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Answer 1

Part (a)

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

Since it gives "False" for every possibile case the statement (p ∧ q) $\iff$ (¬ p ∨¬ q) is a contradiction.

Part (b)

1	p → ((q ∨ ¬q) → (p ∧ q))	Premise
2	¬p ∨ ((q ∨ ¬q) → (p ∧ q))	Table-7, Rule-1
3	¬p ∨ (¬(q ∨ ¬ q) ∨ (p ∧ q))	Table-7, Rule-1
4	¬p ∨ ((¬q ∧ q) ∨ (p ∧ q))	De Morgan's Laws (Table-6, Rule-8)
5	¬p ∨ (F ∨ (p ∧ q))	Negation Laws (Table-6, Rule-10)
6	¬p ∨ (p ∧ q)	Identity Laws (Table-6, Rule-1)
7	(¬p ∨ p) ∧ (¬p∨ q)	Distributive Laws (Table-6 Rule-7)
8	T ∧ (¬p∨ q)	Negation Laws (Table-6 Rule-10)
9	¬p∨ q	Identity Laws (Table-6 Rule-1)

So "p → ((q ∨ ¬q) → (p ∧ q))" and "¬p∨ q" are logically equivalent.

Answer 2

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

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

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

d) $\exists x \ (W(Büşra,x) \land F(TUBITAK,x))$

e) $\exists z \exists y \exists x \ (S(x,y) \land S(x,z) \land (y \neq z))$

f) $\forall x \forall y \forall z ((W(x,z) \land W(y,z)) \rightarrow (x=y))$

g) $\exists x \exists y \exists z \forall t ((W(x,z) \land W(y,z) \land (x \neq y)) \land (W(t,z) \rightarrow ((t=x) \lor (t=y))))$

Answer 3

1	$p \rightarrow q$	premise
2	$(q \land \neg r) \rightarrow s$	premise
3	$\neg s$	premise
4	$(q \land \neg r)$	assumed
5	s	$\rightarrow$e 2,4
6	$\bot$	$\neg$e 3,5
7	$\neg(q \land \neg r)$	$\neg$i 4-6
8	p	assumed
9	q	$\rightarrow$e 1,8
10	$\neg r$	assumed
11	$q \land \neg r$	$\land$i 9,10
12	$\bot$	$\neg$e 7,11
13	r	$\neg$i 10-12
14	$p \rightarrow r$	$\rightarrow$i 8-13

Answer 4

Ayşe: p
Barış: s$\rightarrow \neg$q
Can: p$\rightarrow$(q$\land$r)
Duygu: r$\rightarrow$s

1	p	premise
2	r→s	premise
3	p→(q∧r)	premise
4	(q∧r)	→e 1,3
5	q	∧e 4
6	r	∧e 4
7	s	→e 2
8	s→¬q	assumed
9	¬q	→e 8,7
10	⊥	¬e 5,9
11	¬(s→ ¬q)	¬i 8-10

Since I showed that ¬(s→ ¬q) is true, this means that Barış is lying.

Answer 5

1	$\forall x(\text{P(x)}\to(\text{Q(x)}\to\text{R(x)}))$	premise
2	$\exists x(P(x))$	premise
3	$\forall(\neg\text{R(x)})$	premise
4	$\text{P}(c)$	assumed
5	$\neg\text{R}(c)$	$\forall$e 3
6	$\text{P}(c)\to(\text{Q}(c)\to\text{R}(c))$	$\forall$e 1
7	$\text{Q}(c)\to\text{R}(c)$	→e 4,6
8	$\text{Q}(c)$	assumed
9	$\text{R}(c)$	→e 7,8
10	⊥	¬e 5,9
11	$\neg\text{Q}(c)$	¬i 8,10
12	$\exists\text{x}(\neg\text{Q(x)})$	$\exists x$ i 11
13	$\exists x(\neg Q(x))$	$\exists x$ e 2,4-12

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