## 2009 Paper 2 Question 1

## Digital Electronics

(a) With the aid of appropriate sketches, describe how an n-channel MOSFET operates as a switch.
(b) The left-hand figure below shows a circuit that uses an n-channel MOSFET having the properties given in the right-hand figure. The supply voltage $V_{\mathrm{DD}}=10 \mathrm{~V}$ and the resistor $R=200 \Omega$. The circuit input and output voltages are $V_{1}$ and $V_{2}$ respectively.

(i) Find the corresponding values of $V_{2}$ when $V_{1}=0 \mathrm{~V}, 2 \mathrm{~V}, 2.5 \mathrm{~V}, 3 \mathrm{~V}, 3.5 \mathrm{~V}$, $4 \mathrm{~V}, 4.5 \mathrm{~V}$, and sketch $V_{2}$ as a function of $V_{1}$. What logical function does this circuit implement?
(ii) When $V_{1}=4.5 \mathrm{~V}$, calculate the power dissipated by the entire circuit and by resistor $R$.
(c) With the aid of a circuit diagram, describe how a p-channel MOSFET can be used in a modified version of the left-hand figure above to significantly reduce total power dissipation.

