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1. ***C++ :*** Define a template function which will merge two ranges into a single container. **[5✔]**
   (a) It has three template parameters : a forward iterator, a container, and a binary predicate.
   (b) It has six actual parameters : two iterators indicating one range, two iterators indicating another range, a container into which the ranges are to be merged, and a binary predicate returning a boolean which computes a less-than function.
   (c) Assume the output container has a `push_back` method.
   (d) Example call : `merge (c1.begin(), c1.end(), c2.begin(), c2.end(), vec, less);`
   will assume the `c1` range is already sorted into order given by the `less` function, as is the `c2` range. The two ranges will then be copied in sorted order into the output container `vec`. From inside `merge`, the call `less(a,b)` will be true if `a` is considered less than `b`.

2. ***C++ :*** Define a template class `stack` with all methods defined inline. **[5✔]**
   (a) It uses a private `vector` field to hold the stack.
   (b) None of the four default members are declared, since the automatic defaults are acceptable.
   (c) `pop` removes but does not return the top of the stack.
   (d) `push` pushes a new element onto the stack.
   (e) `top` returns the top of the stack but does not modify the stack.
   (f) `empty` tells whether the stack is empty or not.

3. ***C++:*** Write a template function `swap` that will exchange the values of any two variables. Example: `swap(a,b);` should exchange the values of `a` and `b` if the type of those variables has a copy constructor and an `operator=`. **[2✔]**

4. ***Java:*** Write a client/server application that shares the current date and time. Assume, but do not code, any necessary `import` statements.

   (a) Class `date_client` connects to port 10000 of `localhost`, reads one line, prints it, then exits. **[2✔]**

```
class date_client {
   public static void main (String[] args) throws IOException {
```

   (b) Class `date_server` creates a server socket on port 10000, then goes into an infinite loop waiting for clients. Whenever a client connects, it replies by sending the current date, after which it disconnects the client and waits for the next client. Create a `new Date()` object each time a date is needed and use its `toString` method. **[3✔]**

```
class date_server {
   public static void main (String[] args) throws IOException {
```

5. ***C++:*** Define a template function called `find`. Its first template argument is a forward iterator, and its second template argument is a predicate of one argument. The function itself has three arguments, the first and second being a pair of iterators that bound the search space, and the third being a function of one argument which returns a boolean value. Return the first occurrence in the range for which the predicate is true, and if not found, return the end iterator. Example call: `find (c.begin(), c.end(), ispositive);` **[3✔]**

6. ***C++:*** Write a loop that will copy program arguments (but not the program name) into the vector. **[1✓]**

```
int main (int argc, char **argv) {
   vector<string> args;
```

7. ***C++:*** Consider the trivial class shown here.

   (a) Write the prototypes for the `operator=` and the destructor that would otherwise be provided by default. **[1✓]**

   ```
   struct box {
      size_t size;
      int *data;
   ```

   (b) Implement `operator=` for this class. It needs to copy the data instead of sharing it with the source object. Code it as it would appear in the implementation (`.cpp`) file. **[3✓]**

   (c) Implement the destructor as it would appear in the implementation file. **[1✓]**

8. ***C++:*** Finish the function, which returns the average value in the range. **[2✓]**

```
template <typename iterator>
double average (const iterator &begin, const iterator &end) {
```

9. ***C++:*** Define `operator<<` which can print all of the elements of a vector of any type, assuming that the constituent elements already have an appropriate `operator<<` defined. The operator prints all of the elements with a single space between successive elements. **[2✓]**

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. Wrong answers are worth negative points. **[11✔]**

number of correct answers		× 1 =	= a
number of wrong answers		× ½ =	= b
number of missing answers		× 0 =	0
column total $c = \max(a - b, 0)$	11		= c

1. If `v` is a `vector`, then `v.begin()` is the same as :
   (A) `v[0]`
   (B) `&v[0]`
   (C) `*v[0]`
   (D) `~v[0]`

2. Which of the following operators does a bidirectional iterator have that a forward iterator does not have ?
   (A) `*i`
   (B) `++i`
   (C) `--i`
   (D) `i->f`

3. For an integer `a`, if `a` is __(x)__ then `a/8` is equivalent to __(y)__.
   (A) (x) `signed` ; (y) `a<<3`
   (B) (x) `signed` ; (y) `a>>3`
   (C) (x) `unsigned` ; (y) `a<<3`
   (D) (x) `unsigned` ; (y) `a>>3`

4. What is the declaration of the postfix operator `++` which is a member of class `foo` ?
   (A) `foo &operator++ ();`
   (B) `foo &operator++ (foo &);`
   (C) `foo operator++ (foo &, int);`
   (D) `foo operator++ (int);`

5. Which of the following instance fields will most strongly suggest that a default `operator=` is inappropriate for a class ?
   (A) inline object
   (B) pointer
   (C) primitive
   (D) reference

6. The outermost container in a Java GUI is a
   (A) `JArea`
   (B) `JFrame`
   (C) `JGrid`
   (D) `JPanel`

7. Storage management by reference counting fails on what kind of data structure ?
   (A) acyclic graph
   (B) binary tree
   (C) cyclic graph
   (D) hash table

8. The `std::map` data structures is a :
   (A) directed acyclic graph
   (B) hash table
   (C) linear linked list
   (D) red-black tree

9. Which data structure uses a contiguous block of heap memory ?
   (A) `std::deque`
   (B) `std::list`
   (C) `std::map`
   (D) `std::vector`

10. If the exception `exn` is thrown, what is the proper way to catch it ?
    (A) `catch (exn &e)`
    (B) `catch (exn *e)`
    (C) `catch (exn ~e)`
    (D) `catch (exn e)`

11. The first language to use concepts such as ***class*** and ***virtual*** was :
    (A) Algol
    (B) Fortran
    (C) Lisp
    (D) Simula

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. Wrong answers are worth negative points. **[11✓]**

number of correct answers		× 1 =	= a
number of wrong answers		× ½ =	= b
number of missing answers		× 0 =	0
column total $c = \max(a - b, 0)$	11		= c

1. When two threads update the same variable without synchronization, leading to unpredictable results, this is called a ____ condition.
   (A) daemon
   (B) deadlock
   (C) race
   (D) spinlock

2. An abstract class :
   (A) can not be instantiated
   (B) can not specify an interface
   (C) has no virtual functions
   (D) must be derived from a base class

3. The Java GUI considers the coordinate $(0, 0)$ to be at what part of the screen ?
   (A) lower left
   (B) lower right
   (C) upper left
   (D) upper right

4. The Postscript coordinate system considers $(0, 0)$ to be at what part of the page ?
   (A) lower left
   (B) lower right
   (C) upper left
   (D) upper right

5. What is an interface that requires implementation of the metnod `run` ?
   (A) `Runnable`
   (B) `Synchronized`
   (C) `Thread`
   (D) `Throwable`

6. In C++11, if an implicitly generated member should be suppressed as inappropriate for the class, what should be done ?
   (A) Declare it as private and not implement it.
   (B) Declare it as public and throw a logic_error exception if it is called.
   (C) Declare it as public but instead of implementing it, mark it as `= delete`.
   (D) Declare it but put an `assert(false)` statement in the body.

7. Which operator may be declared with any number of arguments, depending on the semantics of the operator ?
   (A) `operator()`
   (B) `operator++`
   (C) `operator<>`
   (D) `operator[]`

8. A keyword in C++11 that has a radically different meaning from what it has in ANSI C is :
   (A) `auto`
   (B) `struct`
   (C) `typedef`
   (D) `volatile`

9. Following the `Makefile` dependency `%.o : %.cpp` an appropriate compilation command would be :
   (A) `${GPP} %.cpp`
   (B) `${GPP} -c $<`
   (C) `${GPP} -c $@`
   (D) `${GPP} -o $<`

10. Given the declaration of `i`, what will print out a string ?
    `vector<string*>::iterator i;`
    (A) `cout<<i;`
    (B) `cout<<*i;`
    (C) `cout<<**i;`
    (D) `cout<<***i;`

11. Following `foo x;` the statement `foo y = x;` is a call to :
    (A) assignment `operator=`
    (B) the copy constructor
    (C) the default constructor
    (D) the destructor