$$(3.57)(4.286) = 15.30102 \Rightarrow 15.3$$

3 sig. figs. — 4 sig. figs. — 7 sig. figs. — 3 sig. figs.

A: With addition / subtraction, for each quantity, compare the position of the last significant figure relative to the decimal point. The one farthest to the left is the position of the last permissible significant figure of the sum or difference.

$$1.0000 + 0.036 + 0.22 = 1.2560 \Rightarrow 1.26$$

Rule of Thumb for Rounding

If the digit to be dropped is a 5, always make the last digit of the rounded-off number even:

$$1.35 \Rightarrow 1.4$$

$$1.25 \Rightarrow 1.2$$

Validating Results

Every Problem you will ever have to solve in Chemical Engineering, involves two questions:

1) How do I get a solution?

2) How do I know my solution is right?

⇒ We are going to be answering the first question during this and other ChemE courses to come.

⇒ There are several ways Chemical Engineers attempt to answer question 2.

The following are three common methods for answering question 2):

a) Back-substitution: Substituting your answer back into the eqns.

b) Order-of-Magnitude Estimation: Obtaining a crude, easy-to-obtain approximate solution to the problem and seeing if it comes reasonably close to the exact solution.

c) Testing for Reasonableness: Verifying that the solution makes sense.

Ex: Is water flowing in a pipe faster than the speed of light?

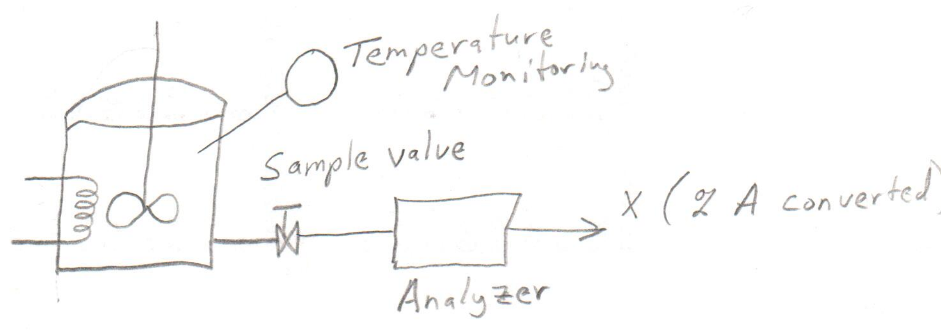
Is the calculated flowrate negative?

Is the calculated temperature hotter than the sun's surface?

NOTE: If you get in the habit of asking yourself "Does this make sense?" everytime you obtain a solution, you will spare yourself considerable grief/embarrassment.

MEAN & VARIANCE OF SAMPLED DATA

Consider the rxn A → Products being carried out @ 45°C starting with pure A.



At two minutes, we take a sample and it to determine the amount of A that has reacted.

Q: If we repeat the experiment, will we obtain the same exact value for the conversion? If not, why not?

A: No, because of variations in a) temperature, b) sampling time, c) sampling technique, d) analysis technique

⇒ In fact, every measured quantity has some variation associated with it. This variation originates from several sources and the precision to which we can estimate a quantity's actual value depends upon the variation's magnitude.

Q: How do we estimate the true value of a measured quantity?

A: By calculating the mean of the measured quantity from N replicated experiments.

$$\bar{X} = \frac{1}{N}\{X_1 + X_2 + \cdots + X_N) = \frac{1}{N}\sum_{j=1}^{N} X_j$$

<u>Example:</u>

Run	1	2	3	4	5	6	7	8	9	10
X(%)	67.1	73.1	69.6	67.4	71.0	68.2	69.4	68.2	68.7	70.2

$$\bar{X} = \frac{1}{10}\{67.1 + 73.1 + \cdots + 70.2\} = 69.3\%$$

Q: How can we quantify the variation of the measured quantity about its mean?

A: By either reporting the Range, the Sample Variance, or the Sample Standard Deviation.

Range:

$$R = X_{max} - X_{min}$$

Advantage: Simple
Disadvantage: Doesn't use all the data.

Sample Variance:

$$S_x^2 = \frac{1}{N-1}\left\{(X_1-\bar{X})^2 + (X_2-\bar{X})^2 + \dots + (X_N-\bar{X})^2\right\}$$

Advantage: Uses all the data.
Disadvantage: More difficult to calc.

Sample Standard Deviation:

$$\sigma_x = \sqrt{S_x^2}$$

↖ The book uses S_x.

Same advantages / disadvantages here as for the sample variance.

⇒ For the variance and standard deviation, the larger a single value deviates from the mean, the larger $(X_i-\bar{X})^2$ becomes, and the larger the variance / standard deviation become.

⇒ If the replicated data are scattered randomly about the mean, then 67% of the data will lie within one standard deviation of the mean; 95% will lie within two standard deviations, and 99.% will lie within three standard deviations.