p12q10
AD

Introduction to Functional Programming - paper 12 2002

a 1.
```
datatype 'a tree = Empty
                 | Leaf of 'a
                 | Branch of 'a * 'a tree *'a tree;
```
[3 marks]

b 2.
```
fun size Empty = 0
  | size (Leaf _) = 1
  | size (Branch(_,t1,t2)) = 1 + size t1 + size t2;
```
[4 marks]

c 3.
```
fun isize(n,Empty) = n
  | isize(n,Leaf _) = n+1
  | isize(n,Branch(_,t1,t2)) = isize(1+isize(n,t1), t2);
```
[6 marks]

d 4. There are two base cases:

```
isize(n,Empty) = n
               = n + 0
               = size(Empty)
```

and

```
isize(n,Leaf(x)) = n + 1
                 = n + size(Leaf(x)).
```

For the induction step:

```
isize(n,Branch(x,t1,t2))
      = isize(1+isize(n,t1),t2)
      = isize(1+n+size(t1),t2)
      = 1+n+size(t1)+size(t2)
      = n+(1+size(t1)+size(t2))
      = n+size(Branch(x,t1,t2))
```

[7 marks]