

$$1. (A \vee B) \leftrightarrow (C \vee D)$$

$$= [(A \vee B) \rightarrow (C \vee D)] \wedge [(C \vee D) \rightarrow (A \vee B)] \quad \text{Biconditional Elimination}$$

$$= [(\neg C \vee B) \vee (C \vee D)] \wedge [(C \vee D) \vee (C \vee B)]$$
 Implication Elimination

$$= [(A \wedge B) \vee (C \vee D)] \wedge [(C \wedge D) \vee (A \vee B)] \quad \text{De Morgan's Laws}$$

$$= \{ [A \vee (C \vee D)] \wedge [B \vee (C \vee D)] \} \wedge \{ [C \vee (A \vee B)] \wedge [D \vee (A \vee B)] \}$$

Distributive Law

$$= (A \vee C \vee D) \wedge (B \vee C \vee D) \wedge (A \vee B \vee C) \wedge (A \vee B \vee D)$$

Associative Law

2.	Knowledge Base	Number of Models
	PVA	48
	$CANTRDVC(\Leftrightarrow TP)$	40
	$PAAAT, RLOAX$	1

$$3 \times 2^4 = 48$$

$$2^4 + 2 \times 2^4 - 2 \times 2^2 = 16 + 32 - 8 = 40$$

3. Biconditional: $B_{3,1} \leftrightarrow (P_{2,1} \vee P_{3,2} \vee P_{4,1})$

steps: $= (B_{3,1} \rightarrow (P_{3,1} \vee P_{3,2} \vee P_{4,1})) \wedge ((P_{3,1} \vee P_{3,2} \vee P_{4,1}) \rightarrow B_{3,1})$

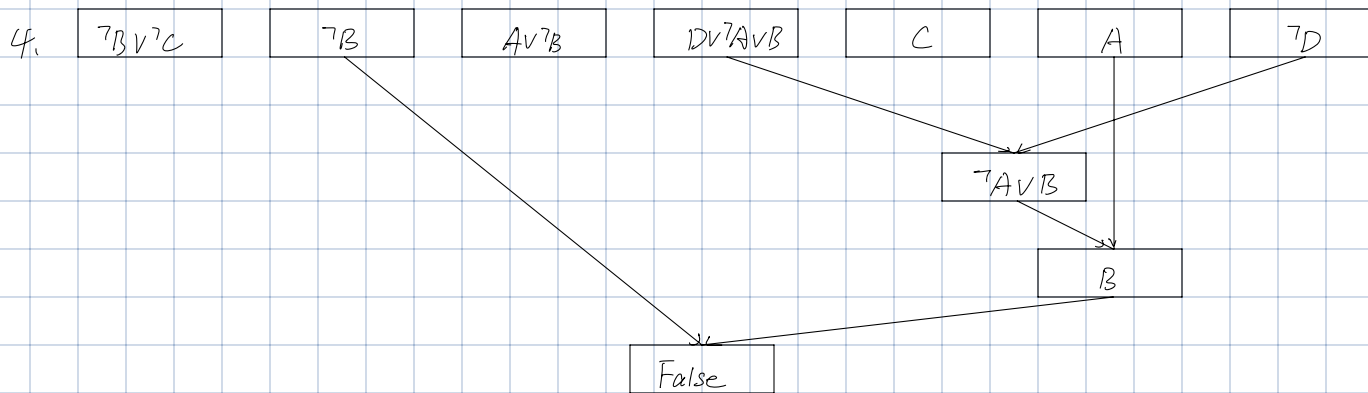
$$= (\neg B_{3,1} \vee (P_{2,1} \vee P_{3,2} \vee P_{4,1})) \wedge ((P_{2,1} \vee P_{3,2} \vee P_{4,1}) \vee B_{3,1})$$

$$= ({}^7B_{3,1} \vee P_{2,1} \vee P_{3,2} \vee P_{4,1}) \wedge [({}^7P_{2,1} \wedge {}^7P_{3,2} \wedge {}^7P_{4,1}) \vee B_{3,1}]$$

$$= (7B_{3,1} \vee P_{2,1} \vee P_{3,2} \vee P_{4,1}) \wedge (7B_{3,1} \vee B_{3,1}) \wedge (7P_{3,2} \vee B_{3,1}) \wedge (7P_{4,1} \vee B_{3,1})$$

		$P_{3,2}$	
	$P_{2,1}$	$B_{3,1}$	$A_{3,1}$

Conjunctive Normal Form = $(P_{3,1} \vee P_{3,2} \vee P_{4,1}) \wedge (P_{2,1} \vee B_{3,1}) \wedge (P_{3,2} \vee B_{3,1}) \wedge (P_{4,1} \vee B_{3,1})$



Contradiction, so D must be true

f. a) $[Occupation(Emily, Surgeon) \vee Occupation(Emily, Lawyer)]$

b) $Occupation(Joe, Actor) \wedge [\exists o \neq Actor \quad Occupation(Joe, o)]$

C) $\forall P \in \text{Person} \quad \text{Occupation}(P, \text{Surgeon}) \rightarrow \text{Occupation}(P, \text{Doctor})$

d) $\neg \text{Person}(\text{Occupation}(\text{CP}, \text{Lawyer}) \rightarrow \neg \text{Customer}(\text{Joe}, \text{P}))$

e) $\exists P \text{ Person} \text{ Boss } CP, \text{ Emily} \wedge \text{Occupation } CP, \text{ Lawyer}$

f) $\exists \text{ Person } \text{hol} \in \text{Person} [\text{Occupation}(\text{P, Lawyer}) \wedge \text{Customer}(\text{Q, p})] \rightarrow \text{Occupation}(\text{Q, Doctor})$

g) $\neg \text{Person} \exists Q \text{ Person} \text{ Occupation}(P, \text{ Surgeon}) \rightarrow [\text{Occupation}(Q, \text{ Lawyer}) \wedge \text{Customer}(P, Q)]$