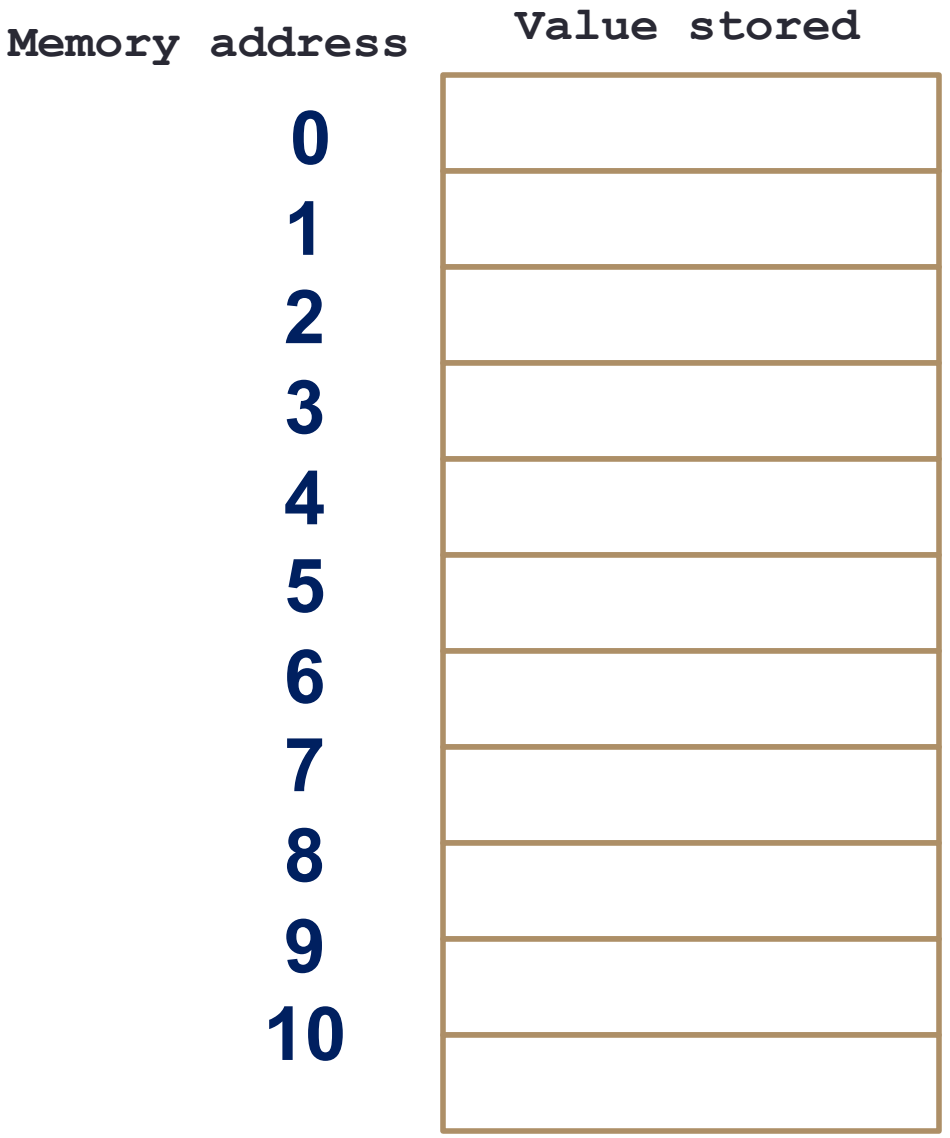
C++ ARRAYS
POINTERS
POINTER ARITHMETIC

Problem Solving with Computers-I

General model of memory

- Sequence of adjacent cells
- Each cell has 1-byte stored in it
- Each cell has an address (memory location)



C++ Arrays

- **List of elements**
- All elements have the same data type
- The elements re located adjacent to each other in memory

Declare an array to store 3 integers

Accessing elements of an array


```
int scores[]={20,10,50}; // declare and initialize
//Print each element



// Use a for loop
```

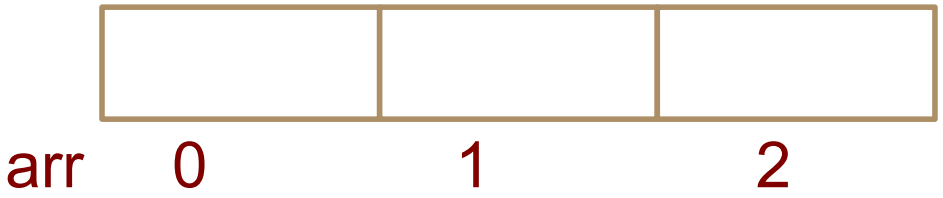
C++11 range based for loops


```
int scores[]={20,10,50}; // declare an initialize
//Print each element using a range based for loop (C++ 11 feature)
```

Modifying the array


```
int scores[]={20,10,50}; // declare an initialize
//Increment each element by 10
```

Tracing code involving arrays




```
int arr[]={10,20,30};
int tmp = arr[0];
arr[0] = arr[2];
arr[2] = tmp;
```

Choose the resulting array after the code is executed

A.

B.

C.

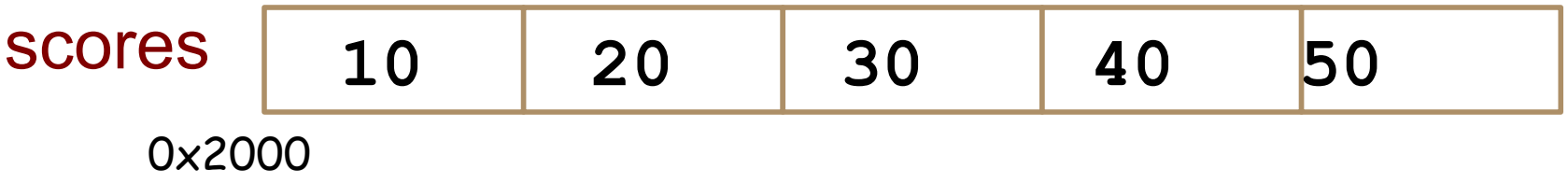
D. None of the above

Most common array pitfall- out of bound access


```
int scores[]={20,10,50}; // declare an initialize
for(int i=0; i<=3; i++)
    scores[i] = scores[i]+10;
```

Demo: Passing arrays to functions

Passing arrays to functions




```
int main(){
   int scores[]={10, 20, 30, 40, 50};
   foo(scores);
}
double foo(int sc[]){
    cout<<sc;
    return
}
```

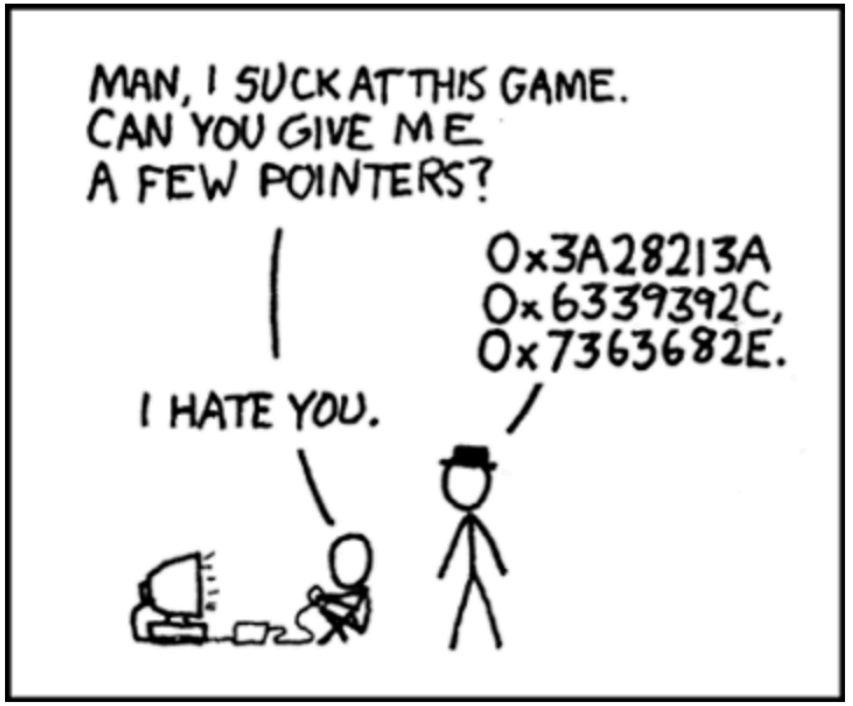
What is the output?

A. 10
B. 10 20 30 40 50
C. 0x2000
D. None of the above

Pointers

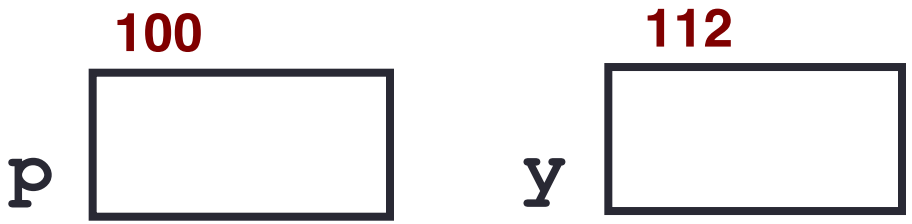
- Pointer: A variable that contains the address of another variable
- Declaration: *type* * pointer_name;

```
int* p;
```



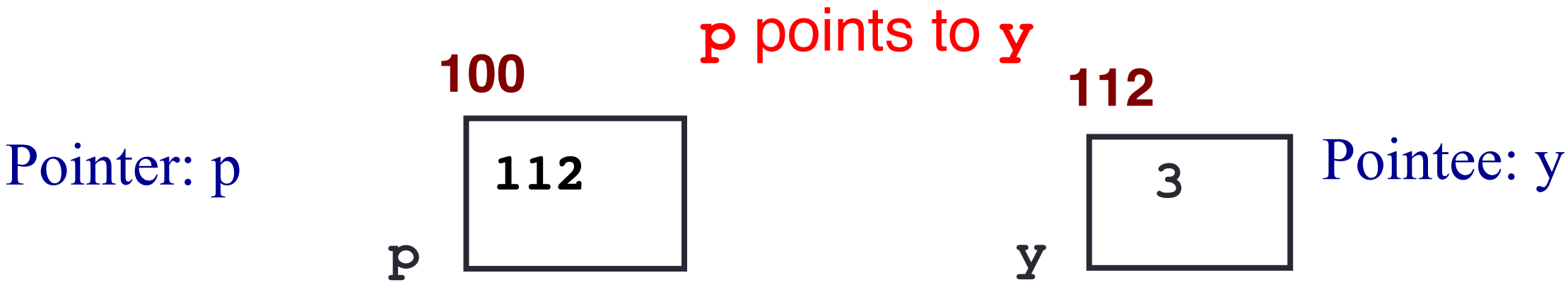
How to make a pointer point to something

```
int *p;
int y = 3;
```



To access the location of a variable, use the address operator ‘&’

Pointer Diagrams:
Diagrams that show the relationship between pointers and pointees



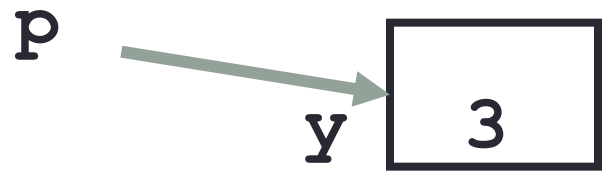
You can change the value of a variable using a pointer !

```
int *p, y;
y = 3;
p = &y;

*p = 5;
```

Two ways of changing the value of a variable

- Change the value of y directly:



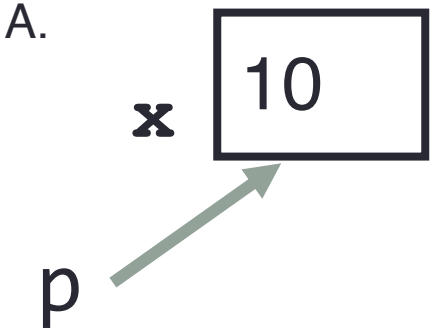
- Change the value of y indirectly (via pointer p):

Tracing code involving pointers

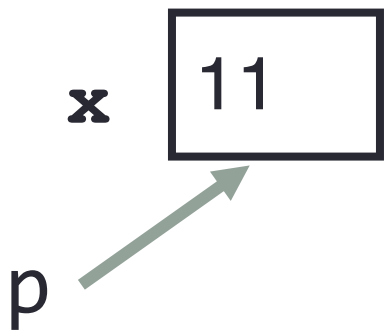
```
int *p;
int x=10;
p = &x;
*p = *p + 1;
```

Q: Which of the following pointer diagrams best represents the outcome of the above code?

A.



B.



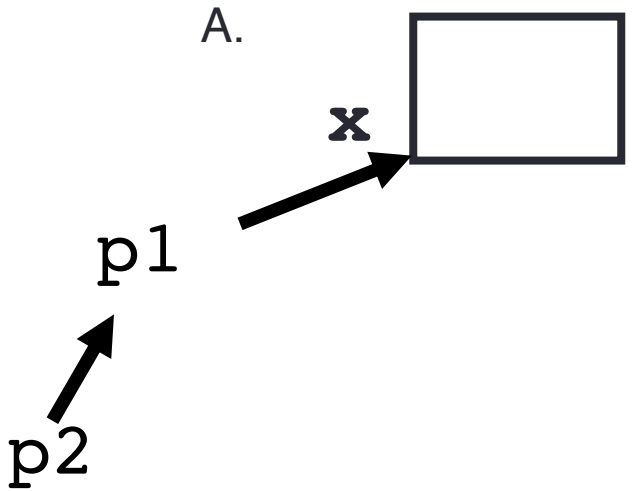
C. Neither, the code is incorrect

Pointer assignment

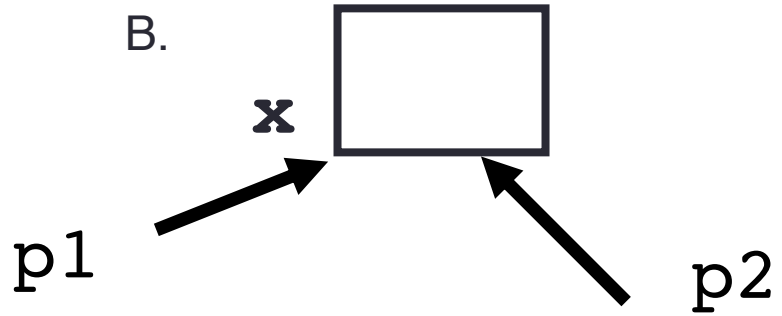
```
int *p1, *p2, x;
p1 = &x;
p2 = p1;
```

Q: Which of the following pointer diagrams best represents the outcome of the above code?

A.

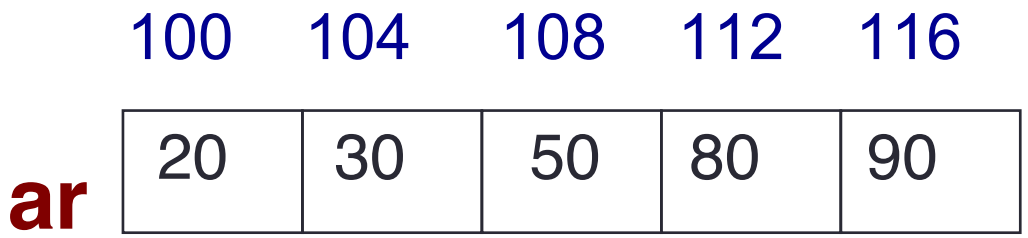


B.



C. Neither, the code is incorrect

Arrays and pointers



- `ar` is like a pointer to the first element
- `ar[0]` is the same as `*ar`
- `ar[2]` is the same as `*(ar+2)`

- Use pointers to pass arrays in functions
- Use *pointer arithmetic* to access arrays more conveniently

Pointer Arithmetic

```
int ar[]={20, 30, 50, 80, 90};
```

How many of the following are invalid?

I. pointer + integer (ptr+1)
II. integer + pointer (1+ptr)
III. pointer + pointer (ptr + ptr)
IV. pointer – integer (ptr – 1)
V. integer – pointer (1 – ptr)
VI. pointer – pointer (ptr – ptr)
VII. compare pointer to pointer (ptr == ptr)
VIII. compare pointer to integer (1 == ptr)
IX. compare pointer to 0 (ptr == 0)
X. compare pointer to NULL (ptr == NULL)

#invalid
A: 1
B: 2
C: 3
D: 4
E: 5

Pointer Arithmetic

```
int ar[]={20, 30, 50, 80, 90};
int *p;
p = arr;
p = p + 1;
*p = *p + 1;
```

Draw the array ar after the above code is executed

char arrays, C-strings

- How are ordinary arrays of characters and C-strings similar and how are they dissimilar?

What is the output of the code?

```
char s1[] = "Mark";
char s2[] = "Jill";
for (int i = 0; i <= 4; i++)
      s2[i] = s1[i];
if (s1 == s2) s1 = "Art";
cout<<s1<<" "<<s2<<endl;
```

A. Mark Jill

B. Mark Mark

C. Art Mark

D. Compiler error

E. Run-time error

Two important facts about Pointers

1) A pointer can only point to one type –(basic or derived) such as `int`, `char`, a `struct`, another pointer, etc

2) After declaring a pointer: `int *ptr;`

   `ptr` doesn't actually point to anything yet.

   We can either:

   - make it point to something that already exists, OR
   - allocate room in memory for something new that it will point to

Pointer Arithmetic

- What if we have an array of large structs (objects)?
  - C++ takes care of it: In reality, `ptr+1` doesn't add `1` to the memory address, but rather adds the size of the array element.
  - C++ knows the size of the thing a pointer points to – every addition or subtraction moves that many bytes: 1 byte for a char, 4 bytes for an int, etc.

Next time

- References
- Call by value, call by reference and call by address