Resolution Exercise Solutions

2. Consider the following axioms:

1. Every child loves Santa.
   $\forall x(CHILD(x) \rightarrow LOVES(x, Santa))$
2. Everyone who loves Santa loves any reindeer.
   $\forall x(LOVES(x, Santa) \rightarrow \forall y(REINDEER(y) \rightarrow LOVES(x, y)))$
3. Rudolph is a reindeer, and Rudolph has a red nose.
   $REINDEER(Rudolph) \wedge REDNOSE(Rudolph)$
4. Anything which has a red nose is weird or is a clown.
   $\forall x(REDNOSE(x) \rightarrow WEIRD(x) \vee CLOWN(x))$
5. No reindeer is a clown.
   $\neg\exists x(REINDEER(x) \wedge CLOWN(x))$
6. Scrooge does not love anything which is weird.
   $\forall x(WEIRD(x) \rightarrow \neg LOVES(Scrooge, x))$
7. (Conclusion) Scrooge is not a child.
   $\neg CHILD(Scrooge)$

3. Consider the following axioms:

1. Anyone who buys carrots by the bushel owns either a rabbit or a grocery store.
   $\forall x(BUY(x) \rightarrow \exists y(OWNS(x, y) \wedge (RABBIT(y) \vee GROCERY(y))))$
2. Every dog chases some rabbit.
   $\forall x(DOG(x) \rightarrow \exists y(RABBIT(y) \wedge CHASE(x, y)))$
3. Mary buys carrots by the bushel.
   $BUY(Mary)$
4. Anyone who owns a rabbit hates anything that chases any rabbit.
   $\forall x \forall y(OWNS(x, y) \wedge RABBIT(y) \rightarrow \forall z \forall w(RABBIT(w) \wedge CHASE(z, w) \rightarrow HATES(x, z)))$
5. John owns a dog.
   $\exists x(DOG(x) \wedge OWNS(John, x))$
6. Someone who hates something owned by another person will not date that person.
   $\forall x \forall y \forall z(OWNS(y, z) \wedge HATES(x, z) \rightarrow \neg DATE(x, y))$
7. (Conclusion) If Mary does not own a grocery store, she will not date John.
   $((\neg\exists x(GROCERY(x) \wedge OWN(Mary, x))) \rightarrow \neg DATE(Mary, John))$

4. Consider the following axioms:

1. Every Austinite who is not conservative loves some armadillo.
   $\forall x(AUSTINITE(x) \wedge \neg CONSERVATIVE(x) \rightarrow \exists y(ARMADILLO(y) \wedge LOVES(x,y)))$
2. Anyone who wears maroon-and-white shirts is an Aggie.
   $\forall x(WEARS(x) \rightarrow AGGIE(x))$
3. Every Aggie loves every dog.
   $\forall x(AGGIE(x) \rightarrow \forall y(DOG(y) \rightarrow LOVES(x,y)))$
4. Nobody who loves every dog loves any armadillo.
   $\neg\exists x((\forall y(DOG(y) \rightarrow LOVES(x,y))) \wedge \exists z(ARMADILLO(z) \wedge LOVES(x,z)))$
5. Clem is an Austinite, and Clem wears maroon-and-white shirts.
   $AUSTINITE(Clem) \wedge WEARS(Clem)$
6. (Conclusion) Is there a conservative Austinite?
   $\exists x(AUSTINITE(x) \wedge CONSERVATIVE(x))$

5. Consider the following axioms:

1. Anyone whom Mary loves is a football star.
   $\forall x(LOVES(Mary,x) \rightarrow STAR(x))$
2. Any student who does not pass does not play.
   $\forall x(STUDENT(x) \wedge \neg PASS(x) \rightarrow \neg PLAY(x))$
3. John is a student.
   $STUDENT(John)$
4. Any student who does not study does not pass.
   $\forall x(STUDENT(x) \wedge \neg STUDY(x) \rightarrow \neg PASS(x))$
5. Any person who does not play is not a football star.
   $\forall x(\neg PLAY(x) \rightarrow \neg STAR(x))$
6. (Conclusion) If John does not study, then Mary does not love John.
   $\neg STUDY(John) \rightarrow \neg LOVES(Mary, John)$

6. Consider the following axioms:

1. Every coyote chases some roadrunner.
   $\forall x(COYOTE(x) \rightarrow \exists y(RR(y) \wedge CHASE(x,y)))$
2. Every roadrunner who says "beep-beep" is smart.
   $\forall x(RR(x) \wedge BEEP(x) \rightarrow SMART(x))$

3. No coyote catches any smart roadrunner.
$\neg \exists x \exists y (COYOTE(x) \wedge RR(y) \wedge SMART(y) \wedge CATCH(x, y))$

4. Any coyote who chases some roadrunner but does not catch it is frustrated.
$\forall x (COYOTE(x) \wedge \exists y (RR(y) \wedge CHASE(x, y) \wedge \neg CATCH(x, y)) \rightarrow FRUSTRATED(x))$

5. (Conclusion) If all roadrunners say "beep-beep", then all coyotes are frustrated.
$(\forall x (RR(x) \rightarrow BEEP(x)) \rightarrow (\forall y (COYOTE(y) \rightarrow FRUSTRATED(y)))$

7. Consider the following axioms:

1. Anyone who rides any Harley is a rough character.
$\forall x ((\exists y (HARLEY(y) \wedge RIDES(x, y))) \rightarrow ROUGH(x))$

2. Every biker rides [something that is] either a Harley or a BMW.
$\forall x (BIKER(x) \rightarrow \exists y ((HARLEY(y) \vee BMW(y)) \wedge RIDES(x, y)))$

3. Anyone who rides any BMW is a yuppie.
$\forall x \forall y (RIDES(x, y) \wedge BMW(y) \rightarrow YUPPIE(x))$

4. Every yuppie is a lawyer.
$\forall x (YUPPIE(x) \rightarrow LAWYER(x))$

5. Any nice girl does not date anyone who is a rough character.
$\forall x \forall y (NICE(x) \wedge ROUGH(y) \rightarrow \neg DATE(x, y))$

6. Mary is a nice girl, and John is a biker.
$NICE(Mary) \wedge BIKER(John)$

7. (Conclusion) If John is not a lawyer, then Mary does not date John.
$\neg LAWYER(John) \rightarrow \neg DATE(Mary, John)$

8. Consider the following axioms:

1. Every child loves anyone who gives the child any present.
$\forall x \forall y \forall z (CHILD(x) \wedge PRESENT(y) \wedge GIVE(z, y, x) \rightarrow LOVES(x, z)$

2. Every child will be given some present by Santa if Santa can travel on Christmas eve.
$TRAVEL(Santa, Christmas) \rightarrow \forall x (CHILD(x) \rightarrow \exists y (PRESENT(y) \wedge GIVE(Santa, y, x)))$

3. It is foggy on Christmas eve.
$FOGGY(Christmas)$

4. Anytime it is foggy, anyone can travel if he has some source of light.
$\forall x \forall t (FOGGY(t) \rightarrow (\exists y (LIGHT(y) \wedge HAS(x, y)) \rightarrow TRAVEL(x, t)))$

5. Any reindeer with a red nose is a source of light.
$\forall x (RNR(x) \rightarrow LIGHT(x))$

6. (Conclusion) If Santa has some reindeer with a red nose, then every child loves Santa.
   $(\exists x(RNR(x) \wedge HAS(Santa, x))) \rightarrow \forall y(CHILD(y) \rightarrow LOVES(y, Santa))$

9. Consider the following axioms:

1. Every investor bought [something that is] stocks or bonds.
   $\forall x(INVESTOR(x) \rightarrow \exists y((STOCK(y) \vee BOND(y)) \wedge BUY(x, y)))$
2. If the Dow-Jones Average crashes, then all stocks that are not gold stocks fall.
   $DJCRASH \rightarrow \forall x((STOCK(x) \wedge \neg GOLD(x)) \rightarrow FALL(x))$
3. If the T-Bill interest rate rises, then all bonds fall.
   $TBRISE \rightarrow \forall x(BOND(x) \rightarrow FALL(x))$
4. Every investor who bought something that falls is not happy.
   $\forall x \forall y(INVESTOR(x) \wedge BUY(x, y) \wedge FALL(y) \rightarrow \neg HAPPY(x))$
5. (Conclusion) If the Dow-Jones Average crashes and the T-Bill interest rate rises, then any investor who is happy bought some gold stock.
   $(DJCRASH \wedge TBRISE) \rightarrow \forall x(INVESTOR(x) \wedge HAPPY(x) \rightarrow \exists y(GOLD(y) \wedge BUY(x, y)))$

10. Consider the following axioms:

1. Every child loves every candy.
   $\forall x \forall y(CHILD(x) \wedge CANDY(y) \rightarrow LOVES(x, y))$
2. Anyone who loves some candy is not a nutrition fanatic.
   $\forall x((\exists y(CANDY(y) \wedge LOVES(x, y))) \rightarrow \neg FANATIC(x))$
3. Anyone who eats any pumpkin is a nutrition fanatic.
   $\forall x((\exists y(PUMPKIN(y) \wedge EAT(x, y))) \rightarrow FANATIC(x))$
4. Anyone who buys any pumpkin either carves it or eats it.
   $\forall x \forall y(PUMPKIN(y) \wedge BUY(x, y) \rightarrow CARVE(x, y) \vee EAT(x, y))$
5. John buys a pumpkin.
   $\exists x(PUMPKIN(x) \wedge BUY(John, x))$
6. Lifesavers is a candy.
   $CANDY(Lifesavers)$
7. (Conclusion) If John is a child, then John carves some pumpkin.
   $CHILD(John) \rightarrow \exists x(PUMPKIN(x) \wedge CARVE(John, x))$