

## APPENDIX A-1: EXACT AND APPROXIMATE NUMBERS

### Exact and Approximate Numbers

- A. **Exact Numbers** – derived by procedures that produce an unchanging value (for example: counting, mathematical relationships, definition, or decision)

*Examples of exact numbers from counting:* sum of all two-digit positive integers, number of 2-letter abbreviations from 26 letters, the exponent 3 in the volume-of-a-cube formula, ...

*Examples of exact numbers from math relationships:* sine of  $30^\circ$ , ratio of the length of a side of a square to the distance between opposite its corners, ratio of the diameter of a circle to the distance around it, tangent of  $30^\circ$ , ...

*Examples of exact numbers from definitions:* number of seconds in an hour, number of micrometers in a kilometer, ...

*Examples of exact numbers from decisions:* breath-alcohol limit, designed size of a part, dosage prescription amounts, voting age, ...

- B. **Approximate Numbers** – derived from **rounding** procedures that shorten a more-exact value, from **tolerance-specification** procedures that directly state the amount of approximation, or from **measurement** procedures that give numerical information about something but don't repeat exactly.

*Examples of approximate numbers from rounding:* baseball batting averages, price with 8.25% sales tax (to the nearest penny), working value for  $\pi$  (3.14, to two decimal places), distance between cities (to the nearest mile), income in the IRS tax table (to the nearest 50 dollars), "floating-point" or "exponential-notation" numbers in a calculator or computer, ...

*Examples of approximate numbers from tolerance specification:* gas-pump accuracy requirements, manufacturing directions, ...

*Examples of approximate numbers from measurement:* "breathalyzer" readings, caliper readings for an actual part as built, actual dose as measured by a pharmacist, ...

***Problems:***

[1] *Which of the categories below do you think fits each of the listed numbers best?*

[exact/counting] [exact/math] [exact/definition] [exact/decision] [approx/rounding] [approx/tolerance]  
[approx/measurement]

[a] **299,792,458** meters per second as the speed of light traveling in space.

[b] **93 million** as the average number of miles from the Earth to the sun.

[2] *Which of the categories do you think fits each of these numbers best?*

[a] **1,609,344** as the number of millimeters in a mile.

[b] **70** as the number of home runs in Mark Maguire's 1998 record.

[c]  $\frac{2}{3}$  as the lowest number that the sum  $\frac{1}{3} + \frac{1}{6} + \frac{1}{12} + \frac{1}{24} +$  (and so forth) will never exceed.

[d] **24** as the percentage of Americans 25 or older in 1998 who had completed 4 years of college.

[e] **87.000 to 87.025** as the planned number of millimeters for the width of an engine cylinder.

[f] **281,421,906** for the total US population on April 1, 2000 (according to the census).

[g] fractions such as  $\frac{1}{3}$  and  $\frac{2}{7}$  as stored in a typical calculator.

[h] the number **12,345** as stored in a typical calculator or computer.

[i] 70 as the speed limit in miles per hour.

[3] *Give one example each (in addition to those mentioned in this handout) for exact numbers produced by counting, mathematical relationships, definition, and decision.*

[4] *Give one example each (in addition to those mentioned in this handout) for approximate numbers produced by [i] rounding, [ii] tolerance specification, and [iii] measurement.*