8 (a)   Complete the truth tables for the following logic gates.

AND Gate		
Input X	**Input Y**	**Output Q**
0	0	
0	1	
1	0	
1	1	

XOR Gate		
Input X	**Input Y**	**Output Q**
0	0	
0	1	
1	0	
1	1	

(2 marks)

8 (b)   A line-following robot has three sensors. It moves along a black line on a white background whilst the following conditions are met:

- the ultrasonic sensor U does not detect any obstacle
- either, but not both, of the infrared sensors L and R are on the black line.

Sensor U returns 1 if it detects an obstacle and 0 if the path is clear.
Sensors L and R each return 1 if they detect black and 0 if they detect white.

A logic circuit will process the input from the sensors and produce an output M.

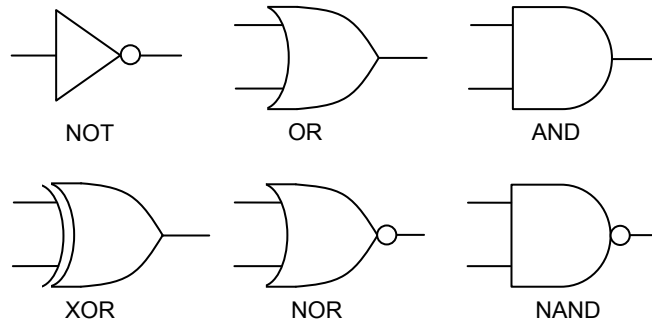M should be 1 if the robot is to move and 0 if the robot should stop.

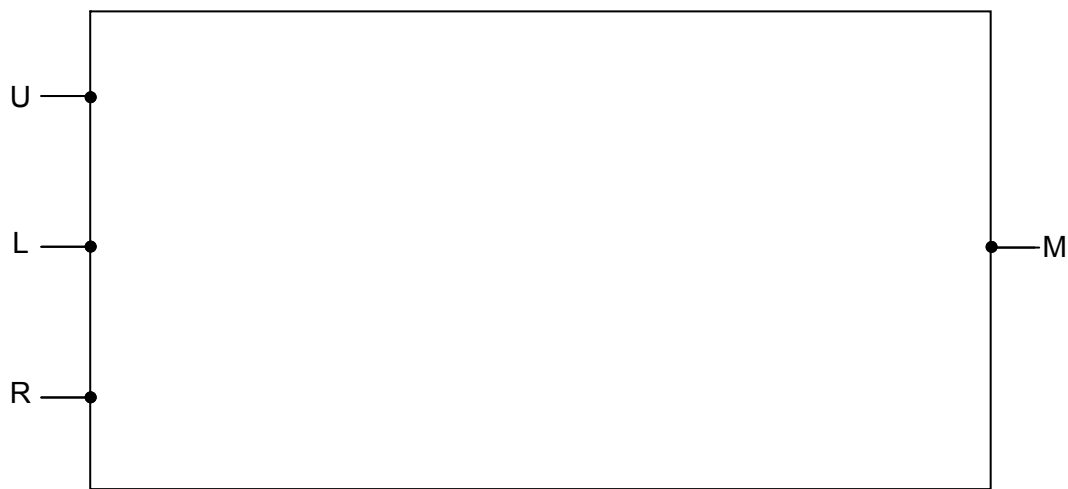**8 (b) (i)**   Represent the output M as a Boolean expression.

M = ...

(3 marks)

8 (b) (ii) The following symbols are used to represent logic gates:

NOT   OR   AND

XOR   NOR   NAND

Using a combination of any of the above logic gates draw a logic circuit for this system in the box below. You will **not** need to use all of the different types of logic gates.

U

L   M

R

(3 marks)

8 (c) Apply De Morgan's Law(s) to the following expression and simplify the result.

$$Q = \overline{\overline{A} + \overline{(B \cdot A)}}$$

Show the stages of your working.

....

....

....

....

(2 marks)

Final answer ....

(1 mark)

11

Turn over ▶