Data Types

Section 2.7 – 2.12

Today

- Last we covered
  - **`main`** function
  - **`cout`** object
  - How data that is used by a program can be declared and stored
- Today we will
  - Investigate the various types of data that C++ can handle

Declaration Statements

- Variable declarations

```
double area;

double circ;

double perimeter, volume;
```

- Constant declaration

```
const double PI = 3.14;

const double RADIUS = 5.4;
```

Identifiers

- Programmer-defined names that represent some element of a program

- C++ limits on variable names:
  1. Identifiers must begin with a letter or an underscore
  2. Identifiers must consist of letters, numbers and underscore, nothing else
  3. Identifiers cannot be a *keyword*

  page 42

Identifiers

- Identifiers are case sensitive

```
int totalCost;
int TotalCost;
```

- Use meaningful variable names

```
width
w
```

Identifiers

- Q 4.1 Which of the following declarations are invalid and why?

a. `char Letter1;`

b. `char 1letter;`

c. `double inches, kms;`

d. `double inches*num;`

e. `int joe's;`

f. `Int cent_per_inch;`

g. `double two-dimensional;`

h. `char hello;`

i. `int return;`

j. `size int;`

Data types

- A data type defines:
  - how the computer interprets data in memory

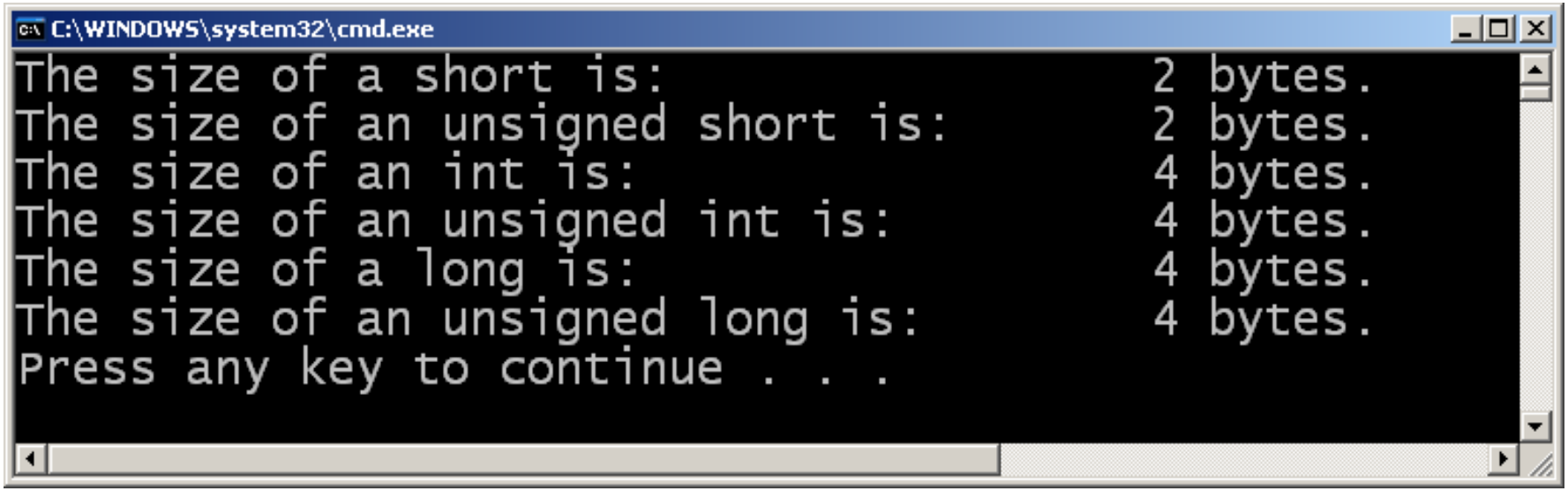
- What? What does memory really look like?
  - what is a byte? a bit?

Integers

- The main integer data type is `int`
- `int`s are finite (why?)
- An `int` without a sign (+ or -) is assumed to be positive
- 2,353 is not an `int`, 2353 is an `int`
- Operations?

Integer Data Types

- There are six integer data types, each with a different range and a different size
  - what does **`unsigned`** mean?



- Range of data types is listed on page 44
- see program 2-17 on page 58 for the above output

Variable Ranges

Type	Size	Values
`short int`	2 bytes	–32,768 to 32,767
`int`	4 bytes	–2,147,483,648 to 2,147,483,647
`unsigned int`	4 bytes	0 to 4,294,967,295
`long int`	4 bytes	–2,147,483,648 to 2,147,483,647

- What is the range of an `unsigned short`?
- What data type should you use for a person's age?
- What data type should you use for the temperature on the moon?
- What data type should you use for the size of a music file (mp3)?

Why?

`char`

- The `char` data type is used to store single characters (letters, digits, special characters)
  - ASCII

- Character literals are enclosed in single quotes
- Examples of character literals are: `'A'`, `'a'`, `'*'`, `'2'`, `'$'`

ASCII Character Set

- page 1097

Decimal Value	Character
32	<space>
33	!
65	A
66	B
67	C
97	a
98	b
99	c

- http://asciitable.com

Example

```
// page 48, program 2-11
#include <iostream>

using namespace std;

int main()
{
   char letter;

   letter = 65;
   cout << letter << endl;
   letter = 66;
   cout << letter << endl;
   return 0;
}
```

Program 4.2

```
// page 49, program 2-12
#include <iostream>

using namespace std;

int main()
{
   char letter;

   letter = 'A';
   cout << letter << endl;
   letter = 'B';
   cout << letter << endl;
   return 0;
}
```

`string` Class

- **`string`** is used to store a list of characters

- To indicate the end of a **`string`**, a null terminator is used
  - why?

- Need to include the preprocessor directive
  - **`#include <string>`**
  - why?

Questions

- Q 4.2 How are the character ‘A’ and the string constant “A” stored in memory?
- Q 4.3 Is the escape character \n a character or a string?
- Q 4.4 How do we declare a `char` variable and assign it a value?

`string` Questions

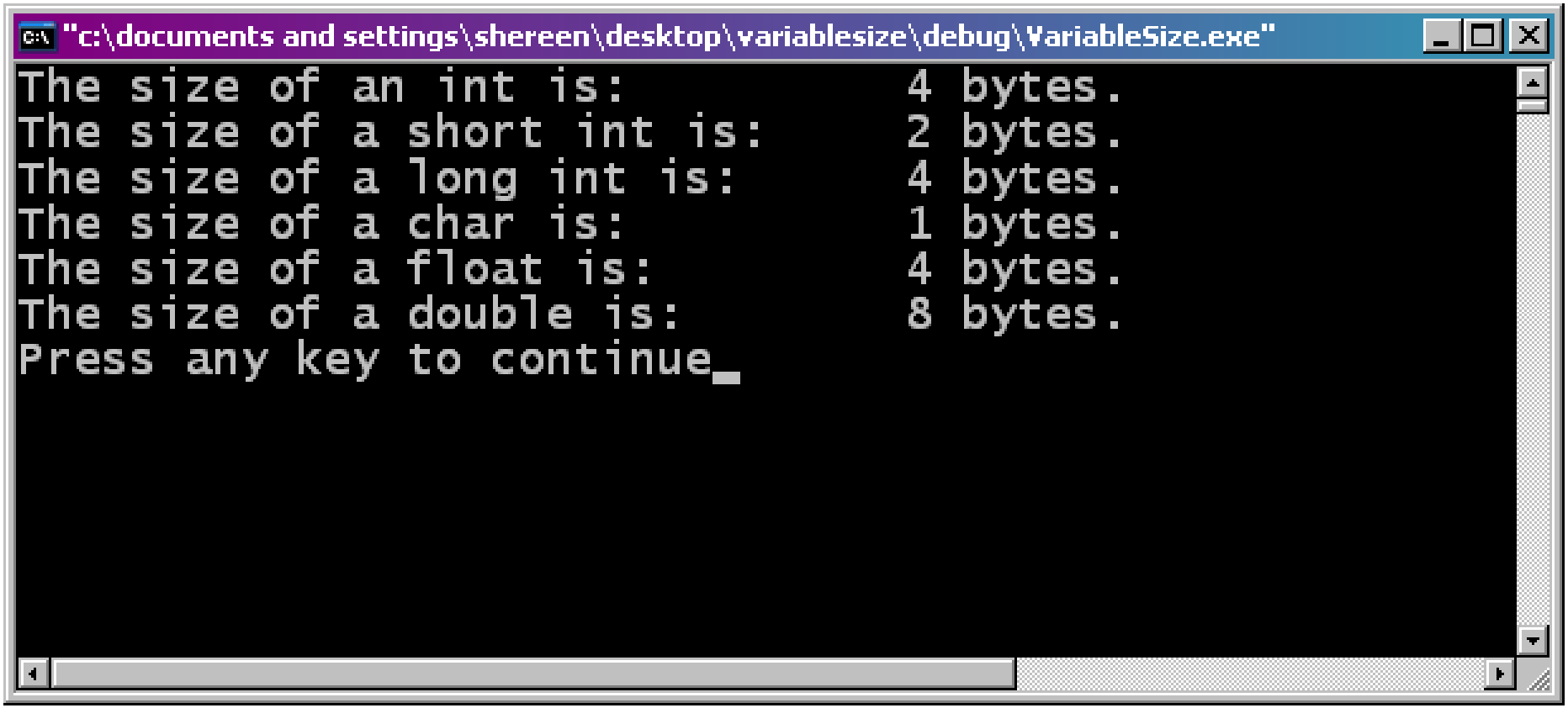
- Q 4.5 How do we declare a variable of type string?
- Q 4.6 How do we assign a value to the variable?
- Q 4.7 How do we output a string constant and a string variable? What is output?

Floating-Point Data Types

- **`float`**, **`double`**, **`long double`**
  - positive and negative
  - no unsigned float!
- Scientific Notation
- Examples:
  - 1.0, -2.3, -0.3, 12E5, -1E-2, 1.4e+8
- 2,353.99 is **not** a **`double`**
- 2353.99 is a **`double`**

Variable Sizes

- On my machine the sizes are



Variable Size Program

```
// page 58, program 2-17
#include <iostream>

using namespace std;

int main()
{
  cout << "The size of an int is:\t\t"    << sizeof(int)    << " bytes.\n";
  cout << "The size of a short int is:\t" << sizeof(short)  << " bytes.\n";
  cout << "The size of a long int is:\t"  << sizeof(long)   << " bytes.\n";
  cout << "The size of a char is:\t\t"    << sizeof(char)   << " bytes.\n";
  cout << "The size of a float is:\t\t"   << sizeof(float)  << " bytes.\n";
  cout << "The size of a double is:\t"    << sizeof(double) << " bytes.\n";

  return 0;
}
```

Variable Ranges

Type	Size	Values
`int`	4 bytes	–2,147,483,648 to 2,147,483,647
`short int`	2 bytes	–32,768 to 32,767
`long int`	4 bytes	–2,147,483,648 to 2,147,483,647
`unsigned int`	4 bytes	0 to 4,294,967,295
`char`	1 byte	256 character values
`float`	4 bytes	±3.4e–38 to ± 3.4e38
`double`	8 bytes	±1.7e–308 to ± 1.7e308

How to Choose a Numeric Data Type

- Ask yourself the following questions
  - What are the largest and smallest numbers that may be stored?
  - How much memory does the variable use?
  - Is the variable signed (positive and negative)?
  - How many decimal places of precision does the variable need?

Problem

- What variables will you need for the following program?
- page 71, #4.
- Write a program the computes the tax and tip on a restaurant bill. The user will enter the original bill and the tax rate. Assume a 15% tip. Display the tax amount, tip amount, and total bill on the screen.

Examples

- Remember, the format for declaring variables is:
  - `data-type identifier;`
- You can declare variables of the different data types as follows
  - `int num1;`
  - `double num2;`
  - `char letter;`

Summary

- In today's lecture we covered
  - Identifiers
  - Data types
  - How data that is used by a program can be declared and stored

- We have covered sections 2.7 – 2.12 of your textbook