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Answer 1

a)

p	q	$(p \wedge q)$	$(\neg p \vee \neg q)$	$(p \wedge q) \iff (\neg p \vee \neg q)$
T	T	T	F	F
T	F	F	T	F
F	T	F	T	F
F	F	F	T	F

b)

$p \implies ((q \vee \neg q) \implies (p \wedge q))$

$p \implies ((q \vee \neg q) \implies (p \wedge q)) = p \implies (T \implies (p \wedge q))$	(Negation Law, Table 6)
$p \implies (T \implies (p \wedge q)) = p \implies (F \vee (p \wedge q))$	(Table 7, Line 1)
$p \implies (F \vee (p \wedge q)) = p \implies (p \wedge q)$	(Identity Law, Table 6)
$p \implies (p \wedge q) = \neg p \vee (p \wedge q)$	(Table 7, Line 1)
$\neg p \vee (p \wedge q) = (\neg p \vee p) \wedge (\neg p \vee q)$	(Distribution law, Table 6)
$(\neg p \vee p) \wedge (\neg p \vee q) = T \wedge (\neg p \vee q)$	(Negation Law, Table 6)
$T \wedge (\neg p \vee q) = \neg p \vee q$	(Identity Law)

Answer 2

a) $\forall x \exists y W(x, y)$

b) $\neg \forall y \exists x F(x, y)$

c) $\forall x(W(x, P) \implies A(Ali, y))$

d) $\exists y(W(Busra, y) \wedge F(TUBITAK, y))$

e) $\exists x \exists y1 \exists y2(S(x, y1) \wedge S(x, y2) \wedge (y1 \neq y2))$

f) $\forall x_1 \forall x_2 \forall y((W(x1, y) \wedge W(x2, y)) \implies (x1 = x2))$

g) $\exists y \exists x_1 \exists x_2 \forall x_3((W(x_1, y) \wedge W(x_2, y) \wedge x_1 \neq x_2) \wedge (W(x_3, y) \implies (x_1 = x_3 \vee x_2 = x_3)))$

Answer 3

1	$p \implies q$	
2	$(q \wedge \neg r) \implies s$	
3	$\neg s$	
4	$\quad p$	
5	$\quad q$	$\Rightarrow$E, 1, 4
6	$\quad\quad q \wedge \neg r$	
7	$\quad\quad s$	$\Rightarrow$E, 2, 6
8	$\quad\quad \bot$	$\neg$E, 3, 7
9	$\quad \neg(q \wedge \neg r)$	$\neg$I, 6–8
10	$\quad\quad \neg r$	
11	$\quad\quad q \wedge \neg r$	$\wedge$I, 5, 10
12	$\quad\quad \bot$	$\neg$E, 10
13	$\quad \neg\neg r$	$\neg$I, 12
14	$\quad r$	$\neg\neg$E, 13
15	$p \implies r$	$\Rightarrow$I, 4, 14

Answer 4

1	p	
2	$p \implies (q \wedge r)$	
3	$r \implies s$	
4	$q \wedge r$	$\Rightarrow$E, 1, 2
5	r	$\wedge$E, 4
6	q	$\wedge$E, 4
7	s	$\Rightarrow$E, 3, 5
8	$s \implies \neg q$	
9	$\neg q$	$\Rightarrow$E, 7, 8
10	q	R, 6
11	$\bot$	$\neg$E, 9, 10
12	$\neg(s \implies \neg q)$	$\neg$I, 8–11

Answer 5

1	$\forall x(P(x) \implies (Q(x) \implies R(x)))$		
2	$\exists x P(x)$		
3	$\forall x(\neg R(x))$		
4	c | $P(c)$		
5	$(P(c) \implies (Q(c) \implies R(c)))$		$\forall$E, 1
6	$(Q(c) \implies R(c))$		$\Rightarrow$E, 4, 5
7	$Q(c)$		
8	$R(c)$		$\Rightarrow$E, 6, 7
9	$\neg R(c)$		$\forall$E, 3
10	$\bot$		$\neg$E, 8, 9
11	$(\neg Q(c)$		$\neg$I, 7–10
12	$\exists x(\neg Q(x))$		$\exists$I, 11
13	$\exists x(\neg Q(x))$		$\exists$E, 2, 4–12