$-1170^\circ$	$-13\pi/2$
h) 1.28	$460^\circ$	$23\pi/5$
i) -0.1875	$-67.5^\circ$	$-3\pi/8$

$$19. \quad 360^\circ = 400 \text{ grads}$$

$$\text{a) } \frac{360}{50} = \frac{400}{x}$$

$$360x = 20000$$

$$x = 55.5 \text{ grads}$$

$$\text{b) } 360^\circ = 400$$

$$9^\circ = 10$$

$$\text{deg} \rightarrow \text{grad} \quad x^\circ \cdot \frac{10}{9}$$

$$\text{grad} \rightarrow \text{deg} \quad x \text{ grad} \cdot \frac{9^\circ}{10}$$

c) makes a right angle  $100^\circ$  (gradians still have not caught on!)