# Rewriting Expressions to Solve Problems

Apply the skill to decisions and designs

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**QUICK REVIEW**

Equivalent expressions reveal different information. $8(x+2)+5=8x+21$ shows an $8$-dollar cost per extra item and a fixed total of $21$ dollars. The distributive property preserves the value for every allowed input, not only for one example.

**Worked example**

A club pays $9$ dollars for each of $x+2$ items and one $4$-dollar fee. Rewrite the bill and find the total at $x=3$.

**1.** The grouped bill is $9(x+2)+4$.
**2.** Distribute and add the one-time fee: $9x+18+4=9x+22$.
**3.** At $x=3$, the rewritten rule gives $9(3)+22=49$ dollars.
**Answer:** $9x+22$ dollars; $49$ dollars at $x=3$.

## Practice Problems

Show your thinking.

**1.** A print shop offers A: $4(x+3)+2$ dollars, or B: $4x+12$ dollars for the same $x$ extra copies. Does the cheaper plan depend on $x$? Prove it using a rewrite.

**2.** An order has identical bundles with $x$ extra supplies per bundle. The total invoice is $6x+24$ dollars. Each bundle has the same whole-dollar rate and fixed charge. Find the greatest possible whole number of bundles and the rule per bundle.

**3.** A package costs $3(x+4)+1$ dollars. A coupon removes the one-time dollar, and the company increases the price of each extra item by $2$ dollars. The four base items still cost $3$ each. Rewrite the new total and find the change from the old total at $x=5$.

**4.** Printing costs $6(x+2)+4$ dollars for $x$ extra pages, with a budget of $40$ dollars. Compare $x=4$ and $x=5$ after rewriting the rule. Which fits the budget?

**5.** A table shows an expanded plan gives $15$ dollars at $x=1$ and $19$ dollars at $x=3$. A clerk says its rule is $2(x+5)+3$. Expand it, check both table entries, and explain whether the table alone proves no other rule can fit.

**6.** A delivery service quotes $7(x+3)+2$ dollars. A worker changes it to $7(x+3+2)$ and says the total is unchanged. Rewrite both. Does the mistake always add the same amount?

**7.** Supply package: a cost in dollars is modeled by $3(2x+5)$. Rewrite it to expose its coefficient and fixed amount, then find the cost at $x=2$.

**8.** Ticket bundle: decide whether $4(3x+2)$ and $12x+8$ are equivalent for every $x$. Give algebra and a numerical check.

# Answer Key

1. B is always 2 dollars less.
2. 6 bundles, each $x + 4$ dollars.
3. New $5x + 12$ dollars; 9 dollars higher at $x = 5$.
4. $6x + 16$ dollars; only $x = 4$ fits (40 versus 46).
5. The rule expands to $2x + 13$ and fits both entries. Two entries alone do not rule out every other kind of rule.
6. Correct $7x + 23$; mistaken $7x + 35$. It always adds 12 dollars.
7. $6x + 15$; cost $27.00.
8. Yes; they are equivalent.

## Step-by-Step Solutions

Follow each calculation, then check your own work.

### Problem 1

1. Expand A: $4(x + 3) + 2 = 4x + 12 + 2 = 4x + 14$.
2. B has the same $4x$ variable cost, so the comparison does not depend on $x$.
3. The difference is $14 - 12 = 2$ dollars, so choose B.

### Problem 2

1. Find a factor of both the coefficient 6 and the constant 24.
2. The greatest common factor is 6, since $24/6 = 4$.
3. Write $6x + 24 = 6(x + 4)$. Each bundle has cost $x + 4$ dollars; distributing recovers the invoice.

### Problem 3

1. Original total expands to $3x + 13$ dollars.
2. Base items cost $3(4) = 12$, the fee is zero, and the extra-item rate is $3 + 2 = 5$, giving $5x + 12$.
3. At $x = 5$, new cost $5(5) + 12 = 37$ and old cost $3(5) + 13 = 28$. The change is $37 - 28 = 9$ dollars.

### Problem 4

1. Distribute the printing price: $6(x + 2) + 4 = 6x + 12 + 4 = 6x + 16$.
2. Four extra pages cost $6(4) + 16 = 40$ dollars.
3. Five cost $6(5) + 16 = 46$ dollars, above the budget. Equality at 40 is allowed.

### Problem 5

1. Distribute: $2(x + 5) + 3 = 2x + 10 + 3 = 2x + 13$.
2. Check $2(1) + 13 = 15$ and $2(3) + 13 = 19$ dollars.
3. The rewrite proves those two expressions match for every input. The two table entries alone only check $x = 1$ and $x = 3$.

### Problem 6

1. The correct rule includes one 2-dollar charge: $7(x + 3) + 2 = 7x + 21 + 2 = 7x + 23$.
2. The changed expression treats the fee as two extra items: $7(x + 3 + 2) = 7x + 35$.
3. The variable parts match; constants differ by $35 - 23 = 12$ dollars every time.

### Problem 7

1. Multiply the variable term: $3(2x) = 6x$.
2. Multiply the constant too: $3(5) = 15$.
3. Combine the two products: $6x + 15$.
4. The cost at $x = 2$ is $6(2) + (15) = 27$ dollars.

### Problem 8

1. Multiply the variable term: $4(3x) = 12x$.
2. Multiply the constant too: $4(2) = 8$.
3. Combine the two products: $12x + 8$.
4. Numerical check at $x = 2$: both equal $12(2) + (8) = 32$.

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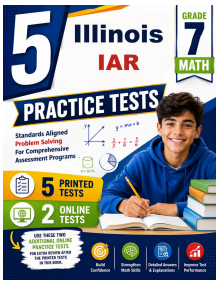


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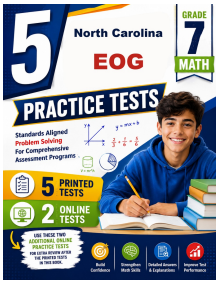


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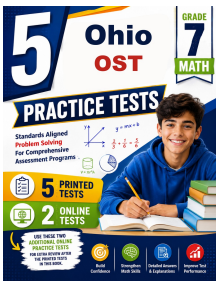


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