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Breakout group: 3

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5. Determine whether the following sentences are valid (i.e. tautologies) using truth tables.

```
 \begin{split} & \text{(i)} \ \left( (P \vee Q) \wedge \neg P \right) \to Q \\ & \text{(ii)} \ \left( (P \to Q) \wedge \neg (P \to R) \right) \to (P \to Q) \\ & \text{(iii)} \ \neg (\neg P \wedge P) \wedge P \\ & \text{(iv)} \ \left( P \vee Q \right) \to \neg (\neg P \wedge \neg Q) \end{split}
```

We test using our tableau_prover.py to test our propositions:

```
tableau_test('((P | Q) & -P) -> Q')
tableau_test('((P -> Q) & -(P -> R)) -> (P -> Q)')
tableau_test('-(-P & P) & P')
tableau_test('(P | Q) -> -(-P & -Q)')
```

For (i), (ii), (iii), (iv) respectively:

```
-(((P | Q) & -P) -> Q)
-Q
((P | Q) & -P)
-P
(P | Q)
P
CLOSED
Q
CLOSED
|- (((P | Q) & -P) -> Q): True
```

```
-(((P -> Q) & -(P -> R)) -> (P -> Q))

((P -> Q) & -(P -> R))

-(P -> Q)

P

-Q

-(P -> R)

P

-R

(P -> Q)

-P

CLOSED

Q

CLOSED

|- (((P -> Q) & -(P -> R)) -> (P -> Q)): True
```

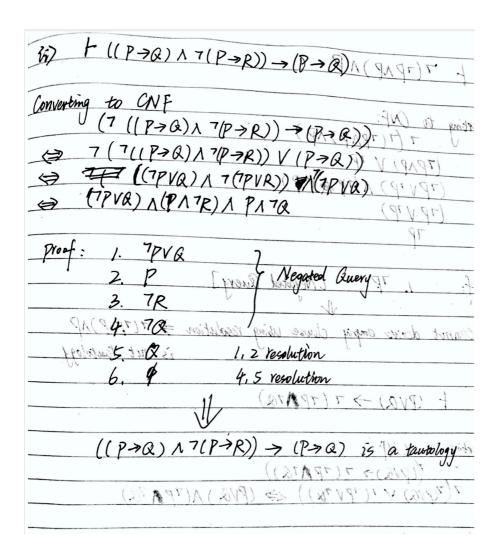
```
-(-(-P & P) & P)
--(-P & P)
(-P & P)
(-P & P)
P
-P
CLOSED
-P
AGENDA EMPTY
[- (-(-P & P) & P): False
```

```
-((P | Q) -> -(-P & -Q))
--(-P & -Q)
(-P & -Q)
-Q
-P
(P | Q)
P
CLOSED
Q
CLOSED
|- ((P | Q) -> -(-P & -Q)): True
```

Which gives us answers: (i),(ii)and(iv) are tautologies, (iii) are not.

- 6. Repeat Question 5 using resolution. In this case, try to show
 - (i) $\vdash ((P \lor Q) \land \neg P) \to Q$
 - (ii) $\vdash ((P \to Q) \land \neg (P \to R)) \to (P \to Q)$
 - (iii) $\vdash \neg(\neg P \land P) \land P$
 - (iv) $\vdash (P \lor Q) \to \neg(\neg P \land \neg Q)$

i) + ((PVQ) 17P) -> Q	J = 1600 mol
	edinon,
Convert to CNF:	min 120 min
711 0 1 1 1 1 1	= 12 14
1 7 ((PVQ) NIP) VQ)	
(>) 77 ((PVQ) A(Y) / IQ	
((PVA)ATY) A /A	
(PVR) ATP ATR	
	*
proof:). PVQ [Negated Query]	
2. TP [Negoted agery]	397
3. 7Q [Negoted Query]	
4. Q [Negated During] [1,2	resolution]
5 \$ [3, 4 resolution]	
, II	
	16
7/1(PVQ) A FP) > Q + 25 Q tauto	794
$((PVQ)\Lambda^{7}P) \rightarrow Q is a tout$	logy
	V
	· · · · · ·
	11. 0



ii) + 7(7PAP)A(P. 9) . (9 . 4) i A (25.5)]
Converting to CNF:	otest to CNF.
7 (7 (9 (9 (9))) (9 (9))	(1 ((P+(x)))
	7 (711 836)1
(7PVP) A (7PVP) (9V9)	(ONDE) ETT
(¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬	
<⇒ 7P	
	DNAL 1 : July
proof: 1. 7P [Negated Query]	7.5
	11
Cannot derive empty clouse using resolute	ion => T(TPAP)AP
	is not tautology
iv) + (PVQ) > 7 (7P17Q)	9.0
	/
Converting to CNF: (259)	TA / Base GAV
(T(PVQ) V 7 (TPVTQ)) (PVQ) A	(7P17Q)
7 /	
1. TVC House of Our	ny
2. 7P 9 Negard Lae	J
4 0	
4. & 1. 2 resolution 5. D 3. 4 resolution	
	A 1
⇒ (PVG) → 7(7P17B) is a tam	tology