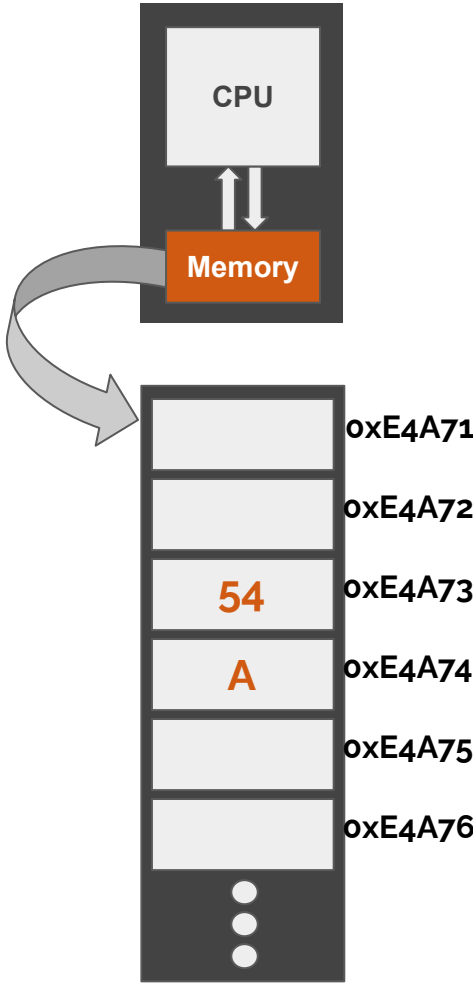
Pointers

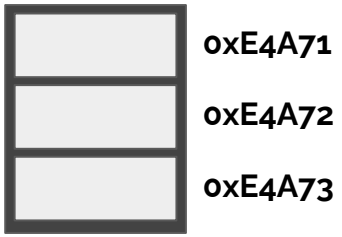
Review: Main Memory

- Memory is called Main Memory, Primary Memory or RAM.
- This memory is divided into different cells.
- Each cell has an address like we have address of our house numbers or PO Boxes
- CPU stores data into these cells and loads data from these cells whenever it is required.



Review: Variable Declaration

When we declare a variable, it reserves memory for a specific datatype.



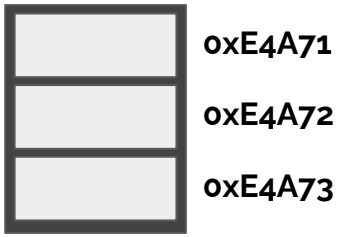
Memory

Review: Variable Declaration

When we declare a variable, it reserves memory for a specific datatype.

For Example:

```
int num;
```



Memory

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```
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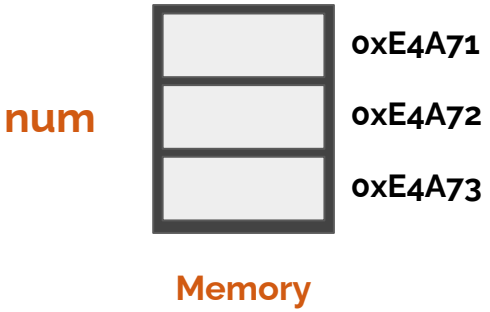
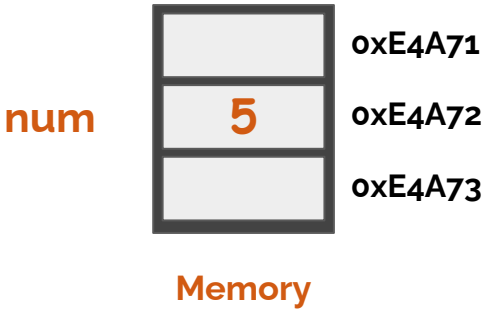


Review: Variable initialization

When we declare a variable, it reserves memory for a specific datatype.

For Example:

```
int num = 5;
```

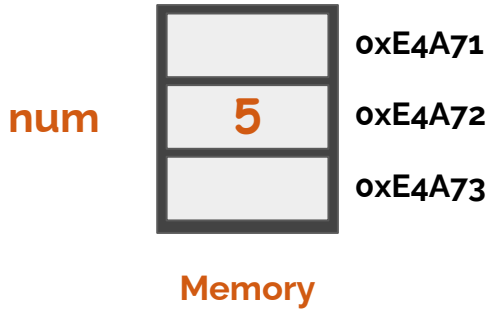


Review: Display the contents of cell

Now, if we want to display the contents of the cell then we can use the variable to see the contents of the memory.

For Example:

```
cout << num;
```



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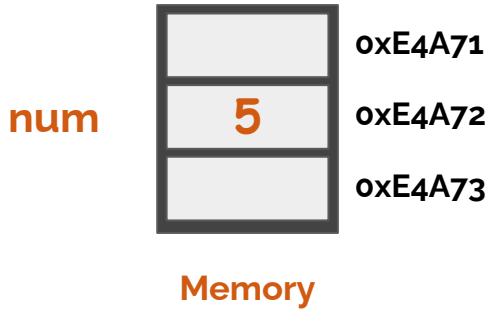
For Example:

```
cout << num;
```

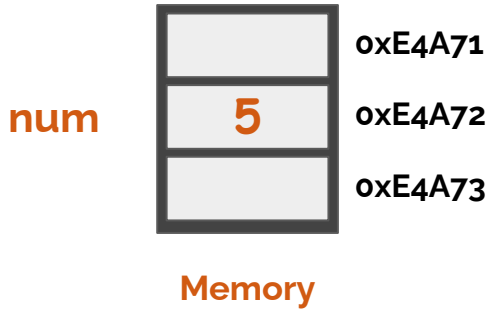
```
C:\C++\Week12>c++ 1.cpp -o 1.exe

C:\C++\Week12>1.exe
5
C:\C++\Week12>
```



Display the address of cell

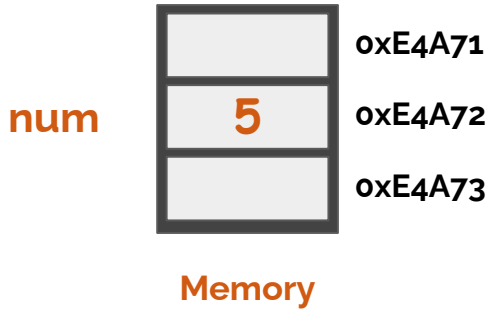
Let's say for some reason we do not want to see the contents (5) of the cell, but we want to see the address (0xE4A73) of the cell.



Display the address of cell

Let's say for some reason we do not want to see the contents (5) of the cell, but we want to see the address (0xE4A73) of the cell.

For that we write & before the Variable name.

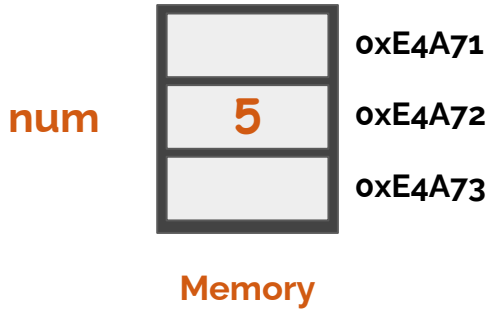


Display the address of cell

Let's say for some reason we do not want to see the contents (5) of the cell, but we want to see the address (0xE4A73) of the cell.

For that we write & before the Variable name.

```
cout << &num;
```



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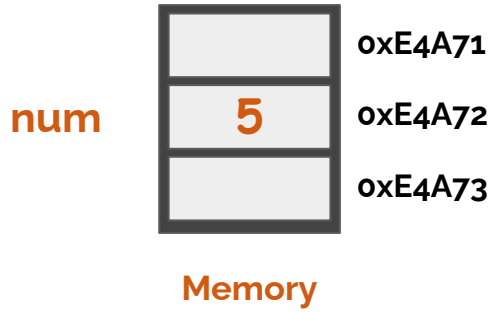



```
cout << &num;
```

```
C:\C++\Week12>c++ 1.cpp -o 1.exe

C:\C++\Week12>1.exe
0xE4A72
C:\C++\Week12>
```

Pointer

Before moving further, can anyone tell What is the role of a **Pointer**?

Pointer

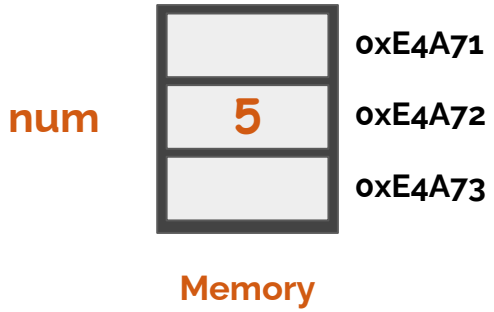
Pointer just points towards something.

Pointer

Pointer just points towards something. If i aim the pointer towards the slides and press the button, it will start pointing towards
the slides

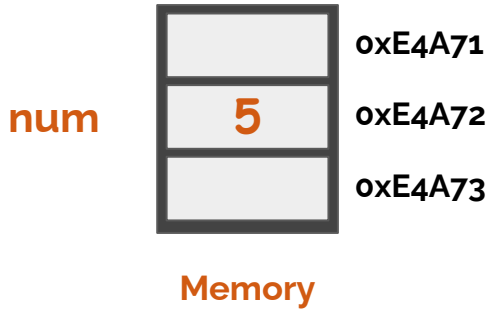
Pointers

In the same way, we have pointers in C++.



Pointers

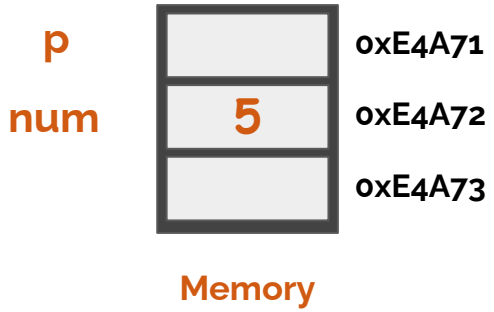
In the same way, we have pointers in C++.
But We can only point towards the address of any memory cell using the pointer.



Pointers: Declaration

Syntax to declare a pointer of a specific datatype in C++ is:

```
int *p;
```

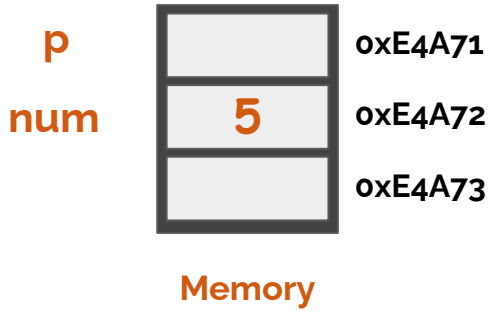


Pointers: Declaration

Syntax to declare a pointer of a specific datatype in C++ is:

```
int *p;
```

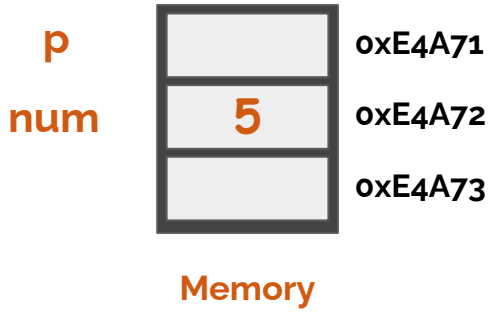
We have declared a pointer of int datatype,
It means it can only point towards the memory cell containing integer type of data.



Pointers: Assign the address

Lets assign the memory address of num variable to the pointer. In short, lets press the on button of the pointer.

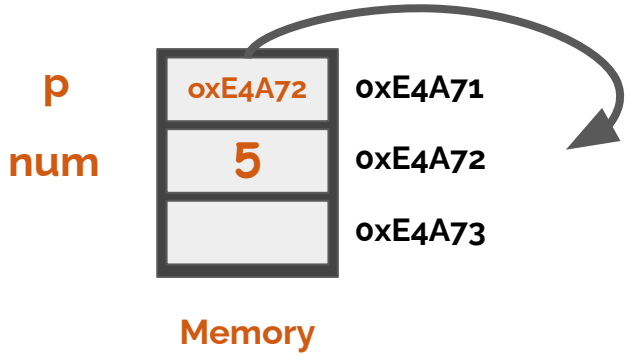
```
int *p;
```



Pointers: Assign the address

Lets assign the memory address of num variable to the pointer. In short, lets press the on button of the pointer.

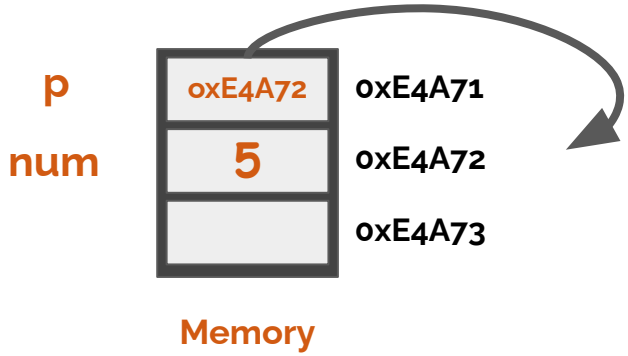
```
int *p;
p = &num;
```



Pointers: Dereferencing

Once a pointer is assigned to an address, you can refer to the value it points to by "dereferencing the pointer". To do this, use the unary * operator

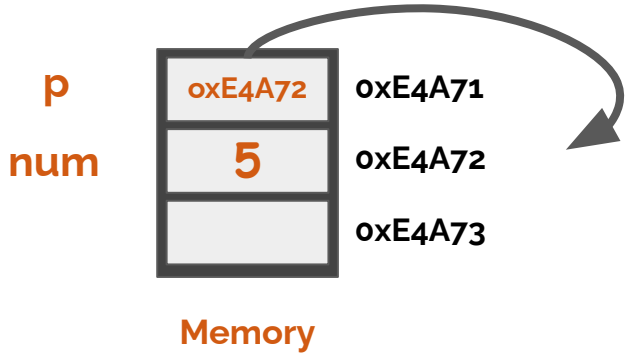
```
int *p;
p = &num;
```



Pointers: Dereferencing

Once a pointer is assigned to an address, you can refer to the value it points to by "dereferencing the pointer". To do this, use the unary * operator

```
int *p;
p = &num;
cout << *p;
```



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cout << *p;
```
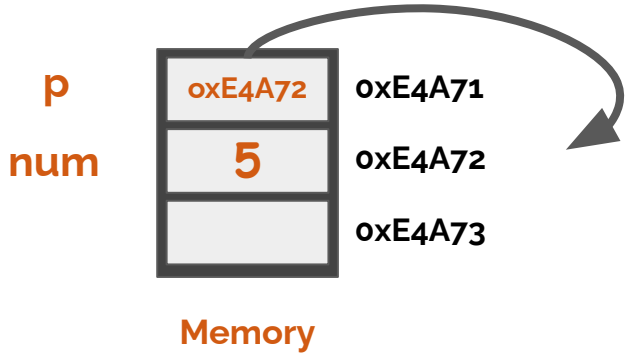
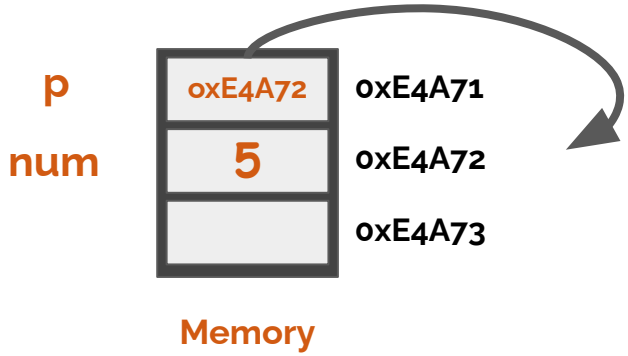

```
C:\C++\Week12>c++ 1.cpp -o 1.exe

C:\C++\Week12>1.exe
5
C:\C++\Week12>
```



Pointers: See the address to which the pointer is pointing

If we want to see which address the pointer is pointing, then we can write.

```
int *p;
p = &num;
cout << p;
```



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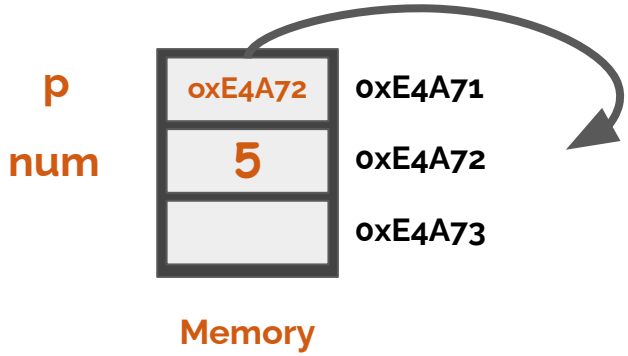


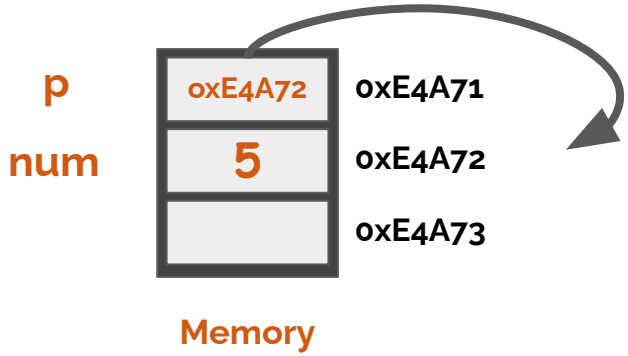

```
C:\C++\Week12>c++ 1.cpp -o 1.exe

C:\C++\Week12>1.exe
0xE4A72
C:\C++\Week12>
```

Pointers: change the value of num using *p

Let's change the value of num variable using the pointer.

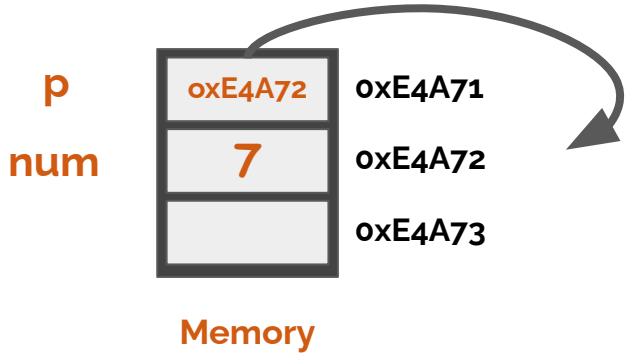
```
int *p;
p = &num;
```



Pointers: change the value of num using *p

Let's change the value of num variable using the pointer.

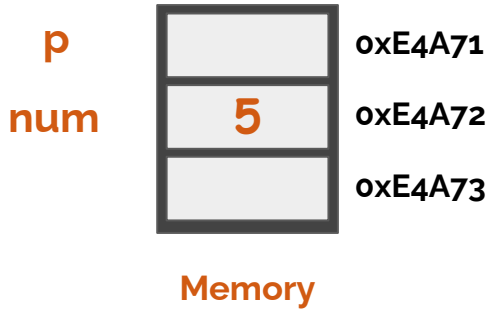
```
int *p;
p = &num;
*p = 7;
```



Pointers: Declaration

In the same manner we can declare pointers for any datatype

```
int *p;
float *mypointer;
char *another;
```



Learning Objective

Understand the access of memory addresses using Pointer

Conclusion

- The address of a variable can be stored in another variable known as a pointer variable. The syntax for storing a variable's address to a pointer is:

```
dataType *pointerVariableName = &variableName;
```

- We need to tell the computer what the data type of the variable is whose address we are going to store.
- If you see the * in a declaration statement, a pointer is being declared for the first time.
- AFTER that, when you see the * on the pointer name, you are dereferencing the pointer to get to the target.

Self Assessment:

1. What is the output of the following code?

```
int int1 = 26;
int int2 = 45;
int *int1Ptr = &int1;
int *int2Ptr = &int2;
*int1Ptr = 89;
*int2Ptr = 62;
int1Ptr = int2Ptr;
*int1Ptr = 80;
int1 = 57;
cout << int1 << " " << int2 << endl;
cout << *int1Ptr << " " << *int2Ptr << endl;
```

Code	int1 (A1)	int2 (A2)		
`int int1 = 26;` `int int2 = 45;`	26	45		
`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`				
`*int1Ptr = 89;`				
`*int2Ptr = 62;`				
`int1Ptr = int2Ptr;`				
`*int1Ptr = 80;`				
`int1 = 57;`				
`cout << int1 << " " << int2 << endl;`				
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
`int int1 = 26;` `int int2 = 45;`	26	45		
`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`	26	45	A1	A2
`*int1Ptr = 89;`				
`*int2Ptr = 62;`				
`int1Ptr = int2Ptr;`				
`*int1Ptr = 80;`				
`int1 = 57;`				
`cout << int1 << " " << int2 << endl;`				
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
`int int1 = 26;` `int int2 = 45;`	26	45		
`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`	26	45	A1	A2
`*int1Ptr = 89;`	89	45	A1	A2
`*int2Ptr = 62;`				
`int1Ptr = int2Ptr;`				
`*int1Ptr = 80;`				
`int1 = 57;`				
`cout << int1 << " " << int2 << endl;`				
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
`int int1 = 26;` `int int2 = 45;`	26	45		
`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`	26	45	A1	A2
`*int1Ptr = 89;`	89	45	A1	A2
`*int2Ptr = 62;`	89	62	A1	A2
`int1Ptr = int2Ptr;`				
`*int1Ptr = 80;`				
`int1 = 57;`				
`cout << int1 << " " << int2 << endl;`				
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
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`*int1Ptr = 89;`	89	45	A1	A2
`*int2Ptr = 62;`	89	62	A1	A2
`int1Ptr = int2Ptr;`	89	62	A2	A2
`*int1Ptr = 80;`				
`int1 = 57;`				
`cout << int1 << " " << int2 << endl;`				
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
`int int1 = 26;` `int int2 = 45;`	26	45		
`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`	26	45	A1	A2
`*int1Ptr = 89;`	89	45	A1	A2
`*int2Ptr = 62;`	89	62	A1	A2
`int1Ptr = int2Ptr;`	89	62	A2	A2
`*int1Ptr = 80;`	89	80	A2	A2
`int1 = 57;`				
`cout << int1 << " " << int2 << endl;`				
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
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`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`	26	45	A1	A2
`*int1Ptr = 89;`	89	45	A1	A2
`*int2Ptr = 62;`	89	62	A1	A2
`int1Ptr = int2Ptr;`	89	62	A2	A2
`*int1Ptr = 80;`	89	80	A2	A2
`int1 = 57;`	57	80	A2	A2
`cout << int1 << " " << int2 << endl;`				
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
`int int1 = 26;` `int int2 = 45;`	26	45		
`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`	26	45	A1	A2
`*int1Ptr = 89;`	89	45	A1	A2
`*int2Ptr = 62;`	89	62	A1	A2
`int1Ptr = int2Ptr;`	89	62	A2	A2
`*int1Ptr = 80;`	89	80	A2	A2
`int1 = 57;`	57	80	A2	A2
`cout << int1 << " " << int2 << endl;`	57 80			
`cout << *int1Ptr << " " << *int2Ptr << endl;`				

Code	int1 (A1)	int2 (A2)	int1Ptr	int2Ptr
`int int1 = 26;` `int int2 = 45;`	26	45		
`int *int1Ptr = &int1;` `int *int2Ptr = &int2;`	26	45	A1	A2
`*int1Ptr = 89;`	89	45	A1	A2
`*int2Ptr = 62;`	89	62	A1	A2
`int1Ptr = int2Ptr;`	89	62	A2	A2
`*int1Ptr = 80;`	89	80	A2	A2
`int1 = 57;`	57	80	A2	A2
`cout << int1 << " " << int2 << endl;`	57 80			
`cout << *int1Ptr << " " << *int2Ptr << endl;`	80 80			

Self Assessment:

2. What is the output of the following code?

```
string str1 = "sunny";
string str2 = "cloudy";
string *s1;
cout << str1 << " " << str2 << endl;
s1 = &str1;
str1 = str2;
str2 = *s1;
cout << str1 << " " << str2 << endl;
```

Code	str1 (A1)	str2 (A2)	
`string str1 = "sunny";` `string str2 = "cloudy";`	sunny	cloudy	
`string *s1;`			
`cout << str1 << " " << str2 << endl;`			
`s1 = &str1;`			
`str1 = str2;`			
`str2 = *s1;`			
`cout << str1 << " " << str2 << endl;`			

Code	str1 (A1)	str2 (A2)	s1
`string str1 = "sunny";` `string str2 = "cloudy";`	sunny	cloudy	
`string *s1;`	sunny	cloudy	
`cout << str1 << " " << str2 << endl;`			
`s1 = &str1;`			
`str1 = str2;`			
`str2 = *s1;`			
`cout << str1 << " " << str2 << endl;`			

Code	str1 (A1)	str2 (A2)	s1
`string str1 = "sunny";` `string str2 = "cloudy";`	sunny	cloudy	
`string *s1;`	sunny	cloudy	
`cout << str1 << " " << str2 << endl;`	sunny cloudy		
`s1 = &str1;`			
`str1 = str2;`			
`str2 = *s1;`			
`cout << str1 << " " << str2 << endl;`			

Code	str1 (A1)	str2 (A2)	s1
`string str1 = "sunny";` `string str2 = "cloudy";`	sunny	cloudy	
`string *s1;`	sunny	cloudy	
`cout << str1 << " " << str2 << endl;`	sunny cloudy		
`s1 = &str1;`	sunny	cloudy	A1
`str1 = str2;`			
`str2 = *s1;`			
`cout << str1 << " " << str2 << endl;`			

Code	str1 (A1)	str2 (A2)	s1
`string str1 = "sunny";` `string str2 = "cloudy";`	sunny	cloudy	
`string *s1;`	sunny	cloudy	
`cout << str1 << " " << str2 << endl;`	sunny cloudy		
`s1 = &str1;`	sunny	cloudy	A1
`str1 = str2;`	cloudy	cloudy	A1
`str2 = *s1;`			
`cout << str1 << " " << str2 << endl;`			

Code	str1 (A1)	str2 (A2)	s1
`string str1 = "sunny";` `string str2 = "cloudy";`	sunny	cloudy	
`string *s1;`	sunny	cloudy	
`cout << str1 << " " << str2 << endl;`	sunny cloudy		
`s1 = &str1;`	sunny	cloudy	A1
`str1 = str2;`	cloudy	cloudy	A1
`str2 = *s1;`	cloudy	cloudy	A1
`cout << str1 << " " << str2 << endl;`			

Code	str1 (A1)	str2 (A2)	s1
`string str1 = "sunny";` `string str2 = "cloudy";`	sunny	cloudy	
`string *s1;`	sunny	cloudy	
`cout << str1 << " " << str2 << endl;`	sunny cloudy		
`s1 = &str1;`	sunny	cloudy	A1
`str1 = str2;`	cloudy	cloudy	A1
`str2 = *s1;`	cloudy	cloudy	A1
`cout << str1 << " " << str2 << endl;`	cloudy cloudy		

Self Assessment:

3. What is the output of the following code?

```
double dec1 = 2.5;
double dec2 = 3.8;
double *p, *q;
p = &dec1;
*p = dec2 - dec1;
q = p;
*q = 10.0;
*p = 2 * dec1 + (*q);
q = &dec2;
dec1 = *p + *q;
 cout << dec1 << " " << dec2 << endl;
 cout << *p << " " << *q << endl;
```

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`				
`*p = dec2 - dec1;`				
`q = p;`				
`*q = 10.0;`				
`*p = 2 * dec1 + (*q);`				
`q = &dec2;`				
`dec1 = *p + *q;`				
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`				
`q = p;`				
`*q = 10.0;`				
`*p = 2 * dec1 + (*q);`				
`q = &dec2;`				
`dec1 = *p + *q;`				
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`				
`*q = 10.0;`				
`*p = 2 * dec1 + (*q);`				
`q = &dec2;`				
`dec1 = *p + *q;`				
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`	1.3	3.8	A1	A1
`*q = 10.0;`				
`*p = 2 * dec1 + (*q);`				
`q = &dec2;`				
`dec1 = *p + *q;`				
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`	1.3	3.8	A1	A1
`*q = 10.0;`	10	3.8	A1	A1
`*p = 2 * dec1 + (*q);`				
`q = &dec2;`				
`dec1 = *p + *q;`				
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`	1.3	3.8	A1	A1
`*q = 10.0;`	10	3.8	A1	A1
`*p = 2 * dec1 + (*q);`	30	3.8	A1	A1
`q = &dec2;`				
`dec1 = *p + *q;`				
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`	1.3	3.8	A1	A1
`*q = 10.0;`	10	3.8	A1	A1
`*p = 2 * dec1 + (*q);`	30	3.8	A1	A1
`q = &dec2;`	30	3.8	A1	A2
`dec1 = *p + *q;`				
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`	1.3	3.8	A1	A1
`*q = 10.0;`	10	3.8	A1	A1
`*p = 2 * dec1 + (*q);`	30	3.8	A1	A1
`q = &dec2;`	30	3.8	A1	A2
`dec1 = *p + *q;`	33.8	3.8	A1	A2
`cout << dec1 << " " << dec2 << endl;`				
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`	1.3	3.8	A1	A1
`*q = 10.0;`	10	3.8	A1	A1
`*p = 2 * dec1 + (*q);`	30	3.8	A1	A1
`q = &dec2;`	30	3.8	A1	A2
`dec1 = *p + *q;`	33.8	3.8	A1	A2
`cout << dec1 << " " << dec2 << endl;`	33.8 3.8			
`cout << *p << " " << *q << endl;`				

Code	dec1 (A1)	dec2 (A2)	p	q

`double dec1 = 2.5;`
`double dec2 = 3.8;`
`double *p, *q;`
	2.5	3.8		

`p = &dec1;`	2.5	3.8	A1	
`*p = dec2 - dec1;`	1.3	3.8	A1	
`q = p;`	1.3	3.8	A1	A1
`*q = 10.0;`	10	3.8	A1	A1
`*p = 2 * dec1 + (*q);`	30	3.8	A1	A1
`q = &dec2;`	30	3.8	A1	A2
`dec1 = *p + *q;`	33.8	3.8	A1	A2
`cout << dec1 << " " << dec2 << endl;`	33.8 3.8			
`cout << *p << " " << *q << endl;`	33.8 3.8			