

Interview Questions

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General Problem Solving

1. Given the digits 3, 3, 7, 7, find a way to make 24 using only the four basic operations (+, -, *, /).
2. You are given three opaque jars, each filled with marbles. One jar contains only white marbles, one jar contains only black marbles, and one jar contains a mix of white and black marbles. One day, you encounter this setup and are told that the marbles have been moved around such that all the labels are incorrect. One jar still holds only black marbles, one jar still holds only white marbles, and one jar still holds some mix of white and black marbles, but it is guaranteed that the labels are incorrect. How many marbles must you remove from these opaque jars before you can identify which jars contain which marbles?
3. How many distinct expressions can be formed using only the digits 3, 3, 7, 7, and the four basic operations?
4. Three missionaries and three cannibals come to a river and find a boat that holds two. If the cannibals ever outnumber the missionaries on either bank, the missionaries will be eaten. How can the boat be used to move the missionaries to the other side of the river without any of them being eaten? Note that at least one missionary or one cannibal is required to move the boat back.
5. You have a six-sided cube and six cans of paint, each a different color. You may not mix colors of paint. How many distinct ways can you paint the cube using a different color for each side? If you can reorient a cube to look like another cube, then the two cubes are not distinct.
6. An explorer is captured by a group of cannibals. There are two types of cannibals—those who always tell the truth and those who always lie. The cannibals will barbecue the explorer unless he can determine whether a particular cannibal always lies or always tells the truth. He is allowed to ask the cannibal exactly one question, and the cannibals will only respond with "yes" or "no". Find the question the explorer can use to determine whether the cannibal always lies or always tells the truth.
7. Each inhabitant of a remote village always tells the truth or always lies. A villager will only give a "Yes" or "No" response to a question the tourist asks. Suppose you are a tourist visiting this area and come to a fork in the road. One branch leads to the ruins you want to visit; the other branch leads deep into the jungle. A villager is standing at the fork in the road. What one question can you ask the villager to determine which branch to take?
8. Steve would like to determine the relative salaries of three coworkers using two facts. First, he knows if Fred is not the highest paid, then Janice is. Second, he knows that if Janice is not the lowest paid, then Maggie is paid the most. Is it possible to determine the relative salaries of Fred, Janice, and Maggie given this information? If so, list the employees in descending salary order.

9. Show that the square root of 2 is irrational.
10. Four people need to cross a rickety rope bridge to get back to their camp at night. Unfortunately, they only have one flashlight and it only has enough light left for 17 minutes. The bridge is too dangerous to cross without a flashlight, and it's only strong enough to support two people at any given time. One camper can cross a certain bridge in 1 minute, another in 2 minutes, the third in 5 minutes, and the slow poke takes 10 minutes. How do the campers make it across in 17 minutes?
11. What will the output be of a NOR gate with one input line tied to the output of the same gate, and the other input tied to ground (logic 0)?
12. Create an XOR gate using only 2-input NAND gates.
13. Consider a license plate of 7 characters. The first four characters must be uppercase English letters, and the last three characters must be decimal digits. Given the restriction that the first and third characters must be the same and the last character cannot be a 7 or a 9, how many different license plates can be formed?
14. If $y''(t) + 3y'(t) = 18y(t)$, what is one possible $y(t)$?
15. An infinite number of mathematicians walk into a bar. The first orders a pint of beer. The second orders half a pint of beer. The third order a quarter of a pint of beer. The bartender gets tired of pouring beers and, realizing the pattern, pours a certain amount of beer to satisfy the order. How much beer does he pour?
16. Compare the number of positive integers to positive even numbers. Explain your reasoning.
17. You toss a balanced coin 10 times. What is the probability that you get exactly 5 heads?
18. How many distinct 5-card poker hands are there?
19. You throw a pair of fair dice. What is the probability the spots on the top two faces sum to seven?
20. You pick a real number at random between 0 and 1, inclusive. What is the probability that your number is rational?
21. I have a black triangle, a white triangle, a black circle and a white circle. If I gave you a shape (triangle or circle) and a color (black or white), the "frobby" items would be those that had either the shape or the color, but not both. That is, in order to be frobby, the item must be of the specified color or the specified shape, but not both the specified shape and the specified color. I'm thinking of a shape and a color in my head and I tell you that the white triangle is frobby. Can you tell me the "frobbyness" of the other items?
22. A password-generating program is being considered for use on a site with 15,000,000 projected users by the end of the year. Major revisions are expected to be implemented at the start of the next year, so it is safe to assume that the site will have no more than

15,000,000 users during the time the password generating-program will be used. A password checker requires all passwords to be within 12 and 15 characters in length and contain 5 A's, 4 D's, 2 J's, and at least one K. Can this program generate 15,000,000 unique passwords?

23. Passwords for a system are required to consist of either 6, 7, or 8 characters, where a character can be one of the digits 0, 1, 2, ..., 9, one of the 26 lower case letters, or one of the 26 upper case letters. Characters are allowed to be repeated in the password. Then, for example, a possible 7-character password is g8aNNe3. How many passwords are possible for this system?
24. Place 8 queens on the following chess board such that no queen can capture another queen in one move.
25. You have 9 balls that appear to be identical, but one is lighter than the others. Identify the lighter ball in a minimal number of uses of a two-pan balance.
26. A band of 23 weary travelers entered a lush forest where they found 63 piles each containing the same number of plantains and a remaining pile containing seven plantains. They divided the plantains equally. How many plantains were in each of the 63 piles?
27. What was the UNIX timestamp when you were born?

C/C++

28. Write a function in C or C++ that swaps the values of two integers.
29. Write a function that implements `pow(2, n)`.
30. Write a function that implements `n % m`, where `m` is a power of 2.
31. Given an unsigned integer, write a function that returns the next greatest number that is divisible by four. If the given number is divisible by 4, add 4.
32. Given an unsigned integer, write a function that returns the next lowest number that is divisible by four. If the number is divisible by 4, leave it unchanged.
33. Implement the absolute value function.
34. In C, reverse a UTF-8 string. Assume you have a function `int get_len(char hdr)` that will give you the length of a character, given that the inputted byte is the error. Perform the reversal inline.
35. Explain how exceptions work in C++.
36. Given the following struct from a linked list implementation:

```
struct
{
    int value;
```

```
void* next;
};
```

How can you change the `void*` pointer to be type correct?

37. What is a typical usage of a virtual destructor?
38. Explain the tradeoff between using a linked list and an array.
39. What is the size of an `int` on a 32-bit system? A 64-bit system? What differs between a 32 and 64-bit system?
40. You have some data that is guaranteed to be 16 bits wide. What datatype should you store it in to guarantee it is exactly 16 bits wide?

PHP

41. What is the difference between `doStuff()` & `@doStuff()`?
42. Are variable names case-sensitive? Function names?
43. If they are valid, what does the set of tags `<?=` and `?>` do?
44. Explain the ternary conditional operator.
45. Which of the following will execute the fastest in conjunction with an `echo` statement: double quotes, single quotes, or heredoc?
46. What is the difference between `include()` and `require()`?
47. Define the `$_REQUEST` superglobal using only built-in PHP functions and variables.

MySQL

48. How do you move a column to a specified location in a table?

Answers

1. $((3 / 7) + 3) * 7$
2. The minimum amount is one marble. The jar labeled "mixed" must contain a solid color. So, take one from it. If it is a white marble, then the "mixed" jar contains only white marbles. Then, the jar labeled "black" is neither black nor white, so it must be "mixed". By process of elimination, the jar labeled "white" must then contain only black marbles. The same reasoning can be applied if the "mixed" jar contains a black marble.
3. This question is really asking how many valid postfix strings can be made with the following inventory: {3, 3, 7, 7, +, -, *, /}.

A valid postfix string has four digits and three operators, so it is seven characters long. There are two possible placements for the operators to go:

__ * __ * * or __ * _ * _ *

In each of these two cases, there are 4^3 choices of operator permutation. The digits must be permuted among the remaining spaces, but not all of the given digits are distinct. So, there are $4!/(2! * 2!)$ distinguishable permutations for the digits among the remaining spaces.

$$2 * (4^3) * 4!/(2! * 2!) = 768 \text{ expressions}$$

4. 2 cannibals over, 1 cannibal back
2 cannibals over, 1 cannibal back
2 missionaries over, 1 cannibal back
1 missionary, 1 cannibal over, 1 cannibal back
5. $C(6, (2,2,2)) / 3 = 6!/(2! * 2! * 2! * 3) = 30$ ways
6. "Are you a cannibal?" or "If I was to incorrectly label you, would you barbecue me?"
7. "If I was to ask you if this particular branch leads to the ruins, would you tell me yes?"
8. Fred, Maggie, Janice
9. Assume the square root of two is rational and in lowest terms. Then $\sqrt{2} = a/b$, where a and b are integers. Squaring the equation yields $2 = a^2/b^2$, so $a^2 = 2*b^2$. Since a and b are integers, a must be even, by definition of even. Furthermore, $b^2 = a^2/2$, so b must also be even. Since a and b are both divisible by 2, the ratio a/b cannot be in lowest terms. This contradicts the assumption, so we have that the square root of 2 is irrational.
10. Camper A: 1 minute
Camper B: 2 minutes
Camper C: 5 minutes
Camper D: 10 minutes

1. A & B cross (2 minutes)
2. B comes back (4 minutes)
3. C & D cross (14 minutes)
4. A comes back (15 minutes)
5. A & B cross (17 minutes)

11. Oscillating

12. $\{[(AB)'A]'[(AB)'B]'\}'$

13. $26 * 26 * 26 * 10 * 10 * 8 = 14,060,800$ ways

Note that 26 is only multiplied three times, since the third character was chosen implicitly by choosing the first character

14. Characteristic equation: $(r - 3)(r + 6) = 0$

$$r = 3, -6$$

$$y = ce^{(3t)} + ke^{(-6t)}$$

Choose arbitrary constants for c and k.

15. Sum from 1 to infinity of $(1/(x^2))$ P-series, $p = 2$. Converges to 2.

16. They are equal. Consider the bijection $f(x) = 2x$. Every integer can be mapped to a unique even number, and vice-versa.

17. $(10, 5) * (0.5)^5 * (0.5)^5 = 24.609375\%$

18. $C(52,5) = 52!/(47! * 5!) = 2,598,960$ hands

19. $P(\text{Sum to } 7) = (\# \text{ ways to sum to } 7) / (\# \text{ ways to throw dice})$

Ways to sum to 7: (1, 6), (2, 5), (3, 4), (4, 3), (5, 2), (6, 1) -> 6

Ways to throw dice: $6 * 6 = 36$

$$6 / 36 = 1 / 6$$

20. 0, since there are an infinite number of irrational numbers for every rational number.

21. Black circle: frobby

White circle: not frobby

White triangle: not frobby

W: Item is white

W': Item is black

C: Item is circle

C': Item is triangle

Frobby(a, b) = a xor b

W'C': not frobby

W'C : frobby (negate both, xor still true)

WC' : frobby (given)

WC : not frobby

- 22. Case 1: 12-character passwords: $12!/(5!4!2!1!) = 83,160$ passwords
- Case 2: 13-character passwords: $13!/(5!4!2!2!) = 540,540$ passwords
- Case 3: 14-character passwords: $14!/(5!4!2!3!) = 2,522,520$ passwords
- Case 4: 15-character passwords: $15!/(5!4!2!4!) = 9,459,450$ ways

The four cases are mutually exclusive and their union is the universe of discourse, so total can be found by adding: 12,605,670 passwords, which is less than 15,000,000.

- 23. Case 1: 6 characters: 62^6 passwords
- Case 2: 7 characters: 62^7 passwords
- Case 3: 8 characters: 62^8 passwords

The three cases are mutually exclusive and their union is the universe of discourse, so the total can be found by adding: $2.21919E14$ passwords

- 24. There are 92 valid solutions, one of which follows:

```
X * * * * * * * *
* * * * * X * *
* * * * * * * * X
* * X * * * * *
* * * * * * X *
* * * X * * * *
* X * * * * * *
* * * * X * * * *
```

- 25. Weigh 3 vs. 3, then 1 vs. 1.

- 26. Solve the Diophantine Equation $63a - 23b = -7$. The GCD of 63 and 23 is 1, so express 1 as a linear combination of 63 and 23. Using the Euclidean Algorithm, $77(23) - 63(28) = -7$, so there were 77 plantains in each of the piles. Any answer of the form $5 + 22n$ is acceptable.

- 27. Know the timestamp starts at January 1, 1970 @ 12:00:00am, counts in seconds, and there are 86,400 seconds in a day. Bonus points if leap years are taken into account.

```
28. int swap (int a, int b)
{
    a ^= b;
    b ^= a;
    a ^= b;
}
```

```
29. int pow_of_2(unsigned int n)
{
    return (1 << n);
}
```

```
30. int mod_pow_of_2(int n, int m)
```

```
{
    return (n & (m - 1));
}
```

31. `return ((n >> 2) + 1) << 2;`

32. `return (n & ~0x3);`

33. `int abs(int n)`
`{`
 `// Sign will be either all 0's or all 1's.`
 `int sign = n >> (CHAR_BIT * sizeof(n) - 1);`

 `/* If n is positive, XOR with 0 and add 0 – does`
 `nothing. If n is negative, XORing with all 1's finds`
 `1's complement, adding 1 finds 2's complement */`
 `return (n ^ sign) + (sign & 0x1);`
`}`

34. - Write a bitwise (C-string) reverse function and use it to reverse the entire string bitwise.
- Iterate over string backwards, re-using the reverse function to reverse the byte order of each character

35. When an exception occurs, the program jumps to the exception vector in program memory, which usually contains an unconditional jump to an exception handler (similar to an interrupt handler). The use of exceptions versus return codes poses a trade-off between code readability/testability and performance, which is why embedded systems tend to use return codes.

36. `struct node`
`{`
 `int value;`
 `node* next;`
`};`

37. Any case where destructing a base class instance should call the derived class' destructor.

38. Linked lists require more storage than arrays, since they need to explicitly store the location of the next item. For this reason, the items in the list need not be contiguous. As a result, embedded systems with limited memory can actually benefit from linked lists since large blocks of continuous memory may not be available.

39. There is no 64-bit datatype defined in the C standard. The long keyword is left to compilers to interpret. The distinction between 32 and 64 bit refers to the amount of addressable memory, not the width of integers.

40. Use `int16_t` or `uint16_t`, and include `stdint.h`.

41. The @ symbol suppresses error output.
42. Variable names are, function names are not.
43. The variable inside the tags is outputted to the browser
44. (Condition to check) ? (code to execute if condition is true) : (code to execute if condition is false);
45. Single quotes. The interpreter does not have to check the string for variables.
46. `require()` will cause a fatal error if the file cannot be found; `include()` will cause a notice.
47. `array_union($_GET, $_POST, $_COOKIE);`
48. `ALTER TABLE table_name MODIFY COLUMN column_name data_type AFTER preceding_column`