***Exercises 7A***

**I.**

**1.** Let *R* = *it will rain tomorrow*, and *S* = *it will be sunny*: *R* v *S*

**2.** Let *F* = *the food in that restaurant stinks*, and *P* = *the portions are too small*: *F* **·** *P*

**3.** Let *I* = *Your ice is cold*: ~ *I*

Although you could translate the statement simply as I (where *I* = *Your ice is not cold*), nevertheless,

~ *I* captures the English more accurately.

**4.** Let *S = my stock portfolio is weak*, and *L = I am losing money*: *S* ⊃ *L*

**5.** Let *C* = *My car does look great*, and *M* = *it gets great gas mileage*: ~ *C* **·** *M*

Although you could translate the first statement simply as *C* (where *C* = *My car does not look great*),

nevertheless, ~ *C* captures the English more accurately.

**6.** Let *F = you feel great*, and *L = you look great*: *F* ⊃ *L*

**7.** Let *T* = *My test score was high*, and *M* = *I am mistaken*: *T* v *M*

**8.** Let *P = you passed the exam*, and *G = you got at least a C*: *P* ⊃ *G*

**9.** Let *C* = *candy is bad for your teeth*, and *Q* = *tobacco is bad for your teeth*: *C* v *Q*

**10.** Let *B = Bill is cold*, and *M = Mary is late*: *B* **·** *M*

**11.** Let *M = Today is Monday*, and *T = today is Tuesday*: *M* v *T*

**12.** Let *S = He is a U.S. senator*: ~ *S*

**13.** Let *T* = *Toothpaste is good for your teeth*, and *B* = *tobacco is good for your teeth*: *T* **·** ~ *B*

**14.** Let *F* = *Driving too fast is hazardous to your health*, and *B* = *driving without buckling up* (*is*

*hazardous to your health*): *F* **·** *B*

**15.** Let *P = Pizza contains all the basic food groups*, and *A = you get it with anchovies*: *P ≡ A*

**16.** Let *L* = *Lava lamps are distracting*, and *M* = *music in the background is soothing*: *L* **·** *M*

**17.** Let *R = My room could use a good cleaning*, and *L = I am too lazy to do anything about it*: *R* **·** *L*

**18.** Let *P* = *You must get a passing grade on the next exam*, and *F* = *you will fail*: *P* v *F*

This is best captured by a *disjunction*, because it is asserting that *either* you get a passing grade *or* you

will fail.

**19.** Let *C = Carly agrees to do a job*, and *R =she will make sure it is done right*: *C* ⊃ *R*

**20.** Let *T* = *It is true that* Titanic *is the highest grossing film of all time*: ~ *T*

Although you could translate the statement simply as *T* (where *T* = *It is not true that* Titanic *is the*

*highest grossing film of all time*), nevertheless, ~ *T* captures the English more accurately.

**21.** Let *T = I will leave a big tip*, and *E = the dinner is excellent*: *T* ⊃ *E*

**22.** Let *L* = *Your paper was turned in late*, and *E* = *I am willing to grant you an extension*: *L*  **·** *E*

**23**. Let *S* = *you stop eating too much pepperoni*, and *U* = *you will develop a stomach ulcer*: *S* v *U*

The “unless” points to the assertion that “*either* you stop eating too much pepperoni, *or* you will

develop a stomach ulcer.”

**24.** Let *P =your paper was turned in late*, and *D = I will deduct a letter grade*: *D* ⊃ *P*

**25.** Let *G* = *Grover Cleveland was the greatest U.S. president*: ~ *G*

Although you could translate the statement simply as *G* (where *G* = *It is false that Grover Cleveland*

*was the greatest U.S. president*); nevertheless, ~ *G* captures the English more accurately.

**26.** Let *H* = *She is happy with her box of candy*, and *C* = *she would have preferred a new car*: *H*  **·** *C*

**27.** Let *T = my car has a turbocharger*, and *F = it is fast*: *F* ⊃ *T*

**28.** Let *C* = Citizen Kane *did win the Academy Award for best picture*, and *G* = *it is still the greatest*

*movie ever made*: ~ *C*  **·**  *G*

**29.** Let *B = Barbara is going to lose her football bet*, and *J = Johnny will get a night at the ballet*: *B*  **·** *J*

**30.** Let *W = My father is wise*, and H = *he is honest*: *W* ⊃ *H*

**31.** Let *S = my stock portfolio is strong*, and *L = I am losing money*: *S* v *L*

**32.** Let *L = I am lazy*, and *C =my room is clean*: *L* ⊃ ~ *C*

**33.** Let *D = driving too fast is hazardous to your health*, and *B = driving without buckling up (is*

*hazardous to your health)*: *D* ⊃ *B*

**34.** Let *W = My father is wise*, and *H = he is honest*: *W*  **·** *H*

**35.** Let *S = My stock portfolio is weak*, and *L =I am losing money*: *S* ⊃ *L*

**36.** Let *C = There are too many circus acts in Las Vegas*: *~ C*

**37.** Let *R = my room could use a good cleaning*, and *L = I am too lazy to do anything about it*: *L* ⊃ *R*

**38.** Let *W = Watching circus acts is hazardous to your health*, and *F = falling into deep holes*: *W*  **·** *F*

**39.** Let *W = my father is wise*, and *H = he is honest*: *W* ⊃ *H*

**40.** Let *F = My car is fast*, and *T = it has a turbocharger*: *T* ⊃ *F*

**41.** Let *R = it rains tomorrow*, and *W= I will have to water my plants*: *R* ⊃ ~ *W*

**42.** Let *R = Reading is relaxing*, and *T = thinking is productive*: *R*  **·** *T*

**43.** Let *C = Cats make great pets*, and *D = dogs make great pets*: *C* **·** *D*

**44.** Let *D = The decathlon is a difficult Olympic event*: *D*

**45.** Let *O = My car is old*, and *R = it is still reliable*: *O* **·** *R*

**46.** Let *R = you are registered*, and *V = you can vote*: *V* ⊃ *R*

**47.** Let *C = coffee contains caffeine*, and *T = tea contains caffeine*: *C* v *T*

**48.** Let *M = Today is Monday*, and *T = today is Tuesday*: *T* v *M*

**49.** Let *S* = *Sally got a promotion*, *L* = *Louis asks for a raise*, and *J* = *he [Louis] looks for another job:*

*S* **·** (*L* v *J*)

**50.** Let *S* = *September has 31 days*, *J* = *July has 31 days*, and *A* = *August has 31 days:* ~ *S* v (*J* ⊃ *A*)

**51.** Let *S* = *slot machines take credit cards*, and *T* = *table gaming takes credit cards:* ~ *S* **·**  ~ *T*

**52.** Let *R* = *Russia is not part of the NATO alliance*, *S* = *Switzerland is not part of the NATO alliance*,

*U* = *the United States has a large military presence in Europe*, and *F* = *France has a large military presence in Europe:* (~ *R* **·** ~ *S*) ⊃ (*U* v *F*)

**53.** Let *M* = *Mary owns a motorcycle*, *P = she [Mary] passes the motorcycle driver’s test, B = she [Mary] will buy her own motorcycle,* and *T = she [Mary] will use Tom’s [motorcycle]:*

*~ M* ***·***[ *P* ⊃(*B v T*)]

**54.** Let *S = stock prices fall this year, U = unemployment rises this year, H = the housing market will suffer dire consequences,* and *M = manufacturing jobs will suffer dire consequences: S* ⊃ [*U* ⊃ ( *H* ***·*** *M*)]

**55.** Let *I = illiteracy is genetically determined, R = racism is genetically determined, E = illiteracy can be reduced by education,* and *C = racism can be reduced by education:* ~ ( *I* ***·*** *R*) ***·*** (*E* ***·*** *C*)

**56.** Let *H =* the human population rises past eight billion*, S = our species will require more food, E =* other animal species become extinct*, P = natural resources may become depleted*, *D = survival may become more difficult,* *C =* *competition for scarce resources may become more violent:*

[(*H* ⊃ *S*) **·** (*E* ⊃ *P*)] **·** (*D* **·** *C*)

**57.** Let *C = Prison populations will continue to grow, S = longer prison sentences will be imposed, N = new laws are created, P = profiling is stopped, R = punishment is seen as retribution,* and *D = punishment can work as a deterrence:* [(*C* **·** *S*) ⊃ (*N* **·** ~ *P*)] **·** (*R* ⊃ ~ *D*)

**58.** Let *C = cars continue to pollute the air, F = factories continue to pollute the air, O = oceans will rise. J = climate change will put some life-forms in jeopardy, P = we can protect future generations, S = we implement sound scientific advice,* and *G = [we] curb global conspicuous consumption:*

[(*C* ***·*** *F*) ⊃ (*O* v *J*)] ***·*** [*P* ≡ (*S* ***·*** *G*)]

**59.** Let *U = My university has many good instructors, R =* *[my university has many good] resources, A = I take advantage of all the university has to offer, T = I will have wasted my time,* and *M = [I will have wasted] my parent’s money:* (*U* ***·*** *R*) ***·*** [~*A* ⊃ (*T* ***·*** *M*)]

**60.** Let *D = I get a degree, J = [I] find a good job, R =* *I can save for my retirement, W = the world economy has a meltdown,* and *N = natural disasters wreck our infrastructure:* [(*D* ***·*** *J*) ⊃ *R*] ≡ (~*W* ***·*** ~ *N*)

**II.**

**1.** Sufficient condition. A bachelor is defined as being an unmarried adult male. Given this, if the antecedent is true (if Ed is a bachelor), then the consequent will be true as well (Ed is an adult male).

**2.** Not a sufficient condition. A bachelor is defined as being an unmarried adult male. Given this, if the antecedent is true (if Ed is an adult male), then the consequent can be true or false.

**3.** Not a sufficient condition. Although oxygen is needed for a fire, it is not enough, by itself, for a fire to exist. Given this, if the antecedent is true, then the consequent can be true or false.

**4.** Sufficient condition. A fire needs oxygen to exist. Given this, if the antecedent is true, then the consequent will be true as well.

**5.** Sufficient condition. Since June has exactly 30 days, if the antecedent is true, then the consequent will be true as well.

**6.** Not a sufficient condition. There is more than one month with exactly 30 days. Therefore, if the antecedent is true, then the consequent can be true or false.

**7.** Not a sufficient condition. Generally speaking, more people than just the president of the United States live in the White House. Therefore, if the antecedent is true, then the consequent can be true or false.

**8.** Sufficient condition. Since the president of the United States’ address is the White House, if the antecedent is true, then the consequent will be true as well.

**9.** Sufficient condition. Since 100 pennies is the equivalent of $1, if the antecedent is true, then the consequent will be true as well.

**10.** Not a sufficient condition. You might have the equivalent of $1 by having ten dimes, or four quarters, and so on. Therefore, if the antecedent is true, then the consequent can be true or false.

**11.** Sufficient condition. *If* it is true that I am over 21 years of age, then it *must be true* that I am over 10 years of age.

**12.** Not a sufficient condition. *If* it is true that I am over 10 years of age, then it might be true that I am over 21 years of age (I could be 22, 23, etc.). However, it might be false that I am over 21 years of age (I could be 11, 12, etc.).

**13.** Sufficient condition. *If* it is true that I am eating a banana, then it must be true that I am eating a fruit.

**14.** Not a sufficient condition. *If i*t is true that I am eating a fruit, then it might be true that I am eating a banana. However, it might be false that I am eating a banana (I could be eating an orange, an apple, etc.).

**15.** Sufficient condition. *If* it is true that I hurt a human, then it must be true that I hurt a mammal, since all humans are mammals.

**16.** Not a sufficient condition. *If i*t is true that I am hurting a mammal, then it might be true that I am hurting a human. However, it might be false that I am hurting a human (I could be hurting a dog, cat, etc.).

**III.**

**1.** Necessary condition. A bachelor is defined as being an unmarried adult male. Given this, if Ed is *not* an adult male, then Ed is *not* a bachelor.

**2.** Not a necessary condition. A bachelor is defined as being an unmarried adult male. Given this, if Ed is *not* a bachelor, then Ed *may* or *may not* be an adult male (Ed could be a married adult male).

**3.** Not a necessary condition. If there is *not* a fire in the room, then there *may* or *may not* be oxygen in the room.

**4.** Necessary condition. A fire needs oxygen to exist. Given this, if there is *not* oxygen in the room, then there is *not* a fire in the room.

**5.** Necessary condition. June has exactly 30 days. Given this, if this month does *not* have exactly 30 days, then this month is *not* June.

**6.** Not a necessary condition. There is more than one month with exactly 30 days. Therefore, if this is *not* the month of June, then this month *may* or *may not* have exactly 30 days.

**7.** Not a necessary condition. Generally speaking, more people than just the president of the United States live in the White House. Therefore, if I am *not* the president of the United States, I *may* or *may not* live in the White House.

**8.** Necessary condition. Since the president of the United States’ address is the White House, if I do *not* live in the White House, then I am *not* the president of the United States.

**9.** Necessary condition. If I do *not* have *at least* the equivalent of $1, then I have *at most* 99 cents. Given this, I do *not* have exactly 100 pennies.

**10.** Not a necessary condition. If I do *not* have exactly 100 pennies, then I *may* or *may not* have at least the equivalent of $1.

**11.** Necessary condition. If I am *not* over 10 years of age, then I am *not* over 21 years of age.

**12.** Not a necessary condition. If I am *not* over 21 years of age, then I *may* or *may not* be over 10 years of age (I could be 5, 6, etc.).

**13.** Necessary condition. If I am *not* eating a fruit, then I am *not* eating a banana.

**14.** Not a necessary condition. If I am *not* eating a banana, then I could be eating an orange, an apple, and so on.

**15.** Necessary condition. If I *not* am hurting a mammal, then I am *not* hurting a human, since all human are mammals.

**16.** Not a necessary condition. If I am *not* hurting a human, then I could be hurting a mammal (a dog or a cat, for example).

***Exercises 7B.1***

**1.** *P* v  *~* *Q* This is a *WFF.*

**2.** *R* ~ v *T* This is *not* a *WFF*. **Rule 1**: The dot, wedge, horseshoe, and triple bar must always go *between* two statements (simple or complound). Also, in this example the negation sign appears in front of another truth-functional connective, not a statement. **Rule 2**: The tilde must always go *in front of* the statement it is meant to negate.

**3.** *K* This is a *WFF.*

**4.** *K* **·** ( *P* ~ *Q*) This is not a *WFF*. In this example, the negation sign appears by itself in between two statements. **Rule 3:** The tilde *cannot go* *by itself* between two statements.

**5.** *L* ⊃ ~ *P* This is a *WFF.*

**6.** *L* ⊃ ~ (*P* v ⊃ *Q*) This is not a *WFF.* **Rule 1**: The dot, wedge, horseshoe, and triple bar must always go *between* two statements (simple or compound).

**7.** *M* (⊃ *P* ⊃ *Q*)This is not a *WFF.* **Rule 1**: The dot, wedge, horseshoe, and triple bar must always go *between* two statements (simple or compound). **Rule 4:** *Parentheses* must be used to indicate the main operator.

**8.** (*P* v *Q* ⊃ *R*)This is not a *WFF.* **Rule 4**: *Parentheses* must be used to indicate the main operator.

**9.** [ ( *P* *Q* ] v ~ *R*This is not a *WFF.* **Rule 1**: The dot, wedge, horseshoe, and triple bar must always go *between* two statements (simple or compound). **Rule 4:** *Parentheses* must be used to indicate the main operator.

**10.** ~ *P* (v ~ *R*) **·** ~ *S*This is not a *WFF.* **Rule 1**: The dot, wedge, horseshoe, and triple bar must always go *between* two statements (simple or compound). **Rule 4:** *Parentheses* must be used to indicate the main operator.

**11.** *P* **·**  v *Q* This is not a *WFF*. **Rule 1**: The dot, wedge, horseshoe, and triple bar must always go *between* two statements (simple or compound).

**12.** *R* v *T*~ This is not a *WFF*. **Rule 2**: The tilde must always go *in front of* the statement it is meant to negate.

**13.** *P Q* This is not a *WFF*. **Rule 1**: The dot, wedge, horseshoe, and triple bar must always go *between* two statements (simple or compound).

**14.** *K* **·** ( *P* v~ *Q*) This is a *WFF.*

**15.** *L* ~ *P* Thus is not a *WFF*.  **Rule 3:** The tilde cannot *go by itself* between two statements.

***Exercises 7B.2***

The *main operator* is circled in each example.

**1.**  *~* *Q* v *P*

**2.** *R* · (~ *T* v *K* )

**3.** ~ *K*

**4.** ( *P* · ~ *Q* ) v *K*

**5.** *L* ⊃ ~ *P*

**6.** ( *L* ⊃ ~ *P* ) ⊃ *Q*

**7.** ( *M* v *P* ) ⊃ ( *Q* v *R* )

**8.** [ *P* v ( *Q* ⊃ *R* ) ] · ( ~ *R* v *S* )

**9.** ( *P* · *Q* ) v  ~ *R*

**10.** ~ [ ( *P* v ~ *R* ) · ~ *S* ]

**11.** ( *~* *Q* v *P* ) ⊃ *R*

**12.** [ *R* · ( ~ *T* v *K* ) ] v *S*

**13.** ~ *K* ⊃ ~ *P*

**14.** ( *P* · ~ *Q* ) v ( *K* ⊃ *R* )

**15.** ( *L* ⊃ ~ *P* ) · ~ *R*

**16.** [ ( *L* ⊃ ~ *P* ) ⊃ *Q* ] ⊃ ~ *S*

**17.** [ ( *M* v *P* ) ⊃ ( *Q* v *R* ) ] v ( *S* · ~ *P* )

**18.** [ *P* v ( *Q* ⊃ *R* ) ] ⊃ ~ ( ~ *R* v *S* )

**19.** ( *P*· *Q* ) v (~ *R* v *S* )

**20.** ~ [ ( *P* ⊃ ~ *R* ) ⊃ ( ~ *S* v *Q* ) ]

**21.**  *~* *Q* · *P*

**22.** ( *R* ·*Q* ) v  (~ *T* v *K* )

**23.** *P*

**24.** ( *P* · ~ *Q* ) · *K*

**25.** *L* ⊃ ( ~ *P* ⊃ *Q* )

***Exercises 7B.3***

**I.**

**1.** Let *S* = *Shane is hungry*, and *C* = *Carly is hungry*: ∼ ( *S*  · *C* )

The conjunction “Shane and Carly are hungry” contains two simple statements: “Shane is hungry,” and “Carly is hungry.” However, the main operator is a negation (“It is not the case that”); therefore the tilde must be placed outside the parentheses that contain the conjunction.

**2.** Let *M* = *I am mistaken*, *T* = *my test score was high*, and *H* = *I am happy about the result*.

(∼ *M* · *T*) · *H* *or*  ∼ *M* · (*T* · *H*)

The translation that most accurately captures the statement “I am *not* mistaken” is ~ *M*. The reason we have two possible translations, both using parentheses, is the need to designate one truth-functional operator as the *main operator*.

**3.** Let *R* = *he attended a remedial driver’s education course*, and *L* = *he did lose his license*.

~ *R* **·** ~ *L* *or* ~ ( *R* v *L* )

The assertion is “*neither* *R* *nor* *L*”; therefore, both have to be negated.

**4.** Let *M* = *Mike wears braces on his teeth*, and J = *Jane wears braces on her teeth*.

~ ( *M* · *J* )

The assertion is that the two statements, *M* and *J*, are not both true; therefore, the negation must go outside the parentheses.

**5.** Let *S* = *you can save $100 a month*, *A* = *you can afford the insurance*, and *B* = *you can buy a motorcycle*.

*S* ⊃ ( *A* ⊃ *B* )

The second use of a conditional, *A* ⊃ *B*, must be placed within parentheses so it becomes the consequent of the conditional that has *S* as the antecedent.

**6.** Let *E* = *you exercise for 20 minutes a day*, *C* = *you cut out 1000 calories a day*, and *T* = *you will be in top physical condition in 6 months*.

( *E* · *C* ) ⊃ *T*

The first two conjoined statements are the antecedent of a conditional statement, so they must be placed within parentheses.

**7.** Let *S* = *you stop studying*, *P* = *you will pass the course*, and *K* = *you will keep your scholarship*.

~ [ *S* ⊃ ( *P* · *K* ) ]

The negation covers the entire conditional, so it has to be placed outside the brackets that contain the conditional. Also, the consequent of the conditional is a conjunction, so it has to be placed within parentheses.

**8.** Let *M* = *We will reinstitute a military draft*, *A* = *we are attacked on our soil*, and *P* = *too few people sign up voluntarily*.

*M* ⊃ ( *A* v *P* )

The consequent is a disjunction, so it must be placed within parentheses.

**9.** Let *W* = *Walter can drive to Pittsburgh next weekend*, *S* = *Sandy can drive to Pittsburgh next weekend*, *J* = *Jessica will come home*, and *F* = *Jennifer is able to arrive on time*.

~ (*W* v *S* ) ⊃ ( ~ *J* v *F* )

The antecedent is the negation of a disjunction, and it must be placed within parentheses; the consequent is a disjunction, so it too must be placed within parentheses.

**10.** Let *F* = *his business is fair*, and *R* = *his business is reputable*.

~ ( *F* v *R* )

The assertion is that either or both of the statements, *F* and *R*, are false; therefore, the negation must go outside the parentheses.

**11.** Let *C* = *we are careful*, *O* = *we do change the oil often enough*, and *E* = *the engine will be ruined*.

( ~ *C* · ~ *O* ) ⊃ *E*

The first two conjoined statements are the antecedent of a conditional statement, so they must be placed within parentheses.

**12.** Let *C* = *he is allowed to go to the concert*, *W* = *he finishes work on time*, and *M* = *he can meet us at the coffee shop*.

~ *C* v ( *W*  ⊃ *M* )

The second disjunct is a conditional, so it has to be placed in parentheses.

**13.** Let *D* = *your disc player breaks*, *B* = *I will get you a new one for your birthday*, and *F* = *you can see about getting it fixed*.

( *D* ⊃ *B* ) v *F*

The first disjunct is a conditional, so it has to be placed in parentheses.

**14.** Let *C* = *He did admit to taking the camera*, *L* = *he is lying*, *P* = *he pawned it for the money*, and *A* = *he has it in his apartment.*

~ *C* · [ *L* ⊃ ( *P* v *A* ) ]

The main operator is a conjunction. The second conjunct is a conditional with the consequent as a disjunction, so parentheses and brackets must be used.

**15.** Let *P* = *Her painting is valuable*, *K* = *she can keep it*, and *S* = *sell it for a lot of money*.

*P* · ( *K* v *S* )

The main operator is a dot. The second conjunct is a disjunction, so it has to be placed in parentheses.

**16.** Let *S* = *soccer is the world’s most popular sport*, *C* = *it catches on in the United States*, *F* = *football will lose fans,* and *B* = *basketball will lose fans*.

*S*  ⊃ [ *C*  ⊃ ( *F* · *B* ) ]

The main operator is the first horseshoe. The second conditional has a conjunction as the consequent, so parentheses and brackets must be used.

**17.** Let *S* = *you will eat a lot of salads*, and *V* = *you will absorb a lot of vitamins*.

~ ( *S* ⊃ *V* ) · ~ ( *V* ⊃ *S* )

The main operator is a dot, so parentheses must be placed around each conjunct with the negation sign outside of each set of parentheses.

**18.** Let *A* = *She is athletic*, *C* = *she is creative*, and *M* = *I am mistaken*.

( *A* · *C* ) v *M*

The main operator is a wedge. The first disjunct is a conjunction, so it has to be placed in parentheses.

**19.** Let *J* = *Johnny will visit Las Vegas*, *B* = *Barbara will visit Las Vegas*, *M* = *Mary Lynn can get a seat on the same flight*, and *L* = *Lee Ann can get a seat on the same flight*.

( *J* **·** *B* ) ⊃ ( *M* · *L* )

The main operator is a horseshoe. Both the antecedent and the consequent are conjunctions, so parentheses must be used.

**20.** Let *J* = *Joyce has visited Hawaii*, *D* = *Judy has been there*, and *E* = *Eddie has been there*.

*J* **·** ~ ( *D* v *E* )

The main operator is a dot. The second conjunct has a disjunction that is negated, so the disjunction goes within parentheses with the negation on the outside.

**II.**

**1.** Let *L = Give me liberty*, and *D = give me death*: *L* v *D*

**2.** Let *H* = *a house is a home*, *F* = *it contains food for the mind as well as the body*, and *R = fire for the mind as well as the body*: ( *F* **·** *M* ) v ~ *H*

**3.** Let *A = you wish to make an apple pie truly from scratch*, and *U = you must first invent the universe:*

*A* ⊃ *U*

**4.** Let *D = I disapprove of what you say*, and *R = I will defend to the death your right to say it*: *D* **·** *R*

**5.** Let *S = a spirit of harmony will survive in America*, and *D = each of us remembers that we share a common destiny*: *S* ⊃ *D*

**6.** Let *S = Life shrinks in proportion to one’s courage*, and *E = life expands in proportion to one’s courage*: *S* v *E*

**7.** Let *H = I hear*, *F = I forget*, *S = I see*, *R = I remember*, *D = I do*, and *U = I understand*:

(*H* **·** *F*) **·**[ (*S* **·** *R*) **·**(*D* **·** *U*) ]

**8.** Let *D = one man offers you democracy*, *G = another offers you a bag of grain*, and *S = at some stage of starvation you prefer the grain to the vote*: ( *D* **·** *G* ) ⊃ *S*

**9.** Let *F = I have failed*, and *W = I’ve just found 10,000 ways that won’t work*: ~ *F* **·**  *W*

**10.** Let *A = America is anything, E = it consists of each of us, S = it is something*, and *U = it consists of all of us*: ( *E* ⊃ ~ *A* ) **·** ( *S* ⊃ *U* )

**11.** Let *D* = *he’s dead*, and *W* = *my watch has stopped*: *D* v *W*

**12.** Let *B = It is from the benevolence of the butcher that we expect our dinner*, *W = it is from the benevolence of the brewer that we expect our dinner the brewer*, *K = it is from the benevolence of the baker that we expect our dinner*, and *I = from their regard to their own interest*: ~ [( *B* v *W* ) v *K* ] **·** *I*

**13.** Let *H* = *the only tool you have is a hammer*, and *N* = *you tend to see every problem as a nail*: *H* ⊃ *N*

**14.** Let *I = An insincere friend is more to be feared than a wild beast, E = an evil friend is more to be feared than a wild beast, W = a wild beast may wound your body*, and *M = an evil friend will wound your mind*: ( *I* **·** *E* ) **·** ( *W* **·** *M* )

**15.** Let *B = the average man will bristle, D = you say his father was dishonest, R = he will brag a little*, and *P = he discovers that his great-grandfather was a pirate*: ( *D*  ⊃ *B* ) **·** ( *P* ⊃ *R* )

**16.** Let *G = knowledge is a great quality*, and *U = knowledge is a very useful quality*: *G* **·**  *U*

**17.** Let *B = The bankrupt New York City Off-Track Betting Corporation will close all of its branches in the city’s five boroughs, S = shutter its account-wagering operation at the close of business on Friday,* and *R = the company gets some relief:*  ( *B* **·** *S* ) v *R*

**18.** Let *G = a general bill of rights is what the people are entitled to against every government on earth, P = a particular bill of rights is what the people are entitled to against every government on earth*, *J = no just government should refuse*, and *R = it should not rest on inference*: ( *G* v *P* ) **·**  ( *J* v ~ *R* )

**19.** Let *C = fundamentally an organism has conscious mental states, B = there is something that it is like to be that organism*, and *F = something it is like for the organism:* *C* *≡* ( *B* **·** *F* )

**20.** Let *F* = *education is the filling of a pail*, and *L* = *education is the lighting of a fire*: ~ *F*  **·** *L*

***Exercises 7C.1***

**1.** (a) *R* is true. The only way for a conjunction to be true is if both conjuncts are true.

**2.** (c) *R* could be true or false. The conjunction could be false if *R* is true and *S* is false, or if *R* is false and *S* is true, or if *R* is false and *S* is false.

**3.** (c) *R* could be true or false. The disjunction could be true if *R* is true and *S* is false, or if *R* is false and *S* is true, or if *R* and *S* are both true.

**4.** (b) *R* is false. The only way for a disjunction to be false is if both disjuncts are false.

**5.** (a) *R* is true. The negation changes the truth value of whatever follows it.

**6.** (b) *R* is false. The negation changes the truth value of whatever follows it.

**7.** (a) *S* is true. A disjunction is true if at least one disjunct is true.

**8.** (b) No. The only way for a disjunction to be false is if both disjuncts are false.

**9.** (a) Yes. A disjunction is true if at least one disjunct is true.

**10.** (a) Yes. A conjunction is false if at least one conjunct is false.

**11.** (c)  *R* could be true or false. A conditional can be true if the antecedent is true and the consequent is true, or if the antecedent is false.

**12.** (a)  *R* is true. A conditional is false if the antecedent is true and the consequent false.

**13.** (c)  *S* could be true or false. A conditional can be true if the antecedent is true and the consequent true, or if the antecedent is false.

**14.** (b)  *S* is false. A conditional is false if the antecedent is true and the consequent false.

**15.** (b) No. A conditional is false if the antecedent is true and the consequent false.

**16.** (a) Yes. A conditional can be true if the antecedent is true and the consequent true, or if the antecedent is false.

**17.** (c)  *S* could be true or false. A biconditional is true when both components have the same truth value (either both true or both false).

**18.** (c)  *R* could be true or false. A biconditional is true when both components have the same truth value (either both true or both false).

**19.** (b) No. A biconditional is false when the components have different truth values.

**20.** (b) No. A biconditional is false when the components have different truth values.

Exercises 7C.2

I.

**1.** P Q P **·** ~ Q

T F T T

**2.** Q S Q **·** ~ S

F F F T

**3.** P Q P ⊃ Q

T F F

**4.** S Q S v ~ Q

F F T T

**5.** Q S Q ≡ S

F F T

**6.** Q R S (Q ν R) ⋅ S

F T F T F F

**7.** S Q P S ν (∼ Q ⋅ P)

F F T F T T T

**8.** P S R P ν (S ν R)

T F T T T T

**9.** Q R S (Q ⊃ R) ⋅ S

F T F T F F

**10.** P S R P ≡ (S ν R)

T F T T T T

**11.** P S R ∼ P ν (∼ S ν ∼ R)

T F T F T T T F

**12.** P S R ∼ P ⊃ (∼ S ⊃ ∼ R)

T F T F T T F F

**13.** R S P (R ⋅ ∼ S) ⋅ P

T F T T T T T

**14.** R S P (R ⋅ ∼ S) ⊃ P

T F T T T T T

**15.** Q R S P ∼ (Q ⋅ R) ⋅ ∼ (S ⋅ P)

F T F T T F T T F

**16.** Q R S P (Q ν R) ⋅ (S ν P)

F T F T T T T

**17.** P Q R S [ P ν (Q ⋅ R) ] ν ∼ S

T F T F T F T T

**18.** P Q R S [ P ⋅ (Q ⋅ R) ] ≡ ∼ S

T F T F F F F T

**19.** P Q R S ∼ [ P ν (Q ν R) ] ν ∼ (S ν P)

T F T F F T T F F T

**20.** P Q R S ∼ [ P ⊃ (Q ⋅ R) ] ν ∼ (S ≡ P)

T F T F T F F T T F

**II.**

**1.** P Q P ⊃ ∼ Q

T T F F

**2.** P Q Q ⋅ ~ S

T T F F

**3.** P Q P ⊃ Q

T T T

**4.** Cannot be determined. Since Q is true, its negation is false. However, because S is unassigned, it could be either true or false. Therefore, if S is true, then the disjunction is true; but if *S* is false, then then the disjunction is false.

**5.** Cannot be determined. Since Q is true, one conjunct is true. However, because S is unassigned, it could be either true or false. Therefore, if S is true, then the compound proposition is true; but if *S* is false, then then the compound proposition is false.

**6.** Cannot be determined. Since Q is true, the disjunction is true. However, because S is unassigned, it could be either true or false. Therefore, if S is true, then the conjunction is true; but if *S* is false, then then the conjunction is false.

**7.** Cannot be determined. Since Q is true, its negation is false, so the conjunction is false. However, because S is unassigned, it could be either true or false. Therefore, if S is true, then the disjunction is true; but if *S* is false, then then the disjunction is false.

**8.** P S R P ν (S ν R)

T F T T

**9.** Q R S (Q ⊃ R) ⋅ S

T F F F

**10.** Cannot be determined. Since P is true, the left side of the biconditional is true. However, because R is false, and S is unassigned, the disjunction could be either true or false. Therefore, if S is true, then the biconditional is true; but if *S* is false, then then the biconditional is false.

**11.** P S R ∼ P ν (∼ S ν ∼ R)

T F F T T T

**12.** P S R ∼ P ⊃ (∼ S ⊃ ∼ R)

T F F T

**13.** R S P (R ⋅ ∼ S) ⋅ P

F T F F

**14.** R S P (R ⋅ ∼ S) ⊃ P

F T T T

**15.** Cannot be determined. Although we can determine that the left conjunct of the main operator is true, we cannot determine whether the right conjunct of the main operator is true or false. Thst is, since S is unassigned, it could be either true or false. If S is true, then the right conjunct of the main operator is false. However, if S is it is false, then the right conjunct of the main operator is true.

**16.** Q R S P (Q ν R) ⋅ (S ν P)

T F T T T T

**17.** P Q R S [ P ν (Q ⋅ R) ] ν ∼ S

T T F T F T

**18.** Cannot be determined. Although we can determine that the left side of the biconditional is false, we cannot determine whether the right side of the biconditional is true or false. That is, since S is unassigned, it could be either true or false. If S is true, then its negation is false. However, if S is it is false, then its negation is true.

**19.** P Q R S ∼ [ P ν (Q ν R) ] ν ∼ (S ν P)

T T F F T T F F T

**20.** P Q R S ∼ [ P ⊃ (Q ⋅ R) ] ν ∼ (S ≡ P)

T T F T F F T

***Exercises 7D***

**1.** *P Q* *P* **·** ~ *Q*

T T F F

T F T T

F T F F

F F F T

**2.** *R S* ~ *R* **·** ~ *S*

T T F F F

T F F F T

F T T F F

F F T T T

**3.** *P Q* *P* ⊃ *Q*

T T T

T F F

F T T

F F T

**4.** *S Q* *S* ⊃ ~ *Q*

T T F F

T F T T

F T T F

F F T T

**5.**  *R S Q* ( *R* · *S* ) v *Q*

T T T T T

T T F T T

T F T F T

T F F F F

F T T F T

F T F F F

F F T F T

F F F F F

**6.**  *P S R* ~ *P*  v( ~ *S* v ~ *R* )

T T T F F F F F

T T F F T F T T

T F T F T T T F

T F F F T T T T

F T T T T F F F

F T F T T F T T

F F T T T T T F

F F F T T T T T

**7.**  *R S P* ( *R* ≡ ~ *S* ) ⊃ *P*

T T T F F T

T T F F F T

T F T T T T

T F F T T F

F T T T F T

F T F T F F

F F T F T T

F F F F T T

**8.**  *Q R S*  ( *Q* ⊃ *R* ) **·** *S*

T T T T T

T T F T F

T F T F F

T F F F F

F T T T T

F T F T F

F F T T T

F F F T F

**9.**  *Q R P* ~ ( *Q* · *R* ) ⊃ *P*

T T T F T T

T T F F T T

T F T T F T

T F F T F F

F T T T F T

F T F T F F

F F T T F T

F F F T F F

**10.**  *P S R*  *P* v( *S* ⊃ *R* )

T T T T T

T T F T F

T F T T T

T F F T T

F T T T T

F T F F F

F F T T T

F F F T T

**11.**  *S Q R S* **·** ( ~ *Q* ⊃ *R* )

T T T T F T

T T F T F T

T F T T T T

T F F F T F

F T T F F T

F T F F F T

F F T F T T

F F F F T F

**12.** *Q R* ( *Q* ⊃ *R* ) **·** *R*

T T T T

T F F F

F T T T

F F T F

**13.**  *P S R P* ≡( ~ *S* v ~ *R* )

T T T F F F F

T T F T F T T

T F T T T T F

T F F T T T T

F T T T F F F

F T F F F T T

F F T F T T F

F F F F T T T

**14.**  *P S R* ~ *P* **·**( *S* v *R* )

T T T F F T

T T F F F T

T F T F F T

T F F F F F

F T T T T T

F T F T T T

F F T T T T

F F F T F F

**15.**  *Q R S* ~ [ ( *Q* **·** *R* ) **·** ~ ( *S* v *R* ) ]

T T T T T F F T

T T F T T F F T

T F T T F F F T

T F F T F F T F

F T T T F F F T

F T F T F F F T

F F T T F F F T

F F F T F F T F

**16.**  *R S P* ( *R* **·** ~ *S* ) **·** *P*

T T T F F F

T T F F F F

T F T T T T

T F F T T F

F T T F F F

F T F F F F

F F T F T F

F F F F T F

**17.**  *P Q R* ~ [ *P* ⊃ ( *Q* v *R* ) ]

T T T F T T

T T F F T T

T F T F T T

T F F T F F

F T T F T T

F T F F T T

F F T F T T

F F F F T F

**18.**  *Q R S* ( *Q* **·** *R* ) ≡ ( *Q* v ~ *S* )

T T T T T T F

T T F T T T T

T F T F F T F

T F F F F T T

F T T F T F F

F T F F F T T

F F T F T F F

F F F F F T T

**19.** *P Q R S*  [ *P* v ( *Q* **·** *R* ) ] ⊃ *S*

T T T T T T T

T T T F T T F

T T F T T F T

T T F F T F F

T F T T T F T

T F T F T F F

T F F T T F T

T F F F T F F

F T T T T T T

F T T F T T F

F T F T F F T

F T F F F F T

F F T T F F T

F F T F F F T

F F F T F F T

F F F F F F T

**20.** *P Q R S*  ~ [ *P* v ( *Q* v *R* ) ] v ~ ( *S* v *P* )

T T T T F T T F F T

T T T F F T T F F T

T T F T F T T F F T

T T F F F T T F F T

T F T T F T T F F T

T F T F F T T F F T

T F F T F T F F F T

T F F F F T F F F T

F T T T F T T F F T

F T T F F T T T T F

F T F T F T T F F T

F T F F F T T T T F

F F T T F T T F F T

F F T F F T T T T F

F F F T T F F T F T

F F F F T F F T T F

**21.**

*P* *Q* *P* ⊃ ∼ *Q*

T T F F

T F T T

F T T F

F F T T

**22.**

*Q* *S* *Q* **·** ∼ *S*

T T F F

T F T T

F T F F

F F F T

**23.**

*P* *Q* *P* ⊃ ~ *Q*

T T F F

T F T T

F T T F

F F T T

**24.**

*S* *Q* *S*  ν ∼ *Q*

T T T F

T F T T

F T F F

F F T T

**25.**

*Q* *S* *Q* ≡ *S*

T T T

T F F

F T F

F F T

**26.**

*Q R S* (*Q*  ν *R*) **·** *S*

T T T T T

T T F T F

T F T T T

T F F T F

F T T T T

F T F T F

F F T F F

F F F F F

**27.**

*S Q P* *S* ν ( ∼ *Q* **·** *P* )

T T T T F F

T T F T F F

T F T T T T

T F F T T F

F T T F F F

F T F F F F

F F T T T T

F F F F F F

**28.**

*P S R* *P* ν (*S*  ν *R*)

T T T T T

T T F T T

T F T T T

T F F T F

F T T T T

F T F T T

F F T T T

F F F F F

**29.**

*Q R S* (*Q* ⊃ *R*) **·** ~ *S*

T T T T F F

T T F T T T

T F T F F F

T F F F F T

F T T T F F

F T F T T T

F F T T F F

F F F T T T

**30.**

*P S R* *P* ≡ (*S* ν *R*)

T T T T T

T T F T T

T F T T T

T F F F F

F T T F T

F T F F T

F F T F T

F F F T F

**31.**

*P S R* ∼ *P* ν (∼ *S* ν ∼ *R*)

T T T F F F F F

T T F F T F T T

T F T F T T T F

T F F F T T T T

F T T T T F F F

F T F T T F T T

F F T T T T T F

F F F T T T T T

**32.**

*P S R* ∼ *P* ⊃ ( ∼ *S*  ⊃ ∼ *R*)

T T T F T F T F

T T F F T F T T

T F T F T T F F

T F F F T T T T

F T T T T F T F

F T F T T F T T

F F T T F T F F

F F F T T T T T

**33.**

*R S P* (*R* **·** ∼ *S*) v *P*

T T T F F T

T T F F F F

T F T T T T

T F F T T T

F T T F F T

F T F F F F

F F T F T T

F F F F T F

**34.**

*R S P* (*R*  **·** ∼ *S*) ⊃ *P*

T T T F F T

T T F F F T

T F T T T T

T F F T T F

F T T F F T

F T F F F T

F F T F T T

F F F F T T

**35.**

*Q R S P* ∼ (*Q* **·**  *R*) **·** ∼ (*S* **·**  *P*)

T T T T F T F F T

T T T F F T F T F

T T F T F T F T F

T T F F F T F T F

T F T T T F F F T

T F T F T F T T F

T F F T T F T T F

T F F F T F T T F

F T T T T F F F T

F T T F T F T T F

F T F T T F T T F

F T F F T F T T F

F F T T T F F F T

F F T F T F T T F

F F F T T F T T F

F F F F T F T T F

**36.**

*Q R S P* (*Q* ν *R*) **·** (*S* ν *P*)

T T T T T T T

T T T F T T T

T T F T T T T

T T F F T F F

T F T T T T T

T F T F T T T

T F F T T T T

T F F F T F F

F T T T T T T

F T T F T T T

F T F T T T T

F T F F T F F

F F T T F F T

F F T F F F T

F F F T F F T

F F F F F F F

**37.**

*P Q R S* [ *P*  ν (*Q*  **·** *R*) ] ν ∼ *S*

T T T T T T T F

T T T F T T T T

T T F T T F T F

T T F F T F T T

T F T T T F T F

T F T F T F T T

T F F T T F T F

T F F F T F T T

F T T T T T T F

F T T F T T T T

F T F T F F F F

F T F F F F T T

F F T T F F F F

F F T F F F T T

F F F T F F F F

F F F F F F T T

**38.**

*P Q R S* [ *P*  **·** ( *Q* **·** *R*) ] ≡ ∼ *S*

T T T T T T F F

T T T F T T T T

T T F T F F T F

T T F F F F F T

T F T T F F T F

T F T F F F F T

T F F T F F T F

T F F F F F F T

F T T T F T T F

F T T F F T F T

F T F T F F T F

F T F F F F F T

F F T T F F T F

F F T F F F F T

F F F T F F T F

F F F F F F F T

**39.**

*P Q R S* ∼ [ *P* ν (*Q* ν *R*) ] ν ∼ (*S* ν *P*)

T T T T F T T F F T

T T T F F T T F F T

T T F T F T T F F T

T T F F F T T F F T

T F T T F T T F F T

T F T F F T T F F T

T F F T F T F F F T

T F F F F T F F F T

F T T T F T T F F T

F T T F F T T T T F

F T F T F T T F F T

F T F F F T T T T F

F F T T F T T F F T

F F T F F T T T T F

F F F T T F F T F T

F F F F T F F T T F

**40.**

*P Q R S* ∼ [ *P* ⊃ (*Q* **·** *R*) ] ν ∼ (*S* ≡ *P*)

T T T T F T T F F T

T T T F F T T T T F

T T F T T F F T F T

T T F F T F F T T F

T F T T T F F T F T

T F T F T F F T T F

T F F T T F F T F T

T F F F T F F T T F

F T T T F T T T T F

F T T F F T T F F T

F T F T F T F T T F

F T F F F T F F F T

F F T T F T F T T F

F F T F F T F F F T

F F F T F T F T T F

F F F F F T F F F T

***Exercises 7G.1***

**I.**

**1.** Invalid. Line 3 has the premise true and the conclusion false. This is indicated by the check mark.

*R S* *R* v *S* / *R*

T T T T

T F T T

F T T F √

F F F F

**2.** Valid. There is no line where the premise is true and the conclusion is false.

*R S R* **·** *S* / *R*

T T T T

T F F T

F T F F

F F F F

**3.** Invalid. Line 2 has the premise true and the conclusion false. This is indicated by the check mark.

*P S ∼ P* v *∼ S P / S*

T T F F F T T

T F F T T T F √

F T T T F F T

F F T T T F F

**4.** Invalid.Both line 2 and line 4 have the premise true and the conclusion false. (Either one of the two lines, by itself, would be sufficient to show the argument is invalid.)

*R S R* v *~ S* / *S*

T T T F T

T F T T F √

F T F F T

F F T T F √

**5.** Invalid. Line 2 has the premise true and the conclusion false.

*R S ~ R* v *~ S / ~ R*

T T F F F F

T F F T T F √

F T T T F T

F F T T T T

**6.** Valid

*R S ~ R* **·**  *~ S / ~ S*

T T F F F F

T F F F T T

F T T F F F

F F T T T T

**7.** Valid

*R S ∼* ( *~ R* v *~ S* )  *S / R*

T T T F F F T T

T F F F T T F T

F T F T T F T F

F F F T T T F F

**8.** Invalid. Line 2 has the premise true and the conclusion false.

*R S ∼* ( *~ R* **·** *~ S* ) *∼ S / ∼ R*

T T T F F F F F

T F T F F T T F √

F T T T F F F T

F F F T T T T T

**9.** Valid

*R S ∼* ( *R* v *S* ) *∼ R / ∼ S*

T T F T F F

T F F T F T

F T F T T F

F F T F T T

**10.** Invalid. Line 3 has the premise true and the conclusion false.

*R S ∼* ( *R* **·**  *S* )  *∼ R / ∼ S*

T T F T F F

T F T F F T

F T T F T F √

F F T F T T

**11.**Invalid. Lines 5, 6, and 7 all have the premise true and the conclusion false. (Any of the three lines, by itself, would be sufficient to show the argument is invalid.)

*P Q S P* v( *Q* v *S* ) */ P*

T T T T T T

T T F T T T

T F T T T T

T F F T F T

F T T T T F √

F T F T T F √

F F T T T F √

F F F F F F

**12.** Valid

*P Q R* ( *P* **·** *Q* )v *R ∼ Q / R*

T T T T T F T

T T F T T F F

T F T F T T T

T F F F F T F

F T T F T F T

F T F F F F F

F F T F T T T

F F F F F T F

**13.** Valid

*S Q R S* v( *Q* v *R* ) *∼ Q ∼ R / S*

T T T T T F F T

T T F T T F T T

T F T T T T F T

T F F T F T T T

F T T T T F F F

F T F T T F T F

F F T T T T F F

F F F F F T T F

**14.** Invalid. Line 1 has the premise true and the conclusion false.

*S Q R* ( *S* v *Q* )v *R Q R / ∼ S*

T T T T T T T F √

T T F T T T F F

T F T T T F T F

T F F T T F F F

F T T T T T T T

F T F T T T F T

F F T F T F T T

F F F F F F F T

**15.** Valid

*P Q R S ∼* (*∼ S* v *Q* )**·**( *P* v *R* ) *∼ Q ∼ P ∼ R / ∼ S*

T T T T F F T F T F F F F

T T T F F T T F T F F F T

T T F T F F T F T F F T F

T T F F F T T F T F F T T

T F T T T F F T T T F F F

T F T F F T T F T T F F T

T F F T T F F T T T F T F

T F F F F T T F T T F T T

F T T T F F T F T F T F F

F T T F F T T F T F T F T

F T F T F F T F F F T T F

F T F F F T T F F F T T T

F F T T T F F T T T T F F

F F T F F T T F T T T F T

F F F T T F F F F T T T F

F F F F T T F F F T T T T

**II.**

**1.** Valid

*P Q P* ⊃ *Q P / Q*

T T T T T

T F F T F

F T T F T

F F T F F

**2.** Valid

*P Q P* ⊃ *Q ∼ Q / ∼ P*

T T T F F

T F F T F

F T T F T

F F T T T

**3.** Valid

*P Q R P* ⊃ *Q Q* ⊃ *R / P* ⊃ *R*

T T T T T T

T T F T F F

T F T F T T

T F F F T F

F T T T T T

F T F T F T

F F T T T T

F F F T T T

**4.** Valid

*P Q P* v *Q ∼ P / Q*

T T T F T

T F T F F

F T T T T

F F F T F

**5.** Valid

*P Q R S* ( *P* ⊃ *Q* )***·***( *R* ⊃ *S* ) *P* v *R / Q* v *S*

T T T T T T T T T

T T T F T F F T T

T T F T T T T T T

T T F F T T T T T

T F T T F F T T T

T F T F F F F T F

T F F T F F T T T

T F F F F F T T F

F T T T T T T T T

F T T F T F F T T

F T F T T T T F T

F T F F T T T F T

F F T T T T T T T

F F T F T F F T F

F F F T T T T F T

F F F F T T T F F

**6.**Valid

*P Q P* ***·*** *Q / P*

T T T T

T F F T

F T F F

F F F F

**7.** Valid

*P Q P Q / P* ***·*** *Q*

T T T T T

T F T F F

F T F T F

F F F F F

**8.** Valid

*P Q P / P* v *Q*

T T T T

T F T T

F T F T

F F F F

**9.** Invalid

*R S R* ≡  *S* */ R*

T T T T

T F F T

F T F F

F F T F √

**10.** Invalid

*R S* ( *R* ***·*** *S* )⊃*S* ***/*** *S*

T T T T T

T F F T F √

F T F T T

F F F T F √

**11.** Valid

*P S P* ≡ *( ∼ P* v *∼ S ) ∼ P / ∼ S*

T T F F F F F F

T F T F T T F T

F T F T T F T F

F F F T T T T T

**12.** Valid

*R S ∼* ( *R* ⊃ *S* )  *∼ R / ∼ S*

T T F T F F

T F T F F T

F T F T T F

F F F T T T

**13.** Invalid

*P R S ∼* ( *R* ***·*** *S* ) *∼ R* ⊃ *P / ∼ S*

T T T F T F T F

T T F T F F T T

T F T T F T T F √

T F F T F T T T

F T T F T F T F

F T F T F F T T

F F T T F T F F

F F F T F T F T

**14.** Invalid

*P Q S* ( *P* v *Q* )⊃ *S / P*

T T T T T T

T T F T F T

T F T T T T

T F F T F T

F T T T T F √

F T F T F F

F F T F T F √

F F F F T F √

**15.**Invalid**.** Eitherline 2, line 4, line 6, or line 8 is sufficient to show the argument is invalid.

*P Q R* ( *P* ***·*** *Q* )v( *R* ⊃ *P* ) *∼ Q* v *∼ R / R*

T T T T T T F F F T

T T F T T T F T T F √

T F T F T T T T F T

T F F F T T T T T F √

F T T F F F F F F T

F T F F T T F T T F √

F F T F F F T T F T

F F F F T T T T T F √

**16.** Invalid

*S Q R* [ *S* v( *Q* v *R* ) ] ⊃ *Q ∼ Q ∼ R / S*

T T T T T T F F T

T T F T T T F T T

T F T T T F T F T

T F F T F F T T T

F T T T T T F F F

F T F T T T F T F

F F T T T F T F F

F F F F F T T T F √

**17.** Invalid

*S Q R* [ ( *S* ***·*** *Q* )***·*** *R* ] ⊃ *Q Q R / ∼ S*

T T T T T T T T F √

T T F T F T T F F

T F T F F T F T F

T F F F F T F F F

F T T F F T T T T

F T F F F T T F T

F F T F F T F T T

F F F F F T F F T

**18.** Valid

*P Q R S ∼* (*∼ S* v *Q* ) ⊃( *P* v *R* ) *∼ Q ∼ P ∼ R / ∼ S*

T T T T F F T T T F F F F

T T T F F T T T T F F F T

T T F T F F T T T F F T F

T T F F F T T T T F F T T

T F T T T F F T T T F F F

T F T F F T T T T T F F T

T F F T T F F T T T F T F

T F F F F T T T T T F T T

F T T T F F T T T F T F F

F T T F F T T T T F T F T

F T F T F F T T F F T T F

F T F F F T T T F F T T T

F F T T T F F T T T T F F

F F T F F T T T T T T F T

F F F T T F F F F T T T F

F F F F F T T T F T T T T

**19.** Invalid

*P Q P* ⊃ *Q Q* ⊃ *P / P* v *Q*

T T T T T

T F F T T

F T T F T

F F T T F √

**20.** Valid

*P Q R* ( *P* ***·*** *Q* )v *R ∼ Q / R*

T T T T T F T

T T F T T F F

T F T F T T T

T F F F F T F

F T T F T F T

F T F F F F F

F F T F T T T

F F F F F T F

**21.** Valid

*P Q R P* ⊃( *Q* v *~ R* ) *Q* ⊃*~ R / P* ⊃ *~ R*

T T T T T F F F F F

T T F T T T T T T T

T F T F F F T F F F

T F F T T T T T T T

F T T T T F F F T F

F T F T T T T T T T

F F T T F F T F T F

F F F T T T T T T T

**22.** Invalid

*P Q R* ( *P* · *Q* ) ≡ ( *R* ⊃ *P* ) ∼ *Q* v ∼ *R* / *R*

T T T T T T F F F T

T T F T T T F T T F √

T F T F F T T T F T

T F F F F T T T T F

F T T F T F F F F T

F T F F F T F T T F

F F T F T F T T F T

F F F F F T T T T F

**23.** Invalid

*P S P* ⊃ ( ∼ *P* v∼ *S* ) ∼ *P*  / ∼ *S*

T T F F F F F F

T F T F T T F T

F T T T T F T F √

F F T T T T T T

**24.** Invalid

*R S R* ⊃ *S* ~ *S* / *R*

T T T F T

T F F T T

F T T F F

F F T T F √

**25.** Invalid

*P Q S* ( *P* v *Q* ) ≡ *S* / *P*

T T T T T T

T T F T F T

T F T T T T

T F F T F T

F T T T T F √

F T F T F F

F F T F F F

F F F F T F √

**III.**

**1.** Valid. Let *J* = *January was the coldest month this year*, and *B* = *February was the coldest month this year.*

*J B* *J* v *B*  ~ *J* / *B*

T T T F T

T F T F F

F T T T T

F F F T F

There is no line where the premises are true and the conclusion is false.

**2.** Invalid. Let *J* = *June was the hottest month this year*, and *Y* = *July was the hottest month this year*.

*J Y J* v *Y Y / ~ J*

T T T T F √

T F T F F

F T T T T

F F F F T

**3.** Invalid. Let *E* = *Eddie is the tallest member of the family*, and *W* = *Walter is the tallest member of the family.*

*E W E* v *W W / ~ E*

T T T T F √

T F T F F

F T T T T

F F F F T

**4.** Invalid. Let *J* = *June has 31 days*, and *S* = *September has 31 days.*

*J S ~* ( *J* ***·*** *S* ) *~ J / ~ S*

T T F T F F

T F T F F T

F T T F T F √

F F T F T T

**5.** Invalid. Let *S* = *we stop interfering in other countries’ internal affairs*, and *E* = *we will find ourselves with more enemies than we can handle*.

*S E S* v *E S / ~ E*

T T T T F √

T F T T T

F T T F F

F F F F T

**6.** Invalid. Let *J* = *Jim is a hog farmer*, and *M* = *Mary Lynn is a hog farmer*.

*J M ~* ( *J* **·** *M* ) *~ M / ~ J*

T T F T F F

T F T F T F √

F T T F F T

F F T F T T

**7.** Valid. Let *L* = *Lee Ann is old enough to collect Social Security*, and *J* = *Johnny is old enough to collect Social Security.*

*L J ~* ( *L* v *J* ) *~ L / ~ J*

T T F T F F

T F F T F T

F T F T T F

F F T F T T

**8.** Invalid. Let *P* = *the prosecuting attorney’s claims are correct*, and *G* = *the defendant is guilty.*

*P G P* ⊃  *G G / P*

T T T T T

T F F F T

F T T T F √

F F T F F

**9.** Invalid. Let *P* = *the prosecuting attorney’s claims are correct*, and *G* = *the defendant is guilty.*

*P G P* ⊃ *G ~ G / P*

T T T F T

T F F T T

F T T F F

F F T T F √

**10.** Valid. Let *P* = *the prosecuting attorney’s claims are correct*, and *G* = *the defendant is guilty.*

*P G P* ⊃ *G ~ G / ~ P*

T T T F F

T F F T F

F T T F T

F F T T T

**11.** Invalid. Let *P* = *the prosecuting attorney’s claims are correct*, and *G* = *the defendant is guilty*,

*P G P* ⊃ *G G / ~ P*

T T T T F √

T F F F F

F T T T T

F F T F T

**12.** Invalid. Let *U* = *UFOs exist*, and *L* = *there is life on other planets.*

*U L U* ⊃ *L ~ U / ~ L*

T T T F F

T F F F T

F T T T F √

F F T T T

**13.** Invalid. Let *U* = *UFOs exist*, and *L* = *there is life on other planets.*

*U L U* ⊃ *L ~ U / L*

T T T F T

T F F F F

F T T T T

F F T T F √

**14.** Invalid. Let *P* = *I am the president of the United States*, and *W* = *I live in the White House.*

*P W P* ⊃  *W ~ P / ~ W*

T T T F F

T F F F T

F T T T F √

F F T T T

**15.** Valid. Let *W* = *I live in the White House*, and *P* = *I am the president of the United States.*

*W P W* ⊃ *P ~ P / ~ W*

T T T F F

T F F T F

F T T F T

F F T T T

**16.** Valid. Let *V* = *you take 1000 mg of Vitamin C every day*, and *C* = *you will get a cold.*

*V C V* ⊃  *~ C C / ~ V*

T T F F T F

T F T T F F

F T T F T T

F F T T F T

**17.** Invalid. Let *V* = *you take 1000 mg of Vitamin C every day*, and *C* = *you will get a cold.*

*V C V* ⊃ *~ C ~ C / V*

T T F F F T

T F T T T T

F T T F F F

F F T T T F √

**18.** Invalid. Let *R* = *Robert went south on I-15 from Las Vegas*, and *L* = *Robert got to Los Angeles.*

*R L R* ⊃ *L ~ R / ~ L*

T T T F F

T F F F T

F T T T F √

F F T T T

**19.** Invalid. Let *J* = *you did finish the job by Friday*, and *B* = *you did get the bonus.*

*J B ~ J* ⊃  *~ B J / B*

T T F T F T T

T F F T T T F √

F T T F F F T

F F T T T F F

**20.** Invalid. If we let *J* = *you finished the job by Friday*, and *B* = *you got the bonus.*

*J B J* ⊃ *B ~ J / ~ B*

T T T F F

T F F F T

F T T T F √

F F T T T

***Exercises 7G.2***

**1.** Valid. Let *B* = *Barbara goes to the party*, *J* = *Johnny goes to the party*, and *L* = *Lee Ann has to pick up Mary Lynn:*

*B J L* (*B* v *J*) ⊃ ~ *L* ~ *B* *L* / ~ *J*

T T T T F F F T F

T T F T T T F F F

T F T T F F F T T

T F F T T T F F T

F T T T F F T T F

F T F T T T T F F

F F T F T F T T T

F F F F T T T F T

**2.** Valid. Let *B* = *you take a Breathalizer test*, and *A* = *you get arrested for DUI.*

*B* *A* *B* v *A ~ B / A*

T T T F T

T F T F F

F T T T T

F F F T F

**3.** Invalid. Let *P* = *animals feel pain*, *L* = *animals learn from experience*, and *C* = *animals are conscious.*

*P L C* ( *P* v *L* ) ⊃ *C ~ P ~ L / C*

T T T T T F F T

T T F T F F F F

T F T T T F T T

T F F T F F T F

F T T T T T F T

F T F T F T F F

F F T F T T T T

F F F F T T T F √

**4.** Invalid. Let *C* = *animals are conscious*, *P* = *animals do feel pain*, and *R* = *animals do have rights.*

*C P R* (*~ C* v *~ P*) ⊃ *~ R ~ R ~ P / ~ C*

T T T F F F T F F F F

T T F F F F T T T F F

T F T F T T F F F T F

T F F F T T T T T T F √

F T T T T F F F F F T

F T F T T F T T T F T

F F T T T T F F F T T

F F F T T T T T T T T

**5.** Valid. Let *R* = *you are right*, and *W* = *you are wrong.*

*R* *W* *R* v *W ~ R / W*

T T T F T

T F T F F

F T T T T

F F F T F

**6.** Invalid. Let *E* = *Elvis sold the most records of all time*, *B* = *the Beatles sold the most records of all time*, and *C* = *I won the contest.*

*E B C* (*E* v *B*) ⊃ *~ C ~ B / C*

T T T T F F F T

T T F T T T F F

T F T T F F T T

T F F T T T T F √

F T T T F F F T

F T F T T T F F

F F T F T F T T

F F F F T T T F √

**7.** Valid. Let *E* = *X is an even number*, and *D* = *X is divisible by 2.*

*E D E* ⊃ *D ~ D / ~ E*

T T T F F

T F F T F

F T T F T

F F T T T

**8.** Valid. Let *E* = *X is an even number*, and let *D* = *X is divisible by 2.*

*E D ~ E* ⊃ *~ D D / E*

T T F T F T T

T F F T T F T

F T T F F T F

F F T T T F F

**9.** Invalid. Let *J* = *Joyce went south on 1-15 from Las Vegas*, and *L* = *Joyce got to Los Angeles.*

*J L J* ⊃ *L ~ J / ~ L*

T T T F F

T F F F T

F T T T F √

F F T T T

**10.** Invalid. Let *F* = *you did finish the job by Friday*, and *B* = *you did get the bonus.*

*F B ~ F* ⊃ *~ B F / B*

T T F T F T T

T F F T T T F √

F T T F F F T

F F T T T F F

**11.** Invalid. Let *F* = *you did finish the job by Friday*, and *B* = *you did get the bonus.*

*F B F* ⊃ *B ~ F / ~ B*

T T T F F

T F F F T

F T T T F √

F F T T T

**12.** Valid. Let *E* = *Eddie can vote*, and *R* = *he (Eddie) is registered.*

*E R E* ≡ *R R / E*

T T T T T

T F F F T

F T F T F

F F T F F

**13.** Valid. Let *E* = *Eddie can vote*, and *R* = *he (Eddie) is registered.*

*E R E* ≡ *R ~ R / ~ E*

T T T F F

T F F T F

F T F F T

F F T T T

**14.** Valid. Let *E* = *Eddie can vote*, and *R* = *he (Eddie) is registered.*

*E R E* ≡ *R ~ E / ~ R*

T T T F F

T F F F T

F T F T F

F F T T T

**15.** Valid. Let *L* = *Linda can think*, and *C* *= she (Linda) is conscious.*

*L C L* ≡ *C C / L*

T T T T T

T F F F T

F T F T F

F F T F F

***Exercises 7H.1***

**I.**

**1.** Invalid

*R Q S* ( *R* **·** *Q* ) v *S* *R* ~ *Q* / ~ *S*

T F T F T T T F √

**2.** Valid

*R Q S* ( *R* v *Q* )***·*** *S Q ~ R / S*

F T F T F T T F

Since there is no other way to get the conclusion false except to make *S* false, the first premise cannot then be true, because one of the conjuncts, *S*, is false. Since it is impossible to get all the premises true and the conclusion false at the same time, we have shown that the argument is valid.

**3.** Valid. Since there are three ways to get the conclusion false, we can instead start by making the second and the third premise both true, because there is only one truth value for each that can do this:

*R Q S* ( *R* ***·*** *Q* )v *S R ~ Q / S* ***·*** *R*

T F F T T

Now, since the conclusion has one of the conjuncts, *R*, true, in order to get the conclusion false, *S* must be false.

*R Q S* ( *R* ***·*** *Q* )v *S R ~ Q / S* ***·*** *R*

T F F F F T T F

This assignment of truth values makes the conclusion false, the second premise true, and the third premise true. However, the first premise is false with this assignment of truth values, so this cannot give us all true premises and a false conclusion. The indirect truth table method has shown that it is impossible to get all the premises true and the conclusion false, at the same time. Therefore, the argument is valid.

**4.** Invalid

*P Q R S* (*P* ***·*** *Q*)v(*R* ***·*** *S*) *Q S R / P*

F T T T F T T T T T F √

**5.** Invalid

*P Q R S* [*P*  v(*Q* v *S* )]**⊃** *R ~ P ~ Q ~ S / ~ R*

F F T F F F T T T T F √

**6.** Valid

*P Q S* (*P* v *Q*)***·***( *~ S* ***·***  *Q*) *~ S ~ Q / ~ P*

T F F T F T F T T F

**7.** Invalid

*Q R S* ( *~ S* v *~ Q* ) **⊃** *~ R S Q / R*

T F T F F F T T T T F √

**8.** Valid

*Q R S R* **⊃**( *Q* ***·*** *~ S* ) *S ~ Q / ~ R*

F T T F F F T T F

Since there is no other way to get the third premise true except for *Q* to be false, the consequent of the first premise will be false. To get the conclusion false, *R* is true, making the antecedent of the first premise true. There is no way to get the first premise true with these assignments. Since it is impossible to get all the premises true and the conclusion false at the same time, we have shown that the argument is valid.

**9.** Valid

*P Q R S ~* (*P* v *Q*)v *~* (*R* ***·*** *S*) *P* ***·*** *Q R / ~ S*

T T T T F T F F T T T F

The only assignments available to get the conclusion false and the second and third premises true make it impossible to then get the first premise true. Since it is impossible to get all the premises true and the conclusion false at the same time, we have shown that the argument is valid.

**10.** Invalid

*P Q R* ( *P* ***·*** *Q* ) v *~ R ~ P ~ Q / R*

F F F F T T T T F√

**11.** Valid

*P Q R S* ( *R* v *S* )**⊃**( *P* ***·*** *Q* ) *~ S ~ Q / ~ R*

T F T F T F F T T F

Since there is no other way to get the conclusion false except for *R* to be true, the antecedent in the first premise then is true. In order to get the third premise true, *Q* must be false, which results in the consequent of the first premise false. So, it will become impossible to get the first premise true with these truth value assignments.

**12.** Since there are three ways to get the conclusion false, we can instead start by making the second and the third premise both true, because only one truth value for each will do this.

*R Q S* ( *R* ***·*** *Q* )v *S R Q / S* ***·*** *R*

T T T T T

Now, in order to get the conclusion false, *S* must be false.

*R Q S* ( *R* ***·***  *Q* )v *S R Q / S* ***·*** *R*

T T F T T T T F √

This assignment of truth values makes the conclusion false, and all the premises true; therefore, the argument is invalid.

**13.** Although there is only one way to get the conclusion false, there are three ways to get each premise true. Therefore, we might need to explore all the possibilities:

(Option 1)

*R Q S* ( *R* v *Q* )⊃ *~ S Q* v *S / R*

F T T T F F T F

This assignment of truth values makes the conclusion false, and the second premise true.However, since the first premise is false with this assignment, this cannot give us all true premises and a false conclusion. Therefore, we must try the next option.

(Option 2)

*R Q S* ( *R* v *Q* ) ⊃ *~ S Q* v *S / R*

F T F T T T T F √

This assignment of truth values makes the conclusion false, and all the premises true; therefore, the argument is invalid. (Thus, it is not necessary to try the other option.)

**14.** Although there is only one way to get the conclusion false, there are three ways to get each premise true. Therefore, we might need to explore all the possibilities:

(Option 1)

*P Q R S*  ( *R* v  *S )* **⊃**( *P* ***·*** *Q*) *~ S* v *~ Q / ~ R*

F T T T F F F T T F

This assignment makes the conclusion false and the second premise true. However, the antecedent of the first premise is true, but the consequent is false no matter what truth value *P* is assigned (because one of the conjuncts, *Q*,is false). Thus, the first premise will be false no matter what truth value *P* is assigned. Since it is impossible to get all the premises true and the conclusion false at the same time, with this assignment of truth values, we must try the next option.

(Option 2)

*P Q R S* ( *R* v *S* )**⊃**( *P* ***·***  *Q* ) *~ S* v *~ Q / ~ R*

T T T F T T T T T F F √

This assignment of truth values makes the conclusion false, and all the premises true; therefore, the argument is invalid.

**15.** Invalid

*R S P Q* ~ ( *R* v *S*) ⊃ ( *P* v *Q* ) ~ *S* v *Q* ~ *Q* ≡ *R* / ~ *R*

T F F F T T T T T T F √

**16.** Invalid

*R Q S* ( *R* **·** *Q* ) v  *~ S R* v ~ *Q* ~ *Q* v ~ *S* / ~ *S* **·**  *R*

F F F F T T T T T T T T F √

**17.** Invalid

*R Q S* ~ ( ~ *R* v ~ *Q* ) ⊃ ~ *S*  *Q* ⊃ *S*  / ~ *R* ⊃ *S*

F F F F T T T T T T F √

**18.** Invalid

*R S P Q*  ( *R* v ~ *S* ) ⊃ ~ ( *P* **·**  *Q*) ~ *S* v ~ *Q* / ~ *R* **·**  *P*

F F T T F T T F √

**19.** Invalid

*P Q S R*  ~ [ *P* v ( *Q* v *S* ) ] ⊃ ~ *R* ~ *Q* ≡ ~ *S* / **~** *R* ⊃ *P*

F T T F T T F T F T F √

**20.** Invalid

*Q S R P* ( *Q* v *S* ) ⊃ ( ~ *R* **·** *P* ) ~ *Q* v *S* /~ *Q*  ⊃ ( *S* v *P* )

F F F F T F T T T F F √

**II.**

**1.** Valid. Let *B* = *Barbara goes to the party*, *J* = *Johnny goes to the party*, and *L* = *Lee Ann has to pick up Mary Lynn.*

*B J L* ( *B*  v *J* ) ⊃ ~ *L* ) ~ *B* *L* / ~ *J*

F T T T F F T T F

**2.** Valid. Let *B* = *you take a Breathalizer test*, and *A* = *you get arrested for DUI.*

*B A B* v *A ~ B / A*

F F F T F

Since the only way to get the conclusion false is for *A* to be false, and the only way to get the second premise true is for *B* to be false, it will be impossible to then get the first premise true. Thus, the argument is valid*.*

**3.** Invalid. Let *P* = *animals feel pain*, *L* = *animals learn from experience*, and *C* = *animals are conscious.*

*P L C* ( *P* v *L* ) ⊃ *C ~ P ~ L / ~ C*

F F T F T T T F √

**4.** Invalid. Let *P* = *animals feel pain*, *L* = *animals learn from experience*, and *C* = *animals are conscious.*

*P L C* ( *P* v *L* ) ⊃ *C ~ P ~ L / C*

F F F F T T T F √

**5.** Invalid. Let *C* = *animals are conscious*, *P* = *animals do feel pain*, and *R* = *animals do have rights.*

*C P R* ( *~ C* v *~ P* ) ⊃ *~ R ~ R ~ P / ~ C*

T F F F T T T T T T F √

**6.** Invalid. Let *C* = *animals are conscious*, *P* = *animals do feel pain*, and *R* = *animals do have rights.*

*C P R* ( *~ C* v *~ P* ) ⊃ *~ R C P / R*

T T F F F F T T T T F √

**7.**  Valid. Let *R* = *you are right*, and *W* = *you are wrong.*

*R W R* v *W ~ R / W*

F F F T F

Since the only way to get the conclusion false is for *W* to be false, and the only way to get the second premise true is to for *R* to be false, it will be impossible to then get the first premise true. Thus, the argument is valid*.*

**8.** Invalid. Let *B* = *Bill committed the crime*, *G* = *Gus committed the crime*, *K* = *Kate committed the crime*, *M* = *Mike did do it*, and *N* = *Tina did do it*.

*B G K M N* [( *B* v *G*)v *K* ] ⊃( *~ M* ***·***  *~ N*)  *~ B ~ G ~ K / M*

F F F F F F F T T T T T T T F √

**9.** Invalid. Let *E* = *Elvis sold the most records of all time*, *B* = *the Beatles sold the most records of all time*, and *C* = *I won the contest.*

*E B C* ( *E* v *B* ) ⊃ *~ C ~ B / C*

F F F F T T T F √

**10.** Invalid. Let *O* = *I save $1 a day*, *R* = *I will be rich in 10 years*, *W* = *I save $2 a day*, and *H* = *I save $3 a day.*

*O R W H O* ⊃ *~ R W* ⊃ *~ R H* ⊃ *~ R ~ O ~ W ~ H / ~ R*

F T F F T F T F T F T T T F √

**11.** Valid. Let *E* = *X is an even number*, and *D* = *X is divisible by 2.*

*E D E* ⊃ *D ~ D / ~ E*

T F F T F

Since the only way to get the conclusion false is for *E* to be true, and the only way to get the second premise true is for *D* to be false, it will be impossible to then get the first premise true. Thus, the argument is valid*.*

**12.** Valid. Let *E* = *X is an even number*, and let *D* = *X is divisible by 2.*

*E D ~ E* ⊃ *~ D D / E*

F T T F F T F

Since the only way to get the conclusion false is for *E* to be false, and the only way to get the second premise true is for *D* to be true, it will be impossible to then get the first premise true. Thus, the argument is valid*.*

**13.** Invalid. Let *J* = *Joyce went south on 1-15 from Las Vegas*, and *L* = *Joyce got to Los Angeles.*

*J L J* ⊃ *L ~ J / ~ L*

F T T T F √

**14.** Invalid. Let *F* = *you did finish the job by Friday*, and *B* = *you did get the bonus.*

*F B ~ F* ⊃ *~ B F / B*

T F F T T T F √

**15.** Invalid. Let *F* = *you did finish the job by Friday*, and *B* = *you did get the bonus.*

*F B F* ⊃ *B ~ F / ~ B*

F T T T F √

**16.** Valid. Let *E* = *Eddie can vote*, and *R* = *he (Eddie) is registered.*

*E R E* ≡ *R R / E*

F T F T F

Since the only way to get the conclusion false is for *E* to be false, and the only way to get the second premise true is for R to be true, it will be impossible to then get the first premise true. Thus, the argument is valid*.*

**17.** Valid. Let *E* = *Eddie can vote*, and *R* = *he (Eddie) is registered.*

*E R E* ≡ *R E / R*

T F F T F

Since the only way to get the conclusion false is for *R* to be false, and the only way to get the second premise true is for *E* to be true, it will be impossible to then get the first premise true. Thus, the argument is valid*.*

**18.** Valid. Let *E* = *Eddie can vote*, and *R* = *he (Eddie) is registered.*

*E R E* ≡ *R ~ R / ~ E*

T F F T F

**19.** Valid. Let *E* = *Eddie can vote*, and *R* = *he (Eddie) is registered.*

*E R E* ≡ *R ~ E / ~ R*

F T F T F

Since the only way to get the conclusion false is for *R* to be true, and the only way to get the second premise true is for *E* to be false, it will be impossible to then get the first premise true. Thus, the argument is valid*.*

**20.** Valid. Let *L* = *Linda can think*, and *C* *= she (Linda) is conscious.*

*L C L* ≡ *C C L*

F T F T F

Since the only way to get the conclusion false is for L to be false, and the only way to get the second premise true is for *C* to be true, it will be impossible to then get the first premise true. Thus, the argument is valid*.*