READ THIS NOW!

- Print your name in the space provided below.
- Print your name and ID number on the Opscan form; be sure to code your ID number on the Opscan form. Code **Form A** on the Opscan; code your section **group** number: Barnette 11:00 TuTh = 1; McQuain 10:00 MWF = 2; or McQuain 12:00 MWF = 3.
- Choose the single best answer for each question — some answers may be partially correct. If you mark more than one answer, it will be counted wrong.
- Unless a question involves determining whether given C++ code is syntactically correct, assume that it is valid. The given code has been compiled and tested, except where there are deliberate errors. Unless a question specifically deals with compiler `#include` directives, you should assume the necessary header files have been included.
- Be careful to distinguish integer values from floating point (real) values (containing a decimal point). In questions/answers which require a distinction between integer and real values, integers will be represented without a decimal point, whereas real values will have a decimal point, [1704 (integer), 1704.0 (real)].
- The answers you mark on the Opscan form will be considered your official answers.
- When you have completed the test, sign the pledge at the bottom of this page and turn in the test.
- This is a closed-book, closed-notes examination. No calculators or other electronic devices may be used during this examination. You may not discuss (in any form: written, verbal or electronic) the content of this examination with any student who has not taken it. You must return this test form when you complete the examination. Failure to adhere to any of these restrictions is an Honor Code violation.
- There are 20 questions, equally weighted. The maximum score on this test is 100 points.

Do not start the test until instructed to do so!

Print Name (Last, First) Solution

Pledge: On my honor, I have neither given nor received unauthorized aid on this examination.

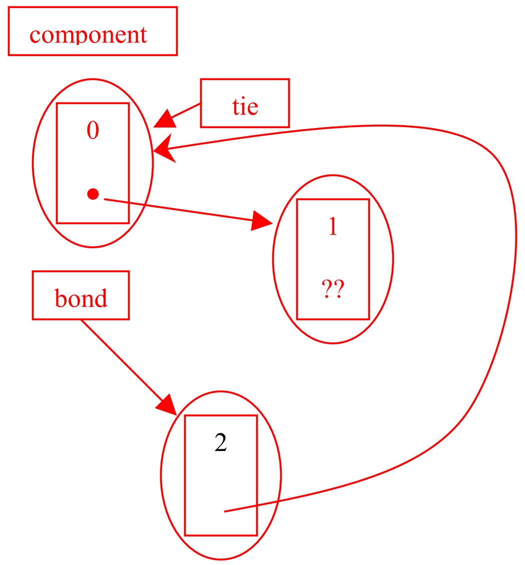
signature

I. Class Pointers

For the following 2 questions, assume the following declarations:

```
class   Nodule;
typedef Nodule*   Linkage;
class   Nodule {
private:
     int       element;
     Linkage   link;
public: //member functions
        void foo();
};
```

```
//inside the Nodule member function foo
Nodule  component;
component.element = 0;
component.link = NULL;
Linkage bond, tie = &component;
bond = new Nodule;
bond->element = 1;
tie->link = bond;
bond = new Nodule;
bond->element = 2;
bond->link = tie;
```



1. From inside the same member function as the above code, what is the data type of the expression at the right: `tie->link`

   1) `NULL`
   2) `Nodule`
   [✓ 3) `Nodule*`]
   4) `int`
   5) `struct*`
   6) `None of the above`

2. From inside the same member function as the above code, which of the following statements could be used to connect, (i.e., link), the `Nodule` containing the integer `1` to the `Nodule` containing the integer `2`?

   1) `bond->link = tie;`
   2) `component->link = bond;`
   3) `tie->link = bond;`
   [✓ 4) `tie->link->link = bond;`]
   5) `bond->link->link = tie;`
   6) `None of the above`

3. From inside the same member function as the above code, assuming the `Nodule`s in the previous question are linked, what would be the data type of the expression at the right? `tie->element->link`

   1) `NULL`
   2) `Nodule`
   3) `Nodule*`
   4) `int`
   5) `struct*`
   [✓ 6) `None of the above`]

4. Assuming the default (language supplied) destructor (i.e. no destructor has been explicitly implemented), consider just the code above, after the member function would complete execution, how many memory leaked `Nodule`s would still exist in memory?

   1) `1`
   [✓ 2) `2`]
   3) `3`
   4) `4`
   5) `0`
   6) `None of the above`

II. Linked List Class Manipulation

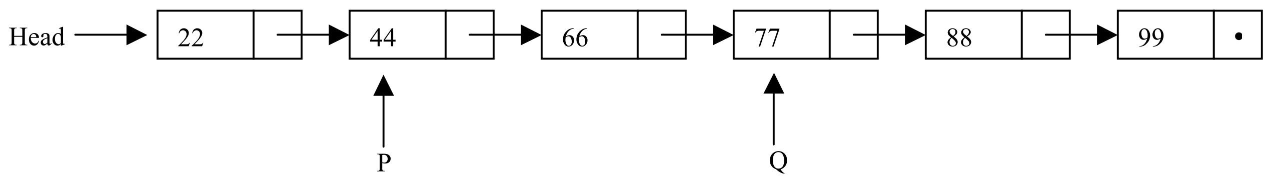
Consider the linked list class and list node declarations given below:

```
class ItemType {
private:
   int Value;
public:
   ItemType();
   ItemType(int newValue);
   void setValue(int newValue);
   int  getValue() const
         {return Value;}
};
```

```
class LinkNode {
private:
   ItemType  Data;
   LinkNode* Next;
public:
   LinkNode();
   LinkNode(ItemType newData);
   bool setNext(LinkNode* newNext);
   bool setData(ItemType  newData);
   ItemType  getData() const;
   LinkNode* getNext() const;
};

LinkNode *Head, *P, *Q;
```

Assume that the member functions above have been implemented correctly to carry out their intended task. Given the initial list structure:



For the next 4 questions, determine what the execution of the given code fragment would do, assuming the list structure above as your starting point (for each question). Note – dangling references into the heap should be ignored, indicated by "??". Choose from the possible answers given on the following page.

5.
```
LinkNode     *R;
R = Q->getNext()->getNext();
R->setNext(P->getNext());
```
$\boxed{7}$

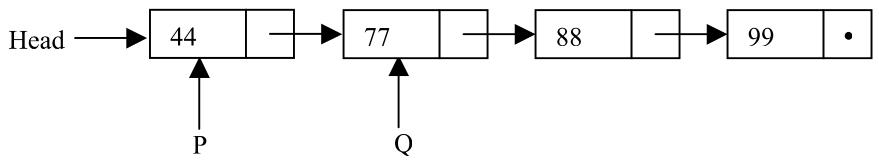
6.
```
LinkNode     *S=Head;
delete P->getNext();
S->setNext(Head->getNext());
P->setNext(Q->getNext());
```
$\boxed{3}$

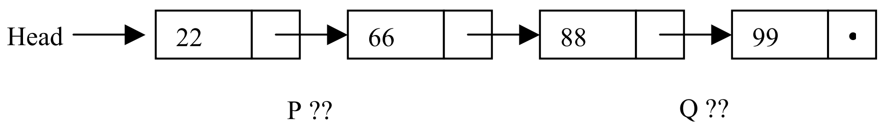
7.
```
LinkNode     *T=P;
while (T->getNext() != NULL) T = T->getNext();
Head->setNext(P->getNext());
P->setNext(T);
T->setNext(Head->getNext());
```
$\boxed{10}$

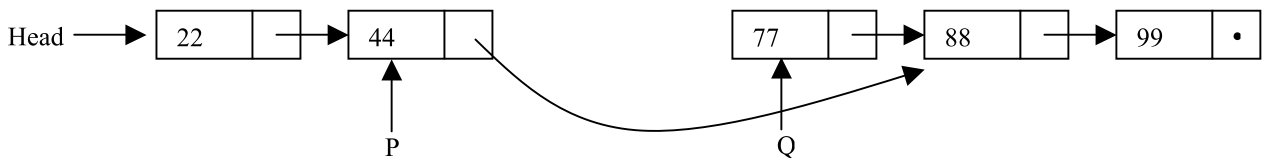
8.
```
LinkNode     *Y, *X=Head;
for (int i=0; i<2; i++;) {
  Y = X->getNext()->getNext();
  delete X->getNext();
  X->setNext(Y);
  X = Y;
}
```
$\boxed{2}$

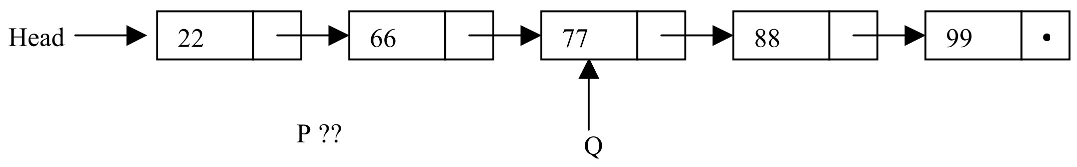
II. Linked List Class Manipulation (*continued*)

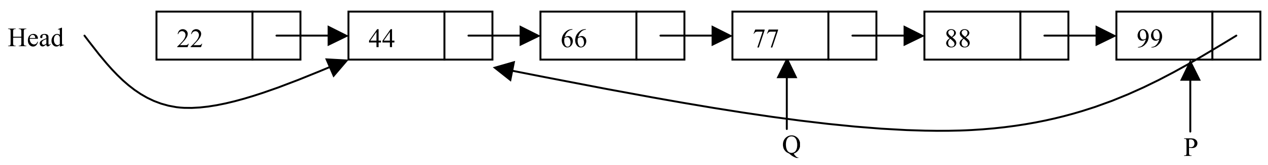
Select from the possible answers for the 4 questions given on the previous page. Question marks (??) indicate the pointer has an unknown, or invalid, value.

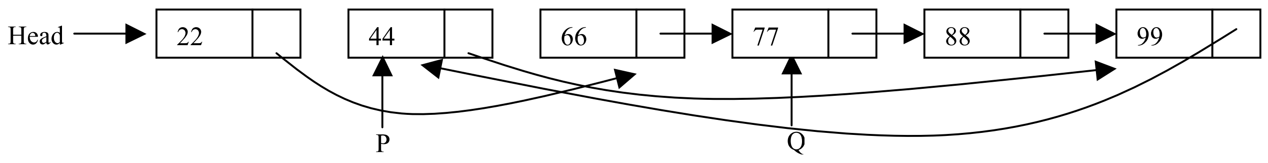
1)


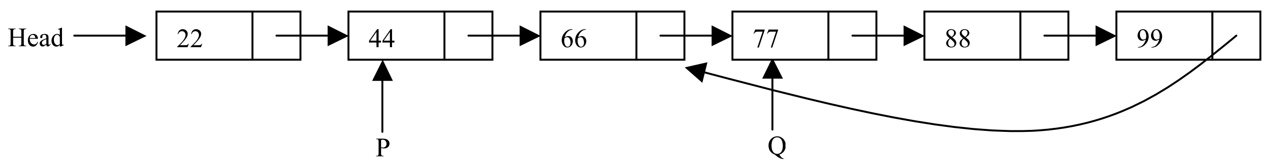
2)


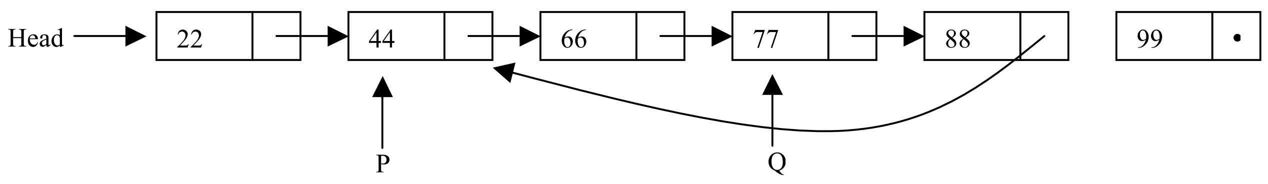
3)


4)


5)


6)


7)


8)


9) Syntax error 10) None of these

III. Command Line Arguments

Consider a program, `view2`, that provides side-by-side coordinated scrolling of two text files, (for comparison purposes). The two files are allowed to be optionally specified as command line arguments, (CLA) to the program, e.g.,

```
view2  FileA.txt  FileB.txt
```

For the next two questions, choose from the following possible answers:

1) `arg`	4) `argc[0]`	7) `argv[0]`
2) `argc`	5) `argc[1]`	8) `argv[1]`
3) `argv`	6) `argc[2]`	9) `argv[2]`

9. The code below checks for the existence of the optional command line arguments. Select the answer to fill in the blank to carry out the indicated task correctly. All of the blanks are to be filled in by the same choice.

$\boxed{2}$

```
if ( ______ > 1) //CLAs present
      if ((______ < 3) || (_______ > 3))//too few or too many files
            cout <<"usage: view2  FileA.txt  FileB.txt"<<endl;
      else if (______ == 3) // process CLAs
```

10. The code below is to check for the existence of the first file, (i.e., `FileA.txt`). Select the answer to fill in the blank to carry out the indicated task correctly. All of the blanks are to be filled in by the same choice.

$\boxed{8}$

```
// process CLAs
ifstream  file1, file2;

file1.open( __________ ); //use ios::nocreate if using old headers
if (file1.fail())
      cout << "***Error, File: "<< __________ << "Does Not Exist"<<endl;
```

IV. Object Manipulations

11. When a copy constructor function is NOT implemented in a class which contains dynamic data, then a *shallow* copy would be performed in each of the following described execution points in a program except one. Identify at which instance a *shallow* copy would **NOT** be automatically performed?

    1) When an object is returned by a function.

    2) When an object is initialized to another object in a definition.

    [✓ **3) When an object is passed by const reference.**]

    4) When an object is passed by value.

    5) None of the above, (all of the above situations would result in a *shallow* copy).

12. (True or False) When a copy constructor function is implemented in a class which contains dynamic data, then the assignment operator should always be over-loaded for safety and completeness?

    [✓ **1) True**]   2) False

IV. Object Manipulations *(continued)*

Assume the following class declaration and implementation:

```
class State {
private:
   char* Status;
public:
   State();
   State(char Status);
   char getState();
   void setState(char Code);
   bool operator==(const Foo& Other);
   ~State();
};

State:: State() {
   Status = new char('\0');
}

State:: State(char Status) {
   this->Status = new char(Status);
}
```

```
char State::getState() {
   return (*Status);
}

void State::setState(char Code) {
   *Status = Code;
}

bool State::operator==
           (const State& Other) {
   return (*Status) ==
           *(Other.Status));
}

State:: ~State() {
    delete Status;
}
```

Given the following code:

```
State Output(State out);
State p, q('$');
State s, r = p;

void main() {
r.setState('@');

cout << "State of p is:" << p.getState() << endl;              //LINE 1
s = Output(q);
cout << "State of s is:" << s.getState() << endl;              //LINE 2
}

State Output(State out) {
    cout << "State of out = " << out.getState() << endl;       //LINE 3
    return out;
}
```

13: State objects contain a pointer to a dynamically-allocated char value, but the class does not contain a (deep) copy constructor; so, when r is initialized using p, they share the same char value. The call r.setState() thus changes the value that p "sees" as well.

For the next 3 questions, select your answers from the following, ignoring the quotes:

1) `'\0' (null char)`
2) `'$'`
3) `'@'`
4) `Execution Error`
5) None of these

13. What is output by the call `p.getState()` in `LINE 1` above? **3**

14. What is outputby the call `s.getState()` in `LINE 2` above? **4**

15. What is outputby the call `out.getState()` in `LINE 3` above? **2**

14: Because there's no deep copy, when q is passed to Output(), q and out share the same char; when out is destructed as Output terminates, that is deallocated. So, getState() causes an access violation.

V. Recursion

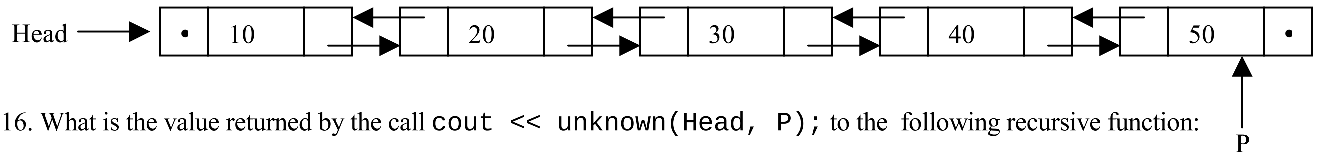
Consider the linked list class and list node declarations given below:

```
class ItemType {
private:
   int Value;
public:
   ItemType();
   ItemType(int newValue);
   void setValue(int newValue);
   int  getValue() const
         {return Value;}
};
```

```
class LinkNode {
private:
   ItemType  Data;
   LinkNode *Next, *Prev;
public:
   LinkNode();
   LinkNode(ItemType newData);
   bool setNext(LinkNode* newNext);
   bool setPrev(LinkNode* newPrev);
   bool setData(ItemType  newData);
   ItemType  getData() const;
   LinkNode* getNext() const;
   LinkNode* getPrev() const;
};

LinkNode *Head, *P, *Q;
```

Assume that the member functions above have been implemented correctly to carry out their intended task. Given the initial list structure:



16. What is the value returned by the call `cout << unknown(Head, P);` to the following recursive function:

```
int unknown (LinkNode *R, LinkNode *S) {

if ((R == NULL) || (S == NULL)) return 0;
else if (R == S) return (R->getData()->getValue());
     else {
      if ((R->getNext() == S) && (S->getPrev() == R))
         return (R->getData()->getValue() + S->getData()->getValue());
      else
         return (R->getData()->getValue() + S->getData()->getValue() +
                    unknown(R->getNext(), S->getPrev()) );
   }
}
```

1) `10`
2) `20`
3) `30`
4) `40`
5) `50`
6) `60`
7) `120`
8) `150`
9) `0`

17. The previous function is an example of what type of recursive problem solving strategy?

1) `going up (tail) recursion`
2) `going down (head) recursion`
3) `middle decomposition recursion`
4) `edges & center decomposition`
5) `backtracking`
6) `None of the above`

V. Recursion *(continued)*

Consider the linked list class and list node declarations given below:

18. In general, considering a correctly coded recursive function which for each call generates no more than one recursive call, how many times does the base case code execute? (Hint – consider the function in the previous question.)

1) once at most
2) at least twice
3) as many times as the recursive code
4) equals the number of recursive calls
5) never, there is no need
6) None of the above

---

19. The following recursive function call, `Find(Element, IntArray, 0, Size)`, searches an array of integers for a desired element value and returns its index or negative one (-1) if the value is not in the array:

```
int Find( int Value, const int Array[], int Begin, int Dim ) {

    if ( Begin >= Dim ) return -1;
    if (__________________)
       return Begin;
    else
       return ( Find(Value, Array, Begin+1, Dim) );
}
```

What should the missing condition in the `if` statement be?

1) Begin == 1
2) Array[Begin] == Value
3) Array[Begin-1] == Value
4) Array[Begin+1] == Value
5) Find(Value, Array, Begin, Dim) == Value
6) None of the above

---

20. Consider the following recursive function:

```
int hmmm(int a, int b) {

   if (a == 0) return (b + 1);
   else if ((a!=0) && (b==0)) return (hmmm(a-1, 1));
   else if ((a!=0) && (b!=0)) return (hmmm(a-1, hmmm(a, b-1) );
}                                //note the call within a call
```

What is returned from the call: `hmmm(2, 1)` ?

1) 1
2) 2
3) 3
4) 4
5) 5
6) 6
7) 7
8) 8
9) None of these

```
hmmm(2, 1)  == hmmm(1, hmmm(2, 0)) == hmmm(1, hmmm(1, 1))
            == hmmm(1, hmmm(0, hmmm(1, 0))) == hmmm(1, hmmm(0, hmmm(0, 1)))
            == hmmm(1, hmmm(0, 2)) == hmmm(1, 3) == hmmm(0, hmmm(1, 2))
            == hmmm(0, h(0, h(1, 1))) == hmmm(0, h(0, 3))  // reuse result above
            == hmmm(0, 4) == 5
```