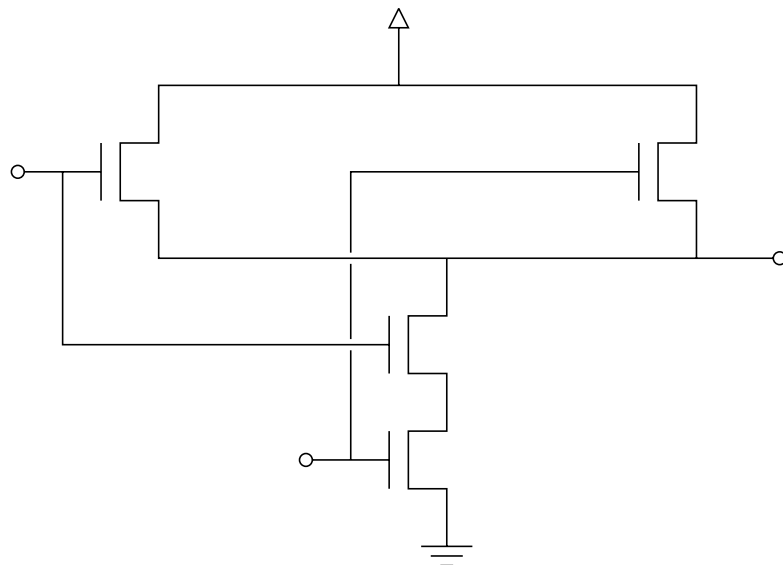## 1999 Paper 2 Question 1

Twenty-part question (*One mark per part*)

(*a*) Consider the ML lists (fn x => [x,x])(ref 0) and map ref [0,0]. What do they have in common, and how do they differ?

(*b*) What does it mean for a function to be *tail-recursive*?

(*c*) How can an ML program form a cyclic list? (Your answer need not present any code.)

(*d*) Find an integer solution x, y to $284x + 220y = 4$.

(*e*) Draw a Venn diagram for three sets, A, B and C, showing the symmetric difference $A \bigtriangleup B \bigtriangleup C$.

(*f*) Define a partial order on set A.

(*g*) Give the name of *one* method that must be implemented in a Java stand-alone application, and *two* of the most important methods that might be defined in an applet which just by being defined can alter its behaviour or appearance.

(*h*) In Java if a is a variable of type int what values of a will result in (a & (a-1)) == 0 being true?

(*i*) What is the range of real numbers which can be represented by a floating point format with 1 sign bit, 8 bias-127 exponent bits, and 23 normalised mantissa bits? You may round the mantissa value to the nearest integer.

(*j*) Unix operating systems give each process its own virtual address space, initially containing three segments. What is contained in each of these segments?

(*k*) What is this?

X   p-channel   p-channel

Z

n-channel

Y   n-channel
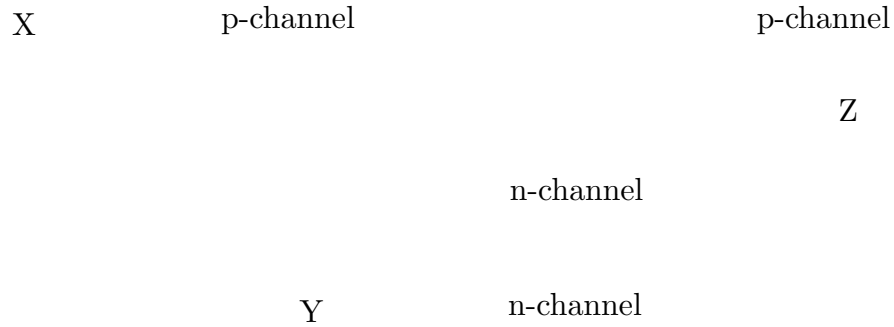
(*l*) Give a sum of products form for the exclusive or of two variables a and b.

(*m*) Give at least one good reason why professionals carry a greater ethical burden in the activities of their profession than ordinary members of the public.

(*n*) Write down a short expression or command which is a syntactically correct piece of program, but which would normally be faulted by a type-checker. Justify your answer in a few words.

(*o*) Given events A and B, demonstrate that $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.

(*p*) Given the axioms of Probability, prove the Empty Set Theorem: $P(\phi) = 0$.

(*q*) An inertial navigation set has a mean time to failure of 1000 hours. If an aircraft is fitted with two of them to increase reliability, is the mean time to failure of both systems which is experienced in practice likely to be several thousand hours or about a million hours? Give a brief justification for your answer.

(*r*) Outline the key principles of loop design, considering the simple case of a `while` loop.

(*s*) What are the differences, if any, between the languages determined by the three regular expressions $\emptyset^*$, $\emptyset(\emptyset^*)$ and $(\emptyset^*)^*$?

(*t*) For the main memory of a computer, why is volatile technology more often used than non-volatile technology?