Problem 1

What does the following Java code print:

class A {
    public int key;
}

class B extends A { }

public class Problem1 {
    public static void f(A X) {
        A Y = X;
        Y.key = X.key + 1;
    }

    public static void f(B X) {
        B Y = new B();
        Y.key = X.key + 2;
        X = Y;
    }

    public static void main(String[] args) {
        A P = new A();
        P.key = 3;
        B Q = new B();
        Q.key = 10;
        f(P);
        System.out.println(P.key);
        f(Q);
        System.out.println(Q.key);
        P = Q;
        f(P);
        System.out.println(P.key);
    }
}

Problem 2

(Multiple choice: One correct answer) An abstract class is

A. A class with no data fields.
B. A class with no methods.
C. A logical specification of how methods interact, independent of the implementation.
D. A class that contains at least one abstract method.
E. A class that implements an interface.
Problem 3

A. What is the problem with the following recursive method to compute $a^n$, for positive integer $n$?

```java
public static double exponent(double a, int n) {
    return a*exponent(a,n-1);
}
```

B. Describe how this should be fixed. Your solution should still use recursion. (The code does not have to work if $n < 0$).

Problem 4

Suppose that you have a doubly linked list with headers at both ends composed out of nodes defined with the following data fields:

```java
class MyNode {
    private int value;
    private MyNode next;
    private MyNode prev;
}
```

Write a method within `MyNode` called `replace(M)`, which does the following. Assume that `L` is a `MyNode` within a doubly linked list, but not either header, and that `M` is another `MyNode`. Calling `L.replace(M)` should cause `L` to be replaced by `M` in the linked list. You should not change the `value` field of any node, just the `next` and `prev` fields.

Problem 5

Suppose that we have defined the following generic class for linked lists:

```java
class MyNode<T> {
    private T value;
    private MyNode<T> next;

    public MyNode(T V) { value = V; } // Constructor
    public SetNext(MyNode<T> N) { next=N; } // Setter
}
```

Show the code you would use to construct a list whose first element is the list [2, 3] and whose second element is the list [6]. You can use either headed or unheaded lists, whichever you prefer.
Problem 6

Suppose that you have constructed a hash table for biographical information in which the keys are Strings, denoting a person, and the values are Integers, denoting the year of their birth. Your table has size 8. The following operations, and the values of the hash function, are shown below. Draw a diagram of the state of the hash table.

\[
\begin{align*}
\text{HT.put("Lincoln", 1809).} & \quad \text{hash} = 4 \\
\text{HT.put("Mozart", 1756).} & \quad \text{hash} = 2 \\
\text{HT.put("Dickens", 1812).} & \quad \text{hash} = 2 \\
\text{HT.put("Obama", 1961).} & \quad \text{hash} = 7 \\
\text{HT.put("Gaga", 1986).} & \quad \text{hash} = 4
\end{align*}
\]