1 Inheritance Practice

```java
public class Q {
    public void a() {
        System.out.println("Q.a");
    }
    public void b() {
        a();
    }
    public void c() {
        e();
    }
    public void d() {
        e();
    }
    public static void e() {
        System.out.println("Q.e");
    }
}

public class R extends Q {
    public void a() {
        System.out.println("R.a");
    }
    public void d() {
        e();
    }
    public static void e() {
        System.out.println("R.e");
    }
}

public class S {
    public static void main(String[] args) {
        R aR = new R();
        run(aR);
    }
    static void run(Q x) {
        x.a();
        x.b();
        x.c();
        ((R)x).c();
        x.d();
        ((R)x).d();
    }
}
```

In `run`, write what gets printed next to each line.
2 Reduce

We’d like to write a method `reduce`, which uses a `BinaryFunction` interface to accumulate the values of a `List` of integers into a single value. `BinaryFunction` can operate (through the `apply` method) on two integer arguments and return a single integer. Note that `reduce` can now work with a range of binary functions (addition and multiplication, for example). Write two classes `Adder` and `Multiplier` that implement `BinaryFunction`. Then, fill in `reduce` and `main`, and define types for `add` and `mult` in the space provided.

```java
import java.util.ArrayList;
import java.util.List;
public class ListUtils {
    /** If the list is empty, return 0.
     * If it has one element, return that element.
     * Otherwise, apply a function of two arguments cumulatively to the
     * elements of list and return a single accumulated value.
     */
    static int reduce(BinaryFunction func, List<Integer> list) {
        // Add additional classes below:
    }

    public static void main(String[] args) {
        ArrayList<Integer> integers = new ArrayList<>();
        integers.add(2); integers.add(3); integers.add(4);
        ___________ add = ____________________;
        ___________ mult = ____________________;
        reduce(add, integers); //Should evaluate to 9
        reduce(mult, integers); //Should evaluate to 24
    }
}

interface BinaryFunction {
    int apply(int x, int y);
}

//Add additional classes below:
```
3 Comparator

We’d like to sort an ArrayList of animals into ascending order, by age. We can accomplish this using Collections.sort(List<T> list, Comparator<? super T> c). Because instances of the Animal class (reproduced below) have no natural ordering, sort requires that we write an implementation of the Comparator interface that can provide an ordering for us. Note that an implementation of Comparator only needs to support pairwise comparison (see the compare method). Remember that we would like to sort in ascending order of age, so an Animal that is 3 years old should be considered "less than" one that is 5 years old.

```java
public interface Comparator<T> {
    /** Compares its two arguments for order.
     * Returns a negative integer, zero, or a positive integer if the first
     * argument is less than, equal to, or greater than the second. */
    int compare(T o1, T o2);

    /** Indicates whether some other object is "equal to" this comparator. */
    boolean equals(Object obj);
}

import java.util.ArrayList;
import java.util.Collections;
public class Animal {
    private String name;
    private int age;
    public Animal(String name, int age) {
        this.name = name;
        this.age = age;
    }
    /** Returns this animal’s age. */
    public int getAge() {
        return this.age;
    }
}
public static void main(String[] args) {
    ArrayList<Animal> animals = new ArrayList<>();
    animals.add(new Animal("Garfield", 4));
    animals.add(new Animal("Biscuit", 2));
    Animal Comparator c = new AnimalComparator(); //Initialize comparator
    Collections.sort(animals, c);
}
```

```java
import java.util.Comparator;
public class AnimalComparator implements Comparator<Animal> {
    @Override
    public int compare(Animal o1, Animal o2) {
        return o1.getAge() - o2.getAge();
    }
}
```
public class PasswordChecker {
    /**
     * Asks you to login (by providing your username and password)
     */
    public void loginPrompt(User u) {
        u.login(this);
    }

    public boolean authenticate(String a, String b) {
        // Does something secret
    }
}

public class User {
    private String username;
    private String password;

    public void login(PasswordChecker p) {
        p.authenticate(username, password);
    }
}

Write a class containing a method public String extractPassword(User u) which returns the password of a given user u. You may not alter the provided classes. Note the access modifiers of instance variables.

public class PasswordExtractor extends __________

    public String extractPassword(User u) {
        return u.password;
    }
}