

1. If m men can do a job in d days, then $m + r$ men can do the job in:
2. The remainder of 7^{100} divided by 9 is:
3. After Andrew had been sick for a week, he asked his best friend Jesse to get his books out of his locker. Instead of telling Jesse the three number combination Andrew said he kept a small piece of paper with the combination under his locker door.

After school Jesse went to Andrew's locker and pulled the paper. On the paper was written:

24 24 22 9 9 9 9 22 24 22 9 9.

Thinking this would be easy but a little tedious, Jesse entered in every arrangement of 24, 22, and 9 there was without the lock opening. Realizing there was something behind these numbers that he wasn't noticing, Jesse sat down for a few minutes to think it out. After ten minutes of intense thinking, Jesse went to the locker, entered the combination into the lock and it opened.

What was the combination?

4. A man's life was at an all time low. He lost his job, his wife, his house; and now his mom just died in a car accident. After the funeral, a man approached him and told him that his mom had taken a mortgage on the house and left him nothing except one thing. It was a note that read:

Dear my only son,

Thhaenrge! Tmhoe Bnaecykiyarsd

After he read the note, he finally got a smile on his face. What did his mom tell him in the note?

5. Diophantus was a Greek mathematician who lived in the third century. He was one of the first mathematicians to use algebraic symbols.

Most of what is known about Diophantus's life comes from an algebraic riddle from around the early sixth century. The riddle states:

Diophantus's youth lasted one sixth of his life. He grew a beard after one twelfth more. After one seventh more of his life, he married. 5 years later, he and his wife had a son. The son lived exactly one half as long as his father, and Diophantus died four years after his son.

How many years did Diophantus live?

6. Suppose you're in a hallway lined with 100 closed lockers. You begin by opening every locker. Then you return to the beginning and close every second locker. Then you go to every third locker and open it (if it's closed) or close it (if it's open). Let's call this action toggling a locker. Continue toggling every n th locker on pass number n . After 100 passes, where you toggle only locker #100, which lockers are open?
7. There is a 10-digit number, represented by ABCDEFGHIJ, where each numeral, 0 through 9, is used once. Given the following clues, what is the number?
- 1) $A + D =$ a square number
 - 2) $G + J =$ a triangle number
 - 3) $B + I =$ an even number
 - 4) $E * F =$ an odd number
 - 5) $C * H =$ a prime number
 - 6) $A / G = G / C$
 - 7) $E + I = B + H$

8. A series of burglaries has plagued London. The famous private investigator, Sheerluck Holmes, is on the case. He has five suspects. As usual, Sheerluck has bungled again, and has lost his notes. Fortunately, he has memorized some of the clues. Help Sheerluck determine each man's age, height, weight, and hair color. Also, help identify the culprit so that he can be put behind bars.

Men: Ben, Gus, Ron, Sam, Tim

Ages: 29, 32, 37, 42, 46

Weights: 166, 178, 190, 201, 216

Heights: 5'8", 5'9", 6'0", 6'3", 6'4"

Hair (descending order of darkness): black, brown, red, blonde ... plus bald

- 1) The man who is 6'0" tall is older than the man who weighs 178 pounds, who is older than Ben (one of these is the guilty man).
- 2) Ron weighs more than the brown-haired man, who weighs more than the man who is 32 years old.
- 3) Ben is taller than the blonde-haired man, who is taller than the man who weighs 166 pounds.
- 4) The man who is 32 years old has darker hair than the man who weighs 190 pounds, who has darker hair than Tim (one of these is the guilty man).
- 5) Each man has one measurement (age, weight, or height in inches) that is an odd number.
- 6) The youngest, the lightest, and the shortest ... are three different men ... and do not have red hair (the guilty man is not among them).
- 7) The oldest, the heaviest, and the tallest ... are three different men ... and do not have black hair (one of these is the guilty man).
- 8) Ben and Gus have a weight difference of 12 pounds.
- 9) Sam and Tim have a height difference of 3 inches.
- 10) Ron is not 4 years older or younger than any other man.
- 11) The guilty man does not have blonde hair.

9. Who wrote (first and last name of each author):

Murder on the Orient Express _____

The DaVinci Code _____

The Pelican Brief _____

Alex Cross _____

The Cuckoo's Calling _____

The Hound of the Baskervilles _____

The Maltese Falcon _____

A is for Alibi _____

The Girl on the Train _____

10. What was the detective's full name in Murder on the Orient Express?
11. Where did Sherlock Holmes live? (Write complete street address and city)
12. What year was Sherlock Holmes introduced to the world?
13. Who was Sherlock Holmes' friend and assistant? (first and last name)
14. Who was Sherlock Holmes' arch enemy? (first and last name)
15. In how many ways can one give change for \$2.83 using only pennies and nickels?
16. A two-digit number is called "special" if, when multiplied by itself, the result is a number whose last two digits are the same as the original number. For example, 25 is a special number, since $25 \cdot 25 = 625$. Find another two-digit number that is "special".
17. What is the last digit of 4^{2019} ?
18. Define K_n to be a 2-dimensional shape with n vertices that has an edge joining any pair of vertices. For example, K_3 has 3 edges, K_4 has 6 edges, K_5 has 10 edges. How many edges are there in K_{10} ?
19. A triangle has vertices at $(8,6,6)$, $(8,12,6)$, and $(2,6,6)$. What is the area of this triangle?
20. Suppose you are in charge of arranging places for six knights around the Round Table. If Sir Lancelot can't sit next to Sir Gawain, Sir Gawain must sit next to Sir Kay, and Sir Kay can't sit across from Sir Tristan (but Sirs Bob and Doug don't care where they sit), how many ways can the six knights be seated? (If two seating arrangements differ only by rotation, you should count them as the same.)
21. A population of bacteria grows at a rate proportional to the $\frac{2}{3}$ root of time. The population begins at a size of 100 and grows to a population of 200 after the first day. What is the population size after 9 days?
22. A fair die is rolled four times. The probability that each of the final three rolls is at least as large as the roll preceding it may be expressed in the form $\frac{M}{N}$ where M and N are relatively prime positive integers. Find $M + N$.

23. Arnold is studying the prevalence of three health risk factors, denoted by A, B, and C, within a population of men. For each of the three factors, the probability that a randomly selected man in the population has only this risk factor (and none of the others) is 0.1. For any two of the three factors, the probability that a randomly selected man has exactly these two risk factors (but not the third) is 0.14. The probability that a randomly selected man has all three risk factors, given that he has A and B is $\frac{1}{3}$. The probability that a man has none of the three risk factors given that he does not have risk factor A is $\frac{p}{q}$, where p and q are relatively prime positive integers.
24. Name as many actors you can think of (Max: 5), who have played Sherlock Holmes and what the respective title of the film/tv show/radio show/play etc. One point for each actor and one additional point if the respective film/show/etc is correct.
25. Calculate the sum in closed form of $\frac{1}{2!} + \frac{2}{3!} + \frac{3}{4!} + \dots + \frac{n}{(n+1)!}$
26. Find an integer value of n such that $\sqrt{\frac{5n-2}{n+3}}$ is also an integer.
27. Find the simplified value of $\frac{6508^2 - 2492^2}{4501^2 - 4499^2}$
28. In the sequence 1,2,2,3,3,3,4,4,4,4,5,5,5,5,... what is the 2006th term?
29. The number $(9^6 + 1)$ is the product of three primes. What is the largest of these three primes?
30. Find a positive integer not exceeding 1000 which leaves a remainder of 3 upon division by 7, 4 upon division by 11 and 2 upon division by 13.
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Each code below reveals a hint to unscramble the next code.

The following message is encoded into code:

43 23 24 21 44

Qypxm tpmge xmzig mtliv

CRRAPQ IAVXOB: $a = 3$, $b = 4$

yum edq e oegjqd nqjqkcpq!

Now for some classic riddles

1. Forward I'm heavy, but backwards I'm not. What am I?
2. It walks on four legs in the morning, two legs at noon and three legs in the evening. What is it?
3. I am the beginning of end, and the end of time and space. I am essential to creation, and I surround every place. What am I?
4. What has a head, a tail, is brown, and has no legs?
5. What English word has three consecutive double letters?
6. Until I am measured I am not known, Yet how you miss me when I have flown.
7. What starts with a T, ends with a T, and has T in it?
8. What gets wetter as it dries?
9. I'm full of holes, yet I'm full of water. What am I?
10. I am a word of 5 letters and people eat me. If you remove the first letter I become a form of energy. Remove the first two and I'm needed to live. Scramble the last 3 and you can drink me. What am I?

Answers

1. $\frac{md}{m+r}$ days
2. 7
3. 28, 4, 17
4. Hang in there! The money is in the backyard!
5. Therefore, Diophantus lived exactly 84 years
6. 1, 4, 9, 16, 25, 36, 49, 64, 81, 100
7. Ben, 29 years, 190 pounds, 6'4", brown
Gus, 42 years, 178 pounds, 6'3", blonde
Ron, 37 years, 216 pounds, 5'8", bald
Sam, 32 years, 166 pounds, 5'9", black
Tim, 46 years, 201 pounds, 6'0", red, guilty
8. 4615972308
9.
 - a. Agatha Christie
 - b. Dan Brown
 - c. John Grisham
 - d. James Patterson
 - e. J.K. Rowling or Robert Galbraith
 - f. Sir Arthur Conan Doyle
 - g. Dashiell Hammett
 - h. Sue Grafton
 - i. Paula Hawkins
10. Hercule Poirot
11. 221 B Baker St., London
12. 1887
13. Dr. John Watson
14. James Moriarty
15. C) or 57
16. 76
17. 4
18. 45
19. 18 square units
20. 28
21. 61000 (Note: $\frac{2}{3}$ root means that the differential equation will be represented as

$$\frac{dp}{dt} = k\sqrt[2]{t} = k * t^{\frac{3}{2}}$$
)
22. 79
23. 21/55
24. https://en.wikipedia.org/wiki/List_of_actors_who_have_played_Sherlock_Holmes

25. $1 - \frac{1}{n!}$
26. 14
27. 2008
28. 63
29. 6481 (Note: $(9^6 + 1) = (9^2 + 1)(9^4 - 9^2 + 1) = 82 \cdot 6481 = 2 \cdot 41 \cdot 6481$)
30. 444

Codes and Ciphers:

1. The following message is encoded in tap code:
2. SHIFT
3. Multiplicative cipher
4. Affine cipher (accept if $a=3$, $b=4$ is given as well)
5. You are a master detective!

Riddles:

1. *Ton*
2. *Man*
3. *The letter e. (End, timE, spacE, Every placE)*
4. *A penny*
5. *Bookkeeper*
6. *Time*
7. *A teapot*
8. *A towel*
9. *A sponge*
10. *Wheat (Wheat, heat, eat, tea)*