# Percent Error: How Close Are Your Estimates?

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**QUICK REVIEW**

The error fraction is $|\text{estimate} - \text{accepted}|/\text{accepted}$. Multiply by $100$ to get the percent number, then attach $\%$. An estimate $19$ cm for a $20$ cm object has $1$ cm absolute error and error fraction $1/20 = 0.05 = 5\%$. Use the accepted value below the fraction.

**Worked example**

Example ruler reading (cm): estimate $19$, accepted value $20$. Find absolute error and percent error.

**1.** Absolute error: $|19 - 20| = 1$ cm.
**2.** Use the accepted value $20$ cm as the denominator: $1/20 = \frac{1}{20}$.
**3.** The percent-error number is $\frac{1}{20}(100) = 5$; therefore the error is $5\%$.
**Answer:** Absolute error $1$ cm; percent error $5\%$.

## Practice Problems

Show your thinking.

**1.** Length in cm: estimate $48$, accepted value $50$. Is the estimate within $5\%$ of the accepted value? Support your decision.

**2.** Mass in g: estimate $84$, accepted value $80$. Is the estimate within $5\%$ of the accepted value? Support your decision.

**3.** Item count: estimate $95$, accepted value $100$. Is the estimate within $5\%$ of the accepted value? Support your decision.

**4.** Volume in mL: estimate $126$, accepted value $120$. Is the estimate within $5\%$ of the accepted value? Support your decision.

**5.** An accepted mass is $500$ g. Find the smallest and largest estimates allowed by a $5\%$ error limit.

**6.** For an accepted length of $500$ cm, two estimates are $475$ cm and $525$ cm. Do their percent errors differ?

**7.** Measuring tape (cm): estimate $58$, accepted value $60$. Is the estimate within $5\%$ of the accepted value? Support your decision.

**8.** Accepted mass is $80$ g. Compare estimates $78$ g and $83$ g; find both percent errors and choose the closer one.

# Answer Key

1. Absolute error $2$ cm; percent error $4\%$. Within tolerance.
2. Absolute error $4$ g; percent error $5\%$. Within tolerance.
3. Absolute error $5$ items; percent error $5\%$. Within tolerance.
4. Absolute error $6$ mL; percent error $5\%$. Within tolerance.
5. $475$ g through $525$ g, inclusive.
6. No. Both have $5\%$ error.
7. Absolute error $2$ cm; percent error $\frac{10}{3}\%$. Within tolerance.
8. Errors $2.5\%$ and $3.75\%$; $78$ g is closer.

## Step-by-Step Solutions

Follow each calculation, then check your own work.

### Problem 1

1. Absolute error: $|48 - 50| = 2$ cm.
2. Use the accepted value $50$ cm as the denominator: $2/50 = \frac{1}{25}$.
3. The percent-error number is $\frac{1}{25}(100) = 4$; therefore the error is $4\%$. Compare $4$ with $5$.

### Problem 2

1. Absolute error: $|84 - 80| = 4$ g.
2. Use the accepted value $80$ g as the denominator: $4/80 = \frac{1}{20}$.
3. The percent-error number is $\frac{1}{20}(100) = 5$; therefore the error is $5\%$. Compare $5$ with $5$.

### Problem 3

1. Absolute error: $|95 - 100| = 5$ items.
2. Use the accepted value $100$ items as the denominator: $5/100 = \frac{1}{20}$.
3. The percent-error number is $\frac{1}{20}(100) = 5$; therefore the error is $5\%$. Compare $5$ with $5$.

### Problem 4

1. Absolute error: $|126 - 120| = 6$ mL.
2. Use the accepted value $120$ mL as the denominator: $6/120 = \frac{1}{20}$.
3. The percent-error number is $\frac{1}{20}(100) = 5$; therefore the error is $5\%$. Compare $5$ with $5$.

### Problem 5

1. Maximum absolute error: $500(5/100) = 25$ g.
2. Lower estimate: $500 - 25 = 475$ g.
3. Upper estimate: $500 + 25 = 525$ g.

### Problem 6

1. Low estimate error: $|475 - 500| = 25$ cm.
2. High estimate error: $|525 - 500| = 25$ cm.
3. Both use denominator $500$, so the percent-error number is $(25/500)100 = 5$; each estimate has $5\%$ error.

### Problem 7

1. Absolute error: $|58 - 60| = 2$ cm.
2. Use the accepted value $60$ cm as the denominator: $2/60 = \frac{1}{30}$.
3. The percent-error number is $\frac{1}{30}(100) = \frac{10}{3}$; therefore the error is $\frac{10}{3}\%$. Compare $\frac{10}{3}$ with $5$.

### Problem 8

1. The errors are $|78 - 80| = 2$ g and $|83 - 80| = 3$ g.
2. Percent-error numbers are $2/80 \times 100 = 2.5$ and $3/80 \times 100 = 3.75$.
3. Since $2.5\% < 3.75\%$, the $78$ g estimate is closer.

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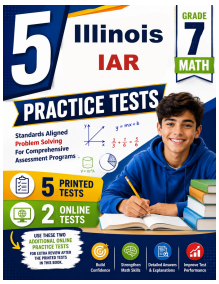


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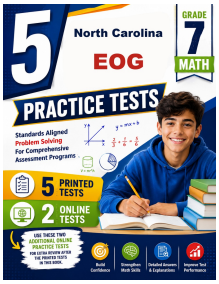


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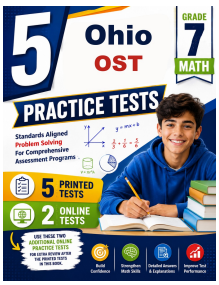


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