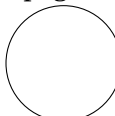
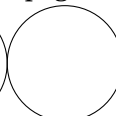
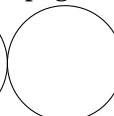
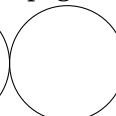
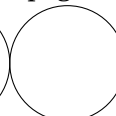
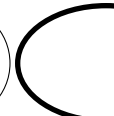


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No books; No calculator; No computer; No email; No internet; No notes; No phone. Neatness counts! Do your scratch work elsewhere and enter only your final answer into the spaces provided.

1. Write the template function `find` which takes a key and a pair of **forward** iterators and returns the iterator which indicates the first item in the container that is `==` to the key. [2✓]

```
template <typename Keytype, typename Itertype>
Itertype find (Itertype begin, Itertype end, const Keytype& key) {
```

2. Write the template function `find` which takes a pair of **forward** iterators and a predicate and which returns the iterator indicating the first item in the container for which the predicate is true. Hint: the predicate takes a `const Keytype&` and returns a `bool`. [2✓]

```
template <typename Keytype, typename Itertype>
Itertype find (Itertype begin, Itertype end, bool (*pred) (const Keytype& key) {
```

3. Write the function `circle` in OpenGL, which draws a circle with the center at the coordinates (x, y) given to it. The radius and color are also given. [3✓]

```
void draw_circle (float xcenter, float ycenter, float radius, const GLubyte* color) {
    glBegin (GL_POLYGON);
```

4. Assuming the `sockets` library from project 5, and assuming that a date server exists that sends a single message back to the client then quits, write a function `date_client`, which when called from `main`, will contact the server for the date and print it. [3✓]

```
void date_client (string host, in_port_t port) {
```

5. In the multiprecision project, it was necessary to add two vectors of digits, each digit being represented in a byte. Write a function which takes to such vectors (signs are ignored here, only absolute values are used) and adds them together. [4✓]

```
typedef unsigned char byte;
typedef vector<byte> unumber;
unumber absadd (const unumber& u1, const unumber& u2) {
```

6. Define an object-oriented hierarchy as shown in the three parts described here. Show all code as it would appear in a header file so that no implementation file is needed. All classes have the virtual functions `area` and `circumference` as well as suitable constructors. Make sure the constructors can not be used in implicit conversions.

- (a) Class `shape` is the base class with abstract functions, and a suitably protected constructor. [2✓]

- (b) Class `circle`¹ has a single radius field which is initialized by the constructor. [2✓]

- (c) Class `square` has a single edge field (the length of one edge) initialized by the constructor and also the two other functions. [2✓]

1. For the mathematically challenged: $A = \pi r^2$ and $C = 2\pi r$.
And `<cmath>` defines `M_PI`: `# define M_PI 3.14159265358979323846 /* pi */`

7. Referring to the question on the previous page, write a function that will take a pair of iterators pointing into a container, and print two numbers: the sum of the areas and the sum of the circumferences. [3✓]

```
typedef vector<shared_ptr<shape>>::const_iterator vec_iterator;  
void print_data (vec_iterator begin, vec_iterator end) {
```

8. Define a template class `queue` with a single typename parameter `T`. Show only what should be in `queue.h`, not anything from `queue.cpp`, except for when an inline is explicitly required.
- (i) Declare the private node which contains a `T` and a link to the next node in the list. [1✓]
 - (ii) Declare the head and tail pointers to be automatically initialized to the null pointer. [1✓]
 - (iii) Disable the copy constructor and copy `operator=`. [1✓]
 - (iv) Declare a `front` function which is a constant function returning a constant reference to the data in the first node. [1✓]
 - (v) Declare a non-constant `front` function which returns a non-constant reference to the data in the first node. [1✓]
 - (vi) Declare `pop_front` in the way consistent with other containers. Do not show the implementation. [1✓]
 - (vii) Declare `push_back`. Do not show the implementation. [1✓]

Multiple choice. To the *left* of each question, write the letter that indicates your answer. Write **Z** if you don't want to risk a wrong answer, which count negative points. [12✓]

number of correct answers		$\times 1 =$	$= a$
number of wrong answers		$\times \frac{1}{2} =$	$= b$
number of missing answers		$\times 0 =$	0
column total $c = \max(a - b, 0)$	12		$= c$

- A process which stays in the background doing nothing until it accepts a request from a client is called a :
(A) daemon
(B) vampire
(C) werewolf
(D) zombie
- The value of a `constexpr` identifier is computed at :
(A) compile time.
(B) link time.
(C) program load time.
(D) function call time.
- Which of the following makes use of the least amount of heap space?
(A) `deque<T>`
(B) `list<T>`
(C) `map<T>`
(D) `vector<T>`
- Two processes communicate via a socket, but each does only writing to the socket, never reading. This results in a :
(A) deadlock
(B) livelock
(C) memory leak
(D) race condition
- The declaration `int x;` inside a function results in `x` being allocated in what memory segment?
(A) data
(B) heap
(C) stack
(D) text
- To prevent a constructor from being used implicitly in a conversion operation, precede its declaration by what keyword?
(A) `const`
(B) `explicit`
(C) `inline`
(D) `private`
- If an object is to be used as if it were a function, it must have what operator defined?
(A) `operator()`
(B) `operator*`
(C) `operator->`
(D) `operator[]`
- If `i` is an iterator pointing into a `map`, then the value associated with a given key is accessed via :
(A) `i->first`
(B) `i->second`
(C) `i.first`
(D) `i.second`
- What are the maximum and minimum values of the exit status value returned by a program?
(A) -1 for error and 0 for success.
(B) -128 to 127.
(C) 0 to 255.
(D) 0 to 65535.
- In a client/server application, the client indicates a need to talk to a server via what system call?
(A) `accept(2)`
(B) `bind(2)`
(C) `connect(2)`
(D) `socket(2)`
- What is a possible way to implement `map` in C++ so that performance is acceptable?
(A) double-ended queue
(B) hash table
(C) linear linked list
(D) red-black tree
- What class performs storage management by reference counting?
(A) `auto_ptr<T>`
(B) `counted_ptr<T>`
(C) `shared_ptr<T>`
(D) `unique_ptr<T>`

Multiple choice. To the *left* of each question, write the letter that indicates your answer. Write **Z** if you don't want to risk a wrong answer, which count negative points. [12✓]

number of correct answers		$\times 1 =$	$= a$
number of wrong answers		$\times \frac{1}{2} =$	$= b$
number of missing answers		$\times 0 =$	0
column total $c = \max(a - b, 0)$	12		$= c$

- After a process exits but before its parent waits for it, it is a :
(A) daemon
(B) vampire
(C) werewolf
(D) zombie
- In OpenGL without transformations on a 2D plane, the x -axis increases ____-ward and the y -axis increases ____-ward.
(A) x leftward and y downward.
(B) x leftward and y upward.
(C) x rightward, and y downward.
(D) x rightward, and y upward.
- To register an interrupt handler, such as, for example, to catch a `SIGINT` without having the program crash, what function is used?
(A) `accept(2)`
(B) `listen(2)`
(C) `sigaction(2)`
(D) `socket(2)`
- When a `runtime_exception` is caught, how is the specific message found?
(A) `e.getMessage()`
(B) `e.strerror()`
(C) `e.to_string()`
(D) `e.what()`
- Which of the following will be flagged (the compiler issues a warning) as a narrowing conversion?
(A) `int a (4.8);`
(B) `int a = 4.8;`
(C) `int a = {int(4.8)};`
(D) `int a {4.8};`
- If we have a class `T` and a variable `T x;`, Then normally we would expect `operator<<` that allows `cout<<x;` to be:
(A) a member of class `T`.
(B) a member of class `ostream`.
(C) a virtual function dispatched on `x`.
(D) not a member of any class.
- For class `T`, in order to ensure that there is no copy constructor for itself nor for any derived classes, it should be declared as:
(A) `T (const T&) = 0;`
(B) `T (const T&) = delete;`
(C) `T (const T&) = void;`
(D) `T (const T&) {}`
- What would one expect to be the first non-comment line in `foo.h`?
(A) `#define __FOO_H__`
(B) `#ifdef __FOO_H__`
(C) `#ifndef __FOO_H__`
(D) `#include "foo.h"`
- Which of the following will generate a compile time error message?
(A) `"a" + "b"`
(B) `"a" + string("b")`
(C) `string("a") + "b"`
(D) `string("a") + string("b")`
- Which system call when executed by a server causes it to block until another process tries to connect to it or until an interrupt occurs?
(A) `accept(2)`
(B) `listen(2)`
(C) `sigaction(2)`
(D) `socket(2)`
- What is the preferred way of referring to the null pointer in C++11?
(A) 0
(B) `NULL`
(C) `null`
(D) `nullptr`
- A move constructor for class `T` would be declared as:
(A) `T (T&&);`
(B) `T (T**);`
(C) `T (const T&);`
(D) `T (const T*);`