6.825

Topics in Artificial Intelligence

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Project 1b

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Problem 1:

We formalize the argument as follows:

$$\forall x \ Man(x) \implies Mortal(x) \tag{1}$$
$$\forall x \ Mortal(x) \implies Boring(x) \tag{2}$$
$$\neg Boring(Hera) \tag{3}$$

And the conclusion

$$\exists x \ \neg Man(x) \tag{4}$$

Proof sketch: We'll prove this by negating the desired conclusion and arriving at a contradiction by resolution. We'll begin by resolving (1) and (2) to show that all men are boring (S5), then resolve this with (3) to show that Hera is not a man (S6). When we resolve this with the negation of our conclusion (4), we reach a contradiction (S7). □

Proof.

A1	¬Man(x34) ∨ Mortal(x34)	
A2	¬Mortal(x36) ∨ Boring(x36)	
A3	¬Boring(CHera)	
A4	Man(x38)	
S5	¬Man(x43) ∨ Boring(x43)	Res(1,2) {x34/x36}
S6	¬Man(CHera)	Res(5,3) {x43/CHera}
S7	F	Res(6,4) {x38/CHera}

□

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Problem 2:

Proof sketch: We'll prove that the surgeon is the child's mother by resolution refutation. We first show that since the surgeon (CA in the proof) can't operate on CS, she must either not be a surgeon or CS's parent (S11). But we know CA is a surgeon (A8), so CA must be a parent of CS (S12). Applying the definition of a parent (A4), we find that CA must be either CS's father or mother (S13). Since she is not the father (A9), she must be the mother (S14). □

Proof.

A1	¬Surgeon(x46) ∨ Parent(x46, y47) ∨ Operate(x46, y47)
A2	¬Operate(x49, y48) ∨ Surgeon(x49)
A3	¬Operate(x51, y50) ∨ ¬Parent(x51, y50)
A4	¬Parent(x55, y54) ∨ Father(x55, y54) ∨ Mother(x55, y54)
A5	¬Father(x57, y56) ∨ Parent(x57, y56)
A6	¬Mother(x59, y58) ∨ Parent(x59, y58)
A7	¬Operate(CA, CS)
A8	Surgeon(CA)

A9	¬Father(CA, CS)	
A10	¬Mother(CA, CS)	
S11	¬Surgeon(CA) ∨ Parent(CA, CS)	Res(1,7) {y47/CS, x46/CA}
S12	Parent(CA, CS)	Res(11,8) {}
S13	Father(CA, CS) ∨ Mother(CA, CS)	Res(12,4) {x55/CA, y54/CS}
S14	Mother(CA, CS)	Res(13,9) {}
S15	F	Res(14,10) {}

□

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Problem 3:

Proof sketch: First, the solution: to put A on B, we'll first move C to the table to clear B, then move A to B.

First, we move C to the table. Steps S31 and S32 show that we can make this move because both C and the table are clear, and S33 shows that the result is that B is now clear. Now we need to establish that we can move A onto B. We need B to be clear, which we just showed. This tells us that if some block is clear, we can move it onto B (S34). In (S35), we resolve with our desired condition (A30); the resulting unification establishes that A is the block we want to move onto B. In order to move A, we'll need to show that A is clear and on some other block. (S36-S38) show that A is clear because it was clear before we moved B and wasn't affected by the move; (S39) and (S40) shows that A is still on the table after the move. This means that we can move A onto B, which gives us the desired result (S41). □

great!

Proof.

A1	¬Equals(CA, CB)	
A2	¬Equals(CA, CC)	
A3	¬Equals(CB, CA)	
A4	¬Equals(CB, CC)	
A5	¬Equals(CC, CA)	
A6	¬Equals(CC, CB)	
A7	¬Equals(CA, CTable)	
A8	¬Equals(CB, CTable)	
A9	¬Equals(CC, CTable)	
A10	Block(CA)	
A11	Block(CB)	
A12	Block(CC)	
A13	¬Block(CTable)	
A14	¬On(x7, y6, s5) ∨ ¬On(x7, z8, s5) ∨ Equals(y6, z8)	
A15	¬On(x15, z14, s13) ∨ ¬On(y16, z14, s13) ∨ Equals(x15, y16) ∨ Equals(z14, CTable)	
A16	¬Clear(x22, s21) ∨ ¬Block(y23) ∨ ¬On(y23, x22, s21) ∨ Equals(x22, CTable)	
A17	Block(F_1(y26, x25, s24)) ∨ Clear(x25, s24)	
A18	On(F_1(y19, x28, s27), x28, s27) ∨ Clear(x28, s27)	
A19	¬Equals(x29, CTable) ∨ Clear(x29, s30)	
A20	¬Clear(x36, s35) ∨ ¬Clear(y37, s35) ∨ ¬On(x36, z38, s35) ∨ On(x36, y37, result(move(x36, y37), s35))	
A21	¬Clear(x40, s39) ∨ ¬Clear(y41, s39) ∨ ¬On(x40, z42, s39) ∨ Clear(z42, result(move(x40, y41), s39))	
A22	¬On(x50, y49, s48) ∨ Equals(x50, z51) ∨ On(x50, y49, result(move(z51, w47), s48))	
A23	¬Clear(x57, s56) ∨ Equals(x57, z58) ∨ Clear(x57, result(move(y59, z58), s56))	
A24	On(CA, CTable, CS0)	
A25	On(CC, CB, CS0)	
A26	On(CB, CTable, CS0)	
A27	Clear(CC, CS0)	
A28	Clear(CA, CS0)	
A29	Clear(CTable, s61)	
A30	¬On(CA, CB, s63) ∨ Answer(s63)	
S31	¬Clear(y67, CS0) ∨ ¬On(CC, z68, CS0) ∨ Clear(z68, result(move(CC, y67), CS0))	Res(21,27) {s39/CS0, x40/CC}
S32	¬On(CC, z69, CS0) ∨ Clear(z69, result(move(CC, CTable), CS0))	Res(31,29) {s61/CS0, y67/CTable}

S33	Clear(CB, result(move(CC, CTable), CS0))	Res(32,25) {z69/CB}
S34	¬Clear(x70, result(move(CC, CTable), CS0)) ∨ ¬On(x70, z71, result(move(CC, CTable), CS0)) ∨ On(x70, CB, result(move(x70, CB), result(move(CC, CTable), CS0)))	Res(33,20) {y37/CB, s35/result(move(CC, CTable), CS0)}
S35	¬Clear(CA, result(move(CC, CTable), CS0)) ∨ ¬On(CA, z72, result(move(CC, CTable), CS0)) ∨ Answer(result(move(CA, CB), result(move(CC, CTable), CS0)))	Res(34,30) {s63/result(move(x70, CB), result(move(CC, CTable), CS0)), x70/CA}
S36	¬Clear(CA, s73) ∨ Clear(CA, result(move(y74, CTable), s73))	Res(7,23) {z58/CTable, x57/CA}
S37	¬On(CA, z75, result(move(CC, CTable), CS0)) ∨ Answer(result(move(CA, CB), result(move(CC, CTable), CS0))) ∨ ¬Clear(CA, CS0)	Res(35,36) {y74/CC, s73/CS0}
S38	¬On(CA, z76, result(move(CC, CTable), CS0)) ∨ Answer(result(move(CA, CB), result(move(CC, CTable), CS0)))	Res(37,28) {}
S39	¬On(CA, y78, s77) ∨ On(CA, y78, result(move(CC, w79), s77))	Res(2,22) {x50/CA, z51/CC}
S40	On(CA, CTable, result(move(CC, w80), CS0))	Res(39,24) {s77/CS0, y78/CTable}
S41	Answer(result(move(CA, CB), result(move(CC, CTable), CS0)))	Res(38,40) {w80/CTable, z76/CTable}

□

Problem 4:

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Proof sketch: We'll prove that if `A1` and `A2` are on `W2` and `W3` respectively in `S1`, then `A1` is allowed to move to `W4`. In order to do so, we'll begin by showing that no athlete is currently on `W4`. (S61) and (S63) show that `A1` isn't on `W4` since it can only be on one station, and (S62) and (S64) do the same for `A2`.

Now we'll reach a contradiction from the negated conclusion (A60): since we assume `A1` isn't allowed to move to `W4`, we'll show this must mean that `A1` or `A2` is on `W4` in `S1`, which we just showed wasn't the case. Resolving (A60) with the definition of `Allowed`, we obtain (S66) that there is some blocking athlete preventing `A1` from moving to `A4`, because it is already on `W4` (S65). But according to (A26), `A1` and `A2` are the only athletes, so the blocking athlete is one of them (S67); therefore, `A1` or `A2` must be on `W4` (S68-S69). But this contradicts our earlier results of (S63-S64), proving the theorem. □

Proof.

A1	Workoutstation(CW1)
A2	Workoutstation(CW2)
A3	Workoutstation(CW3)
A4	Workoutstation(CW4)
A5	¬Workoutstation(w82) ∨ Equals(w82, CW1) ∨ Equals(w82, CW2) ∨ Equals(w82, CW3) ∨ Equals(w82, CW4)
A6	¬Equals(CW1, CW2)
A7	¬Equals(CW1, CW3)
A8	¬Equals(CW1, CW4)
A9	¬Equals(CW2, CW1)
A10	¬Equals(CW2, CW3)
A11	¬Equals(CW2, CW4)
A12	¬Equals(CW3, CW1)
A13	¬Equals(CW3, CW2)
A14	¬Equals(CW3, CW4)
A15	¬Equals(CW4, CW1)
A16	¬Equals(CW4, CW2)
A17	¬Equals(CW4, CW3)
A18	Situation(CS1)
A19	Situation(CS2)
A20	¬Equals(CS1, CS2)
A21	¬Equals(CS2, CS1)
A22	Athlete(CA1)
A23	Athlete(CA2)
A24	¬Equals(CA1, CA2)
A25	¬Equals(CA2, CA1)
A26	¬Athlete(a84) ∨ Equals(a84, CA1) ∨ Equals(a84, CA2)
A27	Connects(CW1, CW2)
A28	Connects(CW3, CW2)
A29	Connects(CW1, CW3)

A30	Connects(CW3, CW4)	
A31	Connects(CW2, CW3)	
A32	Connects(CW2, CW4)	
A33	Connects(CW1, CW1)	
A34	Connects(CW2, CW2)	
A35	Connects(CW3, CW3)	
A36	Connects(CW4, CW4)	
A37	¬Connects(CW2, CW1)	
A38	¬Connects(CW4, CW2)	
A39	¬Connects(CW3, CW1)	
A40	¬Connects(CW1, CW4)	
A41	¬Connects(CW4, CW3)	
A42	¬Connects(CW4, CW1)	
A43	¬On(a91, w190, s89) ∨ ¬On(a91, w292, s89) ∨ Equals(w190, w292)	
A44	Workoutstation(F_2(a97, s96))	
A45	On(a99, F_2(a99, s98), s98)	
A46	¬Unconflicted(s107) ∨ ¬On(a1109, w108, s107) ∨ ¬On(a2110, w108, s107) ∨ Equals(a1109, a2110)	
A47	On(F_4(a2103, a1102, w101, s111), F_3(a2103, a1102, w101, s111), s111) ∨ Unconflicted(s111)	
A48	On(F_5(a2103, a1102, w101, s112), F_3(a2103, a1102, w101, s112), s112) ∨ Unconflicted(s112)	
A49	¬Equals(F_4(a2116, a1115, w114, s113), F_5(a2116, a1115, w114, s113)) ∨ Unconflicted(s113)	
A50	¬On(a121, w2120, CS2) ∨ On(a121, F_6(w2120, a121), CS1)	
A51	¬On(a123, w2122, CS2) ∨ Connects(F_6(w2122, a123), w2122)	
A52	¬On(a125, w2124, CS2) ∨ Allowed(a125, F_6(w2124, a125), w2124)	
A53	¬Allowed(a1133, w1132, w2131) ∨ Equals(w1132, w2131) ∨ ¬Athlete(a2134) ∨ ¬On(a2134, w2131, CS1)	
A54	¬Equals(w1136, w2135) ∨ Allowed(a1137, w1136, w2135)	
A55	Athlete(F_7(a2141, w2140, w1139, a1138)) ∨ Allowed(a1138, w1139, w2140)	
A56	On(F_7(a2129, w2142, w1143, a1144), w2142, CS1) ∨ Allowed(a1144, w1143, w2142)	
A57	Unconflicted(CS1)	
A58	On(CA1, CW2, CS1)	
A59	On(CA2, CW3, CS1)	
A60	¬Allowed(CA1, CW2, CW4)	
S61	¬On(CA1, w1145, CS1) ∨ Equals(w1145, CW2)	Res(43,58) {s89/CS1, w292/CW2, a91/CA1}
S62	¬On(CA2, w1146, CS1) ∨ Equals(w1146, CW3)	Res(43,59) {s89/CS1, w292/CW3, a91/CA2}
S63	¬On(CA1, CW4, CS1)	Res(61,16) {w1145/CW4}
S64	¬On(CA2, CW4, CS1)	Res(62,17) {w1146/CW4}
S65	On(F_7(a2147, CW4, CW2, CA1), CW4, CS1)	Res(56,60) {w2142/CW4, a1144/CA1, w1143/CW2}
S66	Athlete(F_7(a2148, CW4, CW2, CA1))	Res(55,60) {w2140/CW4, w1139/CW2, a1138/CA1}
S67	Equals(F_7(a2149, CW4, CW2, CA1), CA1) ∨ Equals(F_7(a2149, CW4, CW2, CA1), CA2)	Res(66,26) {a84/F_7(a2148, CW4, CW2, CA1)}
S68	Equals(F_7(a2151, CW4, CW2, CA1), CA2) ∨ On(CA1, CW4, CS1)	Para(65,67) {a2149/a2147}
S69	On(CA1, CW4, CS1) ∨ On(CA2, CW4, CS1)	Para(65,68) {a2151/a2147}
S70	On(CA2, CW4, CS1)	Res(63,69) {}
S71	F	Res(64,70) {}

□

Problem 5:

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Proof sketch: We show that there exists a conflict because both `A1` and `A2` can be on `W4` in `S2`. We first establish that `A1` and `A2` are both on stations that connect to `W4`, so they can both move to `W4` if they are `Allowed` to(S62-S65). Then we must show that both are `Allowed` to move to `W4`. We show this in much the same way as Problem 4. First, neither `A1` nor `A2` is on `W4` (S66-S71) and (S72-S77) respectively — details omitted. Then, we show that `A1` is allowed to move to `W4` because neither of the two athletes is blocking it (S78-S87), and similarly for `A2` (S88-S97). Hence, since two different athletes can be on the same station in `S2`, there is a conflict (S98-S101). □

Proof.

A1	Workoutstation(CW1)	
A2	Workoutstation(CW2)	
A3	Workoutstation(CW3)	
A4	Workoutstation(CW4)	
A5	¬Workoutstation(w245) ∨ Equals(w245, CW1) ∨ Equals(w245, CW2) ∨ Equals(w245, CW3) ∨ Equals(w245, CW4)	
A6	¬Equals(CW1, CW2)	
A7	¬Equals(CW1, CW3)	
A8	¬Equals(CW1, CW4)	
A9	¬Equals(CW2, CW1)	
A10	¬Equals(CW2, CW3)	
A11	¬Equals(CW2, CW4)	
A12	¬Equals(CW3, CW1)	
A13	¬Equals(CW3, CW2)	
A14	¬Equals(CW3, CW4)	
A15	¬Equals(CW4, CW1)	
A16	¬Equals(CW4, CW2)	
A17	¬Equals(CW4, CW3)	
A18	Situation(CS1)	
A19	Situation(CS2)	
A20	¬Equals(CS1, CS2)	
A21	¬Equals(CS2, CS1)	
A22	Athlete(CA1)	
A23	Athlete(CA2)	
A24	¬Equals(CA1, CA2)	
A25	¬Equals(CA2, CA1)	
A26	¬Athlete(a247) ∨ Equals(a247, CA1) ∨ Equals(a247, CA2)	
A27	Connects(CW1, CW2)	
A28	Connects(CW3, CW2)	
A29	Connects(CW1, CW3)	
A30	Connects(CW3, CW4)	
A31	Connects(CW2, CW3)	
A32	Connects(CW2, CW4)	
A33	Connects(CW1, CW1)	
A34	Connects(CW2, CW2)	
A35	Connects(CW3, CW3)	
A36	Connects(CW4, CW4)	
A37	¬Connects(CW2, CW1)	
A38	¬Connects(CW4, CW2)	
A39	¬Connects(CW3, CW1)	
A40	¬Connects(CW1, CW4)	
A41	¬Connects(CW4, CW3)	
A42	¬Connects(CW4, CW1)	
A43	¬On(a254, w1253, s252) ∨ ¬On(a254, w2255, s252) ∨ Equals(w1253, w2255)	
A44	Workoutstation(F_20(a260, s259))	
A45	On(a262, F_20(a262, s261), s261)	
A46	¬Unconflicted(s270) ∨ ¬On(a1272, w271, s270) ∨ ¬On(a2273, w271, s270) ∨ Equals(a1272, a2273)	
A47	On(F_22(a2266, a1265, w264, s274), F_21(a2266, a1265, w264, s274), s274) ∨ Unconflicted(s274)	
A48	On(F_23(a2266, a1265, w264, s275), F_21(a2266, a1265, w264, s275), s275) ∨ Unconflicted(s275)	
A49	¬Equals(F_22(a2279, a1278, w277, s276), F_23(a2279, a1278, w277, s276)) ∨ Unconflicted(s276)	
A50	¬On(a285, w2284, CS2) ∨ On(a285, F_24(w2284, a285), CS1)	
A51	¬On(a287, w2286, CS2) ∨ Connects(F_24(w2286, a287), w2286)	
A52	¬On(a289, w2288, CS2) ∨ Allowed(a289, F_24(w2288, a289), w2288)	
A53	¬On(a291, w1290, CS1) ∨ ¬Connects(w1290, w2292) ∨ ¬Allowed(a291, w1290, w2292) ∨ On(a291, w2292, CS2)	
A54	¬Allowed(a1300, w1299, w2298) ∨ Equals(w1299, w2298) ∨ ¬Athlete(a2301) ∨ ¬On(a2301, w2298, CS1)	
A55	¬Equals(w1303, w2302) ∨ Allowed(a1304, w1303, w2302)	
A56	Athlete(F_25(a2308, w2307, w1306, a1305)) ∨ Allowed(a1305, w1306, w2307)	
A57	On(F_25(a2296, w2309, w1310, a1311), w2309, CS1) ∨ Allowed(a1311, w1310, w2309)	
A58	Unconflicted(CS1)	
A59	On(CA1, CW2, CS1)	
A60	On(CA2, CW3, CS1)	
A61	Unconflicted(CS2)	
S62	¬Connects(CW2, w2312) ∨ ¬Allowed(CA1, CW2, w2312) ∨ On(CA1, w2312, CS2)	Res(53,59) {w1290/CW2, a291/CA1}

S63	¬Allowed(CA1, CW2, CW4) ∨ On(CA1, CW4, CS2)	Res(62,32) {w2312/CW4}
S64	¬Connects(CW3, w2313) ∨ ¬Allowed(CA2, CW3, w2313) ∨ On(CA2, w2313, CS2)	Res(53,60) {w1290/CW3, a291/CA2}
S65	¬Allowed(CA2, CW3, CW4) ∨ On(CA2, CW4, CS2)	Res(64,30) {w2313/CW4}
S66	¬Allowed(a1353, CW2, CW4) ∨ ¬Athlete(a2354) ∨ ¬On(a2354, CW4, CS1)	Res(11,54) {w2298/CW4, w1299/CW2}
S67	¬Allowed(a1355, CW2, CW4) ∨ ¬On(CA1, CW4, CS1)	Res(66,22) {a2354/CA1}
S68	¬On(CA1, w2357, CS1) ∨ Equals(CW2, w2357)	Res(43,59) {s252/CS1, a254/CA1, w1253/CW2}
S69	¬On(CA1, CW4, CS1) ∨ ¬Allowed(a1359, CW2, CW2) ∨ ¬On(CA1, CW2, CS1)	Para(67,68) {w2357/CW4}
S70	¬On(CA1, CW4, CS1) ∨ ¬Allowed(a1360, CW2, CW2)	Res(69,59) {}
S71	¬On(CA1, CW4, CS1)	Res(70,55) {a1360/a1304, w1303/CW2, w2302/CW2}
S72	¬Allowed(a1364, CW3, CW4) ∨ ¬Athlete(a2365) ∨ ¬On(a2365, CW4, CS1)	Res(14,54) {w2298/CW4, w1299/CW3}
S73	¬Allowed(a1366, CW3, CW4) ∨ ¬On(CA2, CW4, CS1)	Res(72,23) {a2365/CA2}
S74	¬On(CA2, w2367, CS1) ∨ Equals(CW3, w2367)	Res(43,60) {s252/CS1, a254/CA2, w1253/CW3}
S75	¬On(CA2, CW4, CS1) ∨ ¬Allowed(a1368, CW3, CW3) ∨ ¬On(CA2, CW3, CS1)	Para(73,74) {w2367/CW4}
S76	¬On(CA2, CW4, CS1) ∨ ¬Allowed(a1369, CW3, CW3)	Res(75,60) {}
S77	¬On(CA2, CW4, CS1)	Res(76,55) {w1303/CW3, a1369/a1304, w2302/CW3}
S78	On(CA1, CW4, CS2) ∨ Athlete(F_25(a2372, CW4, CW2, CA1))	Res(63,56) {w2307/CW4, a1305/CA1, w1306/CW2}
S79	On(CA1, CW4, CS2) ∨ Equals(F_25(a2373, CW4, CW2, CA1), CA1) ∨ Equals(F_25(a2373, CW4, CW2, CA1), CA2)	Res(78,26) {a247/F_25(a2372, CW4, CW2, CA1)}
S80	On(CA1, CW4, CS2) ∨ On(F_25(a2374, CW4, CW2, CA1), CW4, CS1)	Res(63,57) {w1310/CW2, w2309/CW4, a1311/CA1}
S81	On(CA1, CW4, CS2) ∨ Equals(F_25(a2379, CW4, CW2, CA1), CA2) ∨ On(CA1, CW4, CS2) ∨ On(CA1, CW4, CS1)	Para(79,80) {a2373/a2374}
S82	On(CA1, CW4, CS2) ∨ Equals(F_25(a2380, CW4, CW2, CA1), CA2) ∨ On(CA1, CW4, CS2)	Res(71,81) {}
S83	Equals(F_25(a21, CW4, CW2, CA1), CA2) ∨ On(CA1, CW4, CS2)	Fact(82) {}
S84	On(CA1, CW4, CS2) ∨ On(CA2, CW4, CS1) ∨ Allowed(CA1, CW2, CW4)	Para(83,57) {w1310/CW2, a21/a2296, a1311/CA1, w2309/CW4}
S85	On(CA1, CW4, CS2) ∨ Allowed(CA1, CW2, CW4)	Res(77,84) {}
S86	On(CA1, CW4, CS2) ∨ On(CA1, CW4, CS2)	Res(63,85) {}
S87	On(CA1, CW4, CS2)	Fact(86) {}
S88	On(CA2, CW4, CS2) ∨ Athlete(F_25(a22, CW4, CW3, CA2))	Res(65,56) {a1305/CA2, w2307/CW4, w1306/CW3}
S89	On(CA2, CW4, CS2) ∨ Equals(F_25(a23, CW4, CW3, CA2), CA1) ∨ Equals(F_25(a23, CW4, CW3, CA2), CA2)	Res(88,26) {a247/F_25(a22, CW4, CW3, CA2)}
S90	On(CA2, CW4, CS2) ∨ On(F_25(a24, CW4, CW3, CA2), CW4, CS1)	Res(65,57) {w1310/CW3, a1311/CA2, w2309/CW4}
S91	On(CA2, CW4, CS2) ∨ Equals(F_25(a25, CW4, CW3, CA2), CA2) ∨ On(CA2, CW4, CS2) ∨ On(CA1, CW4, CS1)	Para(89,90) {a23/a24}
S92	Equals(F_25(a26, CW4, CW3, CA2), CA2) ∨ On(CA2, CW4, CS2) ∨ On(CA1, CW4, CS1)	Fact(91) {}
S93	Equals(F_25(a27, CW4, CW3, CA2), CA2) ∨ On(CA2, CW4, CS2)	Res(71,92) {}
S94	On(CA2, CW4, CS2) ∨ On(CA2, CW4, CS1) ∨ Allowed(CA2, CW3, CW4)	Para(93,57) {a27/a2296, w1310/CW3, a1311/CA2, w2309/CW4}
S95	On(CA2, CW4, CS2) ∨ Allowed(CA2, CW3, CW4)	Res(77,94) {}
S96	On(CA2, CW4, CS2) ∨ On(CA2, CW4, CS2)	Res(65,95) {}
S97	On(CA2, CW4, CS2)	Fact(96) {}
S98	¬Unconflicted(CS2) ∨ ¬On(a28, CW4, CS2) ∨ Equals(CA1, a28)	Res(87,46) {w271/CW4, s270/CS2, a1272/CA1}
S99	¬Unconflicted(CS2) ∨ Equals(CA1, CA2)	Res(97,98) {a28/CA2}
S100	¬Unconflicted(CS2)	Res(99,24) {}
S101	F	Res(100,61) {}

□

80/80