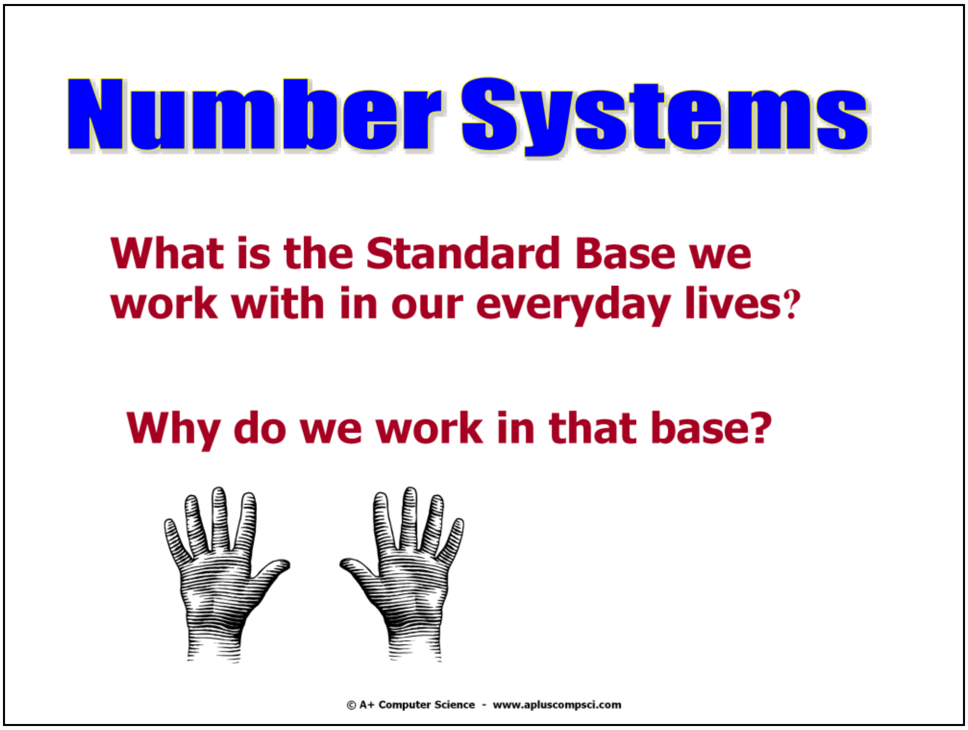


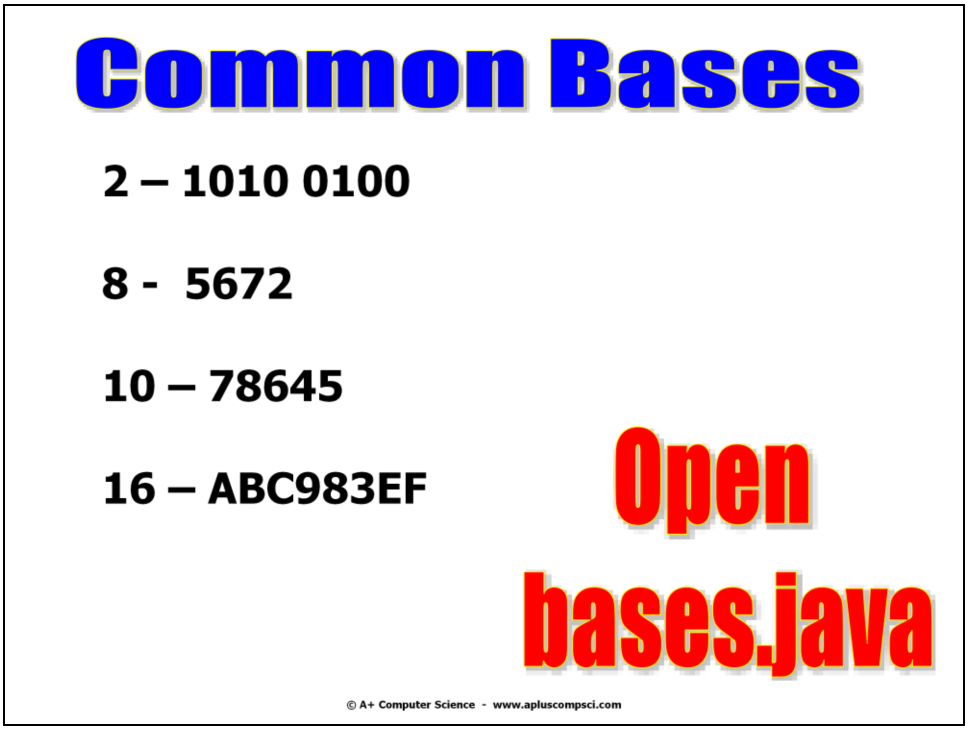
Number Systems

What is the Standard Base we work with in our everyday lives?

Why do we work in that base?

© A+ Computer Science - www.apluscompsci.com

We work mainly in base 10 because humans learned to count using the 5 digits on each hand.



Common Bases

2 – 1010 0100

8 - 5672

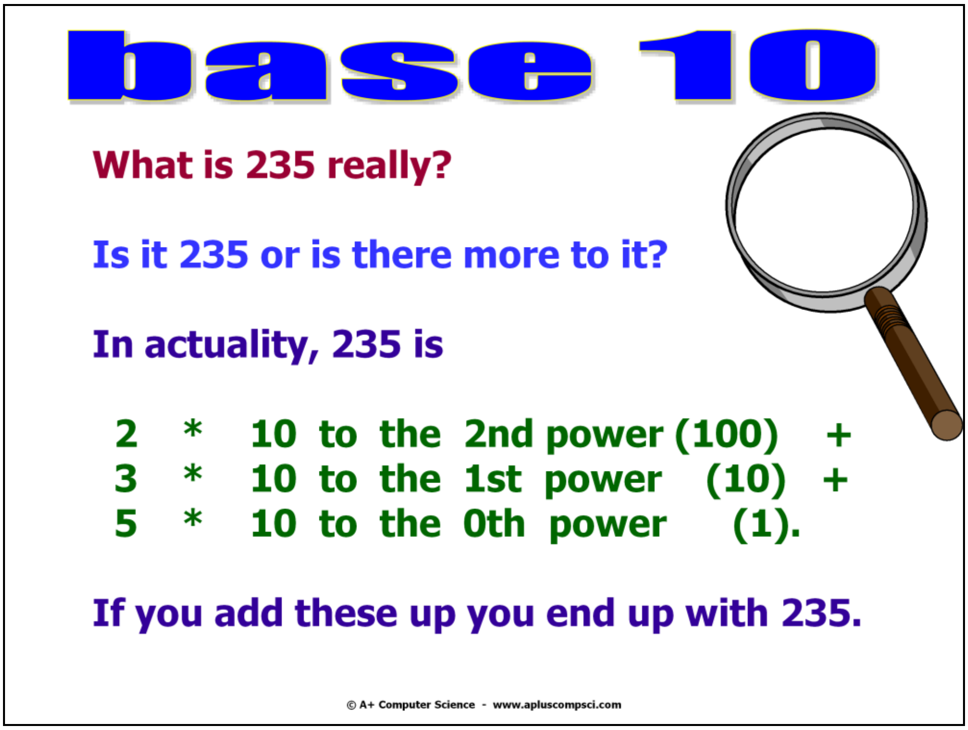
10 – 78645

16 – ABC983EF

Open bases.java

© A+ Computer Science - www.apluscompsci.com

Base 2 is used for computers as computers operate using on and off electric pulses. Bases 8, 16, 32, and 64 are used by computer as well as they are all powers of 2.



base 10

What is 235 really?

Is it 235 or is there more to it?

In actuality, 235 is

2 * 10 to the 2nd power (100) +
3 * 10 to the 1st power (10) +
5 * 10 to the 0th power (1).

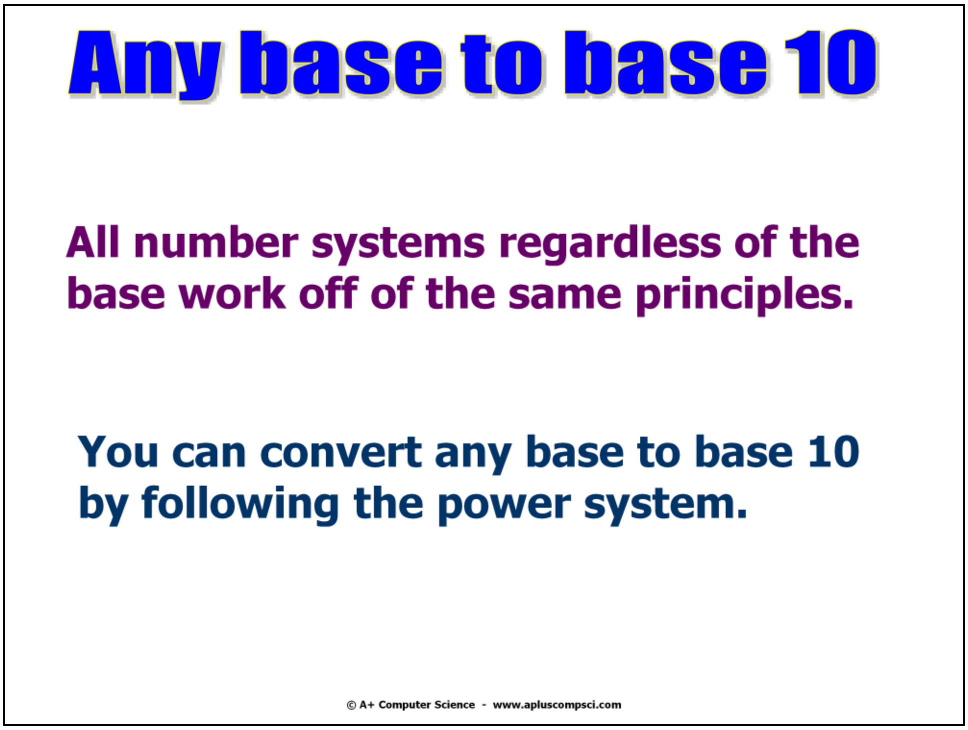
If you add these up you end up with 235.

© A+ Computer Science - www.apluscompsci.com

In order to understand other bases, you must understand base 10.

The number 514 is really 500+10+4.
5 is the in the 100 spot. There are 5 100s.
1 is the 10 spot. There is 1 10.
4 is the in 1 spot. There are 4 1s.

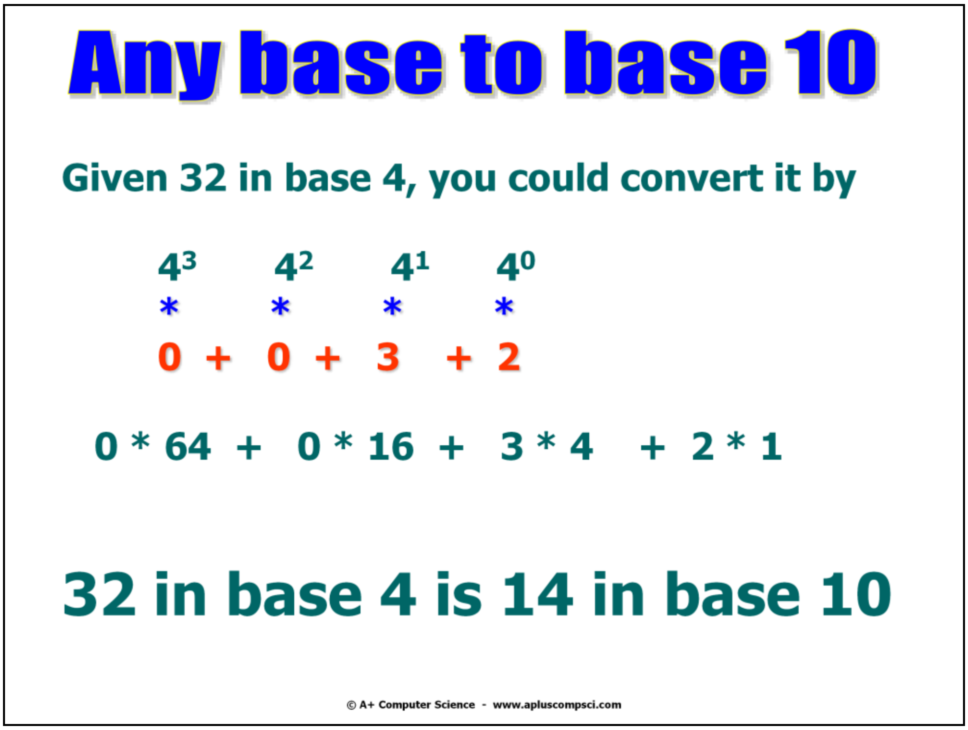
5 is in the x^2 spot.
1 is in the x^1 spot.
4 is in the x^0 spot.
x is 10.



Any base to base 10

All number systems regardless of the base work off of the same principles.

You can convert any base to base 10 by following the power system.



Any base to base 10

Given 32 in base 4, you could convert it by

$$\begin{array}{ccccccc} 4^3 & & 4^2 & & 4^1 & & 4^0 \\ * & & * & & * & & * \\ 0 & + & 0 & + & 3 & + & 2 \end{array}$$

$$0 * 64 + 0 * 16 + 3 * 4 + 2 * 1$$

32 in base 4 is 14 in base 10

514 base 6 can be converted to base 10 pretty easily.

5 is the in the 36 spot. There are 5 36s.

1 is the 6 spot. There is 1 6.

4 is the in 1 spot. There are 4 1s.

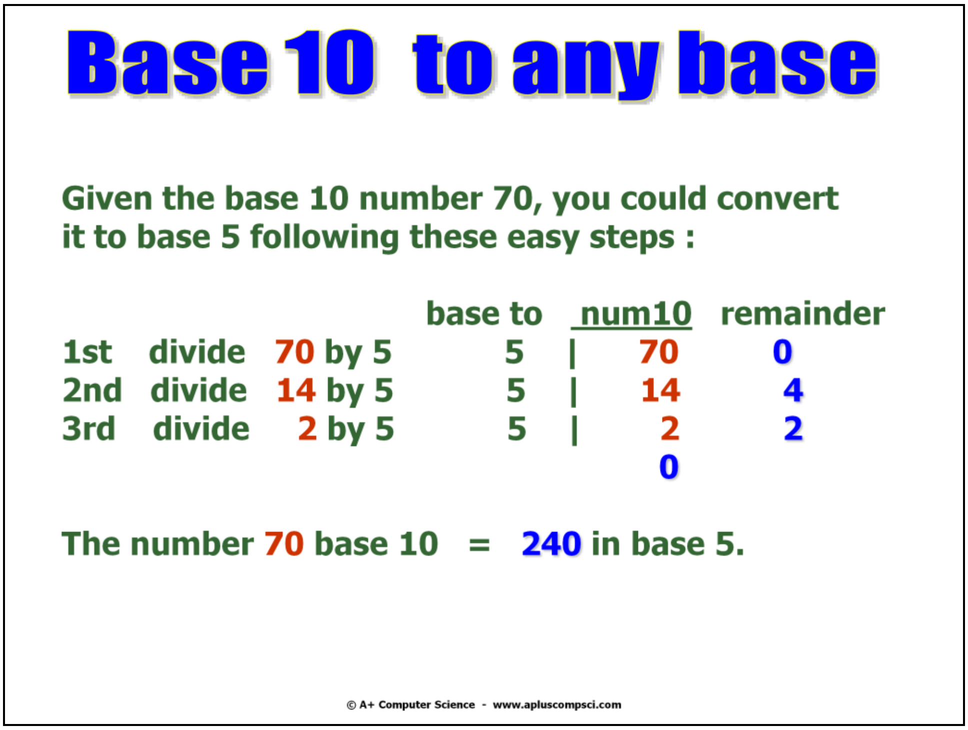
5 is in the x^2 spot.

1 is in the x^1 spot.

4 is in the x^0 spot.

x is 6.

514 base 6 is equal to 190 in base 10.

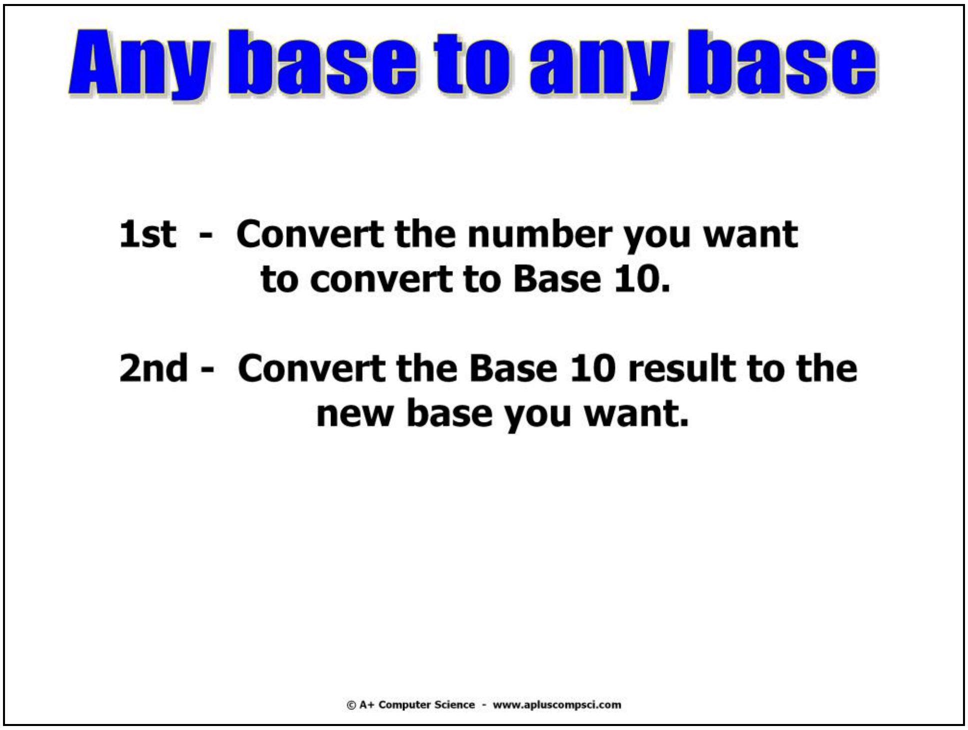


Base 10 to any base

Given the base 10 number 70, you could convert it to base 5 following these easy steps :

			base to		num10	remainder
1st	divide	70 by 5	5	|	70	0
2nd	divide	14 by 5	5	|	14	4
3rd	divide	2 by 5	5	|	2	2
					0	

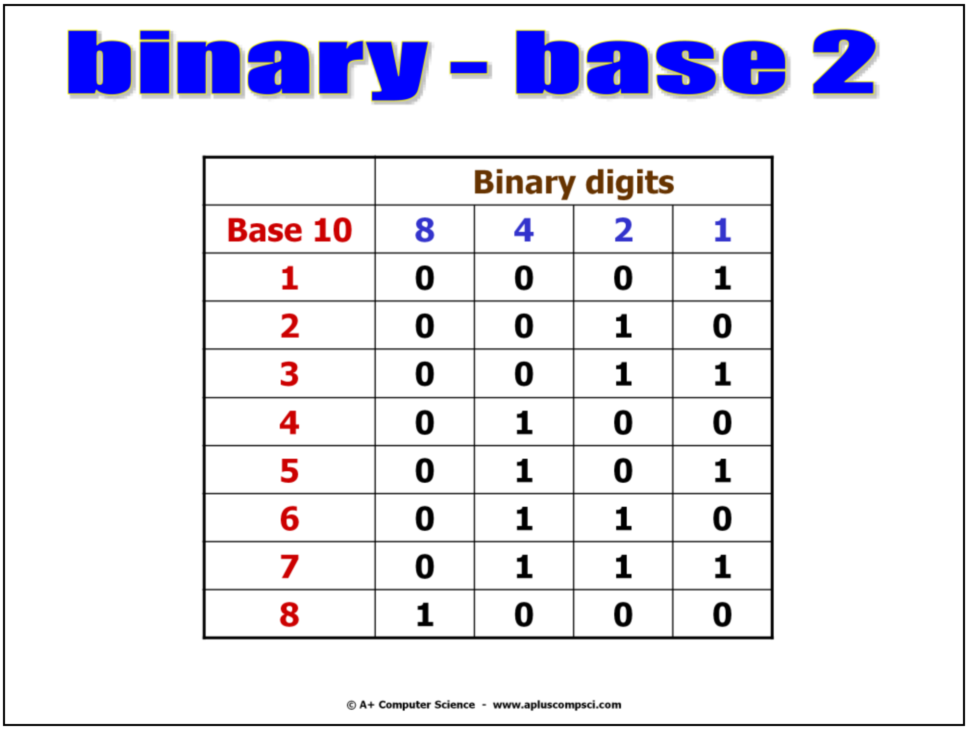
The number 70 base 10 = 240 in base 5.



Any base to any base

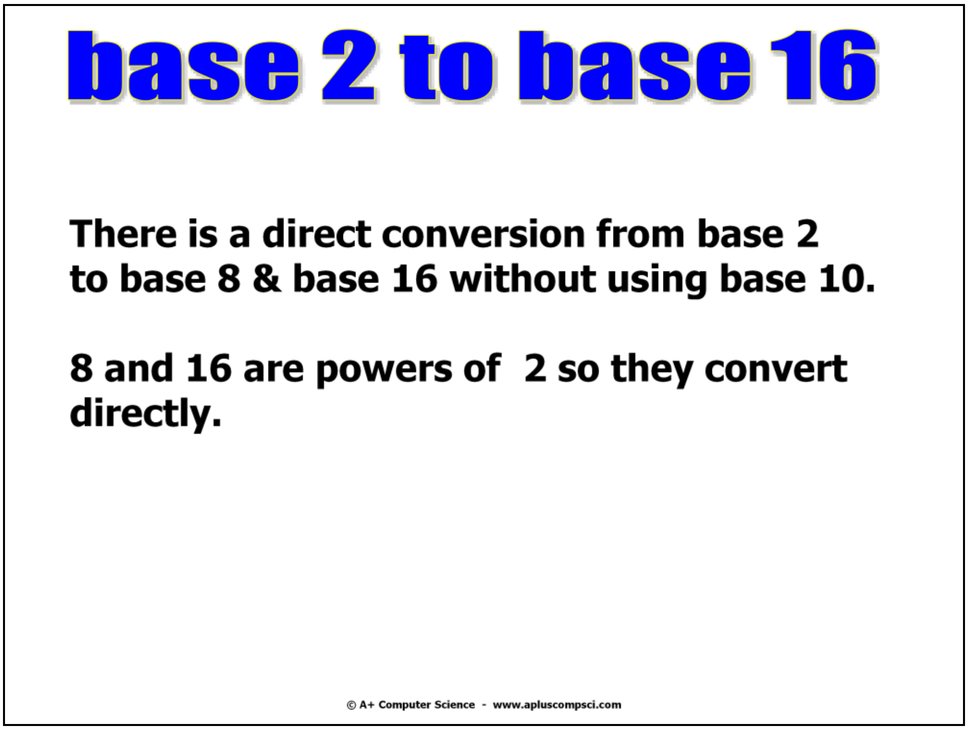
1st - Convert the number you want to convert to Base 10.

2nd - Convert the Base 10 result to the new base you want.



binary - base 2

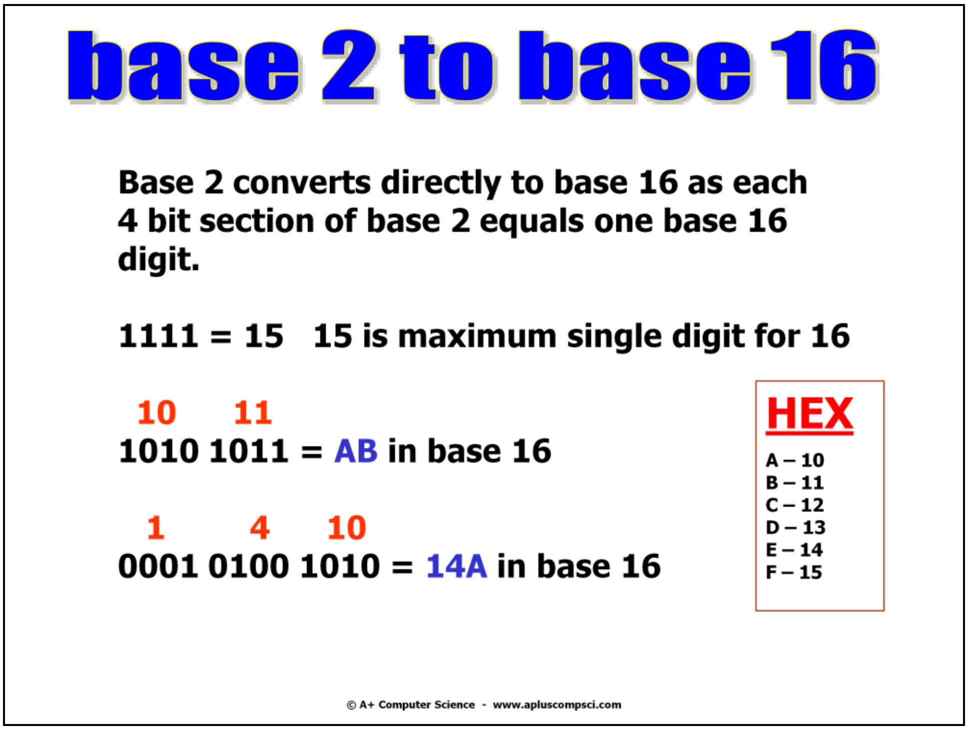
	Binary digits			
Base 10	8	4	2	1
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0



base 2 to base 16

There is a direct conversion from base 2 to base 8 & base 16 without using base 10.

8 and 16 are powers of 2 so they convert directly.



base 2 to base 16

Base 2 converts directly to base 16 as each 4 bit section of base 2 equals one base 16 digit.

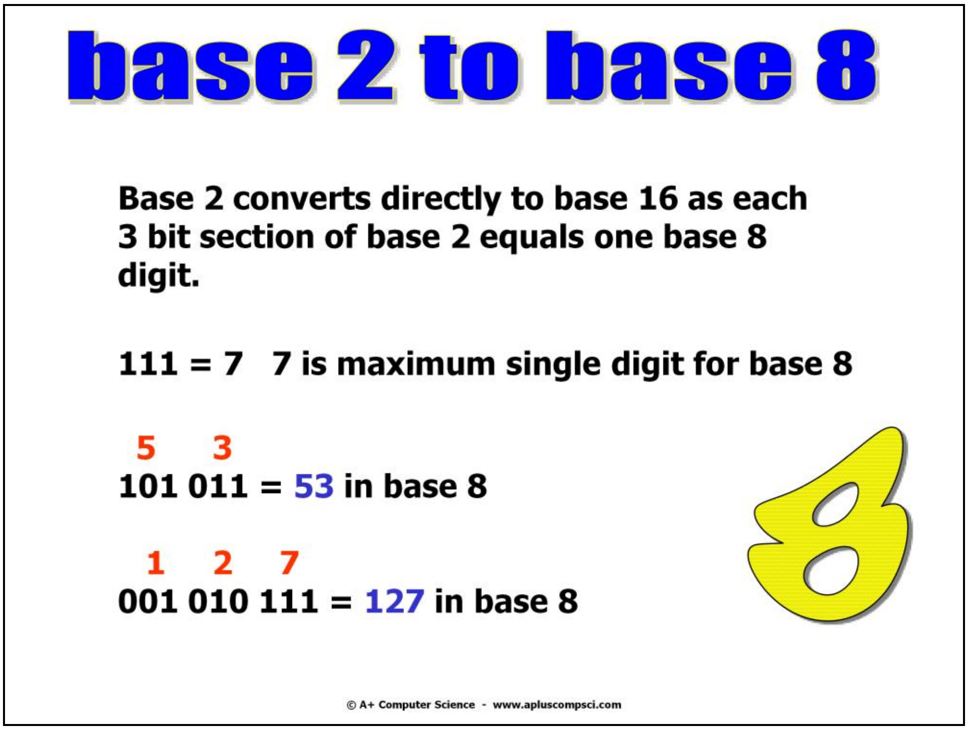
1111 = 15   15 is maximum single digit for 16

10 11
1010 1011 = AB in base 16

1 4 10
0001 0100 1010 = 14A in base 16

HEX

A – 10
B – 11
C – 12
D – 13
E – 14
F – 15



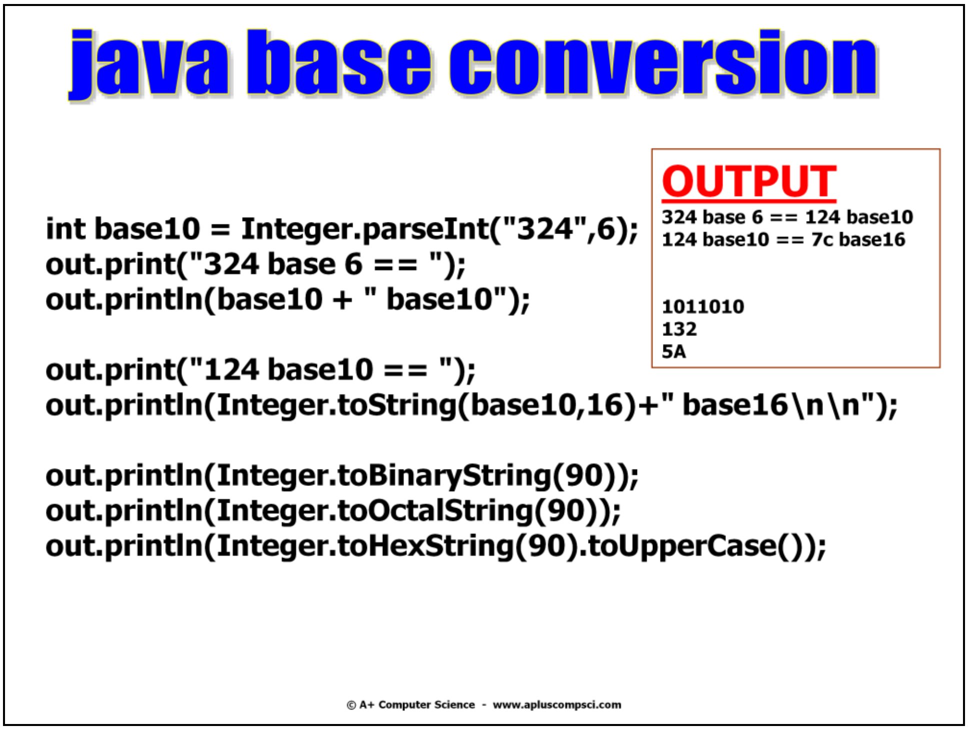
base 2 to base 8

Base 2 converts directly to base 16 as each 3 bit section of base 2 equals one base 8 digit.

111 = 7   7 is maximum single digit for base 8

5 3
101 011 = 53 in base 8

1 2 7
001 010 111 = 127 in base 8



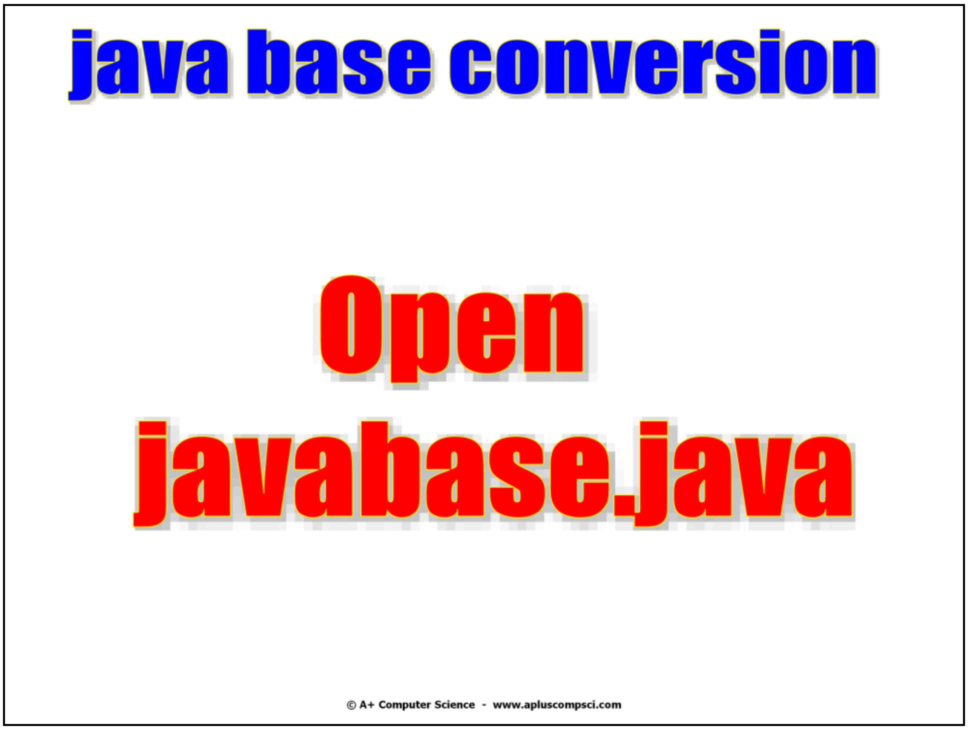
java base conversion

```
int base10 = Integer.parseInt("324",6);
out.print("324 base 6 == ");
out.println(base10 + " base10");

out.print("124 base10 == ");
out.println(Integer.toString(base10,16)+" base16\n\n");

out.println(Integer.toBinaryString(90));
out.println(Integer.toOctalString(90));
out.println(Integer.toHexString(90).toUpperCase());
```

OUTPUT

```
324 base 6 == 124 base10
124 base10 == 7c base16


1011010
132
5A
```

© A+ Computer Science - www.apluscompsci.com

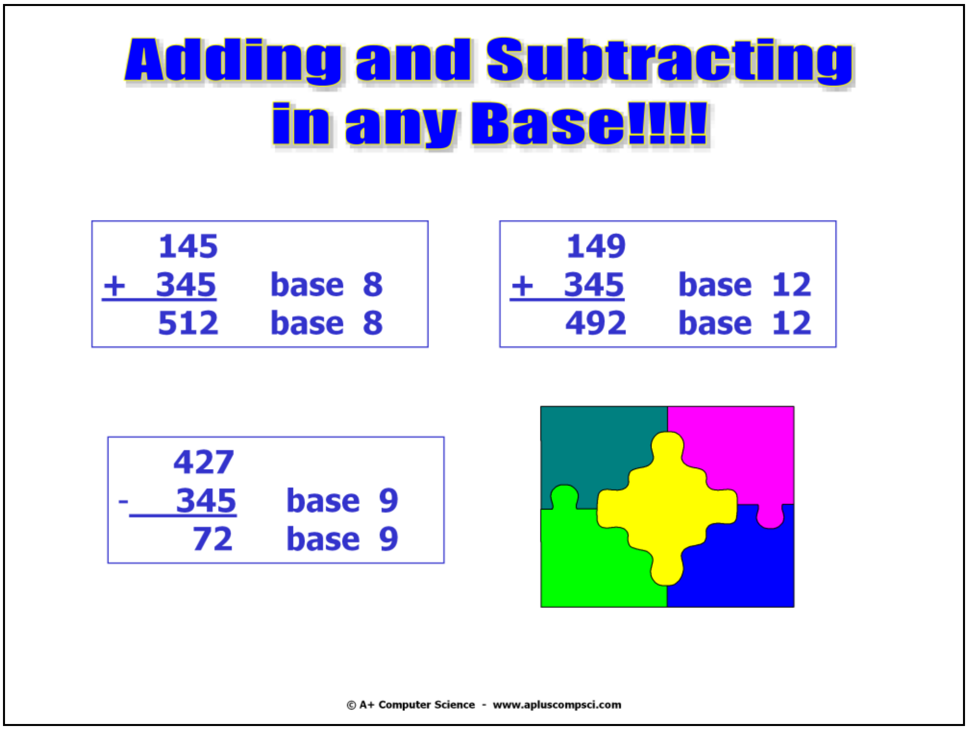


java base conversion

Open javabase.java

© A+ Computer Science - www.apluscompsci.com

Adding and Subtracting in any Base!!!!

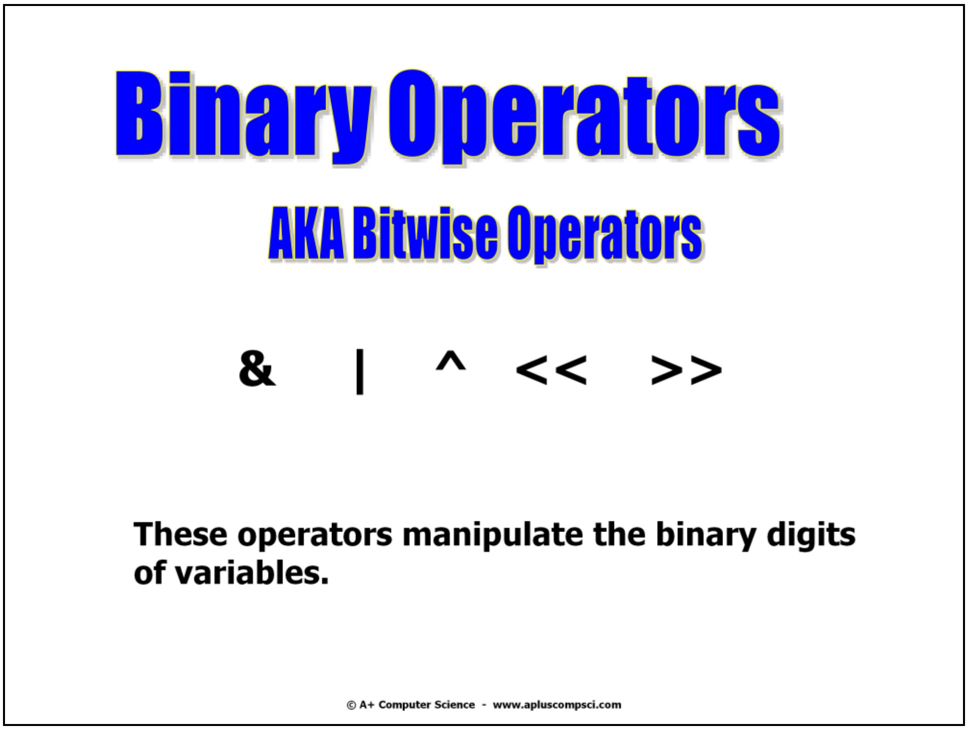


Adding and Subtracting in any Base!!!!

$$\begin{array}{rl} 145 & \\ \underline{+\ \ 345} & \text{base } 8 \\ 512 & \text{base } 8 \end{array}$$

$$\begin{array}{rl} 149 & \\ \underline{+\ \ 345} & \text{base } 12 \\ 492 & \text{base } 12 \end{array}$$

$$\begin{array}{rl} 427 & \\ -\ \underline{\ \ 345} & \text{base } 9 \\ 72 & \text{base } 9 \end{array}$$

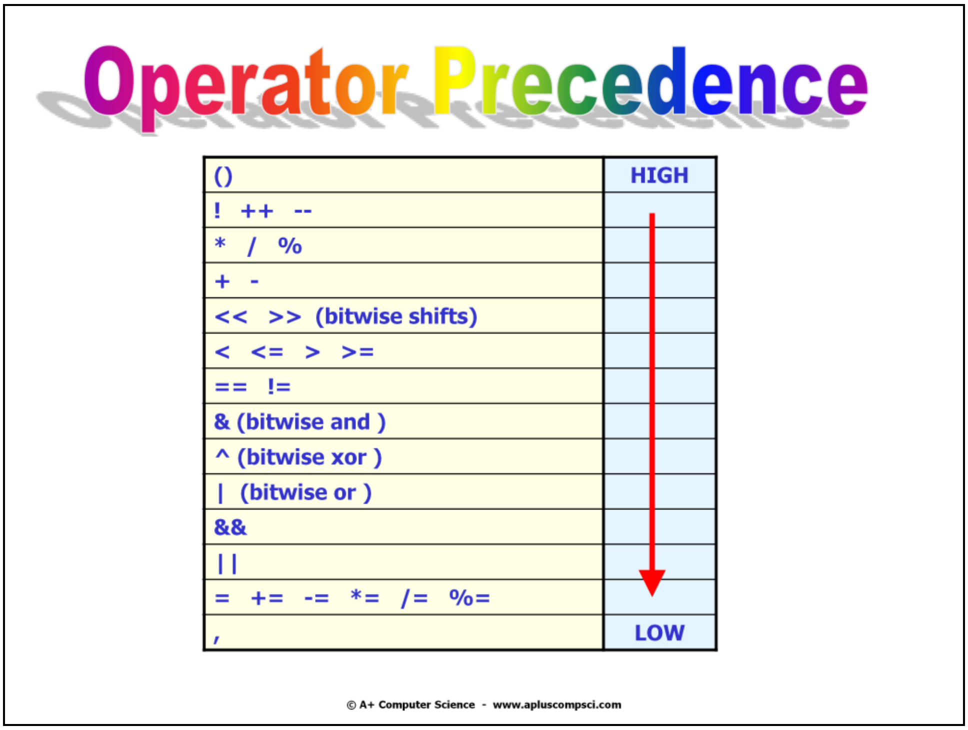


Binary Operators

AKA Bitwise Operators

& | ^   <<   >>

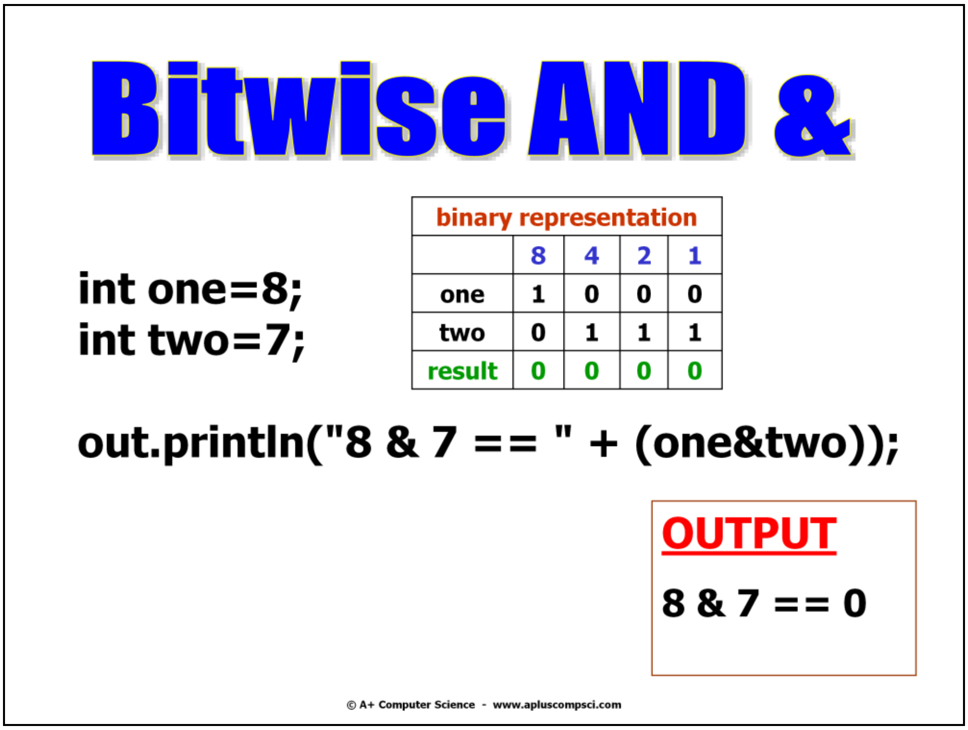
These operators manipulate the binary digits of variables.



Operator Precedence

()	HIGH
! ++ --	
* / %	
+ -	
<< >> (bitwise shifts)	
< <= > >=	
== !=	
& (bitwise and)	
^ (bitwise xor)	
| (bitwise or)	
&&	
||	
= += -= *= /= %=	
,	LOW

© A+ Computer Science - www.apluscompsci.com



Bitwise AND &

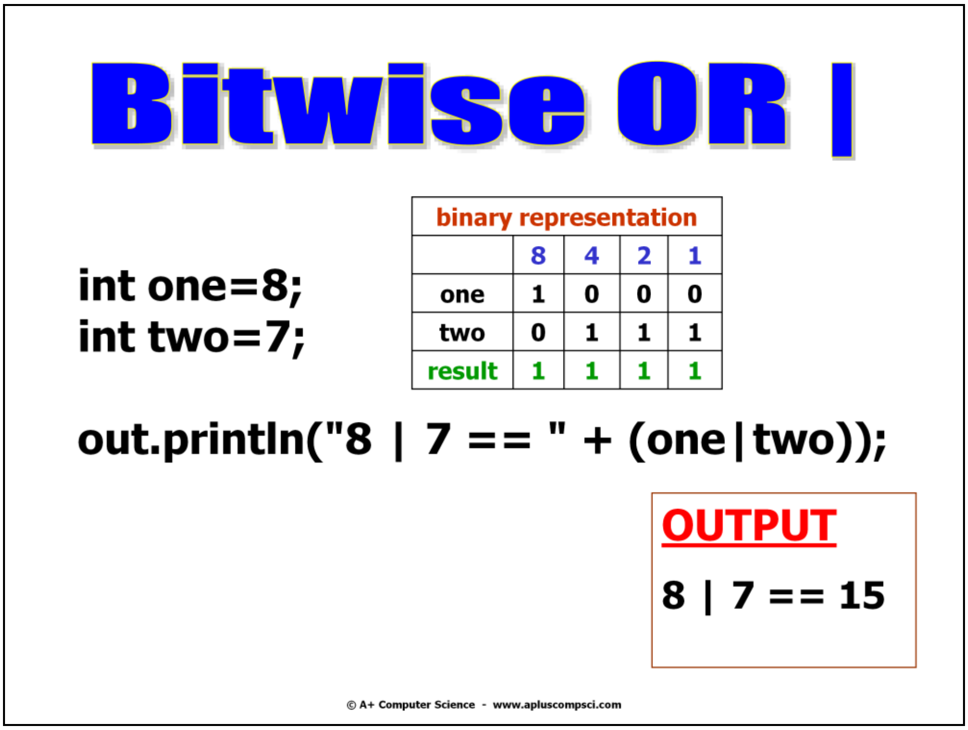
```
int one=8;
int two=7;
```

binary representation				
	8	4	2	1
one	1	0	0	0
two	0	1	1	1
result	0	0	0	0

```
out.println("8 & 7 == " + (one&two));
```

OUTPUT

```
8 & 7 == 0
```



Bitwise OR |

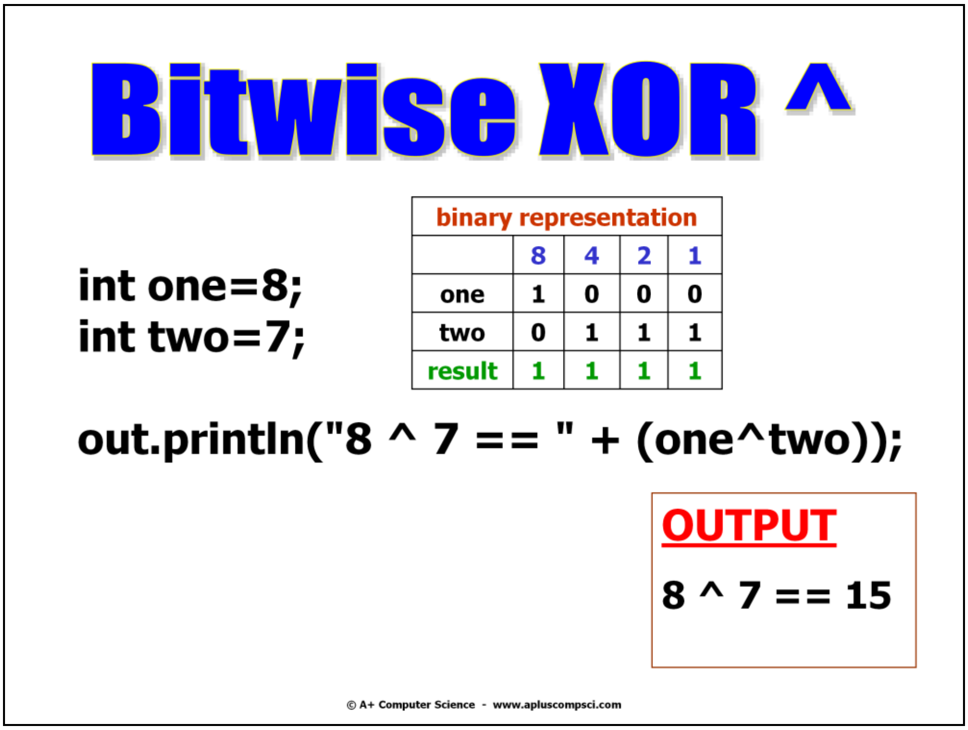
```
int one=8;
int two=7;
```

binary representation				
	8	4	2	1
one	1	0	0	0
two	0	1	1	1
result	1	1	1	1

```
out.println("8 | 7 == " + (one|two));
```

OUTPUT

```
8 | 7 == 15
```



Bitwise XOR ^

```
int one=8;
int two=7;
```

binary representation				
	8	4	2	1
one	1	0	0	0
two	0	1	1	1
result	1	1	1	1

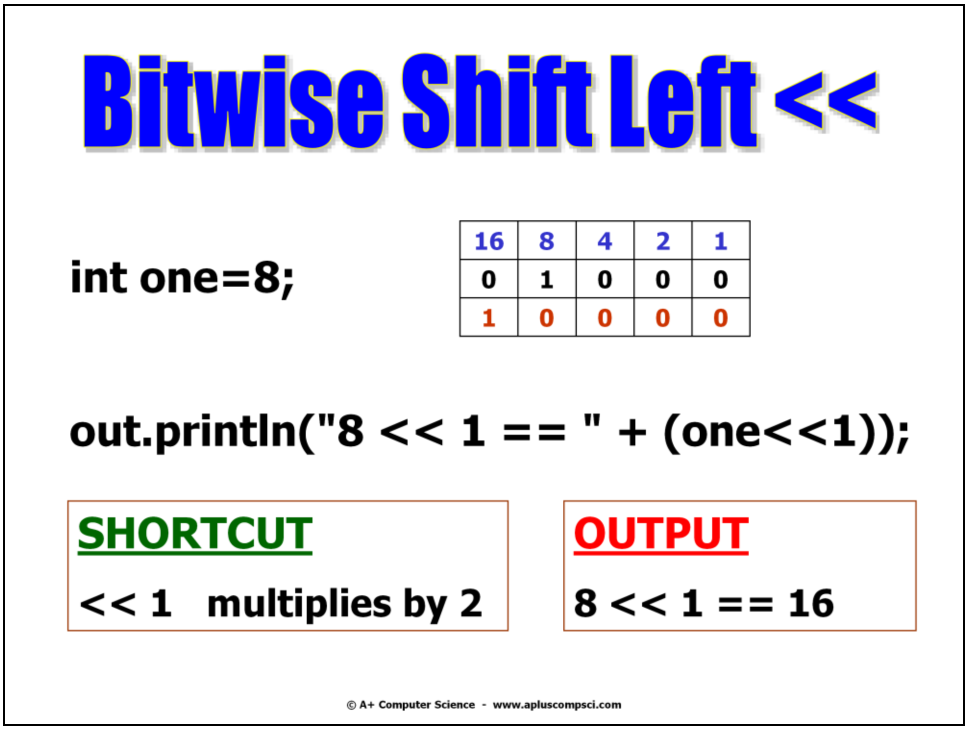
```
out.println("8 ^ 7 == " + (one^two));
```

OUTPUT

```
8 ^ 7 == 15
```

© A+ Computer Science - www.apluscompsci.com

open
bitwiseand.java
bitwiseor.java
bitwisexor.java



Bitwise Shift Left <<

int one=8;

16	8	4	2	1
0	1	0	0	0
1	0	0	0	0

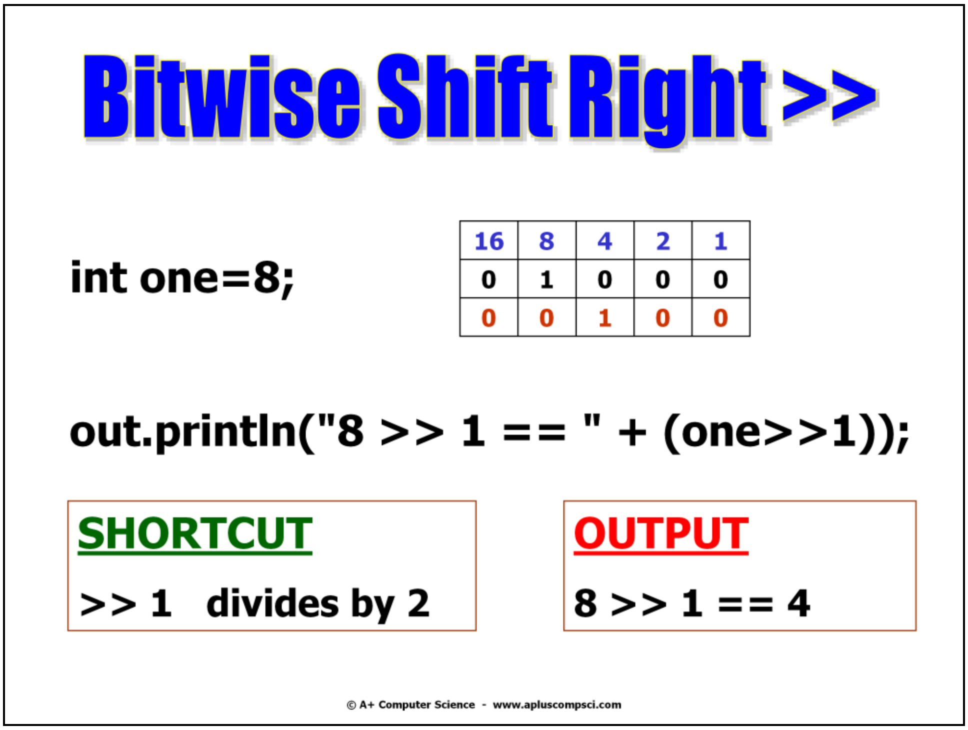
```
out.println("8 << 1 == " + (one<<1));
```

SHORTCUT

<< 1   multiplies by 2

OUTPUT

```
8 << 1 == 16
```



Bitwise Shift Right >>

```
int one=8;
```

16	8	4	2	1
0	1	0	0	0
0	0	1	0	0

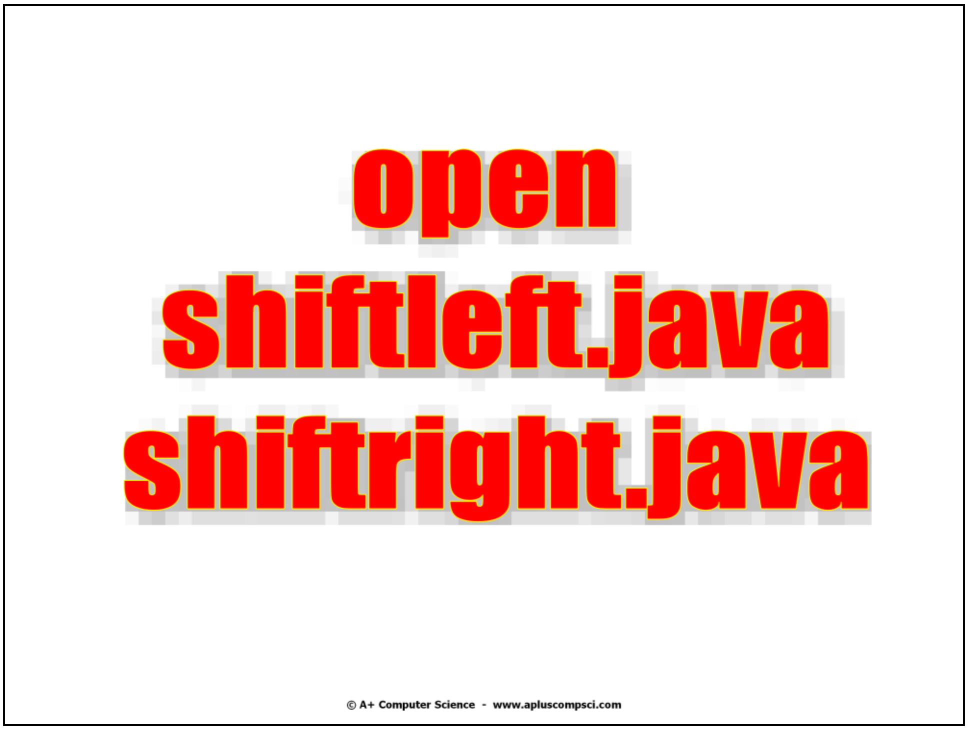
```
out.println("8 >> 1 == " + (one>>1));
```

SHORTCUT

>> 1   divides by 2

OUTPUT

```
8 >> 1 == 4
```



open
shiftleft.java
shiftright.java