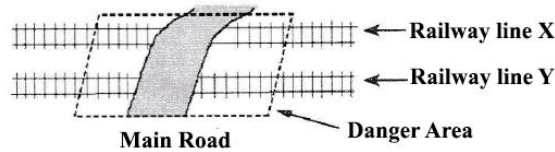


Grade 10 | Logic Gates with Boolean Function | Essay Paper

1. A main road crosses two parallel railway lines X and Y. An alarm bell should ring when a train enters the danger area on any of the lines from any direction (see figure). (2015)



The truth table below is given to indicate the operation of the alarm bell.

P - A train has entered ('1') or not entered ('0') the danger area of line X.

Q - A train has entered ('1') or not entered ('0') the danger area of line Y.

State of bell (Z):

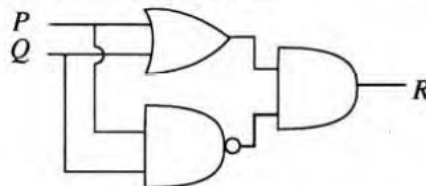
Bell is ringing - '1'

Bell is not ringing - '0'

Copy the above truth table to your answer script and fill the last column (Z).

P	Q	State of bell (Z)
0	0	
0	1	
1	0	
1	1	

2. A basic rule (axiom) in Boolean algebra is: $x + \bar{x} = 1$. This rule can be proved using a logic circuit with a two-input OR gate and a NOT gate. Draw the relevant logic circuit diagram to illustrate the proof of the above rule. (2015)
3. Consider the following logic circuit diagram: Present the equivalent Boolean expression for the above logic circuit. (2016)



4. A flashlight with motion and light sensors is located outside a front door of a building. The light turns 'on' automatically when it is dark and when someone approaches the door from outside (when both conditions are satisfied). The motion sensor turns from OFF (0) to ON (1) when someone comes near the door. The light sensor is ON (1) when there is light and OFF (0) when it is dark. The block diagram of the circuit Figure 1 relating to this scenario is shown below. (2017)

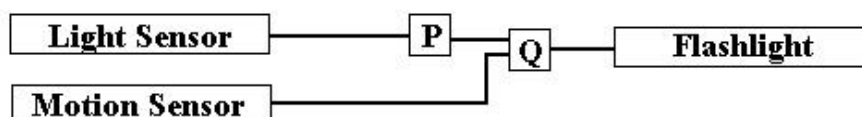
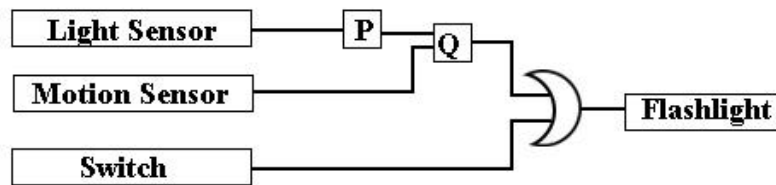


Figure 1 – Logic Circuit

- a. What are the suitable logic gates for P and Q in the above circuit?

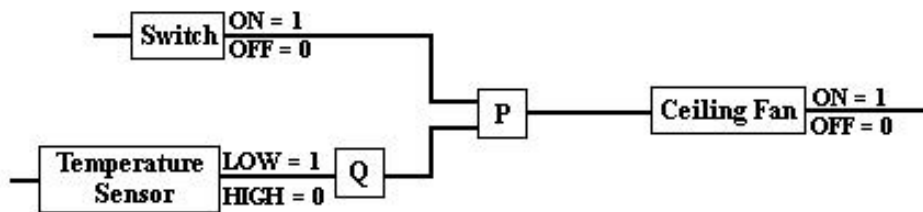
The above circuit is modified by adding an OR gate and a switch |ON (1). OFF (0)| as shown below in Figure 2.



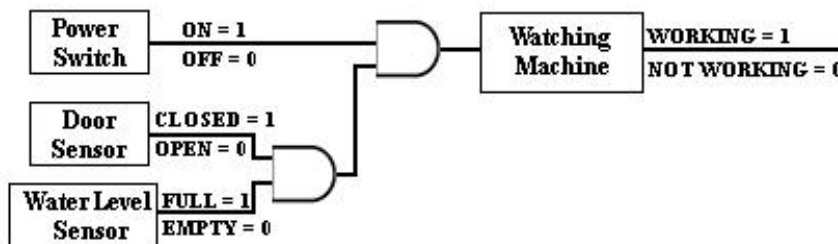
B. Identify which of the two in the following statements are correct regarding the modified circuit given in Figure 2. Write down the relevant statement numbers.

- 1 - When switch is ON (1) the flashlight will always be on.
- 2 - When switch is OFF (0) this circuit behaves as the circuit in Figure 1.
- 3 - The behavior or two circuits are identical.

5. Consider the following simplified logic circuit, which is designed to switch on a ceiling fan when temperature is HIGH while the power switch is ON. Write down the two relevant logic gates for P and Q. (2018)



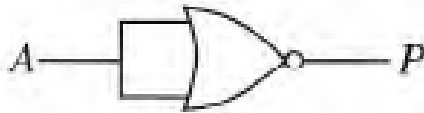
6. Consider the following simplified circuit of a washing machine. (2018)



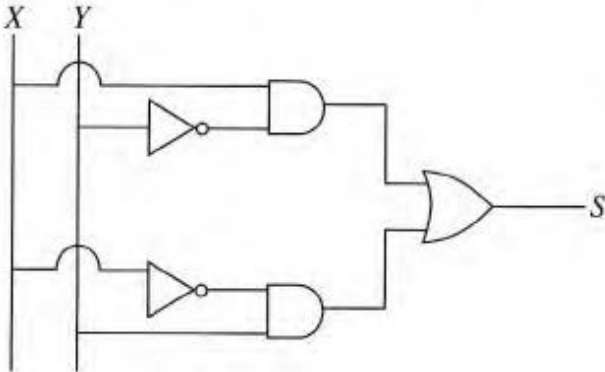
The following is the truth table equivalent to the above logic circuit. Write down labels (A - H) and the corresponding truth value (1, 0) of each label.

Power switch	Door sensor	Water level sensor	Washing machine
OFF (0)	OPEN (0)	EMPTY (0)	A
OFF (0)	OPEN (0)	FULL (1)	B
OFF (0)	CLOSED (1)	EMPTY (0)	C
OFF (0)	CLOSED (1)	FULL (1)	D
ON (1)	OPEN (0)	EMPTY (0)	E
ON (1)	OPEN (0)	FULL (1)	F
ON (1)	CLOSED (1)	EMPTY (0)	G
ON (1)	CLOSED (1)	FULL (1)	H

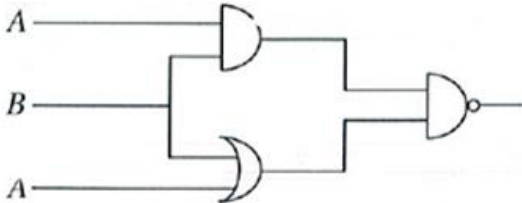
7. Consider the following logic gate. Draw the truth table (having two columns as A and P) for the above gate. (2019)



8. Consider the following logic circuit. Write down the relevant Boolean expression for S. (2019)



9. Draw the truth table for the logic circuit given below. (2020)



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