

Solutions to Workbook Exercises

Unit 3:

Symbolizations

Ex. Disambiguation

Consider the following ambiguous sentences. Try to phrase them in such a way as to disambiguate them. Then symbolize them.

- (a) Abe will read a couple of textbooks or listen to some lectures and solve some problems.

1: Either Abe will read a couple of textbooks or both listen to some lectures and solve some problems.

2: Abe will read a couple of textbooks or listen to some lectures, but in any event he will solve some problems.

L: Abe will listen to some lectures

R: Abe will read some textbooks

S: Abe will solve some problems

[1] $R \vee (L \bullet S)$

[2] $(R \vee L) \bullet S$

- (b) If Ann finishes her graduate studies then she will work as a scientist or she will become a teacher.

1: If Ann finishes her graduate studies then she will either work as a scientist or become a teacher.

2: Either Ann will work as a scientist if she finishes her graduate studies or she will become a teacher.

G: Ann finishes her graduate studies

S: Ann will work as a scientist

T: Ann will become a teacher

[1] $G \rightarrow (S \vee T)$

[2] $(G \rightarrow S) \vee T$

- (c) Ann will finish her graduate studies and she will work as a scientist or she will become a teacher if she can live with little pay.

1: Either Ann will both finish her graduate studies and work as a scientist or she will become a teacher if she can live with little pay.

2: Ann will finish her graduate studies and if she can live with little pay then she will either work as a scientist or become a teacher.

3: Ann will finish her graduate studies and either she will work as a scientist or if she can live with little pay then she will become a teacher.

4: If Ann can live with little pay then she will both finish her graduate studies and either work as a scientist or become a teacher.

5: If Ann can live with little pay then either she will both finish her graduate studies and work as a scientist or she will become a teacher.

G: Ann finishes her graduate studies
 L: Ann can live with little pay
 S: Ann will work as a scientist
 T: Ann will become a teacher

[1]	$(G \bullet S) \vee (L \rightarrow T)$
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[2]	$G \bullet (L \rightarrow (S \vee T))$
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[3]	$G \bullet (S \vee (L \rightarrow T))$
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[4]	$L \rightarrow (G \bullet (S \vee T))$
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[5]	$L \rightarrow ((G \bullet S) \vee T)$
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Ex. Symbolization 1

Symbolize the following statements:

D: Ann diets **F:** Ann is fat **I:** Billy diets
E: Ann exercises **H:** Ann is healthy **O:** Billy jogs
S: Ann swims **T:** Billy is fat
J: Ann jogs

(a) If Ann does not exercise, she will get fat.	$\sim E \rightarrow F$
(b) If Ann either diets or exercises, she will get healthier.	$(D \vee E) \rightarrow H$
(c) Ann will either diet and swim or she will diet and jog.	$(D \bullet S) \vee (D \bullet J)$
(d) Ann will diet and she will either swim or jog.	$D \bullet (S \vee J)$
(e) If Ann swims then she will not jog.	$S \rightarrow \sim J$
(f) Ann will be healthy if she both diets and either swims or jogs.	$(D \bullet (S \vee J)) \rightarrow H$
(g) Ann will be healthy just in case both she and Billy will jog.	$H \equiv (J \bullet O)$
(h) Billy will jog if but only if either Ann jogs or exercises	$O \equiv (J \vee E)$
(i) Provided that Billy and Ann are on a diet, they will both be jogging.	$(I \bullet D) \rightarrow (O \bullet J)$
(j) Ann will either swim or jog provided that Billy either jogs or is on a diet.	$(O \vee I) \rightarrow (S \vee J)$
(k) If either Ann or Billy are getting fat that if Ann does not diet then Billy will not diet.	$(F \vee T) \rightarrow (\sim D \rightarrow \sim I)$
(l) Assuming that Ann and Billy are both on a diet, Ann will jog when and only when Billy jogs.	$(D \bullet I) \rightarrow (J \equiv O)$
(m) Either Ann and Billy will diet or they will both jog.	$(D \bullet I) \vee (J \bullet O)$
(n) If either Ann and Billy both diet or they both jog then if Ann is not getting fat then Billy won't be getting fat.	$((D \bullet I) \vee (J \bullet O)) \rightarrow (\sim F \rightarrow \sim T)$

Ex. Symbolization 2

Symbolize the following statements:

D: Ann diets **F:** Ann is fat **J:** Ann jogs **I:** Billy diets
E: Ann exercises **H:** Ann is healthy **S:** Ann swims **O:** Billy jogs
T: Billy is fat

(a) If Ann swims, then she will not jog though she will diet.	$S \rightarrow (\sim J \bullet D)$
(b) If Ann swims then she will not jog, but she will diet.	$(S \rightarrow \sim J) \bullet D$
(c) If Ann swims then she will not jog, and if she jogs then she will not swim.	$(S \rightarrow \sim J) \bullet (J \rightarrow \sim S)$
(d) If Ann is on a diet then Billy will be on a diet, but he will not jog.	$(D \rightarrow I) \bullet \sim O$
(e) If Ann is on a diet, then Billy will be on a diet but he will not jog.	$D \rightarrow (I \bullet \sim O)$
(f) Ann will jog just in case Billy jogs, and Billy will go on a diet just in case Ann goes on a diet.	$(J \equiv O) \bullet (I \equiv D)$
(g) If Ann jogs, then she will not be getting fat provided that she goes on a diet.	$J \rightarrow (D \rightarrow \sim F)$
(h) If Ann diets then she will not be getting fat, assuming that she is healthy.	$H \rightarrow (D \rightarrow \sim F)$

Ex. Symbolization 3

A: Ann is on a diet **L:** Larry is getting fat
B: Betty is on a diet. **M:** Martin is getting fat
C: Charlie is on a diet **N:** Newt is getting fat

(a) Either Ann is on a diet or Betty and Charlie are both on a diet.	$A \vee (B \bullet C)$
(b) It is both the case that either Ann or Betty is on a diet and that Charlie is on a diet.	$(A \vee B) \bullet C$
(c) Either Ann or Betty is on a diet, and in any event Charlie is on a diet.	$(A \vee B) \bullet C$
(d) Either Larry and Martin are getting fat or Martin and Newt are getting fat	$(L \bullet M) \vee (M \bullet N)$
(e) Either Ann or Betty is on a diet; however, it is also the case that either Betty or Charlie is a on a diet.	$(A \vee B) \bullet (B \vee C)$
(f) Either both Larry and Martin are not getting fat or Newt is not getting fat.	$(\sim L \bullet \sim M) \vee \sim N$

Exercise Neither-Nor, Not-both – 1

Provide the symbolizations of the following statements using the provided symbolization key:

A: Ann is on a diet D: Dirk is on a diet
 B: Betty is on a diet. E: Evelyn is on a diet.
 C: Charlie is on a diet F: Frank is on a diet

(a) Ann and Betty are both on a diet	$A \bullet B$
(b) Ann and Charlie are not both on a diet.	$\sim(A \bullet C)$
(c) Evelyn and Frank are both not on a diet.	$\sim E \bullet \sim F$
(d) Neither Dirk nor Charlie are on a diet.	$\sim D \bullet \sim C$
(e) Ann and Dirk are not both on a diet.	$\sim(A \bullet D)$
(f) Betty and Frank are both not on a diet.	$\sim B \bullet \sim F$
(g) Neither Frank nor Evelyn are on a diet.	$\sim F \bullet \sim E$
(h) Ann is on a diet but neither Betty nor Charlie is on a diet.	$A \bullet (\sim B \bullet \sim C)$
(i) Betty and Charlie are both not on a diet though Ann is on a diet.	$(\sim B \bullet \sim C) \bullet A$
(j) Ann is on a diet but not both Betty and Evelyn are on a diet	$A \bullet \sim(B \bullet E)$
(k) If neither Betty nor Evelyn is on a diet then Charlie and Frank are not both on a diet.	$(\sim B \bullet \sim E) \rightarrow \sim(C \bullet F)$
(l) If Betty and Evelyn are not both on a diet then Charlie and Frank are both not on a diet.	$\sim(B \bullet E) \rightarrow (\sim C \bullet \sim F)$
(m) Neither Ann nor Betty is on a diet if and only if Charlie and Dirk are not both on a diet.	$(\sim A \bullet \sim B) \equiv \sim(C \bullet D)$
(n) If Ann and Betty both are not on a diet and Evelyn is not on diet then neither Charlie nor Dirk is on a diet.	$[(\sim A \bullet \sim B) \bullet \sim E] \rightarrow (\sim C \bullet \sim D)$
(o) If Ann and Betty are not both on a diet then either Evelyn is not on diet or Charlie and Dirk are not both on a diet.	$\sim(A \bullet B) \rightarrow [\sim E \vee \sim(C \bullet D)]$

Exercise Neither-Nor, Not-both – 2

Provide two equivalent symbolizations of the following statements using the provided symbolization key:

A: Ann is on a diet D: Dirk is on a diet
 B: Betty is on a diet. E: Evelyn is on a diet.
 C: Charlie is on a diet F: Frank is on a diet

(a) Not both Charlie and Ann are on a diet.	$\sim(C \bullet A)$	$\sim C \vee \sim A$
(b) Neither Ann nor Betty are on a diet.	$\sim A \bullet \sim B$	$\sim(A \vee B)$
(c) Ann and Betty are not both on a diet.	$\sim(A \bullet B)$	$\sim A \vee \sim B$
(d) Neither Betty nor Evelyn are on a diet.	$\sim B \bullet \sim E$	$\sim(B \vee E)$
(e) Charlie and Frank are both not on a diet.	$\sim C \bullet \sim F$	$\sim(C \vee F)$
(f) Neither Ann nor Betty are on a diet.	$\sim A \bullet \sim B$	$\sim(A \vee B)$
(g) Both Charlie and Frank are not on a diet.	$\sim C \bullet \sim F$	$\sim(C \vee F)$
(h) Betty and Evelyn are not both on a diet.	$\sim(B \bullet E)$	$\sim B \vee \sim E$
(i) Neither Betty nor Evelyn is on a diet though Ann is on diet.	$(\sim B \bullet \sim E) \bullet A$	$\sim(B \vee E) \bullet A$
(j) If Ann is on a diet then Betty and Charlie are not both on a diet.	$A \rightarrow \sim(B \bullet C)$	$A \rightarrow (\sim B \vee \sim C)$
(k) Either Ann is not on a diet or Betty and Charlie are not both on a diet.	$\sim A \vee \sim(B \bullet C)$	$\sim A \vee (\sim B \vee \sim C)$
(l) It is not the case that neither Ann nor Betty is on a diet	$\sim(\sim A \bullet \sim B)$	$\sim\sim(A \vee B)$
(m) It is not the case that Charlie and Dirk are not both on a diet.	$\sim\sim(C \bullet D)$	$\sim(\sim C \vee \sim D)$
(n) It would be a lie to say that Evelyn and Ann are both not on a diet.	$\sim(\sim E \bullet \sim A)$	$\sim\sim(E \vee A)$
(o) It is neither the case that Ann is not on a diet nor that Betty is not on a diet.	$\sim\sim A \bullet \sim\sim B$	$\sim(\sim A \vee \sim B)$

Exercise Neither-Nor, Not-both – 3

In this exercise, you will be given the same statements as you were given in Exercise Neither-Nor, Not-both – 1. This time you should only provide the symbolizations in terms of negations and disjunctions.

A: Ann is on a diet D: Dirk is on a diet
 B: Betty is on a diet. E: Evelyn is on a diet.
 C: Charlie is on a diet F: Frank is on a diet

(b) Ann and Charlie are not both on a diet.	$\sim A \vee \sim C$
(c) Evelyn and Frank are both not on a diet.	$\sim(E \vee F)$
(d) Neither Dirk nor Charlie are on a diet.	$\sim(D \vee C)$
(e) Ann and Dirk are not both on a diet.	$\sim A \vee \sim D$
(f) Betty and Frank are both not on a diet.	$\sim(B \vee F)$
(g) Neither Frank nor Evelyn are on a diet.	$\sim(F \vee E)$
(h) Ann is on a diet but neither Betty nor Charlie is on a diet.	$A \bullet \sim(B \vee C)$
(i) Betty and Charlie are both not on a diet though Ann is on a diet.	$\sim(B \vee C) \bullet A$
(j) Ann is on a diet but not both Betty and Evelyn are on a diet	$A \bullet (\sim B \vee \sim E)$
(k) If neither Betty nor Evelyn is on a diet then Charlie and Frank are not both on a diet.	$\sim(B \vee E) \rightarrow (\sim C \vee \sim F)$
(l) If Betty and Evelyn are not both on a diet then Charlie and Frank are both not on a diet.	$(\sim B \vee \sim E) \rightarrow \sim(C \vee F)$
(m) Neither Ann nor Betty is on a diet if and only if Charlie and Dirk are not both on a diet.	$\sim(A \vee B) \equiv (\sim C \vee \sim D)$
(n) If Ann and Betty both are not on a diet and Evelyn is not on diet then neither Charlie nor Dirk is on a diet.	$[\sim(A \vee B) \bullet \sim E] \rightarrow \sim(C \vee D)$
(o) If Ann and Betty are not both on a diet then either Evelyn is not on diet or Charlie and Dirk are not both on a diet.	$(\sim A \vee \sim B) \rightarrow [\sim E \vee (\sim C \vee \sim D)]$

Exercise Exclusive-Disjunction

Symbolize the following statement given the symbolization key provided

A: Ann is on a diet C: Charlie is on a diet

B: Betty is on a diet. D: Dirk is on a diet

(a) Ann or Betty are on a diet but not both.

$$(A \vee B) \bullet \sim(A \bullet B)$$

(b) Betty or Charlie are on a diet but not both.

$$(B \vee C) \bullet \sim(B \bullet C)$$

(c) Either Charlie or Dirk is on a diet but not both.

$$(C \vee D) \bullet \sim(C \bullet D)$$

(d) If Ann or Charlie are on a diet though not both then either Betty or Dirk are on a diet.

$$[(A \vee C) \bullet \sim(A \bullet C)] \rightarrow (B \vee D)$$

Exercise Unless

Symbolize the following statements in two equivalent ways.

A: Ann will go on a diet D: Ann's doctor objects to Ann going on a diet
 B: Betty will go on a diet. E: Evelyn forbids Betty to go on a diet
 C: Charlie will go on a diet F: Frank will go on a diet

(a) Ann will not go on a diet unless her doctor objects to her going on a diet.	$\sim D \rightarrow A$
	$D \vee A$
(b) Betty will not go on a diet unless Evelyn forbids her to do so.	$\sim E \rightarrow B$
	$E \vee B$
(c) Charlie will go on a diet unless Frank goes on a diet.	$\sim F \rightarrow C$
	$F \vee C$
(d) Ann will not go on a diet unless Betty goes on a diet.	$\sim B \rightarrow \sim A$
	$B \vee \sim A$
(e) Unless Ann goes on a diet, Betty will not go on a diet.	$\sim A \rightarrow \sim B$
	$A \vee \sim B$
(f) Betty and Ann will go on a diet unless Ann's doctor objects to Ann's going on a diet.	$\sim D \rightarrow (B \bullet A)$
	$D \vee (B \bullet A)$
(g) Charlie and Frank will both not go on a diet unless both Betty and Ann go on a diet.	$\sim(B \bullet A) \rightarrow (\sim C \bullet \sim F)$
	$(B \bullet A) \vee (\sim C \bullet \sim F)$
(h) Either Ann or Betty will not go on a diet unless either Charlie or Frank go on a diet.	$\sim(C \vee F) \rightarrow (\sim A \vee \sim B)$
	$(C \vee F) \vee (\sim A \vee \sim B)$
(i) Ann will go on a diet just in case Betty goes on a diet, unless Ann's doctor objects to Ann's going on a diet.	$\sim D \rightarrow (A \equiv B)$
	$D \vee (A \equiv B)$
(j) Ann will go on a diet unless Frank does not go on a diet.	$\sim \sim F \rightarrow A$
	$\sim F \vee A$

Exercise Only If – 1

Offer two paraphrases of the following only-if conditionals and symbolize them:

(a) Trippy is a cat only if Trippy can meow.

1: If Trippy is a cat then [this means that] Trippy can meow.

2: If Trippy cannot meow, then Trippy is not a cat

C: Trippy is a cat

[1] $C \rightarrow M$

M: Trippy can meow

[2] $\sim M \rightarrow \sim C$

(b) Tramp is a dog only if Tramp can bark.

1: If Tramp is a dog then [this means that] Tramp can bark.

2: If Tramp cannot bark, then Tramp is not a dog.

B: Tramp can bark

[1] $D \rightarrow B$

D: Tramp is a dog

[2] $\sim B \rightarrow \sim D$

(c) Truppy is a fish only if Truppy can swim.

1: If Truppy is a fish then [this means that] Truppy can swim.

2: If Truppy cannot swim, then Truppy is not a fish.

F: Truppy is a fish

[1] $F \rightarrow S$

S: Truppy can swim

[2] $\sim S \rightarrow \sim F$

(d) It rains only if it is cloudy

1: If it rains then [this means that] it is cloudy.

2: If it is not cloudy, then it does not rain.

C: It is cloudy

[1] $R \rightarrow C$

R: It rains

[2] $\sim C \rightarrow \sim R$

(e) It snows only if it is cloudy

1: If it snows then [this means that] it is cloudy.

2: If it is not cloudy, then it does not snow.

C: It is cloudy

[1] $S \rightarrow C$

S: It snows

[2] $\sim C \rightarrow \sim S$

(e) It snows only if it is very cold.

1: If it snows then [this means that] it is very cold.

2: If it is not very cold, then it does not snow.

C: It is very cold

[1] $S \rightarrow C$

S: It snows

[2] $\sim C \rightarrow \sim S$

(f) I will pass logic only if I work very hard.

1: If I passed logic [this means that] I worked very hard.

2: If I don't work very hard, then I will not pass logic.

P: I pass logic

[1] $P \rightarrow W$

W: I work very hard

[2] $\sim W \rightarrow \sim P$

Exercise Only If – 2

Provide the symbolizations of the following statements using the provided symbolization key. Provide two equivalent symbolizations for ‘only if’.

A: Ann is on a diet E: Betty exercises
 B: Betty is on a diet. H: Ann is healthy
 C: Charlie is on a diet L: Betty is healthy

(a)	Ann will be healthy only if she goes on a diet.	$H \rightarrow A$
		$\sim A \rightarrow \sim H$
(b)	Betty will be healthy only if either she goes on a diet or starts exercising regularly.	$L \rightarrow (B \vee E)$
		$\sim(B \vee E) \rightarrow \sim L$
(c)	Ann will go on a diet only if both Betty and Charlie go on a diet.	$A \rightarrow (B \bullet C)$
		$\sim(B \bullet C) \rightarrow \sim A$
(d)	Betty will either go on a diet or start exercising regularly only if Ann goes on a diet.	$(B \vee E) \rightarrow A$
		$\sim A \rightarrow \sim(B \vee E)$
(e)	Charlie will go on a diet, only if Betty goes on a diet but Ann does not.	$C \rightarrow (B \bullet \sim A)$
		$\sim(B \bullet \sim A) \rightarrow \sim C$
(f)	Betty will exercise only if she does not go on a diet.	$E \rightarrow \sim B$
		$\sim\sim B \rightarrow \sim E$
(g)	Only if Charlie is on a diet will Ann go on a diet.	$A \rightarrow C$
	Paraphrase: Ann will go on a diet only if Charlie is on a diet.	$\sim C \rightarrow \sim A$
(h)	Only if Betty either is healthy or starts exercising will Charlie go on a diet.	$C \rightarrow (L \vee E)$
	Paraphrase: Charlie will go on a diet only if Betty either is healthy or exercises.	$\sim(L \vee E) \rightarrow \sim C$
(i)	Ann and Betty will be healthy only if they both go on a diet.	$(H \bullet L) \rightarrow (A \bullet B)$
		$\sim(A \bullet B) \rightarrow \sim(H \bullet L)$

Exercise Only-if – 3

Ascertain the truth or falsehood of the following claims:

- (a) You will get an A for this course *if* you get 95% on all your quizzes. true
 false
- (b) You will get an A for this course *only if* you get 95% on all your quizzes. true
 false
- (c) You will get an A for this course *if* you work hard. true
 false
- (d) You will get an A for this course *only if* you work hard. true
 false

Exercise All-Some-None-Not-All

Provide the symbolizations of the following statements using the provided symbolization key, on the understanding the expressions ‘all’ and ‘some’ can pertain at most to the group of six persons: Ann, Betty, Charlie, Dirk, Evelyn and Frank.

A: Ann is on a diet D: Dirk is on a diet
 B: Betty is on a diet. E: Evelyn is on a diet.
 C: Charlie is on a diet F: Frank is on a diet

(a) Ann, Betty and Charlie are all on a diet	$(A \bullet B) \bullet C$
(b) Dirk, Evelyn or Frank is on a diet.	$(D \vee E) \vee F$
(c) All six are on a diet	$((A \bullet B) \bullet (C \bullet D)) \bullet (E \bullet F)$
(d) At least one of the six is on a diet.	$((A \vee B) \vee (C \vee D)) \vee (E \vee F)$
(e) All girls from this group are on a diet.	$(A \bullet B) \bullet E$
(f) Some boys from this group are on a diet.	$(C \vee D) \vee F$
(g) There is a girl in this group who is on a diet.	$(A \vee B) \vee E$
(h) Betty and Charlie are not both on a diet	$\sim(B \bullet C)$ $\sim B \vee \sim C$
(i) Dirk, Evelyn and Frank are not all on a diet.	$\sim[(D \bullet E) \bullet F]$ $(\sim D \vee \sim E) \bullet \sim F$
(j) Neither Betty, Charlie nor Evelyn is on a diet.	$(\sim B \bullet \sim C) \bullet \sim E$ $\sim[(B \vee C) \vee E]$
(k) Not all girls in this group are on a diet	$\sim[(A \bullet B) \bullet E]$ $(\sim A \vee \sim B) \vee \sim E$
(l) No boys in this group are on a diet.	$(\sim C \bullet \sim D) \bullet \sim F$ $\sim[(C \vee D) \vee F]$
(m) Nobody in this group is on a diet.	$[(\sim A \bullet \sim B) \bullet (\sim C \bullet \sim D)] \bullet (\sim E \bullet \sim F)$ $\sim[(A \vee B) \vee (C \vee D)] \vee (E \vee F)$
(n) Not everybody in this group is on a diet.	$\sim[(A \bullet B) \bullet (C \bullet D)] \bullet (E \bullet F)$ $[(\sim A \vee \sim B) \vee (\sim C \vee \sim D)] \vee (\sim E \vee \sim F)$

Exercise Symbolizations – 4

Please symbolize the following statements, using the symbolization key provided.

A: Ann is on a diet L: Larry is getting fat
 B: Betty is on a diet. M: Martin is getting fat
 C: Charlie is on a diet N: Newt is getting fat

(a) Either both Ann and Betty are on a diet, or neither of them is.	$(A \bullet B) \vee (\sim A \bullet \sim B)$ $(A \bullet B) \vee \sim(A \vee B)$
(b) Either both Ann and Betty are on a diet, or not both of them are.	$(A \bullet B) \vee \sim(A \bullet B)$ $(A \bullet B) \vee (\sim A \vee \sim B)$
(c) Not both Larry and Martin are getting fat, though both Martin and Newt are getting fat.	$\sim(L \bullet M) \bullet (M \bullet N)$ $(\sim L \vee \sim M) \bullet (M \bullet N)$
(d) It is both the case that neither Ann is on a diet nor Larry is getting fat and that neither Betty nor Charlie are on a diet.	$(\sim A \bullet \sim L) \bullet (\sim B \bullet \sim C)$ $\sim(A \vee L) \bullet \sim(B \vee C)$
(e) Either neither Ann nor Charlie is on a diet or neither Betty nor Charlie is on a diet.	$(\sim A \bullet \sim C) \vee (\sim B \bullet \sim C)$ $\sim(A \vee C) \vee \sim(B \vee C)$
(f) It is not the case that neither Ann nor Charlie is on a diet.	$\sim(\sim A \bullet \sim C)$ $\sim\sim(A \vee C)$
(g) It is not the case that both Martin and Newt are getting fat	$\sim(M \bullet N)$ $\sim M \vee \sim N$
(h) It is not the case that not both Martin and Newt are getting fat.	$\sim\sim(M \bullet N)$ $\sim(\sim M \vee \sim N)$
(i) It is not both the case that neither Ann nor Betty is on a diet and that neither Betty nor Charlie is on a diet. Hint: Symbolize first the statement that is being negated here, i.e. the statement that is enclosed in parentheses: It is not [both the case that neither Ann nor Betty is on a diet and that neither Betty nor Charlie is on a diet].	$\sim[(\sim A \bullet \sim B) \bullet (\sim B \bullet \sim C)]$ $\sim[\sim(A \vee B) \bullet \sim(B \vee C)]$ $\sim(\sim A \bullet \sim B) \vee \sim(\sim B \bullet \sim C)$ $\sim\sim(A \vee B) \vee \sim\sim(B \vee C)$

Exercise Symbolizations – 5

Symbolize the following statements, using the first letters of a name to abbreviate the simple statements, e.g.:

A: Amy is nice

B: Betty is nice

...

(a) Both Jennifer and Katrina are nice but Susan certainly is not.	$(J \bullet K) \bullet \sim S$
(b) Neither Amy nor Susan are nice, though Mary is very nice.	$(\sim A \bullet \sim S) \bullet M$ $\sim(A \vee S) \bullet M$
(c) Katrina and Mary are never both nice.	$\sim(K \bullet M)$ $\sim K \vee \sim M$
(d) Katrina and Susan are never both nice, either.	$\sim(K \bullet S)$ $\sim K \vee \sim S$
(e) Either Jennifer is nice or Mary is nice, but never both.	$(J \vee M) \bullet \sim(J \bullet M)$ $(J \vee M) \bullet (\sim J \vee \sim M)$
(f) Jennifer is nice just in case Mary or Katrina are nice.	$J \equiv (M \vee K)$
(g) If Jennifer is nice, then Lucy is nice provided that Donna is nice.	$J \rightarrow (D \rightarrow L)$
(h) Lucy is nice if Jennifer is nice, provided that Donna is nice.	$D \rightarrow (J \rightarrow L)$
(i) Donna is not nice unless Jennifer is nice.	$J \vee \sim D$ $\sim J \rightarrow \sim D$
(j) Mary is nice unless Amy and Betty are both nice.	$(A \bullet B) \vee M$ $\sim(A \bullet B) \rightarrow M$
(k) Susan is not nice unless either Amy or Betty are nice	$(A \vee B) \vee \sim S$ $\sim(A \vee B) \rightarrow \sim S$
(l) Jennifer, Katrina, Mary and Lucy are all nice.	$(J \bullet K) \bullet (M \bullet L)$
(m) At least one of these four girls is nice.	$(J \vee K) \vee (M \vee L)$

Exercise Symbolizations – 6 (after V. Klenk)

Symbolize the following statements, using the first letters of a name to abbreviate the simple statements, e.g.:

- | | |
|---|--------------------------------|
| A: There is a boom in the automobile industry | H: There is a boom in housing |
| C: Consumers increase borrowing | J: More jobs are created |
| D: Deficit is reduced | R: Interest rates rise |
| E: The economy improves | S: Consumer spending will fall |
| F: Stock prices will fall | T: Taxes are raised |
| G: Government spending increases | U: Unemployment rises |

(a) Interest rates will rise only if the economy improves and consumers increase borrowing.	$R \rightarrow (E \bullet C)$
(b) The economy will not improve and interest rates will not rise if either consumer spending falls or unemployment rises.	$(S \vee U) \rightarrow (\sim E \bullet \sim R)$
(c) Either interest rates or unemployment rates will rise, but not both.	$(R \vee U) \bullet \sim(R \bullet U)$
(d) Interest rates will not rise if the economy improves, provided consumers do not increase borrowing.	$\sim C \rightarrow (E \rightarrow \sim R)$
(e) The deficit will be reduced and the economy will improve if taxes are raised and interests rates do not rise	$(T \bullet \sim R) \rightarrow (D \bullet E)$
(f) The deficit will be reduced if and only if taxes are raised and government spending does not increase, unless interest rates rise.	$R \vee [D \equiv (T \bullet \sim G)]$ $\sim R \rightarrow [D \equiv (T \bullet \sim G)]$
(g) Unless the deficit is reduced, taxes and interest rates will rise and the economy will not improve.	$D \vee [(T \bullet R) \bullet \sim E]$ $\sim D \rightarrow [(T \bullet R) \bullet \sim E]$
(h) Stock prices will fall and the economy will fail to improve if interest rates rise and the deficit is not reduced, unless either more jobs are created or there is a boom in housing.	$(J \vee H) \vee [(R \bullet \sim D) \rightarrow (F \bullet \sim E)]$ $\sim(J \vee H) \rightarrow [(R \bullet \sim D) \rightarrow (F \bullet \sim E)]$
(i) Neither taxes nor interest rates will rise if the deficit is reduced, but if the deficit is not reduced then both taxes and interest rates will rise.	$[D \rightarrow (\sim T \bullet \sim R)] \bullet [\sim D \rightarrow (T \bullet R)]$ $[D \rightarrow \sim(T \vee R)] \bullet [\sim D \rightarrow (T \bullet R)]$

- (j) The economy will improve if the deficit is reduced, but the deficit will be reduced only if government spending does not increase and taxes are raised.
- (k) Stock prices will fall and either interest rates or unemployment will rise, unless either the deficit is reduced and the economy improves or taxes are not raised and consumer spending does not fall.
- (l) Only if there is a boom in housing and the automobile industry will more jobs be created and the deficit be reduced, but more jobs will not be created unless government spending increases.

$$(D \rightarrow E) \bullet (D \rightarrow (\sim G \bullet T))$$

$$[(D \bullet E) \vee (\sim T \bullet \sim S)] \vee [F \bullet (R \vee U)]$$

$$\sim[(D \bullet E) \vee (\sim T \bullet \sim S)] \rightarrow [F \bullet (R \vee U)]$$

$$[(J \bullet D) \rightarrow (H \bullet A)] \bullet (G \vee \sim J)$$

$$[(J \bullet D) \rightarrow (H \bullet A)] \bullet (\sim G \rightarrow \sim J)$$

A: There is a boom in the automobile industry
 C: Consumers increase borrowing
 D: Deficit is reduced
 E: The economy improves
 F: Stock prices will fall
 G: Government spending increases

H: There is a boom in housing
 J: More jobs are created
 R: Interest rates rise
 S: Consumer spending will fall
 T: Taxes are raised
 U: Unemployment rises