Rational Equation Word Problems: Setup Card

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Three formulas

- **Work:** rate = 1 ÷ time alone; part done = rate × time worked.
- **Motion:** time = distance ÷ speed. With a current c: $r + c$ one way, $r - c$ the other.
- **Shares and ratios:** share = total ÷ count; proportion = part ÷ whole, so $\frac{3}{4} = 75\%$.

The routine

1. Name the unknown with its units.
2. Build a table: one row per worker, leg, or group.
3. Fill the fraction column by dividing.
4. Turn the sentence that compares the rows into the equation.
5. List the excluded values, multiply by the LCD, solve.
6. Check in the equation, then in the table. Answer with units.

Phrases to equations

Words in the problem	What they tell you	Equation piece
"Working together, they finish in 2 hours"	The rates add to the rate together	$\frac{1}{a} + \frac{1}{b} = \frac{1}{2}$
"The drain empties it in d hours"	Subtract the drain's rate	$\frac{1}{a} - \frac{1}{d}$
"Hose B takes 4 hours longer than hose A"	Compare the times	B's time = $t + 4$
"Alone for 2 hours, then he joins"	T = total time: she works T h, he works $T - 2$ h	$\frac{T}{a} + \frac{T-2}{b} = 1$
"In the same time"	The times are equal	$\frac{9}{r+2} = \frac{5}{r-2}$
"The round trip takes 2 hours 30 minutes"	The times add, in hours	$\frac{15}{r} + \frac{15}{r-5} = \frac{5}{2}$
"Downstream" / "upstream"	The current adds / subtracts	$r + c$ and $r - c$
"Arrives 30 minutes sooner"	The times differ by $\frac{1}{2}$ hour	$\frac{90}{r} - \frac{90}{r+15} = \frac{1}{2}$
"Each share drops by $10"	Old share minus new share	$\frac{240}{n} - \frac{240}{n+2} = 10$
"Wins the next x games in a row"	Adds to the part and the whole	$\frac{9+x}{15+x}$
"Average speed for the round trip"	Total distance ÷ total time	$\frac{2d}{\frac{d}{10} + \frac{d}{r}}$

Two checks

- **Equation:** reject any candidate that makes an original denominator zero; it lies outside the equation's domain. Substitute the rest into the original equation.
- **Story:** times, speeds, and counts must be positive, counts must be whole, and a current must be slower than the boat. While a pipe and a drain both run, the filling rate must exceed the draining rate for the tank to keep filling. A candidate that fails here is nonviable.

Work estimate

Two workers who take a and b hours alone finish together in $T = \frac{ab}{a+b}$. That is less than the faster time alone and at least half of it.

Worked in one line

9 miles downstream and 5 upstream in the same time, current 2 mph: $\frac{9}{r+2} = \frac{5}{r-2} \rightarrow 9r - 18 = 5r + 10 \rightarrow r = 7$ mph.