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# C Brain Teasers

Exercise Your Mind



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## On the Case

```
#include <stdio.h>
int main()
{
    char a;

    for( a='A'; a<='Z'; a++ )
        putchar( a | 0x20 );
    putchar('\n');

    for( a='a'; a<='z'; a++ )
        putchar( a & 0xdf );
    putchar('\n');

    return(0);
}
```

## Guess the Output



Try to guess what the output is before moving to the next page.

---

Two lines are output:

```
abcdefghijklmnopqrstuvwxy  
z  
ABCDEFGHIJKLMNPOQRSTUVWXYZ
```

The uppercase letters are converted into lowercase. Lowercase letters are converted to uppercase.

---

## Discussion

Most C programmers rush to the ctype functions when letters need case conversions. The toupper() and tolower() functions handle the job nicely. Yet, because of the way the ASCII is designed, you can use bitwise logical operators to manipulate case, as shown in this chapter.

In the ASCII table, the difference between an uppercase letter and its lowercase counterpart is 32 or 0x20 hexadecimal:

A is 0x41 or 0100 0001

a is 0x61 or 0110 0001

Flipping that sixth bit (from the right) transforms the character from uppercase to lowercase and back again. In C programming, if you want to flip a bit, you use bitwise logical operators, such as & (AND) and | (OR).

The bitwise OR operator sets a bit. In the code, | 0x20 sets the sixth bit, which punches up the value of characters A through Z to lowercase a through z.

The bitwise AND operator filters out a bit. In the code, & 0xdf resets the sixth bit to zero, which transforms lowercase a through z into uppercase A through Z.

Unlike the ctype toupper() and tolower() functions, however, this trick affects all ASCII characters, not just letters. While it's not a complete replacement, this bit manipulation trick can be used to quickly and efficiently change case for letters of the alphabet.

## Further Reading

*ASCII everything*

<https://www.asciitable.com/>

*History of coded character sets (PDF document)*

[https://textfiles.meulie.net/bitsaved/Books/Mackenzie\\_CodedCharSets.pdf](https://textfiles.meulie.net/bitsaved/Books/Mackenzie_CodedCharSets.pdf)

*C programming tutorial on bitwise operators*

<https://www.programiz.com/c-programming/bitwise-operators>