

The Back of the Envelope

A Sample Question

Principles

Two Answers Are Better Than One

Tabular Computations

Reminders

Exercises

Computing

Everyday Life

A Quiz

How much water flows out of the Mississippi River per day?

One Possible Answer. The river is about a mile wide, twenty feet deep, and flows at five miles per hour.

$$1 \text{ mile} \times 1/250 \text{ mile} \times 120 \text{ miles/day}$$

$$\approx 1/2 \text{ mile}^3/\text{day}$$

It discharges roughly one-half cubic mile per day.

Two Answers Are Better Than One

How much water flows out? As much as flows in.

The Mississippi basin is about 1000 by 1000 miles, and the annual runoff from rainfall is about one foot. Yearly drainage is

$$\begin{aligned} &1000 \text{ miles} \times 1000 \text{ miles} \times 1/5000 \text{ mile/year} \\ &\approx 200 \text{ miles}^3/\text{year} \end{aligned}$$

so daily outflow is

$$\begin{aligned} &200 \text{ miles}^3/\text{year} / 400 \text{ days/year} \\ &\approx 1/2 \text{ mile}^3/\text{day} \end{aligned}$$

A cheating triple check: An almanac reports that the river's discharge is 640,000 cubic feet per second, or 0.4 cubic miles per day.

Tabular Computation

How much water flows in per year?

1000 miles	1000 miles	1 mile
		5000 year

Cancel terms.

1000 miles	1000 miles	1 mile	200 mile ³
		5000 year	

Multiply by 1 year = 400 days (almost).

1000 miles	1000 miles	1 mile	200 mile ³	year
		5000 year		400 days

Cancel again.

1000 miles	1000 miles	1 mile	200 mile³	year	1
		5000 year		400 days	2

Reminders About Quick Calculations

How To Do Them.

Two answers are better than one.

Tabular computations.

Dimension checks.

Quick checks.

Common sense.

Rules of thumb.

Safety factors

When To Do Them.

After a system has been designed, before starting implementation.

Before any efficiency improvements.

Cost-benefits analysis.

Exercises

When is a cyclist with removable media faster than a high-speed data line?

How long would it take you to fill a floppy disk by typing?

If a system makes 100 disk accesses to process a transaction, how many transactions per hour per disk can it handle?

Suppose the world is slowed down by a factor of a million. How long does it take to execute one instruction? A disk to rotate once? A disk arm to seek across the disk? You to type your name?

Exercises, Part II

A newspaper asserts that a quarter has “an average life of 30 years”. Is that reasonable?

An advertisement asserts that a salesperson drives a car 100,000 miles in a year. Is that reasonable?

How many tons of people are in this room? How many cubic feet of people? Of room?

If every person in this city threw a ping pong ball into this room, how deep would we be?

What is the cost of a one-hour lecture?

How much money will Americans spend on soft drinks this year?

How many words in a book? How many words a minute do you read? How many hours per week do you watch television?

How many dollars per year is the difference between a 20 mpg car and a 40 mpg car? Over the lifetime of a car? What if the USA chose one or the other?