

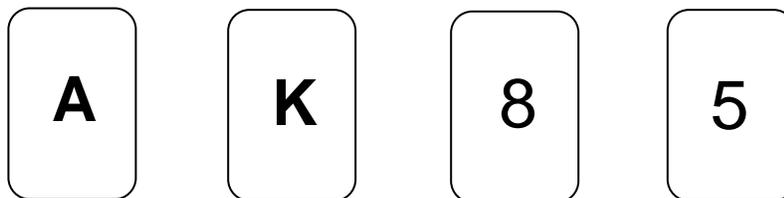
PUZZLES

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1. A structural engineer named Jason builds a large square brick wall that is one brick higher and one brick narrower than a second brick wall. How many more bricks are in the first wall than the second?
2. Ana, Brittany, Chun-hua, and Devina are four female IE students who are considering attending a concert. Assume that the following statements are true.
 - (a) If Ana goes to the concert, then Brittany will go.
 - (b) If Brittany goes to the concert, then Chun-hua will go.
 - (c) If Chun-hua goes to the concert, then Devina will go.
 - (d) Only two of the four students will go to the concert.

State the names of the two students who will attend the concert.

3. Over the summer a bioengineering student named Steve won a four-day trout tournament by catching a total of 36 trout. Suppose that he had caught two more trout on the first day than he actually caught, two fewer trout on the second day, twice his actual catch on the third day, and half on the fourth day. Then he would have caught the exactly same number of trout on each day, but he would have lost the tournament. In winning the tournament, how many trout did he catch each day? State your answer in the form (a, b, c, d), where the i^{th} component corresponds to the number of trout caught on day i .
4. A CSE graduate student named Prabhu is doing research into the nature of rational decision making. To do so, he obtains the solutions of 100 engineering students to the following problem, which you are also to solve. Each of the four cards below has a letter on one side and a number on the other. Two of the cards are letter-side up, and two of the cards are number-side up.



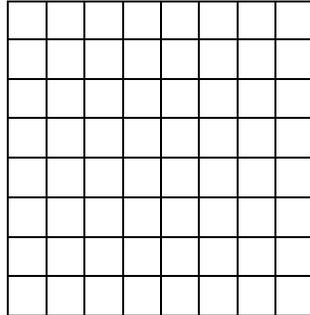
The objective is to test the following rule R: for these four cards, if a card has a vowel on its letter side, then it has an even number on its number side. Specify the smallest set of card or cards that must be turned over to determine whether rule R is true or false. Use the numbers and letters A,K,8,5 to specify the required set, which is unique.

5. A materials science student named Paul cuts a four-foot long graphite rod with a two-inch diameter into two pieces with an infinitesimally narrow cut made at random along the length of the rod. On the average, what would be the length of the shorter of the two resulting pieces to the nearest two decimal places?
6. An ME named Carlos gets a job working 6 – 9 a.m. at a drive-through Starbucks on Cooper Street. His pay starts at \$100 per week with the possibility of being changed every week subject to the previous week's sales. After one week, Carlos' initial salary is reduced 10% to give his second week's pay. At the end of the second week, his second week's salary is increased 10% for the third week. His salary continues to alternate decreasing and then increasing 10% every week for the following week's pay. After n weeks, where n is any positive even integer, how much will Carlos be paid during week $n + 1$? Express your answer as a function of n using fractions ($1/10$ for 10%, for example).
7. EE professor Dr. Max Short is teaching a course in information theory this semester based on the Shannon definition that information is a measure of the surprise but not the meaning of a message. This definition specifies as $-\log_2 p$ bits the information content conveyed by a message that an event E has occurred, where the probability of E 's occurrence is p . Assume that a baseball player's batting average represents a batter's probability of getting a hit for each official at-bat during a game. Then to then the nearest two decimal places, how many bits of information are communicated by a batter with a 0.300 batting average getting two hits in four official at-bats during a game?
8. This semester Dr. Frank N. Stein of the CSE Department is teaching a graduate course in cellular automata. In the first class, Dr. Stein illustrates update rules with the example of a cellular automaton composed of light bulbs in the following configuration.



The eminent AI guru asks the class to calculate the total possible number of distinct rules that can be defined for updating the state (“on” or “off”) of the middle light bulb based on its current state and the states of the eight distinct surrounding light bulbs. One rule would be to turn the middle light bulb “off” whenever it is currently “on,” whenever the three bottom light bulbs are currently “on,” and whenever the rest are currently “off.” Determine the total possible number of update rules for the middle light bulb above as a power of the number two and state as your answer only the associated integer exponent of two. For example, if you get 2^4 , then give 4 as your answer.

9. A CSE student named Eric is watching The Tudors on television. In one scene the French army, marching at a constant rate in a column 40 miles long, advances 40 miles while a messenger on horseback rides from the rear of the column to the front and then back to the rear. To the nearest two decimal places, how far does this messenger travel?
10. 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 civil engineer named 𐌆𐌹𐌺𐌹 needs to visit each island. Can 𐌆𐌹𐌺𐌹 start at the northwest island, visit each island in any order exactly once, and return to the northwest island? If such a trip is not possible, state as your answer “NOT POSSIBLE.” If 𐌆𐌹𐌺𐌹 can make such a trip, state as your answer the minimum possible distance that he must travel.



11. An ME student named Omar is playing dominoes in his dorm room. Each domino is two inches long and uniform in density, with its center of gravity at its geometrical center, which is one inch from each end. Can Omar stack n dominoes on a level table so that the top domino totally overhangs the table (i.e., neither end is above the table)? State as your answer the letter below corresponding to the correct statement.
- It is possible for only even values of n .
 - It is possible for only odd values of n .
 - It is possible for any number $n > 1$.
 - There is not enough information to select (a) – (c) with certainty.
12. In her IE 3301 class, IMSE professor Dr. Maria Savant writes the following eight integers 81, 73, 52, 42, 34, 22, 18, 10 on the board to illustrate the concept of correlation. She then asks the students to determine the next integer in the series based on some relationship to the others in the decreasing order given. Answer her question by stating the letter below corresponding to the correct response.
- 2.
 - 10.
 - Any integer.
 - There is not enough information to select (a) – (c) with certainty.

13. (Remember, it's a dirty dozen.) The favorite TV show of bioengineering professor Dr. Mi Yin is CSI. On last week's episode the homicide victim - a nanotech researcher - was found in a lab kept at the constant temperature of 70° F. On the show, the body's temperature was measured as 80° F by CSI investigators and then again as 75° F exactly one hour later. But they never gave the time of death. While watching, however, Dr. Yin assumes that the victim's temperature is 98.6° F at death. He then applies Newton's Law of Cooling (http://en.wikipedia.org/wiki/Heat_transfer#Newton.27s_law_of_cooling), which states that the researcher's body is cooled by convection to the room's temperature. To the nearest minute, how many minutes did Dr. Yin calculate that the victim died before his body temperature was taken the first time on the show?

ANSWERS

1. One brick.
2. Chun-hua, and Devina.
3. (6,10,4,16).
4. A, 5
5. 1.00 feet. "Random" is best interpreted as the cut being equally likely to be anywhere along the 4-foot length. Given that the cut is in [0,2] or (2,4], the average shortest length is 1. But the probability that the cut is ½ of being in either, so the answer is still 1. Note that the shortest length can be at most 2, which can thus not be the answer.
6. $\$100(99/100)^{n/2}$
7. $1.92 \text{ bits} = -\log_2(0.2646) = -\log_2 [(4!/2!2!)(0.3)^2(0.7)^2]$.
8. 10. There are 2^9 configurations of "on" or "off" for the 9 distinct light bulbs. For each configuration you can assign "on" or "off" as the updated state. Hence there are 2^{10} rules.
9. 96.57 miles. Let A be the speed of the army, H be the speed of the messenger's horse, and D be the distance traveled by the horse. The marching time for the army is $40/A$. But this time must be the time for the horse to get to the front plus the time for the horse to return to the rear. So $40/(H-A) + 40/(H+A) = 40/A$. Then $H = A(1+\sqrt{2})$ after solving for H in terms of A. Hence $D = 40(1+\sqrt{2})$.

10. Not Possible. Outline of Proof: Color each island red or black in a checkerboard fashion starting with black at the NW island. Then there are 41 black and 40 white islands. Starting at the NW corner, one must alternate colors on the trip, so the 81st island is also black. But then to get back to the starting point would require two consecutive blacks, so the trip cannot be made.
11. c.
12. c. For any next integer there exists a relation giving it. No pattern is more rational than another except that perhaps you saw it. For further information, see *A General Formula for the Nth Term of a Sequence*, Etta Mae Whitton, College Mathematics Journal, 2:2, 1971, 96-98. See online via UTA at the link <http://www.jstor.org/stable/3026975?cookieSet=1>.
13. 91 minutes.