HW#2 solution:

```
4.1

(a) x = ABC + \overline{AC} = C(AB + \overline{A}) = C(\overline{A} + B)

(b) y = (Q + R)(\overline{Q} + \overline{R}) = Q\overline{Q} + Q\overline{R} + R\overline{Q} + R\overline{R} = Q\overline{R} + R\overline{Q}

(c) w = ABC + A\overline{BC} + \overline{A} = AC(B + \overline{B}) + \overline{A} = AC + \overline{A} = \overline{A} + C

(d)

q = \overline{RST(R + S + T)}
q = (\overline{R} + \overline{S} + \overline{T})(\overline{RST})
q = \overline{RST} + \overline{SRST} + \overline{TRST}
q = \overline{RST} + \overline{RST} + \overline{RST}
q = \overline{RST}

(e)

x = \overline{ABC} + \overline{ABC} + ABC + A\overline{BC} + A\overline{BC}
x = \overline{ABC} + BC(A + \overline{A}) + A\overline{B}(C + \overline{C})
x = \overline{ABC} + BC + A\overline{B}
x = BC + \overline{B}(\overline{AC} + A) = BC + \overline{B}(A + \overline{C})
```

(f)
$$z = (B + \overline{C})(\overline{B} + C) + \overline{A} + B + \overline{C}$$

$$z = B\overline{B} + BC + B\overline{C} + C\overline{C} + \overline{A}B\overline{C}$$

$$z = BC + \overline{BC} + A\overline{BC}$$

$$z = BC + \overline{B(C} + AC)$$

$$z = BC + \overline{B(C} + A)$$

$$z = BC + \overline{BC} + A\overline{B}$$
(g)
$$y = \overline{(C + D)} + \overline{ACD} + A\overline{BC} + \overline{ABCD} + A\overline{CD}$$

$$y = \overline{CD} + \overline{ACD} + A\overline{BC} + \overline{ABCD} + A\overline{CD}$$

$$y = \overline{CD} + \overline{CD}(\overline{A} + A) + A\overline{BC} + \overline{ABCD}$$

$$y = \overline{CD} + \overline{CD} + A\overline{BC} + \overline{ABCD}$$

$$y = \overline{DC} + \overline{CD} + A\overline{BC} + \overline{ABCD}$$

$$y = \overline{DC} + \overline{CD} + A\overline{BC} + \overline{ABCD}$$

$$y = \overline{DC} + \overline{CD} + \overline{ABC} + \overline{ABCD}$$

$$y = \overline{D} + \overline{ABC} + \overline{ABCD}$$

$$y = \overline{D} + \overline{ABC} + \overline{ABCD}$$

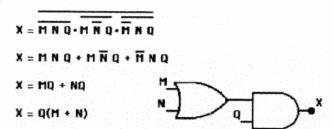
$$y = \overline{D} + \overline{ABC} + \overline{ABCD}$$

(h)
$$x = AB(\overline{CD}) + \overline{ABD} + \overline{BCD}$$

$$x = AB(C + \overline{D}) + \overline{ABD} + \overline{BCD}$$

$$x = ABC + AB\overline{D} + \overline{ABD} + \overline{BCD}$$

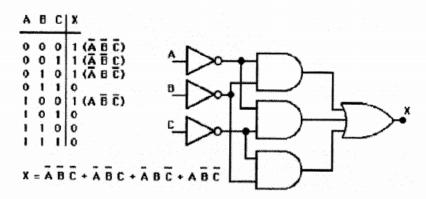
4.2



4.4 Use \overline{X} since this would give only three terms.

Alternate solution using S-of-P expression for X would be: $X = \overline{A}B + \overline{B}\overline{C} + BC$

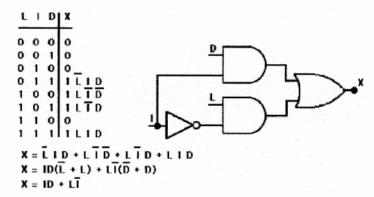




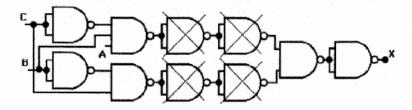
By adding the term \overline{ABC} three times and then factoring, the following is obtained:

$$X = \overline{AB}(C + \overline{C}) + \overline{AC}(B + \overline{B}) + \overline{BC}(A + \overline{A})$$
$$X = \overline{AB} + \overline{AC} + \overline{BC}$$

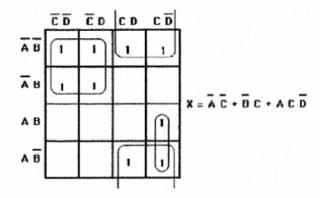
4.8 Door = D; Ignition = I; Lights = L



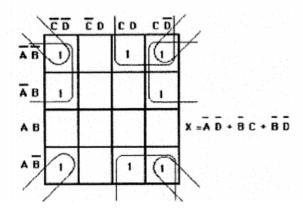
4.9 Change each gate to its NAND equivalent and then cancel double inversions.



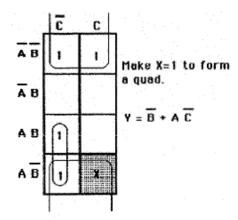
4.11 (a)



(b)

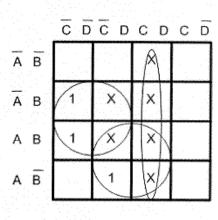


(c)



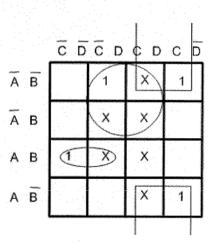
4.16 (a)
$$X = B\overline{C} + AD$$

D	С	В	Α	X
	0	0	0	0 0 1 1 0 0 0 0 0 1 x x x x
0	0	0	1	0
0	0	1	0	1
0	0	1	1.	1
0	1	0	0	0
0	1 .	0	1	0
0	1	1	0	0
0	1	1	1	0
4	0	0	0	0
1	0	0	1	1
1	0	1	0	x
1	0	1	1.	X
1	1	0	0	×
1	1	0	. 1	x
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1	0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1 1 1	0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1 1	0	x
1	1	1	0 1 0 1 0 1 0 1 0 1 0 1 0 1	X



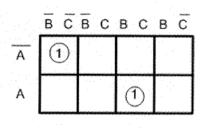
(b)
$$X = \overline{B}C + \overline{A}D + AB\overline{C}$$

D	С	В	Α	X
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1	0	0	0	0
0	0	0	1	0
0	0 0 0 1	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	. 1	0
1	0	0	0	1
1	0	0	1	0
1	0	1.	0	x
1	0	1	1	X
1	1	0	0	x
1	1 1 0 0 0 0 1 1	0	1	x
1	1	0 0 1 1 0 0 1 1 0 0 1 1	0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1	0 0 0 1 1 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0
1	1	1	.1	Х
-	-			



4.22 (a)
$$X = ABC + \overline{ABC}$$

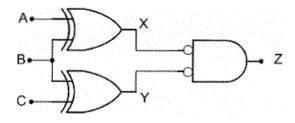
С	В	Α	X
0	0	0	1
0	0	1	0
0 0	1	0	0
0	1	1	0 0 0 0 0
1	0	0	0
1	0		0
1	1	0	0
1	1	1	1



(b) To find if A=B=C:

- 1. $X = A \oplus B$ (X is Low when A=B)
- 2. $Y = B \oplus C$ (Y is Low when B=C)

A=B=C when both 1 & 2 are true.



4.23

