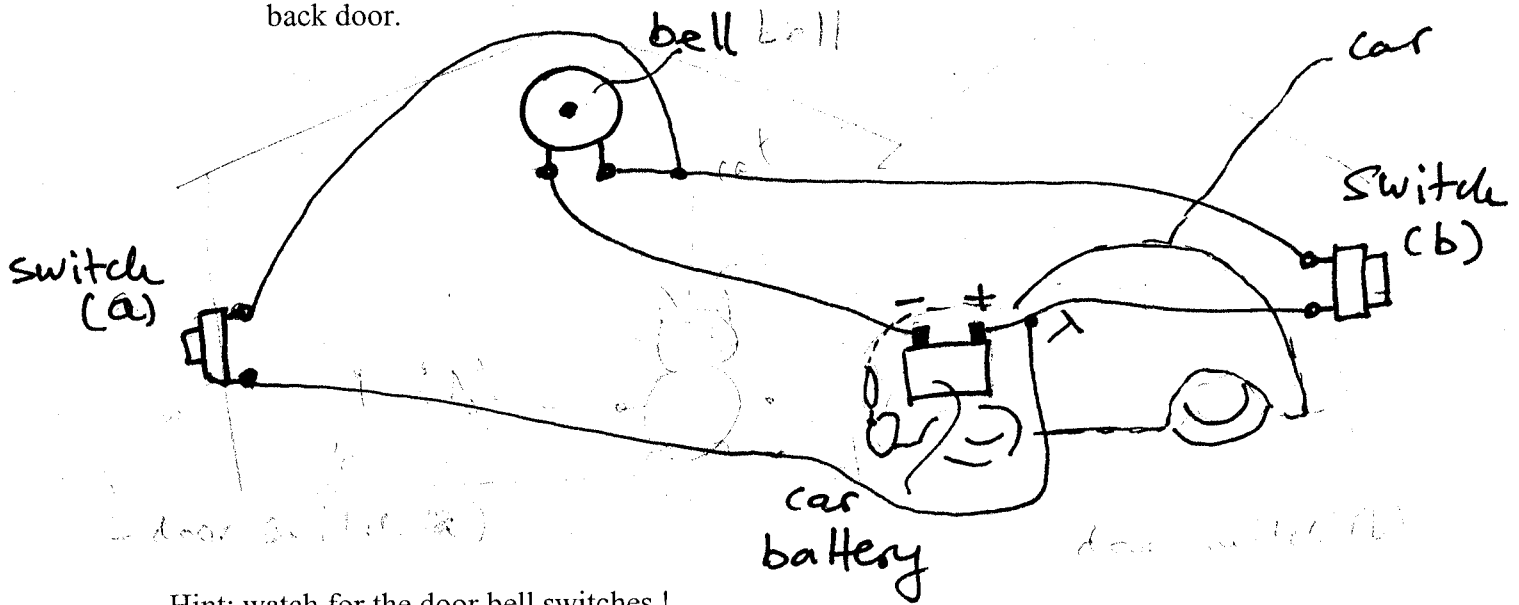


Your Name: KEY

**Problem #1:** Ben is an engineer working in the Silicon Valley start-up company. He is very energy consciencious. In order to save on his electricity bill he wants to use his car battery to power his door bell.

(a.) Finish the wiring diagram so that the bell can be activated from both: front and back door.



Hint: watch for the door bell switches !

(b.) The door bell switch operates in the following way: when pressed the contact is ON. When released - there is no contact (it is OFF). What is the logical expression for the door bell as a function of the two door bell swithes a and b ?

i.e.  $f(a,b) = ?$  (assume that door bell rings when  $f=1$ )

$$f = a + b$$

(c.) Ben has gone to work in his car. He is now sitting at a shareholders meeting of his company in San Jose. The mailman came to his back door to deliver his dividend check and he is pressing the door switch. Would the bell ring ?

no, car left with battery

(d.) Ben is sleeping. The cat accidentally jumped on the top of his car and scared the dog. The dog started barking and this triggered Ben's car alarm. Would the door bell ring ?

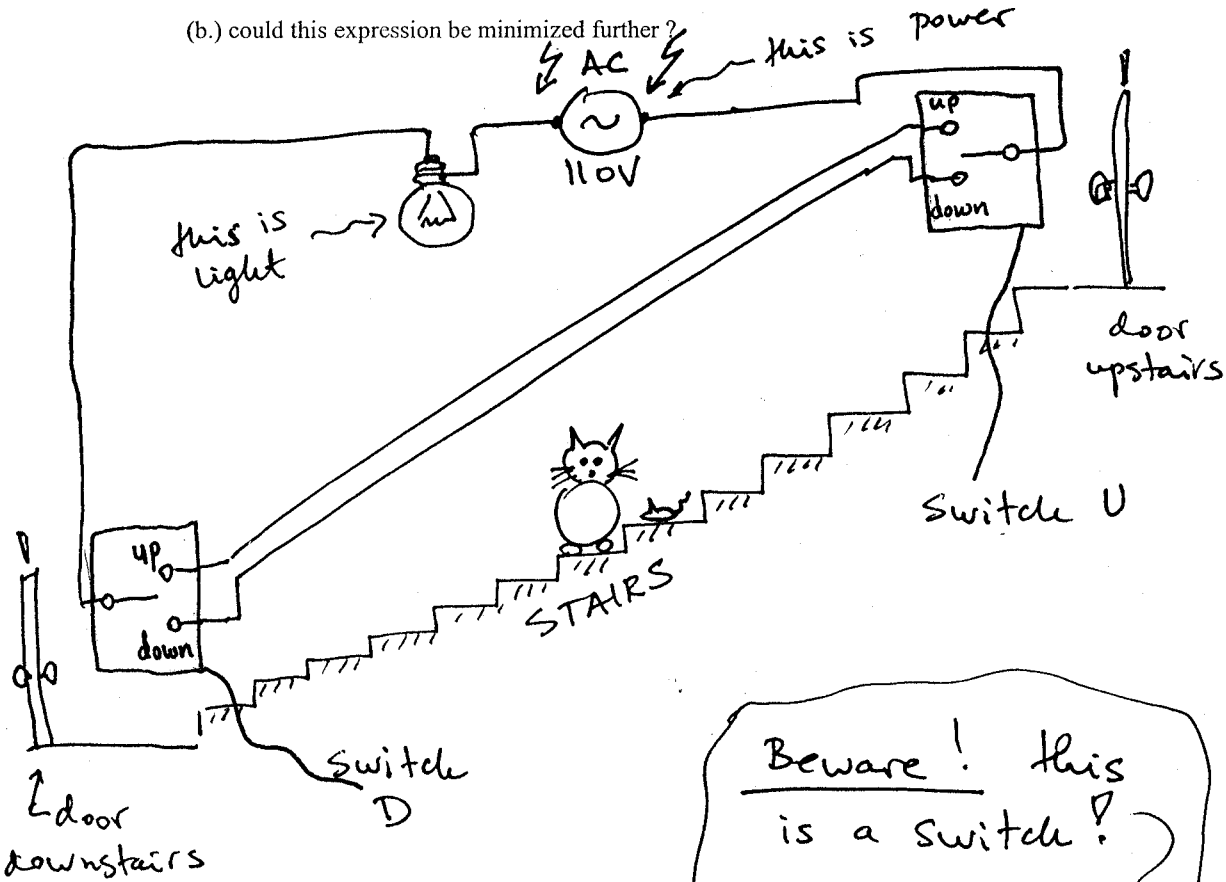
no, car alarm can not trigger bell.

**Problem #2:** Given is a famous staircase wiring diagram with the switch arrangement that can turn light OFF or ON on both sides of the stairs. (you do not need to go downstairs to turn the light OFF if you are exiting upstairs).

If you designate the downstairs switch as D (which can have values 0, 1) and upstairs switch as U (0,1), what is the logic function (logic expression) for the light being ON ?

(a.) I.e.  $L=f(U,D)$ . Write this expression and explain !

(b.) could this expression be minimized further ?



(a) 2 possible answers, depending on orientation of switch positions

1)  $D=1=up$      $U=1=up$   
 $D=0=down$     $U=0=down$

D	U	L
0	0	1
0	1	0
1	0	0
1	1	1

$$L = \bar{U}\bar{D} + UD$$

2)  $D=0=up$     $D=1=down$   
 $U=1=up$     $U=0=down$

D	U	L
0	0	0
0	1	1
1	0	1
1	1	0

$$L = \bar{D}U + D\bar{U}$$

b) 1)  $L = \bar{U} \oplus \bar{D}$   
 XNOR gate

2)  $L = U \oplus D$   
 XOR gate

Beware! this is a switch!  
 with two positions  
 Hint it can be only in one position.