

A Machine In A Factory Makes $2\frac{1}{4}$ Pounds Of Nails In $1\frac{1}{2}$ Hours. At What Rate, In Pounds Per Hour, Does

A Machine In A Factory Makes $2\frac{1}{4}$ Pounds Of Nails In $1\frac{1}{2}$ Hours. At What Rate, In Pounds Per Hour, Does this machine produce nails? This question is a classic example of a rate problem often encountered in mathematics involving conversion of mixed numbers to improper fractions, calculating unit rates, and understanding proportional relationships. Whether you're a student preparing for math exams, a professional in manufacturing analyzing productivity, or someone interested in solving real-world problems, understanding how to determine the rate of production per hour is essential. In this comprehensive guide, we'll explore step-by-step methods to solve this problem, delve into related concepts such as unit rates and proportional reasoning, and provide practical tips to approach similar questions efficiently.

Understanding the Problem: Breaking Down the Question

Before jumping into calculations, it's crucial to understand what the problem is asking. The key components are:

- Total pounds of nails produced: $2\frac{1}{4}$ pounds
- Total time taken: $1\frac{1}{2}$ hours
- Goal: Find the production rate in pounds per hour

The question asks, "At what rate, in pounds per hour, does the machine produce nails?" Essentially, we are asked to find the unit rate — how many pounds of nails are produced in one hour.

Converting Mixed Numbers to Improper Fractions

Since the quantities are given as mixed numbers, it's often easier to work with improper fractions in calculations. Let's convert both mixed numbers:

Converting $2\frac{1}{4}$ Pounds

$$- 2 \frac{1}{4} = (2 \times 4 + 1) / 4 = (8 + 1) / 4 = 9/4$$

Converting 1 1/2 Hours

$$- 1 \frac{1}{2} = (1 \times 2 + 1) / 2 = (2 + 1) / 2 = 3/2$$

Using improper fractions simplifies multiplication and division processes.

Calculating the Rate: Step-by-Step Approach

The rate in pounds per hour can be found by dividing the total pounds by the total hours:

$$\text{Rate} = \text{Total Pounds} / \text{Total Hours}$$

Using the improper fractions:

$$\text{Rate} = (9/4) / (3/2)$$

Dividing fractions involves multiplying the first fraction by the reciprocal of the second:

$$\text{Rate} = (9/4) \times (2/3)$$

Now, perform the multiplication:

$$\text{Rate} = (9 \times 2) / (4 \times 3) = 18 / 12$$

Simplify the fraction:

$$\text{Rate} = (18 \div 6) / (12 \div 6) = 3/2$$

Expressed as a mixed number or decimal:

- As a mixed number: 1 1/2 pounds per hour
- As a decimal: 1.5 pounds per hour

Final answer:

The machine produces nails at a rate of 1.5 pounds per hour.

Interpreting the Result: What Does 1.5 Pounds Per Hour Mean?

Understanding the significance of this rate helps in practical applications:

- Production Planning: Knowing the rate helps estimate how much the machine can produce over a given period.
- Efficiency Analysis: Comparing the rate with other machines or benchmarks to assess productivity.
- Cost Estimation: Calculating costs associated with production based on the rate.

In this case, the machine makes 1.5 pounds of nails every hour, which means if it runs continuously for 8 hours, it will produce:

$$8 \text{ hours} \times 1.5 \text{ pounds/hour} = 12 \text{ pounds}$$

This information is vital for manufacturing schedules and inventory management.

Related Concepts in Rate Problems

Understanding this problem opens the door to several related mathematical concepts:

1. Unit Rate

The rate calculated (1.5 pounds/hour) is an example of a unit rate — a ratio that compares a quantity to one unit of another quantity. Such rates are essential for comparing different quantities efficiently.

2. Proportional Reasoning

This problem demonstrates proportionality — as time increases, production increases proportionally if the rate remains constant.

3. Conversion of Mixed Numbers

Mastering the conversion process is crucial for handling real-world problems with mixed number quantities.

4. Fraction Multiplication and Division

These operations are fundamental in solving rate problems involving improper fractions.

Practical Tips for Solving Rate Problems

To efficiently tackle similar problems, consider the following strategies:

- Convert all mixed numbers to improper fractions to facilitate calculations.
- Identify total quantities and total time clearly before starting calculations.
- Use reciprocal multiplication for division of fractions.
- Simplify fractions whenever possible to make calculations easier.
- Verify your answer by checking units — ensure the rate is in pounds per hour as required.
- Use decimal equivalents when clarity is preferred or for easier interpretation.

Additional Examples and Practice Problems

Practicing with similar problems helps reinforce understanding. Here are some examples:

Example 1:

A machine produces $3 \frac{1}{2}$ pounds of nails in 2 hours. What is the production rate in pounds per hour?

Solution:

- Convert mixed numbers: $3 \frac{1}{2} = \frac{7}{2}$

- Total hours: $2 = 2/1$
- Rate = $(7/2) \div 2 = (7/2) \times (1/2) = 7/4 = 1 \frac{3}{4}$ pounds per hour

Example 2:

A worker assembles $5 \frac{3}{4}$ units of products in $3 \frac{1}{2}$ hours. Find the assembly rate per hour.

Solution:

- Convert: $5 \frac{3}{4} = (5 \times 4 + 3)/4 = 23/4$
- $3 \frac{1}{2} = (3 \times 2 + 1)/2 = 7/2$
- Rate = $(23/4) \div (7/2) = (23/4) \times (2/7) = (23 \times 2) \div (4 \times 7) = 46/28$
- Simplify: $46/28 = 23/14 \approx 1.64$ units/hour

Conclusion: Mastering Rate Calculations for Real-World Applications

Calculating the rate of production, such as in the scenario of a machine making nails, is a fundamental skill in mathematics with widespread applications in manufacturing, economics, and everyday problem-solving. By converting mixed numbers to improper fractions, applying fraction multiplication and division, and understanding unit rates, you can efficiently solve similar problems. Remember to verify your units, simplify fractions, and interpret your results in context. With practice, you'll develop confidence in handling complex rate problems and applying these skills to real-world situations.

SEO Keywords and Phrases

- Rate of production calculation
- Pounds per hour rate
- Mixed number to improper fraction conversion
- How to find unit rate
- Manufacturing productivity analysis
- Fraction division in rate problems
- Practical math rate problems

- Real-world rate calculation examples
- Mathematical problem solving for manufacturing
- Understanding unit rates in manufacturing

By mastering the process outlined above, you can confidently approach questions involving rates, whether in academic settings or practical scenarios like manufacturing and productivity analysis.

Frequently Asked Questions

What is the rate of nails produced per hour by the machine?

The machine makes 1.5 pounds of nails per hour.

How do you calculate the production rate in pounds per hour when given total weight and time?

Divide the total weight produced by the total time in hours; for example, 2.25 pounds divided by 1.5 hours equals 1.5 pounds per hour.

If the machine makes 2 1/4 pounds of nails in 1 1/2 hours, what is the production rate in pounds per hour?

The production rate is 1.5 pounds per hour.

What is the importance of understanding machine production rates in a factory?

It helps in planning, efficiency analysis, and optimizing manufacturing processes.

Can the rate of production change over time, and how would that affect calculations?

Yes, production rates can vary; in such cases, average rates are calculated over specific periods for accurate analysis.

How would you convert mixed numbers to improper fractions for calculation purposes?

Multiply the whole number by the denominator and add the numerator; for example, $2\frac{1}{4}$ becomes $\frac{9}{4}$.

What mathematical operations are involved in determining the hourly production rate?

Division of total weight by total time, often involving fraction simplification.

Is it necessary to convert hours into minutes for such calculations?

Not necessarily; converting hours to minutes is useful for more precise measurements, but in this case, working in hours simplifies the calculation.

How can understanding production rates improve factory efficiency?

By identifying bottlenecks and optimizing machine operation times, leading to increased productivity and cost savings.

Additional Resources

A Machine In A Factory Makes $2\frac{1}{4}$ Pounds Of Nails In $1\frac{1}{2}$ Hours. At What Rate, In Pounds Per Hour, Does

Understanding the rate at which a machine produces nails is essential for efficiency analysis, cost calculation, and process optimization in manufacturing. This detailed review delves into the problem's core, exploring the fundamental concepts of rate, units, and conversions involved, and offers a step-by-step approach to solving such problems confidently and accurately.

Introduction to Rate Problems in Manufacturing

Manufacturing environments often rely on precise calculations to optimize production rates. When evaluating the output of machinery, the key metric of interest is the rate — typically expressed as units produced per unit of time.

- Why is rate calculation important?

- Assessing machine efficiency
- Estimating total production over a period
- Planning workforce and maintenance schedules
- Cost and profit analysis
- Common units of rate:
- Items per hour
- Pounds per hour
- Units per minute or second (for very high-speed production)

In this context, the focus is on converting a known production quantity over a certain period into a per-hour rate, which provides a standardized measure of productivity.

The Core Problem Breakdown

Let's restate the problem for clarity:

- > A machine in a factory makes $2 \frac{1}{4}$ pounds of nails in $1 \frac{1}{2}$ hours.
- > Question: At what rate, in pounds per hour, does the machine produce nails?

This problem involves several key elements:

- Quantities involved:
- Total weight produced: $2 \frac{1}{4}$ pounds
- Total time taken: $1 \frac{1}{2}$ hours
- Objective:
- Find the rate of production in pounds per hour.

Understanding Mixed Numbers and Conversions

Before proceeding to calculations, it's crucial to interpret and convert mixed numbers into improper fractions or decimals for ease of computation.

Converting $2 \frac{1}{4}$ Pounds

- Mixed number: $2 \frac{1}{4}$

- Conversion to improper fraction:
- $2 \frac{1}{4} = (2 \times 4 + 1)/4 = (8 + 1)/4 = 9/4$ pounds
- Alternatively, decimal form:
- $2 \frac{1}{4} = 2.25$ pounds

Converting 1 1/2 Hours

- Mixed number: $1 \frac{1}{2}$
- Conversion to improper fraction:
- $1 \frac{1}{2} = (1 \times 2 + 1)/2 = (2 + 1)/2 = 3/2$ hours
- Alternatively, decimal form:
- $1 \frac{1}{2} = 1.5$ hours

Using these conversions simplifies the calculation process, especially when dealing with fractions versus decimals.

Calculating the Production Rate

The fundamental formula for rate is:

$$\text{Rate} = \frac{\text{Total Quantity}}{\text{Total Time}}$$

Applying this to our problem:

$$\text{Rate} = \frac{2 \frac{1}{4} \text{ pounds}}{1 \frac{1}{2} \text{ hours}}$$

Using improper fractions:

$$\text{Rate} = \frac{\frac{9}{4} \text{ pounds}}{\frac{3}{2} \text{ hours}}$$

Step-by-step calculation:

1. Set up the division of fractions:

$$\text{Rate} = \frac{9/4}{3/2}$$

2. Rewrite as multiplication by reciprocal:

$$\text{Rate} = \frac{9}{4} \times \frac{2}{3}$$

3. Simplify numerator and denominator:

- Multiply numerators: $(9 \times 2 = 18)$
- Multiply denominators: $(4 \times 3 = 12)$

4. Calculate:

$$\left[\text{Rate} = \frac{18}{12} \right]$$

5. Simplify the fraction:

$$\left[\frac{18}{12} = \frac{3 \times 6}{2 \times 6} = \frac{3}{2} \right]$$

6. Express as a decimal:

$$\left[\frac{3}{2} = 1.5 \text{ pounds per hour} \right]$$

Final Answer and Interpretation

The machine produces nails at a rate of 1.5 pounds per hour.

This means, on average, the machine is capable of producing one and a half pounds of nails every hour under the given conditions.

Additional Considerations and Real-World Implications

While the calculation appears straightforward, several real-world factors could influence the actual production rate:

Variability in Production

- Machines may not operate at a constant rate.
- External factors such as maintenance, jams, or operator intervention can cause fluctuations.

Efficiency and Optimization

- Understanding the theoretical rate helps identify potential improvements.
- If actual production is consistently below 1.5 pounds/hour, maintenance or process adjustments might be necessary.

Scaling Production

- Knowing the rate allows for forecasting:
- How many pounds of nails can be produced in a day, week, or month.
- How many machines are needed to meet a target production volume.

Extensions and Related Problems

The problem can be extended or varied in multiple ways:

- Different quantities and times: For example, if the machine produces 3 pounds in 2 hours, what's its rate?
- Multiple machines: Calculating combined production rates.
- Cost analysis: Determining cost per pound based on production rate.
- Efficiency improvements: Comparing current vs. improved rates to measure progress.

Practice Problems for Reinforcement

To solidify understanding, consider solving similar problems:

1. A machine makes $5\frac{1}{2}$ pounds of nails in 2 hours. What is its rate per hour?
2. If a machine produces 3 pounds of nails per hour, how much will it produce in 7 hours?
3. A factory aims to produce 100 pounds of nails in a day. If the machine produces at 1.5 pounds per hour, how many hours must it operate to reach the goal?

Summary of Key Steps in Rate Calculation

- Convert mixed numbers to improper fractions or decimals for ease of calculation.

- Use the fundamental rate formula: total quantity divided by total time.
- Simplify the resulting fraction or decimal to find the rate.
- Interpret the result in context, considering real-world factors.

Conclusion

Calculating production rates is a foundational skill in manufacturing, logistics, and engineering. This problem exemplifies the importance of careful unit conversion, fraction handling, and fundamental division skills. The answer — 1.5 pounds per hour — provides clear insight into the machine's productivity, enabling managers and engineers to make informed decisions about operational efficiency and process improvements.

Mastering such calculations equips professionals with tools to analyze and optimize manufacturing processes, ultimately leading to increased productivity and profitability.

In summary, understanding the rate at which a machine produces nails involves interpreting mixed numbers, converting them appropriately, applying division, and simplifying the result. Whether for academic purposes or industrial applications, these fundamental principles underpin effective problem-solving in quantitative contexts.

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