Section 3.6 Order of Operations with Rational Numbers

B   Do the operations in brackets first
E   Next, evaluate any exponents
D
M } Then, divide and multiply in order from left to right

A
S } Finally, add and subtract in order from left to right

Order of Operations with Decimals

Example # 1   **(- 2.4) ÷ 1.2** – 7 × 0.2

                                                          Divide First
               = -2 − **7 × 0.2**   Then, multiply
               = -2 − 1.4   To subtract, add the opposite
               = -2 + (-1.4)
               = - 3.4

Example # 2   **(-3.4 + 0.6)** + 4^2 × 0.2

                                                          Brackets First
               = - 2.8 + **4^2** × 0.2   Then evaluate the power
               = - 2.8 + **16 × 0.2**   Then multiply
               = - 2.8 + 3.2
               = 0.4

Order of Operations with Fractions

Example # 1

$$\left(\frac{3}{4} - \frac{7}{8}\right) \div \left(-\frac{5}{16}\right)$$

Subtract in the brackets first

Use a common denominator of 8

$$\left(\frac{6}{8} - \frac{7}{8}\right) \div \left(-\frac{5}{16}\right)$$

$$\left(-\frac{1}{8}\right) \div \left(-\frac{5}{16}\right)$$

To divide, multiply by the reciprocal

$$\left(-\frac{1}{8}\right) \times \left(-\frac{16}{5}\right)$$

Look for common factors

$$\left(-\frac{1}{\cancel{8}_1}\right) \times \left(-\frac{\cancel{16}^{\,2}}{5}\right)$$

Both factors are negative, so the product is positive.

$$= \frac{2}{5}$$

Example #2

$$\left(-\frac{2}{3}\right) \times \frac{1}{6} + \frac{1}{2}$$

Multiply First

$$\left(-\frac{\cancel{2}^{\,1}}{3}\right) \times \frac{1}{\cancel{6}^{\,3}} + \frac{1}{2}$$

Look for common factors

$$\left(-\frac{1}{9}\right) + \frac{1}{2}$$

Add.

Use a common denominator of 18.

$$-\frac{2}{18} + \frac{9}{18}$$

$$= \frac{7}{18}$$

Example # 3 $\left(2\frac{1}{3}\right) + \left(1\frac{1}{4}\right) \times \left(-\frac{2}{3}\right)$ Convert mixed numbers to improper fractions

$$\left(\frac{7}{3}\right) + \left(\frac{5}{4}\right) \times \left(-\frac{2}{3}\right)$$ Multiply first

$$\left(\frac{7}{3}\right) + \left(-\frac{10}{12}\right)$$ Add

Use a common denominator of 12

$$\frac{28}{12} + \left(-\frac{10}{12}\right)$$

$$= \frac{18}{12}$$ Convert improper fractions to mixed numbers

$$= 1\frac{6}{12} = 1\frac{1}{2}$$ Always Reduce

Error Questions

1. A student's solution to a problem, to the nearest hundredth, is shown below. The solution is incorrect. Identify the errors. Provide a correct solution.

$(-8.2)^2 \div (-0.2) - 2.9 \times (-5.7)$

$= 67.24 \div (-0.2) - 2.9 \times (-5.7)$
$= 67.24 \div (-0.2) - 16.53$
$= 67.24 \div (16.73)$
~ 4.02

Answer: $(-8.2)^2 \div (-0.2) - 2.9 \times (-5.7)$

$67.24 \div (-0.2) - 2.9 \times (-5.7)$

$- 336.2 - 2.9 \times (-5.7)$

$- 336.2 - 16.53$

-352.73

2. Two students were asked to evaluate:

$$(-8) - 2(24 \div (-8))^2$$

Here are their calculations.

Student 1

$(-8) - 2(24 \div (-8))^2$
$= (-10)(24 \div (-8))^2$
$= (-10)(-3)^2$
$= (-10)(9)$
$= -90$

Student 2

$(-8) - 2(24 \div (-8))^2$
$= (-8) - 2(-3)^2$
$= (-8) - (-6)^2$
$= -8 - 36$
$= -44$

Why did both these students get incorrect answers?   What is the correct answer?

Answer:

Student 1

$(-8) - 2(24 \div (-8))^2$
$= (-10)(24 \div (-8))^2$
$= (-10)(-3)^2$
$= (-10)(9)$
$= -90$

Student 2

$(-8) - 2(24 \div (-8))^2$
$= (-8) - 2(-3)^2$
$= (-8) - (-6)^2$
$= -8 - 36$
$= -44$

Student 1 subtracted first.
They didn't follow BEDMAS.

Student 2 multiplied 2 and 3
when they should have done the
exponent next.

Correct Answer:
$(-8) - 2(24 \div (-8))^2$

$= (-8) - 2(-3)^2$
$= (-8) - 2(9)$
$= (-8) - 18$
$= -26$

3. The following test question was marked out of 3. What mark would you give this student? Justify your answer.

Calculate: $\dfrac{-7}{8} - \dfrac{3}{4} \div \dfrac{1}{5} - \dfrac{1}{4}$

Student's Answer:

$$= \dfrac{-7}{8} - \dfrac{3}{4} \times \dfrac{1}{5} - \dfrac{1}{4}$$

$$= \dfrac{-7}{8} - \dfrac{3}{20} - \dfrac{1}{4}$$

$$= \dfrac{-7}{40} - \dfrac{3}{40} - \dfrac{1}{40}$$

$$= \dfrac{-11}{40}$$

The student might get 1/3. They knew they had to change the divide to a multiply but forgot to reciprocal the second fraction. They also knew they had to get common denominators but didn't use equivalent fractions and adjust the numerators too.

Correct Answer

$$\dfrac{-7}{8} - \dfrac{3}{4} \times \dfrac{5}{1} - \dfrac{1}{4}$$

$$= \dfrac{-7}{8} - \dfrac{15}{4} - \dfrac{1}{4}$$

$$= \dfrac{-7}{8} - \dfrac{30}{8} - \dfrac{2}{8}$$

$$= \dfrac{-39}{8}$$