

1993 Paper 10 Question 2

Modula-2

What is a Modula-2 *union*?

[3 marks]

A Modula-2 program includes the following declarations:

```
TYPE
  SymbType = (plus, minus, multiply, divide);
  NodeType = (NumNode, OpNode);
  NumType  = RECORD val : CARDINAL END;
  PtrToNode = POINTER TO Node;
  OpType   = RECORD op : SymbType; f, s : PtrToNode END;
```

The objective is to be able to include assignment statements like:

```
test := MakeOpNode (multiply, MakeNumNode(4),
                  MakeOpNode (minus, MakeNumNode(7), MakeNumNode(2)));
```

The variable `test` is of type `Node`, a record in which one field is either of type `NumType` or of type `OpType`, the latter representing a dyadic operator together with pointers to its two operands.

The procedure `MakeNumNode` takes a single `CARDINAL` parameter and returns a pointer to a `Node` which includes a `NumType` field. The procedure `MakeOpNode` returns a pointer to a `Node` which includes an `OpType` field.

The effect of the example assignment statement is to assign to `test` a syntax tree which represents the expression $4*(7-2)$.

Provide a suitable declaration for type `Node`.

[5 marks]

Write the procedures `MakeNumNode` and `MakeOpNode`.

[6 marks each]