

CSC 209 Review 9 Solution

August 31, 2020

1. a) 0

Notes

- a) is 0 because $(i \gg 1 + j \gg 1 = i \gg 10 \gg 1 = 0)$
- **Bitwise Shift Operators**
 - has lower precedence than arithmetic operators

Example:

$i \ll 2 + 1$ means $i \ll (2+1)$ and not $(i \ll 2) + 1$

- \ll : Left Shift
- \gg : Right Shift
- *Tip*: Always shift only on unsigned numbers for portability

Example

```
unsigned short i, j;

i = 13;          /* i is now 13 (binary 0000000000001101) */
j = i << 2;       /* j is now 52 (binary 0000000000110100) */
j = i >> 2;       /* j is now 3  (binary 0000000000000011) */
```

As these examples show, neither operator modifies its operands. To modify a variable by shifting its bits, we'd use the compound assignment operators $\ll=$ and $\gg=$:

```
i = 13;          /* i is now 13 (binary 0000000000001101) */
i <<= 2;         /* i is now 52 (binary 0000000000110100) */
i >>= 2;         /* i is now 3  (binary 0000000000001101) */
```

Shifts to left

Shifts to right

- $\gg=$ / $\ll=$: Are bitwise shift equivalent of $+=$

b) 0

Notes

- `i` is 1111111111111111
- `i` is 0000000000000000
- so `i & i = 0`
- `~`: Bitwise complement (NOT)

a	$\sim a$
0	1
1	0

Example:

```

1      0   1   1   1   //<- this is 7
2      -----
3      1   0   0   0   //<- this is 8
4
5      so, ~ 7 = 8

```

- `&`: Bitwise *and*

a	b	a & b
0	0	0
0	1	0
1	0	0
1	1	1

Example:

```

1      0   1   1   1   //<- this is 7
2      0   1   0   0   //<- this is 4
3      -----
4      0   1   0   0   //<- this is 4
5
6      so, 7 & 4 = 4

```

- `^`: Bitwise *exclusive or*
- `|`: Bitwise *inclusive or*

c) 1

Notes

- `i` is 1111111111111110
- `j` is 0000000000000000
- `i & j` is 0000000000000000 or 1
- `i & j ^ k` is 1

- \wedge : Bitwise XOR

a	b	$a \wedge b$
0	0	0
0	1	1
1	0	1
1	1	0

Example:

```

1      0   1   1   1   //<- this is 7
2      0   1   0   0   //<- this is 4
3      -----
4      0   0   1   1   //<- this is 3
5
6      so, 7 ^ 4 = 3
7

```

d) 0

Example

- i is 0000000000000111
- j is 0000000000001000
- $i \wedge j$ is 0000000000000000 or 0
- k is 0000000000001001
- $i \wedge j \& k$ is 0000000000000000 or 0

Correct Solution

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Notes

- There is a precedence to the order of operations

Highest:	\sim
	$\&$
	\wedge
Lowest:	$ $

- e) • toggling from 0 to 1

```
i = 0x0000;
i |= 0x0001;
```

or

```
i |= 1 << 0; where i = 0x0000;
```

- toggling from 1 to 0

```
i = 0x0001;
i &= ~0x0001;
```

or

```
i &= ~(1 << 0); where i = 0x0001;
```

Correct Solution

- toggling from 0 to 1 of 4th bit

```
i = 0x0010;
i ^= 0x0000;
```

or

```
i ^= 1 << 4; where i = 0x0000;
```

- toggling from 1 to 0 of 4th bit

```
i = 0x0010;
i ^= 0x0010;
```

or

```
i ^= (1 << 4); where i = 0x0010;
```

Notes

- Toggling can be done using bitwise XOR
- **Setting a bit**
 - Is done using `|` or bitwise OR

```
i = 0x0000;          /* i is now 0000000000000000 */
i |= 0x0010;         /* i is now 0000000000010000 */
```

- The idiom of above is `i |= 1 << j`

- **Clearing a bit**

- Is done using `|` or bitwise AND

```
i = 0x00ff;          /* i is now 0000000011111111 */
i &= ~0x0010;        /* i is now 0000000011101111 */
```

- The idiom of above is `i &= ~(i << j)`

2. It swaps the elements between x and y.

Notes

- Preprocessor performs operations of statements in order from left to right

```
#define M(x,y) ((x) ^=(y) , (y) ^=(x) , (x) ^=(y) )
```

New value of x → New value of y → New value of x

3. `#define MK_COLOR(r,g,b) (r >>, ,)`

Notes

- **Using the Bitwise Operators to Access Bit-Fields**

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