

Section 13-1 Linear Measure

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Measurement is a 3 step process:

1. Pick an attribute to measure (ex: length, width, perimeter, volume, area, etc.)
2. Pick a unit
3. Determine how many units are necessary to run the length of (length), go around the object (perimeter), fill the object (volume) or cover the object (area).

It is best to start kids off using non-standard units. You can use anything to measure: pencil, shoe, hand, book, etc.

Ex1: You tell your class to measure the width of their desk using their pencil. Here are some of their results:

Brianna : 4 pencils wide

Chanel : 3 pencils wide

Rudy : 6 pencils wide

Rudy proclaims that his desk is the widest, but you tell the class that the desks are all the same width. So, why are their answers different?

A pencil is a non-standard unit.
The 3 kids are using different sized pencils to measure.

From looking at the results, we can see that Chanel's pencil is longer than Rudy's pencil (by about double!)

- * When comparing measurements, you want to either use a standard unit of measure or use the same non-standard item for each measurement.

Nonstandard units evolved into standard units.

English Units

12 inches = 1 foot

3 feet = 1 yard

5280 feet = 1 mile

1760 yards = 1 mile

inches = in

foot = ft

yard = yd

mile = mi

Frames of Reference:

1 inch $\approx$ length of small paperclip 

1 foot $\approx$ length of human foot

(men's size 13 $\approx$ 11.6 inches)

1 yard $\approx$ distance from middle of your chest to the end of fingers on outstretched arm

(100 yds = length of football field excluding end zones)

Ex 2 Convert

a) 96 ft = _____ yd

$$96 \cancel{\text{ft}} \left(\frac{1 \text{ yd}}{3 \cancel{\text{ft}}} \right) = \boxed{32 \text{ yd}}$$

This is called a conversion factor.
You are basically multiplying by 1.

b) 8 ft = _____ in

$$8 \cancel{\text{ft}} \left(\frac{12 \text{ in}}{1 \cancel{\text{ft}}} \right) = \boxed{96 \text{ in}}$$

c) $7240 \text{ yd} = \underline{\hspace{2cm}} \text{ mi}$

$$7240 \cancel{\text{yd}} \left(\frac{1 \text{ mi}}{1760 \cancel{\text{yd}}} \right) \approx \boxed{4.11 \text{ mi or } \frac{181 \text{ mi}}{44}}$$

d) $1.52 \text{ mi} = \underline{\hspace{2cm}} \text{ ft}$

$$1.52 \cancel{\text{mi}} \left(\frac{5280 \text{ ft}}{1 \cancel{\text{mi}}} \right) = \boxed{8025.6 \text{ ft}}$$

e) $48 \text{ in} = \underline{\hspace{2cm}} \text{ yd}$

$$48 \cancel{\text{in}} \left(\frac{1 \cancel{\text{ft}}}{12 \cancel{\text{in}}} \right) \left(\frac{1 \text{ yd}}{3 \cancel{\text{ft}}} \right) = \boxed{1.\bar{3} \text{ yd or } \frac{4 \text{ yd}}{3}}$$

f) $0.4 \text{ mi} = \underline{\hspace{2cm}} \text{ in}$

$$0.4 \cancel{\text{mi}} \left(\frac{5280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \right) \left(\frac{12 \text{ in}}{1 \cancel{\text{ft}}} \right) = \boxed{25,344 \text{ in}}$$

Kilo

hecto

deka

base

deci

centi

milli:

K

h

da

d

c

m

Unit	Symbol	Relationship to Base	
Kilometer	km	1000 m	10^3
hectometer	hm	100 m	10^2
deka meter	dam	10 m	10^1
Base meter	m	base unit	10^0
decimeter	dm	0.1 m	10^{-1}
centimeter	cm	0.01 m	10^{-2}
millimeter	mm	0.001 m	10^{-3}

Metric units were developed by the French Academy of Sciences in order to create a more "natural" standard system of measurement. If you take the distance from the North Pole to the equator and subdivide it into 10 million parts, you get 1 meter.

Frames of Reference:

1 mm $\approx$ width of paper clip's tip

1 cm $\approx$ width of plain M+M (also width of pointer fingernail)

1 dm $\approx$ hand span

1 m $\approx$ distance from waist to floor
(On me, it's exactly 1m and I'm 5'5".)

Converting among metric units is super easy if you use the stairs on the previous page.

Since metric units are based on powers of 10, we can convert by simply moving the decimal point.

Ex 3: Convert

a) $3 \text{ km} = \underline{\hspace{2cm}} \text{ m}$

km	hm	dam	m	dm	cm	mm
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3.000 → move 3 places to the right

3.000

↑↑
fill in these dips with 0s.

3000.m

↙ not necessary

b) $700 \text{ cm} = \underline{\hspace{2cm}} \text{ hm}$ not necessary

↖ 0.700

4 places left

or

0.0700 hm
 0.07 hm

c) $0.53 \text{ dm} = \underline{\hspace{2cm}} \text{ m}$

↖ 0.53

left 1 place

0.053m

d) $74\text{m} = \underline{\hspace{2cm}} \text{km}$

0.74

$$\boxed{0.074\text{km}}$$

e) $31.2\text{mm} = \underline{\hspace{2cm}} \text{dam}$

0.0312

$$\boxed{0.00312\text{dam}}$$

Conversions Between English + Metric

$$1\text{ inch} \approx 2.54\text{cm}$$

$$3\text{ mi} \approx 5\text{ km}$$

Ex 4: Convert

a) $2\text{ft} = \underline{\hspace{2cm}} \text{cm}$

$$2\cancel{\text{ft}} \left(\frac{12\cancel{\text{in}}}{1\cancel{\text{ft}}} \right) \left(\frac{2.54\text{cm}}{1\cancel{\text{in}}} \right) = \boxed{60.96\text{cm}}$$

b) $100 \text{ km} = \underline{\hspace{2cm}} \text{ mi}$

$$100 \cancel{\text{ km}} \left(\frac{3 \cancel{\text{ mi}}}{5 \cancel{\text{ km}}} \right) = \boxed{60 \text{ mi}}$$

The perimeter of a polygon is the sum (add) of the lengths of the sides.

Perimeter
↑
edge!

Perimeter Perimeter
Area
Perimeter Peri-
meter Peri-

Perimeter = baseboards

Area = flooring (think "Area rug")

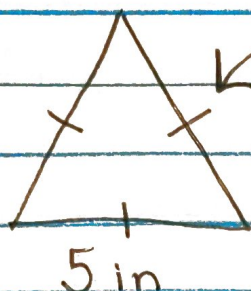
Ex 5: Find the perimeter

a)  2 cm rectangle
8 cm
$$= 8 + 2 + 8 + 2$$

$$= \boxed{20 \text{ cm}}$$

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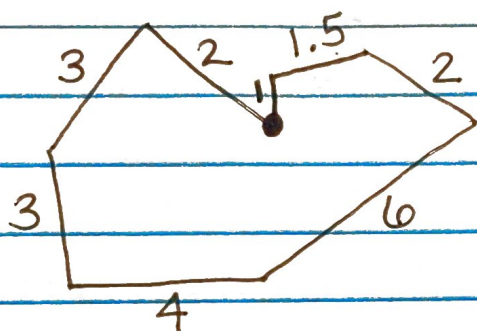
b)



equilateral triangle

$$P = 5 + 5 + 5 = \boxed{15 \text{ in}}$$

c)



$$P = 2 + 3 + 3 + 4 + 6 + 2 + 1.5 + 1$$

$$P = \boxed{22.5 \text{ units}}$$

d) What is the perimeter of a regular 23-gon with side length x ? all sides congruent

$$\underbrace{x + x + x + \dots + x}_{23} = \boxed{23x}$$

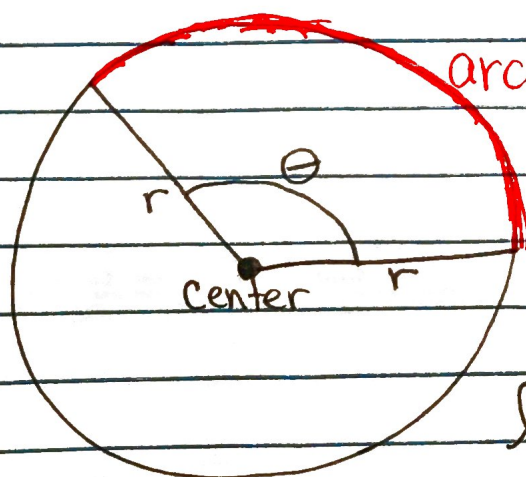
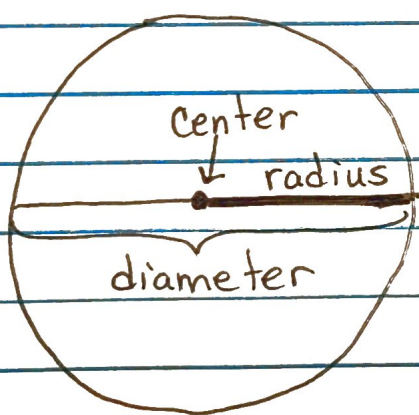
A circle is the set of all points in a plane that are the same distance from a fixed point called the center.

Circumference - the perimeter of a circle.

$$C = \pi d \text{ or } C = 2\pi r$$

$\uparrow$ diameter $\nwarrow$ radius

Pi (π) - the ratio of a circle's circumference to its diameter



$$l = \frac{\pi r \theta}{180^\circ}$$

"theta" $\swarrow$

$$l = 2\pi r \cdot \frac{\theta}{360^\circ} \quad \left(\text{arclength is a fraction of the circumf.} \right)$$

Ex 6:

- a) Find the circumference of a circle with radius 2m.

$$C = 2\pi r$$

$$C = 2\pi(2)$$

$$C = 4\pi \text{ m}$$

- b) Find the radius of a circle with circumference 15π meters.

↓

$$C = 2\pi r$$

$$\frac{15\pi}{2\pi} = \frac{2\pi r}{2\pi}$$

$$r = \frac{15}{2} \text{ m}$$

- c) Find the length of a 25° arc of a circle with diameter 10 cm.

$$l = \frac{\pi r \theta}{180^\circ}$$

$$r = 5 \text{ cm}$$

$$l = \frac{\pi(5)(25^\circ)}{180^\circ} \Rightarrow l = \frac{25}{36} \pi \text{ cm}$$

- d) Find the radius of an arc whose central angle is 87° and whose arclength is 154 cm.

$$l = \frac{\pi r \theta}{180^\circ}$$

$$154 = \frac{\pi r (87^\circ)}{180^\circ}$$

$$154 = 1.518436 r$$
$$\frac{154}{1.518436} = r$$

$$101.42 \text{ cm} = r$$