Section 2.1E

1.a. Not a sentence of *SL*—in sentences of *SL* '&' occurs only between *two* sentences. Here there is no sentence to the left of '&'.

c. A sentence of *SL*.

e. A sentence of *SL*.

g. A sentence of *SL*.

i. Not a sentence of *SL*—if parentheses occur in a sentence of SL they occur in pairs, and the sentence as a whole contains an equal number of left and right parentheses (and left and right square brackets). Adding a right parentheses does result in a sentence of SL: `[(G ∨ ~ E) ⊃ (~ H & (K ⊃ B))]'.

2.a. Material conditional

c. Material biconditional

e. Material conditional

g. Conjunction

i. Material conditional

k. Negation

m. Disjunction

3.a. ~ A (&) H
~ A
H
A

c. ~ (S & G) (∨) B
~ (S & G)
B
S & G
S
G

e. (C ≡ K) (⊃) (~ H ⊃ (M & N))
C ≡ K
~ H ⊃ (M & N)
C
K
~ H
M & N
H
M
N

4.a. 'H' can occur neither immediately to the left of '~' nor immediately to the right of 'A'. As a unary connective, '~' can immediately precede but not

immediately follow sentences of *SL*. Both 'H' and 'A' are sentences of *SL*, and no sentence of *SL* can immediately precede another sentence of *SL*.

c. '(' may occur immediately to the left of '~', as in '(~ A & B)'. But '(' may not occur immediately to the right of 'A', as a sentence of *SL* can be followed only by a right parenthesis or right square bracket or a binary connective.

e. '[' may occur immediately to the left of '~', as it functions exactly as does '('. But '[' may not occur immediately to the right of 'A'.

Section 2.2E

1.a. It is no t the case that Bob is a marathon runner.

B: Bob is a marathon runner.

~ B

c. If Carol if a jogger then Carol is a marathon runner.

C: Carol is a jogger.

M: Carol is a marathon runner.

C ⊃ M

e. Carol will run in the Boston Marathon if and only if Albert will run in the Boston Marathon.

C: Carol will run in the Boston Marathon.

A: Albert will run in the Boston Marathon.

C ≡ A

g. Carol will run in the Boston Marathon or Albert will run in the Boston Marathon.

C: Carol will run in the Boston Marathon.

A: Albert will run in the Boston Marathon.

C ∨ A

2.a. If Felice will vacation in Bermuda then Clarence will vacation in Bermuda.

F: Felice will vacation in Bermuda.

C: Clarence will vacation in Bermuda

F ⊃ C

c. If Felice will vacation in Bermuda then Veronica will vacation in Bermuda.

F: Felice will vacation in Bermuda.

V: Veronica will vacation in Bermuda.

F ⊃ V

e. If Clarence will vacation in Bermuda then Veronica will vacation in Bermuda.

C: Clarence will vacation in Bermuda.

V: Veronica will vacation in Bermuda

$C \supset V$

Section 2.3E

1.a. If the Red Sox improve their itching then the Red Sox have a good chance of winning the American League pennant.

$P \supset C$

c. If (it is not the case that the Twins win tonight and it is not the case that the Mariners win tonight) then the Angels move into first place.

$(\sim T \ \& \sim M) \supset N$

e. If the Indian's starting pitcher can go the full nine innings then the Indians win tonight.

$S \supset I$

g. If (the Twins win tonight or the Mariners win tonight) then it is not the case that the Royals are in the running for the pennant.

$(T \vee M) \supset \sim R$

i. (It is not the case that the Royals are in the running for the pennant and the Yankees will win the pennant) if and only if [the Twins win tonight and (it is not the case that the Mariners win tonight and it is not the case that the Angels win tonight)].

$(\sim R \ \& \ Y) \equiv [T \ \& \ (\sim M \ \& \sim A)]$

2. Symbolization key:

G: George will graduate with honors.

E: Emily will graduate with honors.

D: Donna will graduate with honors

F: Fred will graduate with honors.

Paraphrases and symbolizations:

a. George will graduate with honors or Emily will graduate with honors,

$G \vee E$

c. (George will graduate with honors or Emily will graduate with honors) or (Donna will graduate with honors or Fred will graduate with honors).

$(G \vee E) \vee (D \vee F)$

e. [(George will graduate with honors and Emily will graduate with honors) and (Donna will graduate with honors and Fred will graduate with honors)] or ~ [(George will graduate with honors or Emily will graduate with honors) or (Donna will graduate with honors or Fred will graduate with honors)].

$[(G \,\&\, E) \,\&\, (D \,\&\, F)] \vee \sim[(G \vee E) \vee (D \vee F)]$

g. (Fred will graduate with honors and George will graduate with honors) if and only if (Donna will graduate with honors and Emily will graduate with honors).

$(F \,\&\, G) \equiv (D \,\&\, E)$

i. (It is not the case that George will graduate with honors and Fred will graduate with honors) and (Donna will graduate with honors if and only if Emily will graduate with honors).

$(\sim G \,\&\, F) \,\&\, (D \equiv E)$

3. Symbolization key:

F: Felice will vacation in Bermuda.

C: Clarence will vacation in Bermuda.

V: Veronica will vacation in Bermuda.

R: Robert will vacation in Bermuda.

Paraphrases and symbolizations:

a. If Felice vacations in Bermuda then Clarence will vacation in Bermuda.

$F \supset C$

c. If (Felice will vacation in Bermuda or Veronica will vacation in Bermuda) then (Felice will vacation in Bermuda and Veronica will vacation in Bermuda).

$(F \vee V) \supset (F \,\&\, V)$

e. If Veronica will vacation in Bermuda then (Clarence will vacation in Bermuda and it is not the case that Felice will vacation in Bermuda).

$V \supset (C \,\&\, \sim F)$

g. (Veronica will vacation in Bermuda if and only if it is not the case that Clarence will vacation in Bermuda) and (Felice will vacation in Bermuda if and only if Robert will vacation in Bermuda).

$(V \equiv \sim C) \,\&\, (F \equiv R)$

4.a. [(*Casablanca* will be shown at this year's classical film festival and *The Lion in Winter* will be shown at this year's classical film festival) and (*Witness for the Prosecution* will be shown at this year's classical film festival and *The Third Man* will be shown at this year's classical film festival)] and *Charade* will be shown at this year's classical film festival.

C: *Casablanca* will be shown at this year's classical film festival.
L: *The Lion in Winter* will be shown at this year's classical film festival.
W: *Witness for the Prosecution* will be shown at this year's classical film festival.
T: *The Third Man* will be shown at this year's classical film festival.
H: *Charade* will be shown at this year's classical film festival.

[(C & L) & (W & T)] & H

c. (If Phil will see *The Lion in Winter* then Marion will see *The Lion in Winter*) and (Phil will see *Charade* and Marion will see *Charade*).

P: Phil will see *The Lion in Winter.*
M: Marion will see *The Lion in Winter.*
H: Phil will see *Charade.*
A: Marion will see *Charade.*

(P ⊃ M) & (H & A)

e. (If *Witness for the Prosecution* is screened at 8:00 pm and *The Lion in Winter* is screened at 8:00 pm) then [(Marion will see *Witness for the Prosecution* and Phil will see *Witness for the Prosecution*) and (Eric will see *The Lion in Winter* and Betty will see *The Lion in Winter*)]

W: *Witness for the Prosecution* is screened at 8:00 pm.
T: *The Lion in Winter* is screened at 8:00 pm.
M: Marion will see *Witness for the Prosecution.*
P: Phil will see *Witness for the Prosecution.*
E: Eric will see *The Lion in Winter.*
B: Betty will see *The Lion in Winter.*

(W & T) ⊃ [(M & P) & (E & B)]

g. If (if Eric likes Katherine Hepburn then Eric will see *The Lion in Winter*) then (if Marion likes Eric then Marion will see *The Lion in Winter*).

E: Eric likes Katherine Hepburn.
R: Eric will see *The Lion in Winter.*
M: Marion likes Eric.
A: Marion will see *The Lion in Winter.*

(E ⊃ R) ⊃ (M ⊃ A)

i. [(It is not the case that Betty likes James Coburn and it is not the case that Eric likes James Coburn) and (Betty likes Audrey Hepburn and Eric likes Audrey Hepburn)] and ([(if Audrey Hepburn is in *Charade* then (Betty will see *Charade* and Eric will see *Charade*)] and Audrey Hepburn is in *Charade*).

B: Betty likes James Coburn.
E: Eric likes James Coburn.
T: Betty likes Audrey Hepburn.
R: Eric likes Audrey Hepburn.
C: Audrey Hepburn is in *Charade*.
Y: Betty will see *Charade*.
H: Eric will see *Charade*.

$[(\sim B \,\&\, \sim E) \,\&\, (T \,\&\, R)] \,\&\, ([C \supset (Y \,\&\, H)] \,\&\, C)$

5.a. If (Betty sees *Casablanca* and Betty sees *The Third Man*) then it is not the case that (Betty will see *Witness for the Prosecution* or Betty will see *The Lion in Winter*).
Betty will see *Witness for the Prosecution* and it is not the case that Betty will see *The Lion in Winter*.

It is not the case that Betty will see *Casablanca* or it is not the case that Betty will see *The Third Man*.

C: Betty will see *Casablanca*.
T: Betty will see *The Third Man*.
W: Betty will see *Witness for the Prosecution*.
L: Betty will see *The Lion in Winter*.

$(C \,\&\, T) \supset \sim (W \vee L)$
$W \,\&\, \sim L$

$\sim C \vee \sim T$

c. [Phil will see *The Third Man* if and only if (Phil likes Joseph Cotton and Phil likes Orson Wells)] and [Phil will see *Witness for the Prosecution* if and only if (Phil likes Marlene Dietrich and Phil likes Charles Laughton)].

It is not the case that (Phil likes Joseph Cotton or Phil likes Orson Wells) and (Phil likes Marlene Dietrich and Phil likes Charles Laughton).

Phil will see *Witness for the Prosecution*.

T: Phil will see *The Third Man*.
J: Phil likes Joseph Cotton.
O: Phil likes Orson Wells.
W: Phil will see *Witness for the Prosecution*.
M: Phil likes Marlene Dietrich.
C: Phil likes Charles Laughton.

$[T \equiv (J \,\&\, O)] \,\&\, [W \equiv (M \,\&\, C)]$
$\sim (J \vee O) \,\&\, (M \,\&\, C)$

W

6. a. Fred will go to New York only if Fred can get a first class air ticket and Fred can get tickets to a Yankees game).

Fred will go to Chicago only if Fred can travel by train and Fred can get tickets to a White Sox game).

It is not the case that Fred can get a first class air ticket and it is not the case that Fred can get tickets to a White Sox game.

It is not the case that (Fred will go to New York or Fred will go to Chicago).

N: Fred will go to New York.
A: Fred can get a first class air ticket.
Y: Fred can get tickets to a Yankees game.
C: Fred will go to Chicago.
T: Fred can travel by train.
W: Fred can get tickets to a White Sox game.

$N \supset (A \ \& \ Y)$
$C \supset (T \ \& \ W)$
$\sim A \ \& \sim W$

$\sim N \ \& \sim C$

c: Alice will go to Vienna if and only if (Burt is willing to go with Alice to Vienna and Burt speaks German).

If Alice goes to Vienna then (Alice will take the Orient Express to Istanbul or it is not the case that Burt will travel by train).

(Burt is willing to go with Alice to Vienna and Burt speaks German) and it is not the case that Burt will travel by train.

If Alice will go to Vienna then it is not the case that Alice will take the Orient Express to Istanbul.

V: Alice will go to Vienna.
B: Burt is willing to go with Alice to Vienna.
G: Burt speaks German.
I: Alice will take the Orient Express to Istanbul.
T: But is willing to travel by train.

$V \equiv (B \ \& \ G)$
$V \supset (I \vee \sim T)$
$(B \ \& \ G) \ \& \sim T$

$V \supset \sim I$

e. (A good mystery has memorable characters and a good mystery has a plot that keeps the reader in suspense) and a good mystery contains enough factual information to allow the reader to actually learn some interesting things.

(Charles Todd's mysteries have memorable characters and Charles Todd's mysteries have plots that keep the reader in suspense) and Charles Todd's mysteries contain enough factual information to allow the reader to actually learn some interesting things.

Charles Todd's mysteries are good mysteries.

M: A good mystery has memorable characters.
P: A good mystery has a plot that keeps the reader in suspense.
F: A good mystery contains enough factual information to allow the reader to actually learn some interesting things.
C: Charles Todd's mysteries have memorable characters.
S: Charles Todd's mysteries have plots that keep the reader in suspense.
I: Charles Todd's mysteries contain enough factual information to allow the reader to actually learn some interesting things.
T: Charles Todd's mysteries are good mysteries.

(M & P) & F
(C & S) & I

T

Section 2.4E

1. Since we do not know how these sentences are being used (*e.g.*, as premises, conclusions, or as isolated claims) it is best to symbolize those that are non-truth-functional compounds as atomic sentences of *SL*.

a. 'It is likely that' is a unary connective that never generates a truth-functionally compound sentence. Thus the given sentence should be treated as non-compound and symbolized by a single sentence letter of *SL*, *e.g.*, 'L'.

c. The expression 'thinks that', preceded by a singular term (as in 'Marcie thinks that') is a unary connective that never generates a truth-functionally compound sentence. Thus the given sentence should be treated as non-compound and symbolized by a single sentence letter of *SL*, *e.g.*, 'M'.

e. This sentence can be paraphrased as a truth-functional compound: It is not the case that Tamara will stop by and Tamara promised to phone early in the evening.
An appropriate symbolization is

~ B & E

g. 'John believes that' is not a truth-functional connective. The given sentence should be symbolized as an atomic sentence of *SL*, *e.g.*, as 'J'.

i. 'Only after' has no truth-functional use. Therefore the given sentence should be symbolized as an atomic sentence of *SL*, *e.g.*, 'D'.

2.a. If the maid committed the murder then the maid believed her life was in danger.

If the butler committed the murder then (the murder was done silently and it is not the case that the body was mutilated).

The murder was done silently and it is not the case that the maid's life was in danger.

The butler committed the murder if and only if it is not the case that the maid committed the murder.

The maid committed the murder.

Notice that 'The maid believed her life was in danger' (first premise) and 'The maid's life was in danger' (third premise) make different claims and cannot be paraphrased as the same sentence. Further, since the subjunctive conditional in the original argument is a premise, it can be weakened and paraphrased as a truth-functional compound. Using the symbolization key

M: The maid committed the murder.
D: The maid believed that her life was in danger.
B: The butler committed the murder.
S: The murder was done silently.
W: The body was mutilated.
L: The maid's life was in danger.

we can symbolize the paraphrased argument as follows:

$M \supset D$
$B \supset (S \,\&\, \sim W)$
$S \,\&\, \sim L$
$B \equiv \sim M$

M

c. If (Charles Babbage had the theory of the modern computer and Charles Babbage had modern electronic parts) then the modern computer was developed before the beginning of the twentieth century.

Charles Babbage lived in the early nineteenth century and Charles Babbage had the theory of the modern computer.

It is not the case that Charles Babbage had modern electronic parts and Charles Babbage was forced to construct his computers out of mechanical gears and levers.

If Charles Babbage had had modern electronic parts available to him then the modern computer would have been developed before the beginning of the twentieth century.

In the original argument contrary to fact conditionals occur in the first premise and the conclusion. Since it is acceptable to weaken the premises but not the conclusion, the first premise, but not the conclusion, is given a truth-functional paraphrase. The conclusion must therefore by symbolized as an atomic sentence of *SL*.

T: Charles Babbage had the theory of the modern computer.
E: Charles Babbage had modern electronic parts.
C: The modern computer was developed before the beginning of the twentieth century.
L: Charles Babbage lived in the early nineteenth century.
F: Charles Babbage was forced to construct his computers out of mechanical gears and levers.
W: If Charles Babbage had had modern electronic parts available to him then the modern computer would have been developed before the beginning of the twentieth century.

An appropriate symbolization in *SL* is

$(T \mathbin{\&} E) \supset C$
$L \mathbin{\&} T$
$\sim E \mathbin{\&} F$

W