Q8. Read the following description of Java programs and the programs themselves, and then answer **Subquestions 1** through **3**.

[Program Description]

A system development team of a university is building a prototype for a university information system. The system manages SMS, e-mail and allowance information of the students and staffs of the university. The prototype is being analyzed and debugged using tester classes with methods for testing purposes. These methods are invoked from the main method in the tester classes. As for some statements in the main method, they may

- be executed properly by invoking the appropriate methods through polymorphism
- cause a runtime exception
- cause compile errors

So, the output, exceptions and errors need to be determined.

In the programs, there are four classes: `Person`, `Student`, `Staff` and `PostGradStudent`. Figure 1 shows that `Student` and `Staff` inherit from `Person` and that `PostGradStudent` inherits from `Student`.

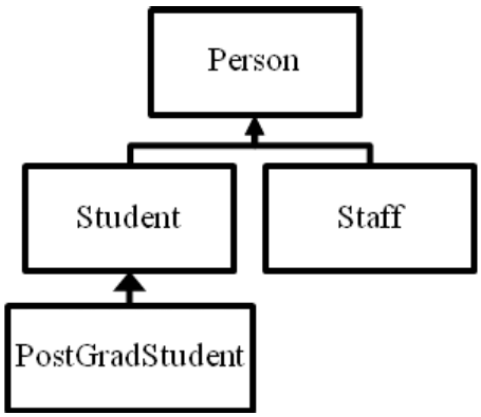

Figure 1 Inheritance relation

[Program 1]

```
public class Person {
    static double LIVING_COST = 1000.0;
    double allowance;
    String cellPhoneNumber, emailAddresses[];
    Person() {
        this("0123456", LIVING_COST);
        //0123456 is the contact number for information desk
    }
    Person(String cellPhoneNumber, double allowance) {
        _____A_____.cellPhoneNumber = cellPhoneNumber;
        _____A_____.allowance = allowance;
    }
    public void setEmail(String email1){
        emailAddresses = _____B_____ { email1 };
    }
    public void setEmail(String email1, String email2){
        emailAddresses = _____B_____ { email1, email2 };
    }
    public void setEmail(String email1, String email2, String email3){
        emailAddresses = _____B_____ { email1, email2, email3 };
    }
    public void sendSMS() {
        System.out.println(this + "Person sendSMS");
        sendEmail();
    }
    public void sendEmail() {
        System.out.println(this + "Person sendEmail");
    }
    public String toString(){
        return "I am Person: ";
    }
}
```

[Program 2]

```
public class Student extends Person {
    public void sendEmail() {
        System.out.println(this + "Student sendEmail");
    }
    public void depositAllowance() {
        System.out.println(this + "Student depositAllowance");
        allowance += LIVING_COST;
    }
}
```

[Program 3]

```
public class Staff extends Person {
    public void sendSMS() {
        System.out.println(this + "Staff sendSMS");
    }
    public void sendEmail() {
        System.out.println(this + "Staff sendEmail");
        sendSMS();
    }
    public String toString(){
        return "I am Staff: ";
    }
}
```

[Program 4]

```
public class PostGradStudent extends Student {
    public void sendSMS() {
        super.sendSMS();
        System.out.println(this + "PostGradStudent sendSMS");
    }
    public void sendEmail() {
        System.out.println(this + "PostGradStudent sendEmail");
    }
    public void depositAllowance() {
        System.out.println(this + "PostGradStudent depositAllowance");
        allowance += 2 * LIVING_COST;
    }
}
```

[Program 5]

```
public class Tester1 {
    public static void main(String[] args) {
        Person person1 = new Student();
        Person person2 = new PostGradStudent();
        Student student1 = new Student();
        Student student2 = new PostGradStudent();
        Staff staff1 = new Staff();
        Object obj1 = new Student();
        staff1.sendSMS();
        person1.sendEmail();
        person2.sendEmail();
        student1.sendEmail();
        student2.sendEmail();
        student1.depositAllowance();
        student2.depositAllowance();
    }
}
```

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank [_____] in Program 1.

Answer group for A

a) `Object` b) `Person` c) `super` d) `this`

Answer group for B

a) `new String[]` b) `new String[3]`

c) `new String` d) `new String ...`

Subquestion 2

From the answer group below, select the correct answer to be inserted in each blank [_____] in the following description.

The purpose of [Program 5] (class `Tester1`) is to check whether the programs are executed properly by invoking the appropriate methods through polymorphism.

When [Program 5] is executed, the following lines of output data are displayed:

```
I am Staff: Staff sendSMS
I am [___C___]: [___D___] sendEmail
I am [___C___]: [___E___] sendEmail
I am [___C___]: [___D___] sendEmail
I am [___C___]: [___E___] sendEmail
I am [___C___]: [___D___] depositAllowance
I am [___C___]: [___E___] depositAllowance
```

Answer group for C, D and E

a) `Person` b) `PostGradStudent`

c) `Staff` d) `Student`

Subquestion 3

From the answer group below, select the correct answer to be inserted in each blank [_____] in Table 1.

A person can be a `Student`, `PostGradStudent` or `Staff`. Based on the actual object, the behaviors of the methods `depositAllowance`, `sendEmail` and `sendSMS` may vary. So, to investigate the behavior of the methods, [Program 6] (class `Tester2`) is created.

[Program 6]

```
public class Tester2 {
    public static void main(String[] args) {
        Person person1 = new Student();
        Person person2 = new PostGradStudent();
        Student student1 = new Student();
        Student student2 = new PostGradStudent();
        Staff staff1 = new Staff();
        Object obj1 = new Student();
        ____________________
    }
}
```

In the blank ____ in [Program 6], one of the statements shown in Table 1 is inserted one at a time. In this way, [Program 6] is executed three times with a different statement in the blank.

Table 1 shows the statements to be inserted in the blank and their execution results.

Table 1 Statements to be inserted in the blank and their execution results

Statements to be inserted in the blank ____	Execution result
`((PostGradStudent)staff1).depositAllowance();`	____F____
`((Student)person2).depositAllowance();`	____G____
`((PostGradStudent)obj1).sendEmail();`	____H____

Answer group for F, G and H

a) The statement causes a compile error; hence the program is not executable.

b) The statement causes a runtime exception; hence the program terminates abnormally.

c) **"I am Person: PostGradStudent depositAllowance"** is displayed.

d) **"I am Person: PostGradStudent sendEmail"** is displayed.

e) **"I am Person: Staff depositAllowance"** is displayed.

f) **"I am Person: Staff sendEmail"** is displayed.

g) **"I am Person: Student depositAllowance"** is displayed.

h) **"I am Person: Student sendEmail"** is displayed.

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