

## 2000 Paper 1 Question 9

### Programming in Java

Write a Java class that provides support for arithmetic on the integers performed relative to some prime modulus  $p$ . An instance of the class should be constructible specifying the modulus, and then it should provide methods to create numbers and add, subtract, multiply and print them.

As a sample of the desired behaviour for your class, here is some test code for it:

```
Modular d = new Modular(7); // work mod 7
ModInt a = d.reduceMod(10); // create "10 mod 7"
ModInt b = d.reduceMod(20); // create "20 mod 7"
ModInt c = a.add(b);        // work out a+b mod 7
c.print();
```

Note that I am suggesting a class called `Modular` that keeps track of the modulus  $p$ , and a second class `ModInt` to stand for numbers: these are created for the user via a method in `Modular`.

Your code should complain in some manner if, for example, an attempt is made to add a number that is defined modulo 7 to one that is defined modulo 11.

[14 marks]

Provide an additional method to perform division modulo a prime number.

[6 marks]

Note. Arithmetic modulo a prime number was explained in the lectures on Discrete Mathematics. In particular, the reciprocal of  $a \pmod{p}$  can be found by solving the equation

$$ab = 1 \pmod{p}$$