Solving Multi-Step Problems with Rational Numbers

Apply the skill to decisions and designs

Name _____ **Date** _____ **Score** _____ / 8

QUICK REVIEW

Write one expression for the quantity requested. Use signs for gains and losses, and group amounts that must be combined before multiplying or dividing. For example, dividing a net change of $-6+2$ among 4 stages gives $(-6+2)/4=-1$ per stage.

Worked example

A machine drops $3/2$ m on each of two moves, then rises $1/4$ m. Write one expression for the net change.

1. The two drops are negative changes. Use $2(-\frac{3}{2})+\frac{1}{4}$.
2. Together the drops give $2(-\frac{3}{2})=-3$ m.
3. Evaluate $-3+\frac{1}{4}=-\frac{11}{4}$ m.
Answer: $2(-\frac{3}{2})+\frac{1}{4}=-\frac{11}{4}$ m.

Practice Problems

Show your thinking.

1. A tank has $9/2$ L. A process uses three fills of $5/4$ L and needs a 1 L reserve afterward. Write one expression for the balance. Is the reserve met, and by how much?

2. Plan A costs 4 dollars plus $9/4$ dollars per visit. Plan B costs 2 dollars plus $11/4$ dollars per visit. Write one expression for A minus B at three visits. Which plan is cheaper?

3. A bag can hold 10 kg. It already contains $7/4$ kg of gear and two $3/4$ kg bottles. Samples are $5/4$ kg each. Write one expression for the remaining capacity in samples. What is the most whole samples that fit?

4. A freezer starts at -2 degrees C, cools $1/2$ degree for each of five cycles, then warms $3/4$ degree. Write one expression for its final reading minus the maximum of -4 degrees C. Does it meet the limit?

5. Team A earns $7/4$ points on each of five turns and loses $3/4$ on each of two turns. It cancels one loss. Team B has $33/4$ points. Write one expression for A minus B after the cancellation. Does A take the lead?

6. Blend three $3/2$ L containers with another $5/4$ L. The blend is split equally into five bottles. Write one expression for each bottle. Does each meet a minimum of $6/5$ L?

7. A diver starts at $-7/2$ m relative to the surface, descends $3/4$ m three times, and rises $1/2$ m. Write one expression for the final position. Did the diver stay above $-11/2$ m throughout?

8. A workshop doubles a mixture that uses $5/4$ L of paint and $1/2$ L of thinner per batch, then adds another $3/4$ L of thinner. Write one expression for the total. Does it fit in a 4 L container?

Answer Key

1. $\frac{9}{2} - 3(\frac{5}{4}) = \frac{3}{4}$ L. The reserve is short by $\frac{1}{4}$ L.
2. $[4 + 3(\frac{9}{4})] - [2 + 3(\frac{11}{4})] = \frac{1}{2}$ dollars. The difference is positive, so Plan B is cheaper.
3. $[10 - \frac{7}{4} - 2(\frac{3}{4})] \div \frac{5}{4} = \frac{27}{5}$ samples of capacity. At most 5 whole samples fit, since $5 < 27/5 < 6$.
4. $[-2 - 5(\frac{1}{2}) + \frac{3}{4}] - (-4) = \frac{1}{4}$ degrees C. The reading is $\frac{1}{4}$ degree too warm.
5. $[5(\frac{7}{4}) - 2(\frac{3}{4}) + \frac{3}{4}] - \frac{33}{4} = -\frac{1}{4}$ points. A still trails by $\frac{1}{4}$ point.
6. $[3(\frac{3}{2}) + \frac{5}{4}] \div 5 = \frac{23}{20}$ L. No: $\frac{23}{20} < \frac{24}{20} = \frac{6}{5}$.
7. $-\frac{7}{2} - 3(\frac{3}{4}) + \frac{1}{2} = -\frac{21}{4}$ m. No. The lowest point $-\frac{23}{4}$ is below the limit $-\frac{22}{4}$, even though the final point is above it.
8. $2(\frac{5}{4} + \frac{1}{2}) + \frac{3}{4} = \frac{17}{4}$ L. No. It exceeds 4 L by $\frac{1}{4}$ L.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. Subtract all three fills before comparing with the reserve. Use $\frac{9}{2} - 3(\frac{5}{4})$.
2. The fills use $3(\frac{5}{4}) = \frac{15}{4}$ L.
3. Evaluate $\frac{18}{4} - \frac{15}{4} = \frac{3}{4}$ L.
4. The reserve is short by $\frac{1}{4}$ L.

Problem 2

1. Include the fee and three visit charges for each plan before subtracting. Use $[4 + 3(\frac{9}{4})] - [2 + 3(\frac{11}{4})]$.
2. A costs $4 + \frac{27}{4} = \frac{43}{4}$ and B costs $2 + \frac{33}{4} = \frac{41}{4}$ dollars.
3. Evaluate $\frac{43}{4} - \frac{41}{4} = \frac{1}{2}$ dollars.
4. The difference is positive, so Plan B is cheaper.

Problem 3

1. Subtract gear and both bottles before dividing by the sample weight. Use $[10 - \frac{7}{4} - 2(\frac{3}{4})] \div \frac{5}{4}$.
2. The available mass is $10 - \frac{7}{4} - \frac{6}{4} = \frac{27}{4}$ kg.
3. Evaluate $\frac{27}{4} \div \frac{5}{4} = \frac{27}{5}$ samples of capacity.
4. At most 5 whole samples fit, since $5 < 27/5 < 6$.

Problem 4

1. Apply the signed changes before comparing with the maximum. Use $[-2 - 5(\frac{1}{2}) + \frac{3}{4}] - (-4)$.
2. The actual final reading is $-2 - \frac{5}{2} + \frac{3}{4} = -\frac{15}{4}$ degrees C.
3. Evaluate $-\frac{15}{4} - (-4) = \frac{1}{4}$ degrees C.
4. The reading is $\frac{1}{4}$ degree too warm.

Problem 5

1. Add back one loss, then subtract B from the adjusted A score. Use $[5(\frac{7}{4}) - 2(\frac{3}{4}) + \frac{3}{4}] - \frac{33}{4}$.
2. A ends with $\frac{35}{4} - \frac{6}{4} + \frac{3}{4} = 8$ points.
3. Evaluate $8 - \frac{33}{4} = -\frac{1}{4}$ points.
4. A still trails by $\frac{1}{4}$ point.

Problem 6

1. Combine both supplies before dividing among the 5 bottles. Use $[3(\frac{3}{2}) + \frac{5}{4}] \div 5$.
2. The blend totals $\frac{9}{2} + \frac{5}{4} = \frac{23}{4}$ L.
3. Evaluate $\frac{23}{4} \div 5 = \frac{23}{20}$ L.
4. No: $\frac{23}{20} < \frac{24}{20} = \frac{6}{5}$.

Problem 7

1. Subtract all three descents and add the final rise. Use $-\frac{7}{2} - 3(\frac{3}{4}) + \frac{1}{2}$.
2. The lowest point is just before rising: $-\frac{7}{2} - 3(\frac{3}{4}) = -\frac{23}{4}$ m.
3. Evaluate $-\frac{23}{4} + \frac{1}{2} = -\frac{21}{4}$ m.
4. No. The lowest point $-\frac{23}{4}$ is below the limit $-\frac{22}{4}$, even though the final point is above it.

Problem 8

1. Double both ingredients, but add the extra thinner only once. Use $2(\frac{5}{4} + \frac{1}{2}) + \frac{3}{4}$.
2. Two regular batches give $2(\frac{7}{4}) = \frac{7}{2}$ L.
3. Evaluate $\frac{7}{2} + \frac{3}{4} = \frac{17}{4}$ L.
4. No. It exceeds 4 L by $\frac{1}{4}$ L.

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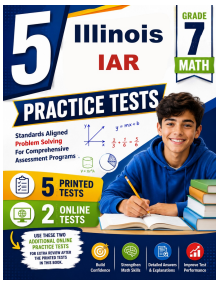

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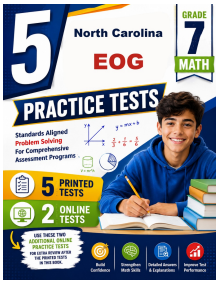

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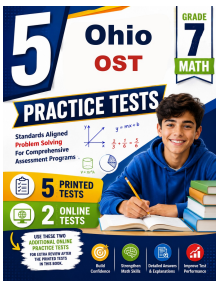

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