



Closed book/closed notes. Show all of your work clearly in the space provided or on the additional page at the end of the exam. If the additional page is used, be sure to clearly label the content for each problem. Be sure to *read each problem carefully*. You should answer all five questions. Note: The exam is double-sided.

1. (15 points) Briefly explain what a compiler does.

2. (15 points) Write the following mathematical expression in C++.

$$x = \frac{a + b}{c}$$

where  $x$  is a `double` and  $a$ ,  $b$ , and  $c$  are all `unsigned ints`.

3. (15 points) What does the following program display?

```
#include <iostream>
2
using namespace std;
4
int main ( )
6 {
    int y ;
8     int x = 1;
    int total = 0;
10    while(x<=10) {
        y = x + x;
12        cout << y << endl;
        total += y;
14        x=++y;
    }
16    cout << total << endl;
    return EXIT_SUCCESS;
18 }
```

4. (20 points) Complete the program started below. The program should asks the user to enter a sentence and display the number of times the letter **i** (upper- or lower-case) appears in the sentence.

Here is a sample user interaction:

```
Please enter a sentence:
Whenever I feel blue, I start breathing again.
This sentence contains 4 i's.
```

```
#include <string>
2 #include <iostream>

4 using namespace std;

6 int main()
  {
8   cout << "Please enter a sentence:" << endl;
   string sentence;
10  getline(cin, sentence);
```

5. The value of  $\pi$  can be approximated by the series

$$4 \left( 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots \right)$$

(a) (15 points) Using the formula, write a program that calculates and displays the value of  $\pi$  using the first four terms of the series.



**(b)** (20 points) Using the same formula, explain how your program in part **(a)** should be modified to display the value of  $\pi$  using the first 300 terms of the series.



Additional work area for any problem. Clearly identify to which problem the work on this page is related.