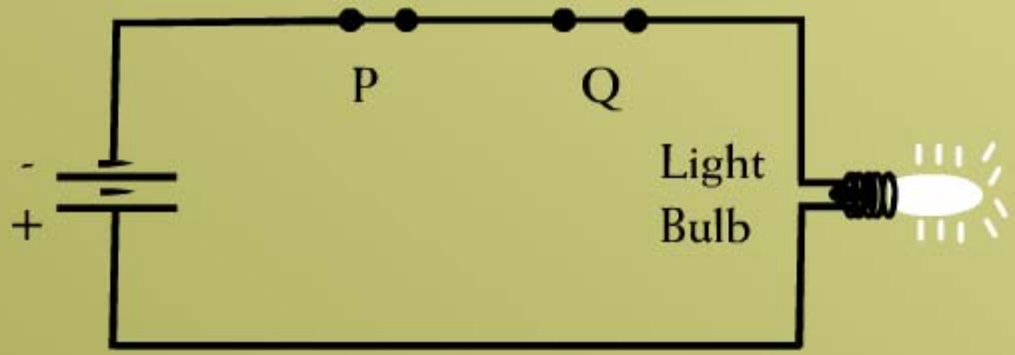
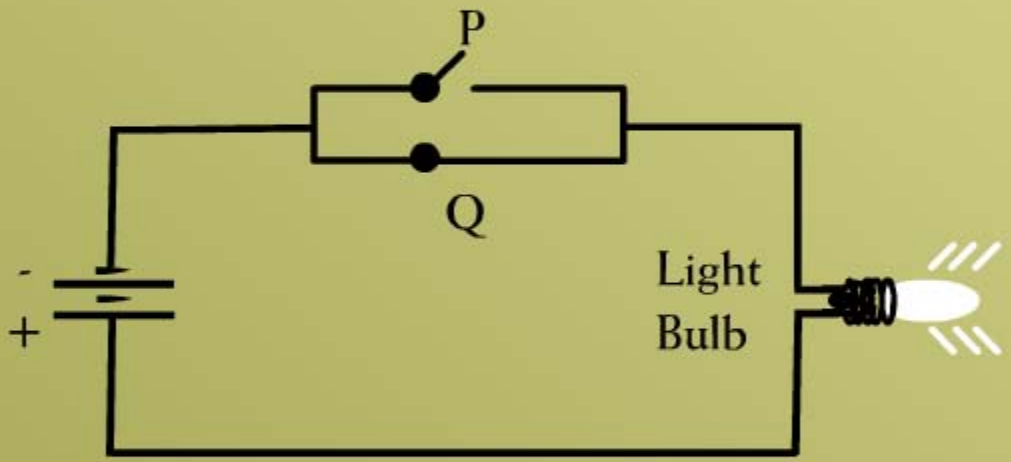
SWITCHES IN SERIES



SWITCHES IN SERIES

Switches		Light Bulb
P	Q	State
Open	Open	Off
Open	Closed	Off
Closed	Open	Off
Closed	Closed	On

SWITCHES IN PARALLEL



SWITCHES IN SERIES

Switches		Light Bulb
P	Q	State
T	T	T
T	F	F
F	T	F
F	F	F

P	Q	P∧Q
T	T	T
T	F	F
F	T	F
F	F	F

SWITCHES IN PARALLEL

Switches		Light Bulb
P	Q	State
T	T	T
T	F	T
F	T	T
F	F	F

P	Q	P∨Q
T	T	T
T	F	T
F	T	T
F	F	F

NOT GATE
OR
INVERTER

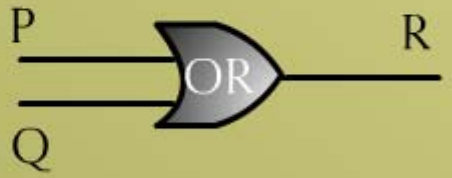
Input	Output
P	Q
1	0
0	1

AND GATE

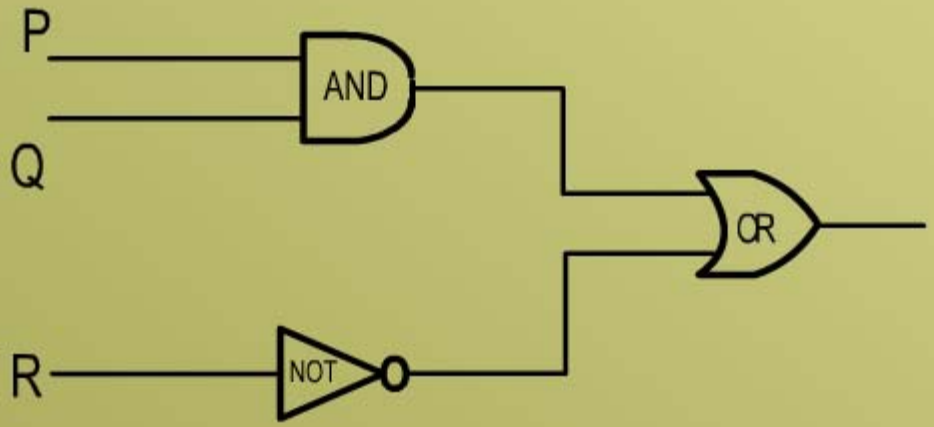
Input		Output
P	Q	R
1	1	1
1	0	0
0	1	0
0	0	0

OR GATE

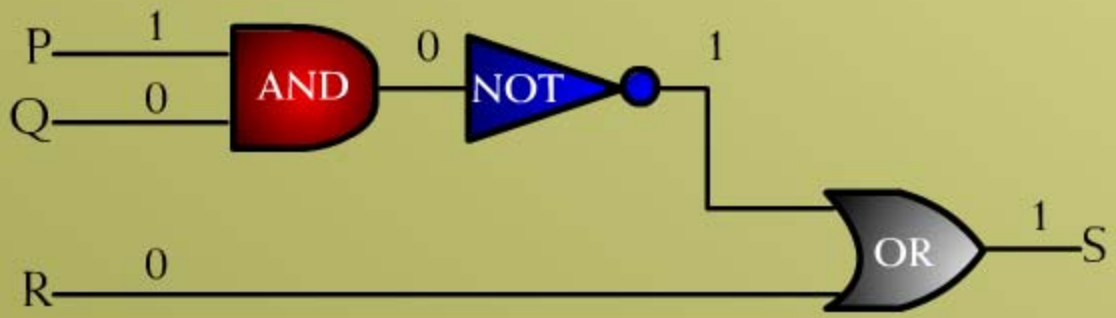
Input		Output
P	Q	R
1	1	1
1	0	1
0	1	1
0	0	0



COMBINATIONAL CIRCUIT



OUTPUT FOR A GIVEN INPUT



INPUT/OUTPUT TABLE FOR A CIRCUIT

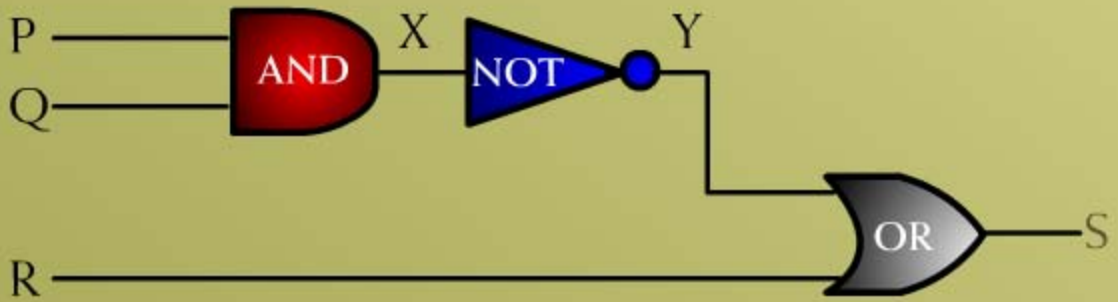


TABLE FOR CIRCUIT

P	Q	R	X	Y	S
1	1	1			
1	1	0			
1	0	1			
1	0	0			
0	1	1			
0	1	0			
0	0	1			
0	0	0			

TABLE FOR CIRCUIT

P	Q	R	X	Y	S
1	1		1		
1	1		1		
1	0		0		
1	0		0		
0	1		0		
0	1		0		
0	0		0		
0	0		0		

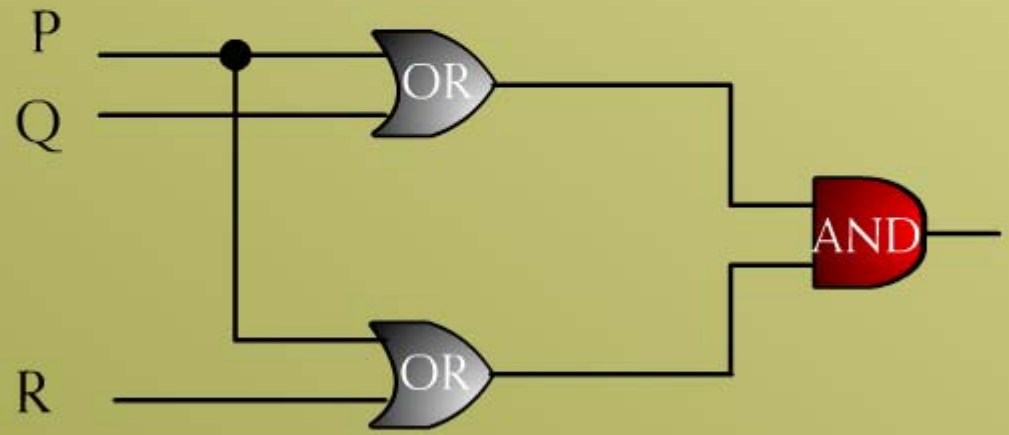
TABLE FOR CIRCUIT

P	Q	R	X	Y	S
			1	0	
			1	0	
			0	1	
			0	1	
			0	1	
			0	1	
			0	1	
			0	1	

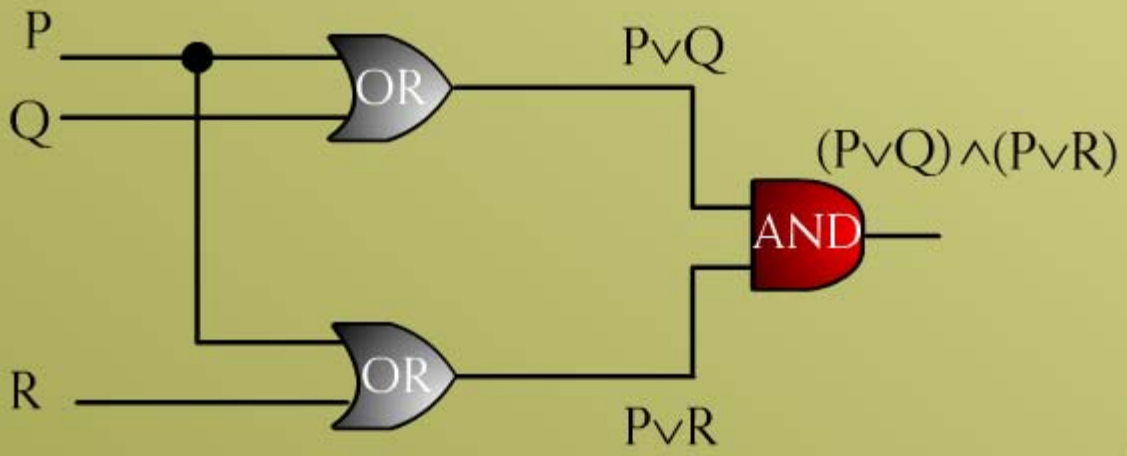
TABLE FOR CIRCUIT

P	Q	R	X	Y	S
		1		0	1
		0		0	0
		1		1	1
		0		1	1
		1		1	1
		0		1	1
		1		1	1
		0		1	1

BOOLEAN EXPRESSION FOR A CIRCUIT

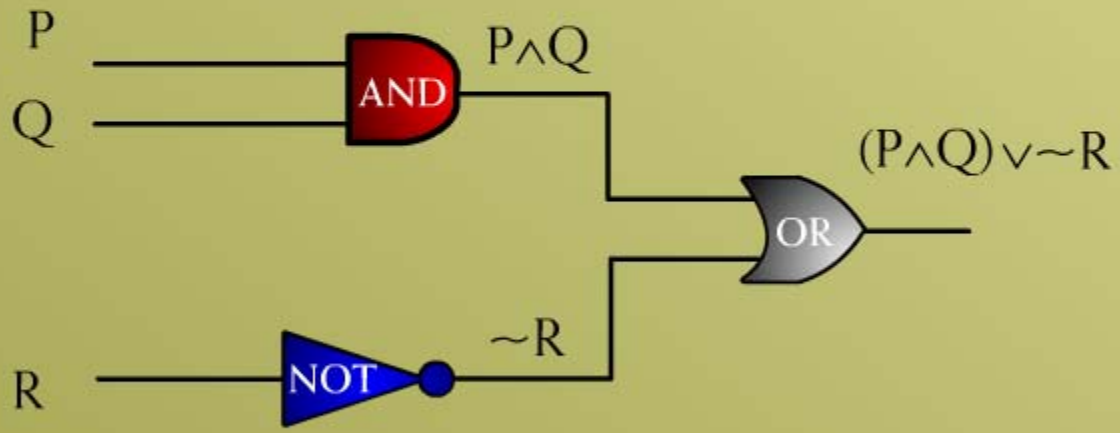


BOOLEAN EXPRESSION FOR A CIRCUIT



CIRCUIT FOR A BOOLEAN EXPRESSION

$(P \wedge Q) \vee \sim R$



CIRCUIT FOR INPUT/OUTPUT TABLE

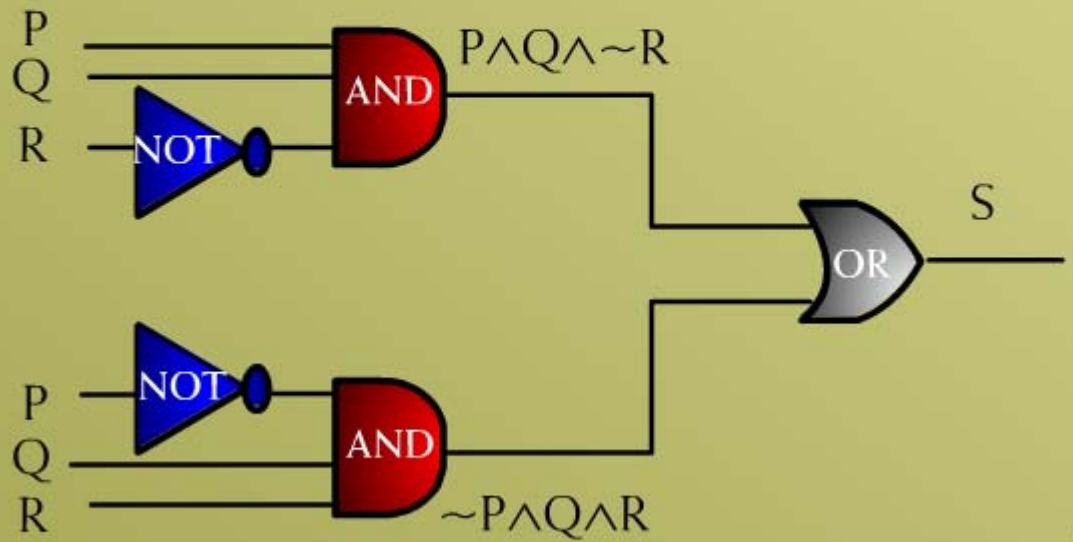
INPUTS			OUTPUTS
P	Q	R	S
1	1	1	0
1	1	0	1
1	0	1	0
1	0	0	0
0	1	1	1
0	1	0	0
0	0	1	0
0	0	0	0

SOLUTION

INPUTS			OUTPUTS	
P	Q	R	S	
1	1	1	0	$P \wedge Q \wedge \sim R$
1	1	0	1	↵
1	0	1	0	
1	0	0	0	$\sim P \wedge Q \wedge R$
0	1	1	1	↵
0	1	0	0	
0	0	1	0	
0	0	0	0	

CIRCUIT DIAGRAM

$$(P \wedge Q \wedge \sim R) \vee (\sim P \wedge Q \wedge R) = S$$



EXERCISE

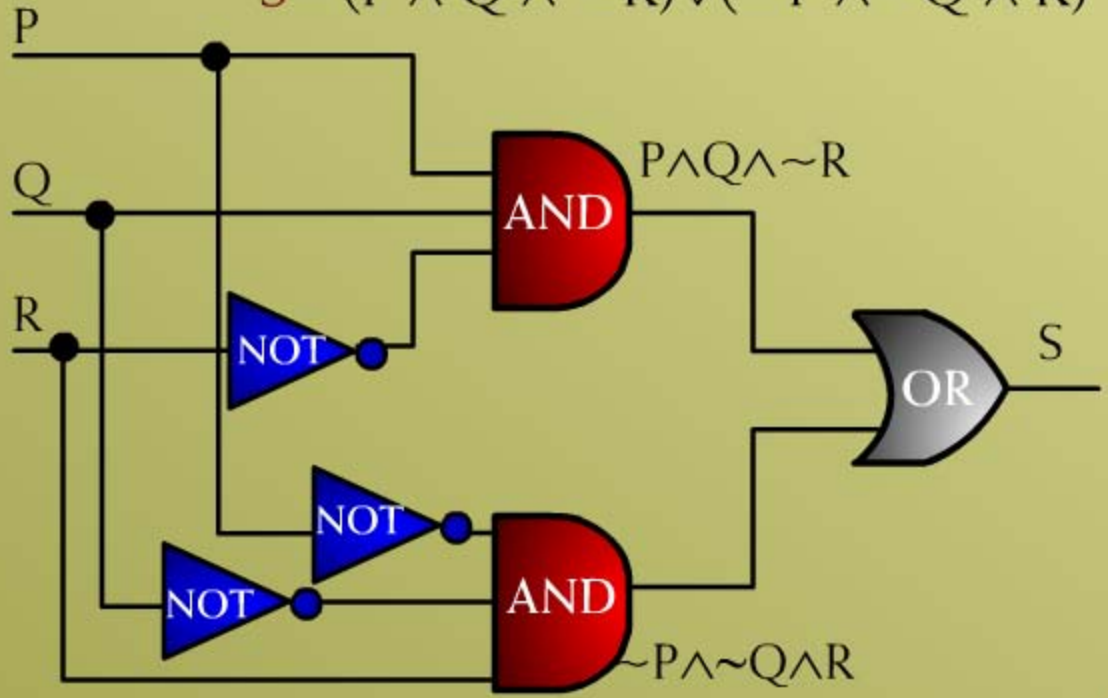
Design a circuit to take input signals P, Q, and R and output a 1 if, and only if, P and Q have the same value and Q and R have opposite values.

EXERCISE

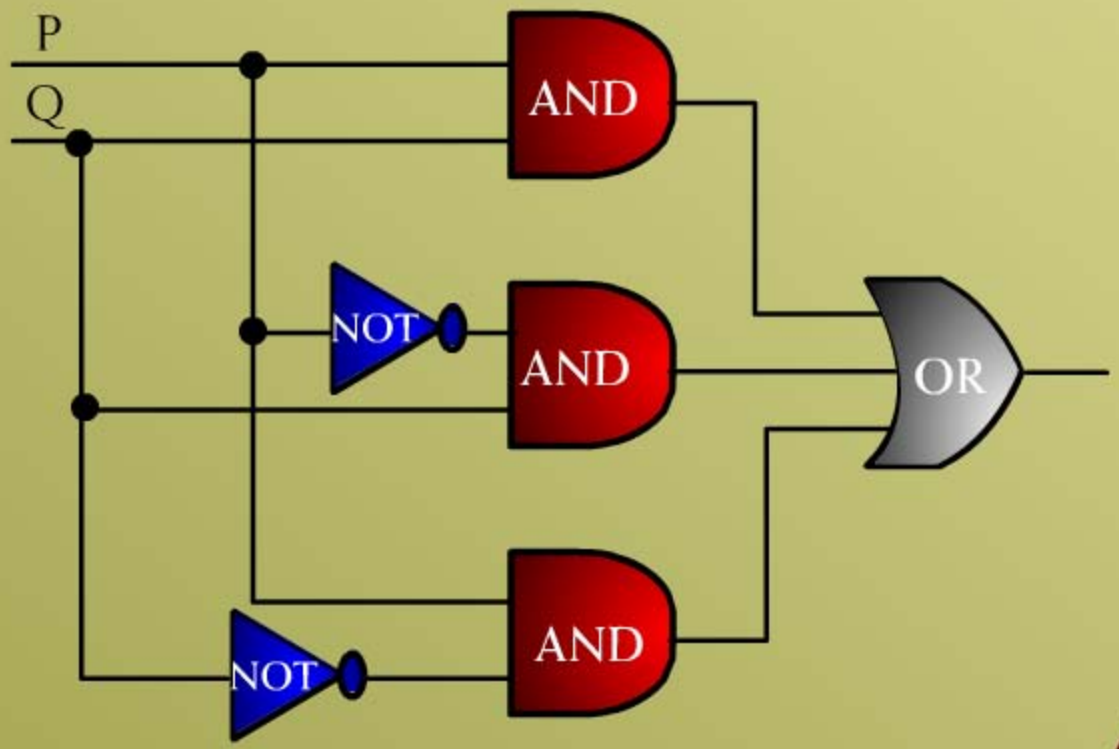
INPUTS			OUTPUTS	
P	Q	R	S	
1	1	1	0	$P \wedge Q \wedge \sim R$
1	1	0	1	↵
1	0	1	0	
1	0	0	0	
0	1	1	0	
0	1	0	0	$\sim P \wedge Q \wedge R$
0	0	1	1	↵
0	0	0	0	

Solution contd..

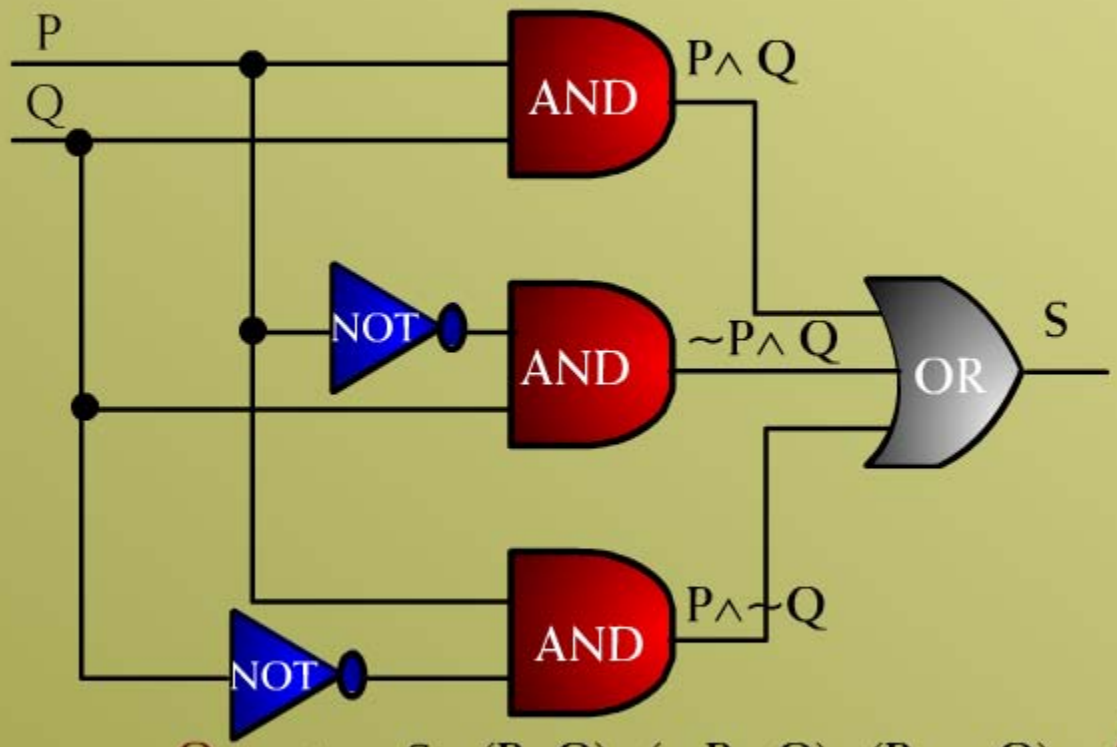
$S = (P \wedge Q \wedge \sim R) \vee (\sim P \wedge \sim Q \wedge R)$



EXERCISE



SOLUTION



Output: $S = (P \wedge Q) \vee (\sim P \wedge Q) \vee (P \wedge \sim Q)$

Solution contd..

Statement	Reason
$(P \wedge Q) \vee (\sim P \wedge Q) \vee (P \wedge \sim Q)$	
$\equiv (P \wedge Q) \vee (\sim P \wedge Q) \vee (P \wedge \sim Q)$	
$\equiv (P \vee \sim P) \wedge Q \vee (P \wedge \sim Q)$	Distributive law
$\equiv t \wedge Q \vee (P \wedge \sim Q$	Negation law
$\equiv Q \vee (P \wedge \sim Q)$	Identity law
$\equiv (Q \vee P) \wedge (Q \vee \sim Q)$	Distributive law

Solution contd..

Statement	Reason
$\equiv(Q \vee P) \wedge t$	Negation law
$\equiv Q \vee P$	Identity law
$\equiv Q \vee P$	Commutative law

Thus $(P \wedge Q) \vee (\sim P \wedge Q) \vee (P \wedge \sim Q) \equiv P \vee Q$