PUZZLES

1. A logistics graduate student named Ron is developing a computer simulation program for a transportation course. Ron begins by developing an unrealistic model in which the trains never stop. On one simulation run of this model, a man is walking next to a DART rail line at 3 miles per hour. For every 40 trains that pass him moving in the same direction as himself, 60 pass him in the opposite directions. Assume that the trains run at the same constant velocity in both directions. In this simulation run, what is the speed of the trains in miles per hour to one decimal place?

2. A bored ME named Mark sits in his TTh 11:00 a.m. – 12:20 p.m. class playing with numbers. As he waits for class to end, Mark deduces the smallest positive integer with the property that

   When he divides it by 2, the remainder is 1.
   When he divides it by 3, the remainder is 2.
   When he divides it by 4, the remainder is 3.
   When he divides it by 5, the remainder is 4.
   When he divides it by 6, the remainder is 5.
   When he divides it by 7, the remainder is 6.
   When he divides it by 8, the remainder is 7.
   When he divides it by 9, the remainder is 8.
   When he divides it by 10, the remainder is 9.

   What is the smallest positive integer with this property?

3. During the class of problem 2 Mark also discovers the largest number that can be obtained as a product of positive integers that add up to 100. Find this number and express your answer as the product of its integer factors to appropriate powers.

4. An AE student named Seoung devises a coded system of arithmetic for keeping his financial information private. His coded system of arithmetic is identical to the usual one except that each digit 0 to 9 has a value different than from standard arithmetic. The following five equations hold in Seoung's arithmetic:

   (a) $8\times7 = 8$

   (b) $4\times9 = 39$

   (c) $7\text{-}33 = \text{-}1$

   (d) $51\div2 = 2$

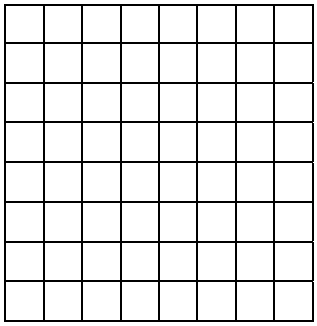
   (e) $7^4 = 6$.

   What is the sum 40 + 04 in Seoung's arithmetic expressed in his new digits?

5. A new EE graduate named Jamal has accepted a job starting at $60,000 per year with three possible advancement plans. In plan A, he would get a raise of $5000 per year, starting in one year. In plan B, he would get a raise of $2500 every 6 months (not per month) starting in 6 months. In plan C, he would get a raise of $416.67 per month starting in 3 months. Rank the plans in decreasing of order of salary for Jamal (written, say, in the form BAC) if he plans to stay at the job for at least 3 years.

6. An IE student named Sasha lives in Kalpana Chawla Hall. She has three slices of bread to toast on a small grill. The grill can hold only two slices at the same time. It takes 30 seconds to toast one side of a piece of bread, 5 seconds to put a slice on the grill or take a slice off the grill, and 3 seconds to turn a slice over on the grill. Only one operation at a time can be performed. What is the shortest time in which Sasha can toast the three slices of bread on both sides and remove them from the grill?

7. The nation of Griddonesia consists of eighty-one equally-spaced islands represented by intersections of the lines in the following grid, where north is up and east is right as on a standard map. Each island is connected to all its adjacent islands by horizontal and vertical bridges exactly one-mile long. There are no diagonal bridges. A Griddonesian oceanic engineer named ♍♋♓⌘ labels each island with a different integer from 1, 2, …, 81 to identify them. In how many ways can he number the islands, where the number 1 is always assigned to the central island?



8. Dr. Frank N. Stein of the CSE faculty is teaching a graduate course in logic this semester at noon. To illustrate deductive reasoning, the eminent AI guru begins his first lecture with the following scenario. Suppose Dr. Stein had brought several pizzas to the class, which includes the three students Linda, Masoud, and Feng. Dr. Stein then told the class that exactly one of the following statements is inconsistent with the other four.

   (a) At least one of the students Linda, Masoud, and Feng ate no pizza.

   (b) Linda ate some pizza.

   (c) Only one of these three students ate some pizza.

   (d) Masoud or Feng or both ate no pizza.

   (e) More than one of these three students ate some pizza.

   Select the inconsistent statement and submit only its corresponding letter.

9. IMSE professor Dr. Maria Savant has an identical twin sister named Ana. Both Marie and Ana have two children not twins. Assume that 0.5 is the probability that a baby of either gender being born to Maria and Ana on any birth.

   (a) To two decimal places, what is the probability that both of Maria's children are girls?

   (b) Suppose that Ana has a girl. To two decimal places, what is the probability that Ana has two girls?

10. A CSE student named Carlos works from 6 – 9 a.m. at a drive-through Starbucks on Cooper Street. Last August Carlos noted that the line at the drive-through window averaged 5 cars, including the car being served at the window. During last December, after the economic downturn, he observed that the line averaged 3 cars. During both months, cars arrived randomly but at different mean rates, while the average service time for a car remained the same. For an IE 4315 class project, Carlos is analyzing the following conclusions.

    (a) The Starbucks lost customers in December as compared to August.

    (b) The Starbucks did not lose customers in December as compared to August since the average line length was not zero in December.

    (c) The Starbucks actually gained customers in December as compared to August since the shorter line length would attract more customers.

    (d) A comparison is impossible to make from the given data.

    Select the correct answer, and submit only the corresponding letter.

11. A CE graduate student named Naresh is experimenting with large concrete block sizes. For a block size of 1 foot high by 1 foot wide by 3 feet long, he tries to pack as many possible blocks as possible into a 7 foot by 7 foot by 7 foot metal box. He soon realizes that it is impossible. There will always be a 1 foot by 1 foot by 1 foot gap somewhere. In how many ways can this gap be in the interior of the blocks and not on an outside surface?

12. A materials science graduate student named Mehmet is taking an advanced course in quantum physics taught by Dr. Vera Bohr. The first question on the closed-book, multiple-choice first exam is "What is the binding energy of two quarks … ?" Unfortunately Mehmet has not studied binding energy calculations. However the three possible answer choices are

    (a) 1.43E-27 eV

    (b) 5.63E-18 eV

    (c) 8.41E-24 eV.

    Then Mehmet remembered that Dr. Bohr had stated that she always randomly constructed wrong multiple-choice answers digit by digit. Using Benford's Law (http://en.wikipedia.org/wiki/Benford's_law), calculate the probability to two decimal places that the correct choice to the question is (a)?

13. (Remember, it's a dirty dozen.) As an undergraduate student, bioengineering professor Dr. Mi Yung learned that a formula for predicting the physiological age of a typical 65-year-old man living in the United States was

$$P(t) = 20 + e^{\lambda(t-21)}, t \geq 21,$$

where P(t) is the man's physiological age at the chronological age of $t \geq 21$ years and λ is a parameter such that a typical man doubles his rate of physiological aging every 8 years after 21. This formula yields a valid prediction of a man's physiological age at a chronological age of approximately 65. At the age of 21, Dr. Yung began a program of exercise, proper diet, stress reduction, weight control, and supplementation that he believed would reduce his personal parameter λ from the typical man's by 20%. If he is correct, to one decimal place what will be Dr. Yung's physiological age at the chronological age of 65?

ANSWERS

1. 15.0 mph.
2. 2519.
3. (2^2) (3^{32}).
4. 11.
5. CBA
6. 118 sec.
7. 80!
8. e
9. (a) 0.25 (b) $1/3 \approx 0.33$
10. a.
11. 1.
12. 0.70.
13. 41.1