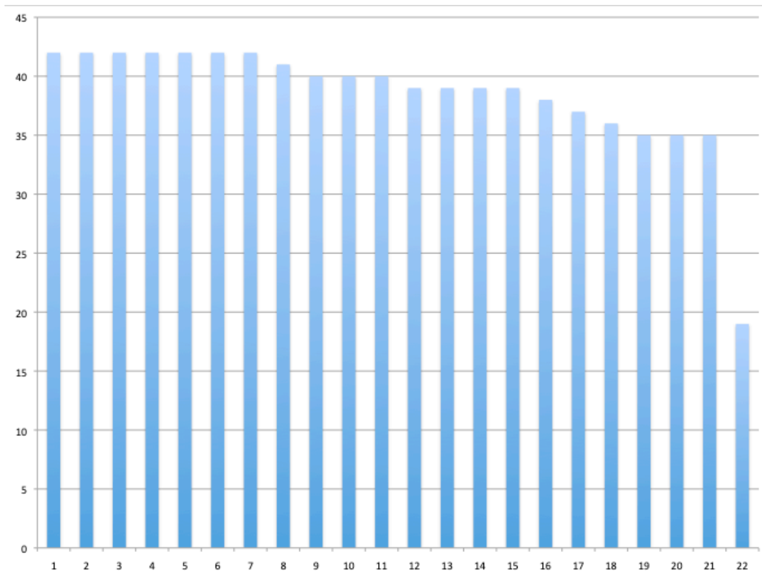
COS 109 Problem Set 6

Graded out of 42.



Problem 1: 7 * 2 = 14

(a) **1 2 3 4 5**

(b) **2 3 4 5 5**

(c) **3 5**

(d) **4 3 2 1**

(e) **0 -4 -4**

(f) **1 7**

(g) **1 5 7 11**

Problem 2: 4 + 2 + 2 + 2 = 10

(a) Graham's numbers right, and why (or not)?

Rule of 72 gives something like 12,800 users (2^7), so 14,000 is good
(actually more accurate: 1.1^52 is about 14,200)

Rule of 72 gives something like 1,638,000 (2^14); again it's reasonably good
1.1^104 is 2.02 million.

(b) Franklin's estimates right, and why (or not)?

about right: 5% doubles in 14 years; 100/14 is about 7,
2^7 * 1000 is 128,000, then add a couple of years -- all very consistent

(c) Minutes to fill Petri dish to 1 million?

72 / 3 = 24 minutes to double 20 doublings to get to 1 million,
so 20 * 24 = **480 minutes**

(d) Minutes to fill Petri dish to 2 million

One more doubling = **504 minutes** to get to 2M

Problem 3: **3 + 3 + 3 + 3 + 3 + 3 = 18**

(a) 50 billion bottles?

What's your experience? Maybe between one bottle a day and one a week, with plenty of outliers. At one bottle per week, that's 50 per year per person, and thus about 15 billion per year for the whole country. One per day is about 100 billion per year.

A defensible estimate would be somewhere between 15 and 100 billion. The average is about 60 billion, but it's often better to use the *geometric mean*, which is the square root of the product. In this case, that's the square root of 1,500 billion billion, or about 40 billion. The geometric mean is better because with the arithmetic mean the much larger value dominates.

[Adapted from *Millions, Billions, Zillions*]

(b) 25 billion barrels?

If it takes 20 billion barrels of oil to make 50 billion bottles, that's 4/10 of a barrel to make one bottle. A barrel is 40-60 gallons so this would imply that it takes 15 or more gallons of oil to make a single plastic water bottle! It's much too high; it probably should have been 25 **million** barrels.

(c) 25 million tons?

I honestly don't know. It seems high, but the frequent error of mixing up tons and pounds would lead to a value that seems too low. More information needed.

(d) Boxed water prices, in increasing order of $/liter?

Remember Excel? D1 = C1/(A1*B1)*1000.

◇	A	B	C	D
1	12	1000	37	3.08
2	24	500	46	3.83
3	24	330	31	3.91
4	24	250	26	4.33
5	12	500	26	4.33
6	6	500	15	5.00
7	12	330	21	5.30
8	8	250	15	7.50

(e) Canned water price in $/liter?

Excess precision follows.

1 liter is 33.76 US fluid ounces. 12 12-oz cans is 144 oz or 4.27 liters, so $19.99/4.27 or **$4.69 / liter.**

(f) Tap water price in $/liter?

1 US gallon (128 oz) costs $0.006 and there are 3.79 liters in a gallon, so **$0.00158 / liter.**

I erroneously wrote that a gallon is 120 oz in the problem, so if you used that, fine. But please don't be bashful about telling me when I screw up.