Oil futures

"Perhaps the Bush administration could use the 660-billion-barrel Strategic Petroleum Reserve to push prices down."
from Newsweek, 5/24/04 (when gas was < $2/gallon)

"The average vehicle uses 550 gallons / year."

How long will the Strategic Petroleum Reserve last?
Oil futures

• How many vehicles are there?
  - about one per person
  - so about 300 million?

• How big is a barrel?
  - bigger than a keg of beer
  - smaller than a 55 gallon drum
  - call it 50 gallons?

Oil futures

\[
\frac{500 \text{ gallons/year}}{1 \text{ barrel/year}} = 10 \text{ barrels/year}
\]

\[
300 \text{ million cars} \times 10 \text{ barrels} = 3 \text{ billion barrels}
\]

or ...

\[
300 \text{ million cars} \times 500 \text{ gallons} = 0.3 \text{ billion cars} \times 500 \text{ gallons} = 150 \text{ billion gallons} = 3 \text{ billion barrels}
\]
Oil futures

the Reserve contains 660 billion barrels
we use 3 billion barrels a year
so it will last 200 years

So why are we worried about oil??

In "Why $2 Gas Isn’t the Real Energy Problem" (May 24) we said that the size of the Strategic Petroleum Reserve is 660 billion barrels. It is actually 660 million barrels.

Newsweek, 6/7/04

 Millions and billions

• Because of an editing error, a report [...] misstated the amount of the increase and the current spending. Funding will increase to $300 million from $100 million, not to $300 billion from $100 billion. (New York Times, 12/22/05)

• An article in Business Day yesterday about Verizon’s stock price [...] misstated the amount that Vodafone is likely to demand for its 45 percent stake in Verizon Wireless. It is $20 billion, not $20 million. (New York Times, 12/29/05)

• The original version of this story misstated the Commonwealth Transportation Board’s cost estimate for the state’s unmet transportation needs during the next 20 years. The estimate is $108 billion, not $108 million. (Virginian-Pilot, 1/9/06)

• A story Friday about the discovery of debris disks surrounding two stars in the Milky Way galaxy misstated an estimate of the age of one of the stars. It is 300 million years, not 300 billion. (San Francisco Chronicle, 1/21/06)
Billions and trillions

EU budget misprint offers trillions to poor states
Thu 8 Dec 2005 5:45 AM ET

BRUSSELS, Dec 8 (Reuters) - EU president Britain is by mistake proposing the European Union spend over 22 trillion euros -- almost 27 times its entire long-term budget -- on cooperation with countries in Africa, the Caribbean and Pacific area.

EU states are haggling over the 2007-13 budget and the British rebate from EU coffers.

But an EU diplomat said on Thursday few had raised questions about the plan to set aside 22,662 billion euros for cooperation with some of the world's poorest states -- vastly more than the 846.8 billion proposed for the EU's long-term budget.

He said the British presidency had probably simply copied proposals made earlier this year by Luxembourg, but failed to change a continental European comma into a British decimal point.

"This would bankrupt the EU," he added.

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Trillions and trillions

Next-generation IPv6 Address Added to the Internet's Root DNS Zone

20 July 2004

Kuala Lumpur, Malaysia (20 July 2004) – ICANN announced today that for the first time, an IPv6 nameserver address has been added to the Internet's root DNS zone. This next generation version of the Internet Protocol provides trillions more addresses than the IPv4 system that is in use by most networks today.

\[
\frac{2^{128}}{2^{32}} = 2^{96} = 2^6 \times 2^{90} \approx 64 \times 10^{27},
\]

or about 79,000 trillion trillions
Powers of 2, powers of 10

\[
2^{10} = 1024 \sim 1000 = 10^3
\]
\[
2^{20} = 1084587 \sim 1000000 = 10^6
\]
\[
2^{30} \sim 10^9
\]
\[
2^{40} \sim 10^{12}
\]

... 
\[
2^{100} \sim 10^{30} \text{ (only 27% too high)}
\]

\[
2^{128}/2^{32} = 2^{96} = 2^6 \times 2^{90} \sim 64 \times 10^{27},
\]
or about 79,000 trillion trillions

**The Rule of 72**

- how long does it take for compounding to double? 
- divide 72 by rate to get number of periods 

- what is the rate of compounding if something doubles in a particular interval? 
- divide 72 by number of periods to get rate 

- if inflation is 2%/year, prices will double in 36 years 
- if tuition is rising at 5%/year, Princeton will cost twice as much in 14 years
The Rule of 72

An alimony agreement: pay her $250/month until she remarries. The payment increases by 5% a year. A good deal?

"Who would have thought that she would never remarry? And who would have ever figured that the $250 per month, after 32 years, would have escalated to nearly $1,200 monthly?"

Newark Star-Ledger, 2/7/05

• at 5%/year, doubles in 14 years, and again in 28
• 4 more years adds another 20%
• not such a big surprise

Going, going, gone...

"The Alpine glaciers -- also in Austria, France and Italy -- are losing one percent of their mass every year and, even supposing no acceleration in that rate, will have all but disappeared by the end of the century."

www.climateark.org/articles/reader.asp?linkid=41630

Losing 1% per year, they will be
1/2 gone in about 70 years,
3/4 gone in 140 years,
7/8 gone in 210 years, ...
Much too high, much too low, or plausible?

"Americans receive almost 2 million tons of junk mail daily."

   Dear Abby, 1/3/96

   2 million tons = 4 billion pounds
   300 million Americans

   ~ 13 pounds / person / day

Passive or apathetic?

"25 years ago, half of all 18 to 24 year-olds voted. Today it's 25%.

18 to 24 year-olds represent 33% of the population but only account for 7% of the voters."

   from The West Wing, Episode 4.03, 10/2/02
   (http://communicationsoffice.tripod.com/4-03.txt)

   suppose everyone lives exactly 70 years
   18-24 is 7 years
   so 18-24 year-olds are ~10% of the population
Little's Law

• customers in process = arrival rate x service time

• for example, 300 million Americans
• if each lives to 100, then
  - 3 million die each year
  - 3 million reach any given milestone each year

• if each lives to 75, then
  - 4 million reach any given milestone each year
  - 10,000 reach any milestone each day

Milestones

"Every day, 10,000 Americans turn 50 years old."
Gambling Magazine, 12/31/05

"Every week for the next 18 years, some 88,500 baby boomers will turn 59½."
Newsweek, 9/12/05

"350,000 Americans turn 50 every month."
Forbes, 1/10/05
Much too high, much too low, or plausible?

"Four thousand teens will try their first cigarette today."
advertisement, New York Times (11/18/05)

Estimation

making your best guess on the basis of inaccurate or incomplete or uncertain information

• how many times are prox cards used in a day?
• would all of Google's computers fit in this room?
• is it faster to carry a CD across campus or send email
• how many touchels are there on your body?
How much does the cannon weigh?

Estimates have ranged from 50 lb to 112000 lb.

Plausibility and common sense

• does the number make sense?

• does it agree with your experience, or run counter to it?

• what would be the implications if the number were accurate?
White water?

"The Passaic River was traveling about 200 miles per hour, about five times faster than average, due to six inches of rain that fell the last two weekends." (Newark Star-Ledger, June 10, 1992)

Faster than a speeding bullet...

The Times
November 16, 2004

Nasa jet travels 850 miles in 10 seconds

FROM CHRIS AVRES IN LOS ANGELES

AN AIRCRAFT that can fly at ten times the speed of sound will be tested over the Pacific Ocean today — possibly leading to "hypersonic" cruise missiles that could travel from Los Angeles to Pyongyang in less than an hour.

The aircraft was designed by Nasa to travel 850 miles in just ten seconds, or 7,000mph.

(London Times)
A quantitative reasoning assignment

Take apart a standard 1.44 MB floppy disk.
Estimate the number of bits per square inch of recording surface.

- estimates range from 3 bits per square inch to 140 million bits per square inch
- many estimates have 8 to 10 "significant" figures
- about half neglect to account for the hole in the middle

Unit conversions

- "The explosive device was set off by a wire 820 feet long."
- "The FCC ruling requires the location of wireless phones to be identified within 410 feet."
- "It can communicate with a Bluetooth-enabled computer up to 66 feet away."
- "Drug-sniffing dogs found a cache of 22 pounds of heroin."
Military precision

The M16A1 ... does not put enough spin on the heavier M855 bullet to stabilize it in flight, causing erratic performance and inaccuracy for training or full combat usage (30.48- to 35.56-centimeter shot group... it should only be used in a combat emergency and then only for close ranges of 91.4 meters or less.


Dimensionality

• how many more chips if the wafer goes from 8 inches to 12 inches?
Dimensionality

• how many more pepperonis if the pizza goes from 8 inches to 12 inches?

Bears in the forest

"Young males can roam 60 to 100 square miles looking for food and mates, but females stay close to the cave, foraging within a 10-mile radius."

Newark Star-Ledger (7/9/99)

How does the area that males cover compare to the more stay-at-home females?

10 mile radius for females:

\[ \text{area} = \pi r^2 = 314 \text{ square miles!} \]
Size matters

"... a cannon with a bore diameter of 3 inches would shoot a slightly smaller iron ball that weighed between 3 and 4 pounds. A cannon with a bore diameter of 9 inches would shoot an iron ball that weighed between 7 and 10 pounds. The size of the cannon came to be referred to in terms of the average weight of the solid ball shot they could fire. A cannon with a bore diameter of 3 inches was called a 3-pounder, one with a bore diameter of 6 inches was called a 6-pounder, and so on."

http://www.motherbedford.com/Cannon.htm

Gee-whiz graphs

Star-Ledger, 12/20/05
The one-dimensional picture

One-dimensional pictures
The one-dimensional picture

Chart junk
Who's number 1?

Who says so?  How do they know?  Why do they care?

"Four thousand teens will try their first cigarette today."
advertisement, New York Times (11/18/05)

"Endorsed by American Academy of Pediatrics, American Heart Assoc, American Lung Assoc, American Medical Assoc, National PTA."

"Every day 5000 teenagers try pot for the first time."
advertisement, New York Times (11/4/05)
Coalition for a Drug-Free America
Much too high, much too low, or plausible?

"Each year, according to the [American Anorexia and Bulimia] Association, 150,000 American women die of anorexia."


---

Much too high, much too low, or plausible?

"The number of American children killed by guns has doubled every year since 1950."

Defenses

- **Recognize the enemy**
  - bad estimates / flaky numbers / excessive precision
  - bad statistics / arithmetic errors
  - deceptive presentation
  - suspect motives

- **Learn some useful numbers and facts**
  - populations, rates, sizes, areas, etc.

- **Learn some arithmetic shortcuts**
  - Rule of 72
  - $2^{10} = 10^3$, etc.
  - Little’s Law: total = rate x time

- **Use your common sense and experience**
  - does it make sense?
  - how could they know?

Good reading

- Daryl Huff, *How to Lie with Statistics*
- Joel Best, *Damned Lies and Statistics*
- John Allen Paulos, *Innumeracy, A Mathematician Reads the Newspaper*
- Edward Tufte, *The Visual Display of Quantitative Information*
- Jon Bentley, *Programming Pearls*

Web sites
- innumeracy.com
- megapenny.com
- www.math.temple.edu/~paulos/