

4) $3 \times 9 = ?$


$$= 3 \times \sqrt{81} = 3\sqrt{81} = 3\sqrt{\begin{array}{r} 27 \\ 6 \\ \hline 21 \\ 21 \\ \hline 0 \end{array}} = 27$$



**FUNCTIONS: PASS BY
REFERENCE VS. PASS BY VALUE**



Pass By Reference

- Pass by reference allows a function to directly modify the original values of parameters passed to it without returning anything.
 - Why use pass by reference:
 - You need to modify multiple related variables simultaneously
 - You need to swap variable values
 - You are passing a huge type into a function and don't want to waste valuable memory space copying it
- 



Value vs. Reference

Pass by Value

- The value of the passed function parameter is copied into a local variable
- Only one value can be returned from a function
- You can have implicit casting
- Can pass a variable, literal, or expression

Pass by reference

- The passed function parameter refers to the same place in memory as the original variable
- Multiple variables can be modified from one function
- No implicit casting allowed
- Must pass a variable

Both of the below print 25

Pass By Value

```
int square(int x) {  
    //parameter passed by value  
    in this case  
    return x * x;  
}  
  
int main() {  
    int num = 5;  
    //Notice how return value  
    must be saved for num to be  
    modified  
    num = square(num);  
    cout << num;  
}
```

Pass By Reference

```
void square(int &x) {  
    //The & means the parameter  
    is passed by reference  
    x = x * x;  
}  
  
int main() {  
    int num = 5;  
    //Notice how num is  
    modified, even when no return  
    value is saved  
    square(num);  
    cout << squared;  
}
```

Pass by Value example

What prints? Is there a logic error? Can you think of a case where this would fail? If so, what fixes need to be made

```
void addMinutes(int
    &hours, int &min, int
    minAdded) {

    hours += minAdded / 60;
    min += (minAdded % 60);
    minAdded = 0;
    return;
}
```

```
int main () {
    double h = 2;
    int m = 10;
    int min2Add = 65;
    addMinutes(h, m,
    min2Add);
    cout << h << " hours and
    " << m << "
    minutes: We added:
    " << min2Add << "
    minutes" << endl;
}
```