

# 2001 Paper 1 Question 1

## Foundations of Computer Science

(a) An ML program makes the following declarations:

```
val x = ref 0;

fun f n = (x := !x + 1; n + !x);

fun g n =
  let val x = ref 0
  in x := !x + 1; n + !x end;
```

Consider evaluating each of the following expressions:

```
map f [1,2,3,4];
map g [1,2,3,4];
map ref [5,5,5];
```

What value is returned in each case and how are the references affected?

[5 marks]

- (b) Code the function `filter` such that `filter p xs` returns the list of those elements of the list `xs` satisfying the predicate `p`. [1 mark]
- (c) Use `filter` to express Quicksort. [4 marks]