



Unit 1: Review of sign rules for arithmetic operations
Lesson 03 Unit multipliers

Rules for addition and subtraction:

If signs are alike: Add the two numbers and apply their sign.

Example group 1:

$$3 + (+4) = +7$$

$$(-5) - 4 = -9$$

$$5 + 8 = +13$$

$$-4 + (-6) = -10$$

$$-9 - 2 = -11$$

If signs are different: Subtract and give the answer the sign of the largest number.

Examples group 2:

$$3 + (-7) = -4$$

$$14 - 8 = 6$$

$$9 - 11 = -2$$

$$22 + (-1) = 21$$

Rules for multiplication:

If signs are alike: Multiply and give the answer a positive sign.

Example group 3:

$$3(4) = 12$$

$$-3(-12) = 36$$

$$(-5)(-3) = 15$$

If signs are different: Multiply and give the answer a negative sign.

Example group 4:

$$(-3)4 = -12$$

$$5(-2) = -10$$

Rules for division (same as for multiplication):

If signs are alike: Divide and give the answer a positive sign.

Example group 5:

$$12 / (4) = 3$$

$$-12 / (-3) = 4$$

$$6 / 2 = 3$$

$$(-15) / (-3) = 5$$

If signs are different: Divide and give the answer a negative sign.

Example group 6:

$$(-30) / 5 = -6$$

$$-8 / 2 = -4$$

$$16 / (-2) = -8$$

Unit multipliers:

Now consider the various ways in which we could express 1 as any number over itself. For example:

$$\frac{189}{189} = 1, \quad \frac{\pi}{\pi} = 1, \text{ etc.}$$

Consider an unusual way in which we could multiply by 1. Since 12 inches = 1 foot, when we “stack” them as follows, the quotient is exactly 1:

$$\frac{12 \text{ in}}{1 \text{ ft}} = 1 \quad \text{or} \quad \frac{1 \text{ ft}}{12 \text{ in}} = 1$$

Some other ways to “build 1” are:

$$\frac{2 \text{ pints}}{1 \text{ quart}}, \quad \frac{1 \text{ yd}}{36 \text{ ''}}, \quad \frac{100 \text{ cm}}{1 \text{ meter}}$$

These quantities that are equivalent to 1 are known as **unit multipliers**. They are useful in converting a number expressed in one type of units to an **equivalent number of different types of units**. . .for example, from inches to yards.

Example 7: Convert 108.19 inches to yards.

$$\frac{108.19 \cancel{\text{in}}}{1} \cdot \frac{1 \text{ yd}}{36 \cancel{\text{in}}} = \frac{108.19 \text{ yd}}{36}$$

$$= \boxed{3.00527 \text{ yd}}$$

Example 8: Convert 22.8 feet into inches.

$$\frac{22.8 \cancel{\text{ft}}}{1} \cdot \frac{12 \text{ in}}{1 \cancel{\text{ft}}} = 22.8(12) \text{ in}$$

$$= \boxed{273.6 \text{ in}}$$

Example 9: Convert 450 cm into meters.

$$\frac{450 \cancel{\text{cm}}}{1} \cdot \frac{1 \text{ m}}{100 \cancel{\text{cm}}} = \frac{450 \text{ m}}{100}$$

$$= \boxed{4.5 \text{ m}}$$

Example 10: Use the fact that 1 inch = 2.54 cm to convert 19 cm into inches.

$$\frac{19 \cancel{\text{cm}}}{1} \cdot \frac{1 \text{ in}}{2.54 \cancel{\text{cm}}} = \frac{19 \text{ in}}{2.54}$$

$$= \boxed{7.4803 \text{ in}}$$

Multiple applications of unit multipliers:

It is possible to apply **more than one unit multiplier in succession** in order to achieve the desired conversion.

***Example 11:** Convert 150 meters into inches.

$$\begin{aligned} \frac{150 \cancel{\text{m}}}{1} \cdot \frac{100 \text{ cm}}{1 \cancel{\text{m}}} &= 15,000 \cancel{\text{m}} \frac{1 \text{ in}}{2.54 \cancel{\text{cm}}} \\ &= \frac{15,000}{2.54} \text{ in} \\ &= \boxed{5,905.5118 \text{ in}} \end{aligned}$$

Assignment:

1. $5(-3) = -15$	2. $8(5) = 40$	3. $-9/(-3) = 3$
4. $-2(-6) = 12$	5. $22(-1) = -22$	6. $-12(-2) = 24$
7. $3 + (-8) = -5$	8. $(-50)/10 = -5$	9. $2 + (19) = 21$
10. $16(2) = 32$	11. $23 + (-2) = 21$	12. $-8/4 = -2$
13. $15 - 6 = 9$	14. $16/(-2) = -8$	15. $36/4 = 9$
16. $(-3)(-8) = 24$	17. $5(-4) = -20$	18. $-3(-22) = 66$
19. $9 - 12 = -3$	20. $5 + (8) = 13$	21. $-6 + (-7) = -13$
22. $8 + (-11) = -3$	23. $(-2) - 4 = -6$	24. $-19(-2) = 38$
*25. $(400 - 20)/(-10) = -38$	*26. $-4 + (-2)(-6) = 8$	*27. $(-5)(-4)(-3) = -60$

28. Use a unit multiplier to convert 24.1 quarts to pints (1 quart = 2 pints).

$$\frac{24.1 \cancel{q}}{1} \cdot \frac{2p}{\cancel{1q}} = (24.1) 2 \text{ pints}$$

$$= \boxed{48.2 \text{ pints}}$$

29. Use a unit multiplier to convert 80.9 millimeters to meters (1000 mm = 1 m).

$$\frac{80.9 \cancel{\text{mm}}}{1} \cdot \frac{1 \text{ m}}{1000 \cancel{\text{mm}}} = \frac{80.9}{1000} \text{ m}$$

$$= \boxed{0.0809 \text{ m}}$$

30. Use a unit multiplier to convert 11.28 inches to centimeters (2.54 cm = 1 in).

$$\frac{11.28 \cancel{\text{in}}}{1} \cdot \frac{2.54 \text{ cm}}{1 \cancel{\text{in}}} = 11.28(2.54) \text{ cm}$$

$$= \boxed{28.6512 \text{ cm}}$$

31. Use a unit multiplier to convert 102 centimeters to inches.

$$\frac{102 \cancel{\text{cm}}}{1} \cdot \frac{1 \text{ in}}{2.54 \cancel{\text{cm}}} = \frac{102}{2.54} \text{ in}$$

$$= \boxed{40.15748 \text{ in}}$$

32. Use a unit multiplier to convert 82,000 feet to miles (5280 ft = 1 mi).

$$\frac{82,000 \cancel{\text{ft}}}{1} \cdot \frac{1 \text{ mi}}{5280 \cancel{\text{ft}}} = \frac{82,000}{5280} \text{ mi}$$

$$= \boxed{15.5303 \text{ mi}}$$

*33. Use multiple unit multipliers to convert 82,000 inches to meters.

$$\frac{82,000 \cancel{\text{in}}}{1} \cdot \frac{2.54 \text{ cm}}{1 \cancel{\text{in}}} = \frac{82,000(2.54) \cancel{\text{cm}}}{1} \cdot \frac{1 \text{ m}}{100 \cancel{\text{cm}}}$$

$$= \frac{82,000(2.54)}{100} \text{ m} = \boxed{2082.8 \text{ m}}$$