

Phi 270 F05 test 3

Analyze the sentences below in as much detail as possible *using only connectives*; that is, the unanalyzed components should all be sentences (rather than individual terms, predicates, or functors). Present the result in *both symbolic and English notation*. Be sure that the unanalyzed components of your answer are complete and independent sentences; also try to respect any grouping in the English.

1. **If the part was fixed, it broke again.**

answer

2. **Unless Tom was early, he got in only if he paid extra.**

answer

Use derivations to check whether each of the entailments below holds. You may use detachment and attachment rules. If an entailment fails, present a counterexample that divides an open gap.

3. $A \rightarrow (B \rightarrow C), C \rightarrow D \Rightarrow B \rightarrow (A \rightarrow D)$

answer

4. $(C \wedge A) \rightarrow B \Rightarrow (A \wedge B) \rightarrow C$

answer

Analyze the sentence below in as much detail as possible, giving a key to your abbreviations of unanalyzed expressions. In this case you *should* identify components that are individual terms, predicates, or functors; however, you do not need to present the result in English notation (i.e., symbolic notation is enough). (Be sure that the unanalyzed components of your answer are independent—in particular, that none contains a pronoun whose antecedent is in another—and be sure also that the individual terms you identify really are individual terms rather than general terms or quantifier phrases.)

5. **Either Fred is the manager or he owns the business.**

answer

6. **Sam received a recall notice from the manufacturer of his car.**

answer

Use a derivation to show that the entailment below holds. You may use detachment and attachment rules. (Be sure to indicate the alias sets whenever an equation is added to the resources.)

7. $Rb(fa), fb = gc, c = fb, d = gc \Rightarrow c = d \wedge (a = b \rightarrow Ra(gd))$

answer

Phi 270 F05 test 3 answers

1. **If the part was fixed, it broke again**
the part was fixed \rightarrow the part broke again

$F \rightarrow B$

if F then B

B: **the part broke again**; F: **the part was fixed**

2. **Unless Tom was early, he got in only if he paid extra**
 \neg Tom was early \rightarrow Tom got in only if he paid extra
 \neg Tom was early $\rightarrow (\neg$ Tom got in $\leftarrow \neg$ Tom paid extra)

$\neg T \rightarrow (\neg G \leftarrow \neg P)$

$\neg T \rightarrow (\neg P \rightarrow \neg G)$

if not T then if not P then not G

G: **Tom got in**; P: **Tom paid extra**; T: **Tom was early**

- 3.

$A \rightarrow (B \rightarrow C)$	3
$C \rightarrow D$	5
B	(4)
A	(3)
3 MPP B \rightarrow C	4
4 MPP C	(5)
5 MPP D	(6)
•	
6 QED D	2
2 CP A \rightarrow D	1
1 CP B \rightarrow (A \rightarrow D)	

4.	$(C \wedge A) \rightarrow B$	4														
	$A \wedge B$	2														
2 Ext	A	(7)														
2 Ext	B															
	$\neg C$															
	$\neg C$															
	\perp	6	○	$A, B, \neg C \Rightarrow \perp$												
6 IP	C	5														
	\bullet															
7 QED	A	5														
5 Cnj	$C \wedge A$	4														
	B															
	\perp	4	○	$A, B, \neg C \Rightarrow \perp$												
	\perp	3														
4 RC	\perp	3														
3 IP	C	1														
1 CP	$(A \wedge B) \rightarrow C$															
	<table style="border-collapse: collapse; width: 100%; border-top: 1px solid black; border-bottom: 1px solid black;"> <tr> <td style="width: 10%; border-right: 1px solid black; padding-right: 5px;">A B C</td> <td style="width: 10%; padding-right: 5px;">(C ∧ A) → B</td> <td style="width: 10%; padding-right: 5px;">/</td> <td style="width: 10%; padding-right: 5px;">(A ∧ B) → C</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">T T F</td> <td style="padding-right: 5px;">F</td> <td style="padding-right: 5px;">Ⓡ</td> <td style="padding-right: 5px;">T</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;"></td> <td style="padding-right: 5px;"></td> <td style="padding-right: 5px;">Ⓢ</td> </tr> </table>	A B C	(C ∧ A) → B	/	(A ∧ B) → C	T T F	F	Ⓡ	T				Ⓢ			
A B C	(C ∧ A) → B	/	(A ∧ B) → C													
T T F	F	Ⓡ	T													
			Ⓢ													

5. Either Fred is the manager or he owns the business
Fred is the manager \vee Fred owns the business
Fred = the manager \vee [owns] Fred the business
 $f = m \vee Ofb$

O: [owns]; b: the business; f: Fred; m: the manager

6. Sam received a recall notice from the manufacturer of his car
Sam received a recall notice from the manufacturer of his car
[received a recall notice from] Sam the manufacturer of
Sam's car
 $Rs(\text{the manufacturer of Sam's car})$
 $Rs([\text{the manufacturer of}] \text{ Sam's car})$
 $Rs(m(\text{Sam's car}))$
 $Rs(m([\text{'s car}] \text{ Sam}))$
 $Rs(m(cs))$
R: [received a recall notice from]; c: ['s car]; m: [the manufacturer of]; s: Sam

7.	$Rb(fa)$	(4)			
	$fb = gc$				$fb-gc, a, b, c, d, fa, gd$
	$c = fb$				$c-fb-gc, a, b, d, fa, gd$
	$d = gc$				$c-fb-gc-d-gd, a, b, fa$
	\bullet				
2 EC	$c = d$	1			
	$a = b$				$c-fb-gc-d-gd-fa, a-b$
	\bullet				
4 QED=	$Ra(gd)$	3			
3 CP	$a = b \rightarrow Ra(gd)$	1			
1 Cnj	$c = d \wedge (a = b \rightarrow Ra(gd))$				

Phi 270 FO4 test 3

Analyze the sentences below in as much detail as possible *using only connectives*; that is, the unanalyzed components should all be sentences (rather than individual terms, predicates, or functors). Present the result in *both symbolic and English notation*. Be sure that the unanalyzed components of your answer are complete and independent sentences; also try to respect any grouping in the English.

1. Dan wasn't home unless it was a holiday.

answer

2. If ten days had passed, then the return was accepted only if the item was damaged.

answer

Use derivations to check whether each of the entailments below holds. You may use detachment and attachment rules. If an entailment fails, present a counterexample that divides an open gap.

3. $A \rightarrow (B \rightarrow \neg C) \Rightarrow C \rightarrow (B \rightarrow \neg A)$

answer

4. $A \rightarrow B \Rightarrow B \rightarrow C$

answer

Analyze the sentence below in as much detail as possible, giving a key to your abbreviations of unanalyzed expressions. In this case you *should* identify components that are individual terms, predicates, or functors; however, you do not need to present the result in English notation (i.e., symbolic notation is enough). (Be sure that the unanalyzed components of your answer are independent—in particular, that none contains a pronoun whose antecedent is in another—and be sure also that the individual terms you identify really are individual terms rather than general terms or quantifier phrases.)

5. Ann called Bill and he picked her up at the garage.

answer

6. If Carol's father is Dave's boss, then she has either met Dave or heard her father speak of him.

answer

Use a derivation to show that the entailment below holds. You may use detachment and attachment rules. (Be sure to indicate the alias sets at each stage when they change.)

7. $a = fc, b = fd, Rac \Rightarrow c = d \rightarrow Rbd$

answer

Phi 270 FO4 test 3 answers

1. Dan wasn't home unless it was a holiday

Dan wasn't home $\leftarrow \neg$ it was a holiday

\neg Dan was home $\leftarrow \neg$ it was a holiday

$\neg H \leftarrow \neg D$

$\neg D \rightarrow \neg H$

if not D then not H

H: Dan was home; D: it was a holiday

2. If ten days had passed, then the return was accepted only if the item was damaged

ten days had passed \rightarrow the return was accepted only if the item was damaged

ten days had passed $\rightarrow (\neg$ the return was accepted $\leftarrow \neg$ the item was damaged)

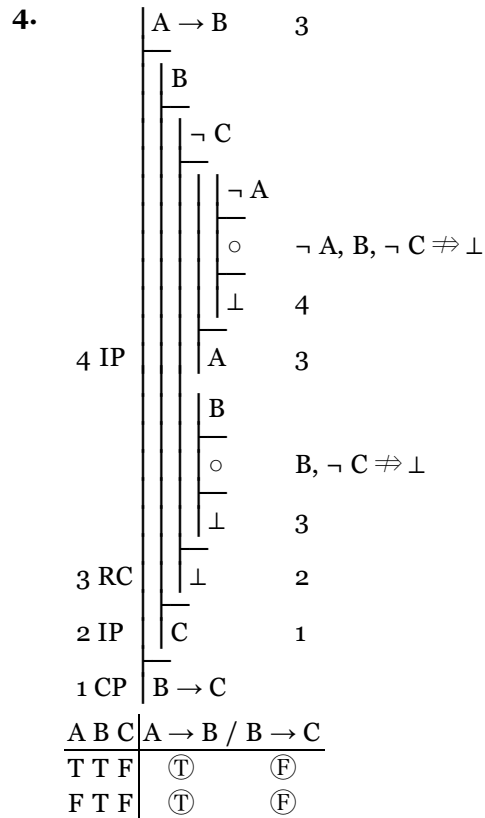
$T \rightarrow (\neg A \leftarrow \neg D)$

$T \rightarrow (\neg D \rightarrow \neg A)$

if T then if not D then not A

T: ten days had passed; D: the item was damaged; A: the return was accepted

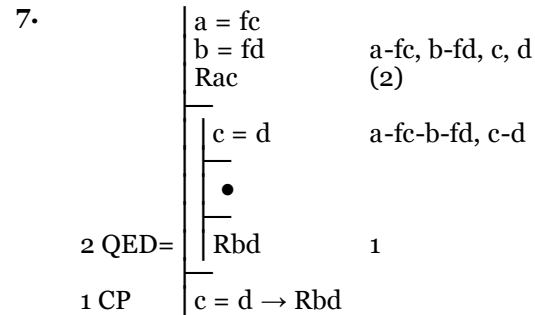
3.	A \rightarrow (B \rightarrow \neg C)	4
	C	(6)
	B	(5)
	A	(4)
4 MPP	B \rightarrow \neg C	5
5 MPP	\neg C	(6)
	•	
	\perp	3
6 Nc	\neg A	2
3 RAA	B \rightarrow \neg A	1
2 CP	C \rightarrow (B \rightarrow \neg A)	
1 CP		



The first row divides the second gap and the second row divides both

5. Ann called Bill and he picked her up at the garage
Ann called Bill \wedge Bill picked Ann up at the garage
 $[_ \text{ called } _] \text{ Ann Bill} \wedge [_ \text{ picked } _ \text{ up at } _] \text{ Bill Ann the garage}$
 $Cab \wedge Pbag$
 C: $[_ \text{ called } _]$; P: $[_ \text{ picked } _ \text{ up at } _]$; a: Ann; b: Bill; g: the garage

6. If Carol's father is Dave's boss, then she has either met Dave or heard her father speak of him
Carol's father is Dave's boss
 \rightarrow Carol has either met Dave or heard her father speak of him
Carol's father = Dave's boss
 \rightarrow (Carol has met Dave \vee Carol has heard her father speak of Dave)
 $[_ \text{'s father}] \text{ Carol} = [_ \text{'s boss}] \text{ Dave}$
 \rightarrow (Carol has met Dave \vee Carol has heard Carol's father speak of Dave)
 $fc = bd \rightarrow ([_ \text{ has met } _] \text{ Carol Dave} \vee [_ \text{ has heard } _ \text{ speak of } _] \text{ Carol Carol's father Dave})$
 $fc = bd \rightarrow (Mc_d \vee Hc(fc)_d)$
 M: $[_ \text{ has met } _]$; H: $[_ \text{ has heard } _ \text{ speak of } _]$; f: $[_ \text{'s father}]$; b: $[_ \text{'s boss}]$; c: Carol; d: Dave



Phi 270 F03 test 3

Analyze the sentences below in as much detail as possible *using only connectives*; that is, you *should not* identify components that are individual terms (or predicates or functors). Present the result in *both symbolic and English notation*. Be sure that the unanalyzed components of your answer are complete and independent sentences; also try to respect any grouping in the English.

1. If it was cloudy, Bob didn't see the eclipse

answer

2. Unless the lock is broken, you can get in only if you have a key

answer

Use derivations to check whether each of the entailments below holds. You may use detachment and attachment rules. If an entailment fails, present a counterexample that divides an open gap.

3. $A \rightarrow \neg C, B \rightarrow C \Rightarrow A \rightarrow \neg B$

answer

4. $(A \wedge B) \rightarrow C \Rightarrow B \rightarrow (\neg C \rightarrow A)$

answer

Analyze the sentence below in as much detail as possible. In this case you should identify components that are individual terms, predicates, or functors. Be sure that the unanalyzed components of your answer are independent (in particular, that none contains a pronoun whose antecedent is in another).

5. If Sam asked Tom to drive him to the meeting, then he is the person who called earlier

answer

6. Dave's father called the mother of the child who hit him

answer

Use a derivation to show that the entailment below holds. You may use detachment and attachment rules.

7. $a = b \wedge Rac \Rightarrow fa = c \rightarrow Rb(fb)$

answer

Phi 270 F03 test 3 answers

1. If it was cloudy, Bob didn't see the eclipse

it was cloudy \rightarrow Bob didn't see the eclipse

it was cloudy $\rightarrow \neg$ Bob saw the eclipse

$C \rightarrow \neg S$

if C then not S

C: it was cloudy; S: Bob saw the eclipse

2. Unless the lock is broken, you can get in only if you have a key

\neg the lock is broken \rightarrow you can get in only if you have a key

\neg the lock is broken $\rightarrow (\neg$ you can get in $\leftarrow \neg$ you have a key)

$\neg B \rightarrow (\neg G \leftarrow \neg K)$

$\neg B \rightarrow (\neg K \rightarrow \neg G)$

if not B then if not K then not G

B: the lock is broken; G: you can get in; K: you have a key

- 3.

	$A \rightarrow \neg C$	2
	$B \rightarrow C$	3
	A	(2)
2 MPP	$\neg C$	(3)
3 MTT	$\neg B$	(4)
	•	
4 QED	$\neg B$	1
1 CP	$A \rightarrow \neg B$	

- 4.

	$(A \wedge B) \rightarrow C$	3
	B	(4)
	$\neg C$	(3)
3 MTT	$\neg (A \wedge B)$	4
4 MPT	$\neg A$	
	$\neg A$	
	○	$\neg A, B, \neg C \not\Rightarrow \perp$
	\perp	5
5 IP	A	2
2 CP	$\neg C \rightarrow A$	1
1 CP	$B \rightarrow (\neg C \rightarrow A)$	

A B C	$(A \wedge B) \rightarrow C$	/	$B \rightarrow (\neg C \rightarrow A)$	
F T F	F	Ⓟ	Ⓟ	T F

5. If Sam asked Tom to drive him to the meeting, then he is the person who called earlier

Sam asked Tom to drive him to the meeting → Sam is the person who called earlier

[_ asked _ to drive _ to _] Sam Tom Sam the meeting → Sam = the person who called earlier

Astsm → s = p

A: [_ asked _ to drive _ to _]; m: the meeting; p: the person who called earlier; s: Sam; t: Tom

6. Dave's father called the mother of the child who hit him

[_ called _] Dave's father the mother of the child who hit Dave

C([_'s father] Dave)([the mother of _](the child who hit Dave))

C(fd)(m([the child who hit _]d))

C(fd)(m(hd))

C: [_ called _]; d: Dave; f: [_'s father]; h: [the child who hit _]; m: [the mother of _]

7.

	a = b ∧ Rac	1
1 Ext	a = b	a-b, c, fa-fb
1 Ext	Rac	(3)
	fa = c	a-b, c-fa-fb
	•	
3 QED=	Rb(fb)	2
2 CP	fa = c → Rb(fb)	

Phi 270 Fo2 test 3

Analyze the sentences below in as much detail as possible *using connectives*; that is, you *should not* identify components that are individual terms (or predicates or functors). Present the result in *both symbolic and English notation*. Be sure that the unanalyzed components of your answer are complete and independent sentences; also try to respect any grouping in the English.

1. They'll be here soon unless they had car trouble

answer

2. If it snowed, then the schools were open only if the plows got out early.

answer

Use derivations to check whether each of the entailments below holds. You may use detachment and attachment rules. If an entailment fails, present a counterexample that divides an open gap.

3. $A \rightarrow (\neg B \rightarrow C) \Rightarrow \neg C \rightarrow (A \rightarrow B)$

answer

4. $A \rightarrow (\neg B \rightarrow C) \Rightarrow C \rightarrow (A \rightarrow B)$

answer

Analyze the sentence below in as much detail as possible. In this case you *should* identify components that are individual terms, predicates, or functors. Be sure that the unanalyzed components of your answer are independent (in particular, that none contains a pronoun whose antecedent is in another).

5. Al is Bob's father and Bob works for him

answer

Synthesize an English sentence with the following logical form:

6. $Sa(mb) \rightarrow \neg S(ma)b$

S: [_ went to school with _]; a: Al; b: Bob; m: [_'s mother]

answer

Use a derivation to show that the entailment below holds. You may use detachment and attachment rules.

7. $Fa \rightarrow C, Fb \Rightarrow a = b \rightarrow C$

answer

Phi 270 Fo2 test 3 answers

1. They'll be here soon unless they had car trouble
They'll be here soon $\leftarrow \neg$ they had car trouble

$S \leftarrow \neg T$ [or: $\neg T \rightarrow S$]

if not T then S

S: they'll be here soon; T: they had car trouble

2. If it snowed, then the schools were open only if the plows got out early
 it snowed \rightarrow the schools were open only if the plows got out early
 it snowed $\rightarrow (\neg$ the schools were open $\leftarrow \neg$ the plows got out early)

$$S \rightarrow (\neg O \leftarrow \neg E) \text{ [or: } S \rightarrow (\neg E \rightarrow \neg O)\text{]}$$

if S then if not E then not O

E: the plows got out early; O: the schools were open; S: it snowed

- 3.
- | |
|---|
| A \rightarrow (\neg B \rightarrow C) 3 |
| \neg C (4) |
| A (3) |
| \neg B \rightarrow C 4 |
| B (5) |
| • |
| B 2 |
| A \rightarrow B 1 |
| \neg C \rightarrow (A \rightarrow B) |

- 4.
- | |
|---|
| A \rightarrow (\neg B \rightarrow C) 3 |
| C |
| A (3) |
| \neg B \rightarrow C 5 |
| \neg B (5) |
| C |
| ○ A, \neg B, C \neq \perp |
| \perp 4 |
| B 2 |
| A \rightarrow B 1 |
| C \rightarrow (A \rightarrow B) |

A B C	A \rightarrow (\neg B \rightarrow C) / C \rightarrow (A \rightarrow B)
T F T	Ⓘ T T ② F

5. Al is Bob's father and Bob works for him
Al is Bob's father \wedge Bob works for Al
 Al = Bob's father \wedge [works for] Bob Al
 a = ['s father] Bob \wedge Wba
 a = fb \wedge Wba

W: [works for]; a: Al; b: Bob; f: ['s father]

6. S Al (['s mother] Bob) $\rightarrow \neg$ S (['s mother] Al) Bob
 [went to school with] Al Bob's mother $\rightarrow \neg$ [went to school with] Al's mother Bob
 Al went to school with Bob's mother $\rightarrow \neg$ Al's mother went to school with Bob
 Al went to school with Bob's mother \rightarrow Al's mother didn't go to school with Bob
 If Al went to school with Bob's mother, then Al's mother didn't go to school with Bob

- 7.
- | |
|-----------------------|
| Fa \rightarrow C 3 |
| Fb (4) |
| a = b a-b |
| \neg C (3) |
| \neg Fa (4) |
| • |
| \perp 2 |
| C 1 |
| a = b \rightarrow C |

Phi 270 Foo test 3

Analyze the sentences below in as much detail as possible *using connectives*; that is, you *should not* identify components that are individual terms (or predicates or functors). Present the result in *both symbolic and English notation*. Be sure that the unanalyzed components of your answer are complete and independent sentences; also try to respect any grouping in the English.

1. **If it rains, you will get wet if you're outside**

answer

2. **Al missed breakfast only if he overslept**

answer

Use derivations to check whether each of the entailments below holds. You may use detachment and attachment rules. If an entailment fails, present a counterexample that divides an open gap.

3. $A \rightarrow (B \rightarrow C) \Rightarrow (A \rightarrow \neg C) \rightarrow (A \rightarrow \neg B)$

answer

4. $A \rightarrow B \Rightarrow \neg A \wedge B$

answer

Analyze the sentence below in as much detail as possible. In this case you *should* identify components that are individual terms, predicates, or functors. Be sure that the unanalyzed components of your answer are independent (in particular, that none contains a pronoun whose antecedent is in another).

5. **Unless Al is the file's owner, the system didn't let him open it**

answer

Expand the following sentence in all possible ways on each of the terms appearing in it (i.e., you need not use vacuous abstraction).

6. Tabc

answer

Use a derivation to show that the entailment below holds. You may use detachment and attachment rules.

7. $A \rightarrow \text{Ra}(\text{fb}), \text{Rb}(\text{fa}) \rightarrow \text{Ga} \Rightarrow A \rightarrow (\neg \text{Gb} \rightarrow \neg a = b)$

answer

Phi 270 Foo test 3 answers

1. **it will rain** \rightarrow **you will get wet if you're outside**
it will rain \rightarrow (**you will get wet** \leftarrow **you will be outside**)

$$R \rightarrow (W \leftarrow O) \text{ [or: } R \rightarrow (O \rightarrow W)]$$

if R then if O then W

O: **you will be outside**; R: **it will rain**; W: **you will get wet**

2. **\neg Al missed breakfast** \leftarrow **\neg Al overslept**

$$\neg M \leftarrow \neg O \text{ [or: } \neg O \rightarrow \neg M]$$

if not O then not M

M: **Al missed breakfast**; O: **Al overslept**

- 3.
- | | | |
|-------|---|---------|
| | $A \rightarrow (B \rightarrow C)$ | 3 |
| | $A \rightarrow \neg C$ | 4 |
| | A | (3),(4) |
| 3 MPP | $B \rightarrow C$ | 5 |
| 4 MPP | $\neg C$ | (5) |
| 5 MTT | $\neg B$ | (6) |
| | • | |
| 6 QED | $\neg B$ | 2 |
| 2 CP | $A \rightarrow \neg B$ | 1 |
| 1 CP | $(A \rightarrow \neg C) \rightarrow (A \rightarrow \neg B)$ | |

- 4.
- | | | |
|-------|-------------------|--|
| | $A \rightarrow B$ | 3,5 |
| | A | (3) |
| 3 MPP | B | $A, B \not\Rightarrow \perp$ |
| | ○ | |
| | \perp | 2 |
| 2 RAA | $\neg A$ | 1 |
| | $\neg B$ | (5) |
| 5 MTT | $\neg A$ | $\neg A, \neg B \not\Rightarrow \perp$ |
| | ○ | |
| | \perp | 4 |
| 4 IP | B | 1 |
| 1 Cnj | $\neg A \wedge B$ | |

A	B	A \rightarrow B	\neg A \wedge B	
T	T	T	F	divides 1st gap
F	F	T	F	divides 2nd gap

5. \neg Al is the file's owner \rightarrow the system didn't let Al open the file
 \neg Al is the file's owner \rightarrow \neg the system let Al open the file
 \neg Al = the file's owner \rightarrow \neg [_ let _ open _] the system Al the file

\neg a = ['s owner] the file \rightarrow \neg Lsaf
 \neg a = of \rightarrow \neg Lsaf

L: [_ let _ open _]; a: Al; f: the file; o: ['s owner]; s: the system

6. [Txbc]_xa
 [Taxc]_xb
 [Tabx]_xc

7.	A \rightarrow Ra(fb) Rb(fa) \rightarrow Ga	4
	A	
	Ra(fb)	(5)
	\neg Gb	(6)
	a=b	a-b, fa-fb
	•	
5 QED=	Rb(fa)	4
	Ga	(6)
	•	
6 Nc=	\perp	4
4 RC	\perp	3
3 RAA	\neg a=b	2
2 CP	\neg Gb \rightarrow \neg a=b	1
1 CP	A \rightarrow (\neg Gb \rightarrow \neg a=b)	

Phi 270 F99 test 3

Analyze the sentences below in as much detail as possible *using connectives*; that is, you need not identify components that are individual terms (or predicates or functors). Present the result in both symbolic and English notation. Be sure that the unanalyzed components of your answer are complete and independent sentences; also try to respect any grouping in the English.

1. We won't have the material by Thursday unless the order goes in today.

answer

2. If the power went out, they finished the job only if they had a generator.

answer

Use derivations to check whether each of the entailments below holds. You may use detachment and attachment rules. If an entailment fails, present a counterexample that divides an open gap.

3. $A \rightarrow (\neg B \rightarrow C)$, $C \rightarrow D \Rightarrow A \rightarrow (\neg D \rightarrow B)$

answer

4. $(A \wedge B) \rightarrow (C \vee D) \Rightarrow A \rightarrow C$

answer

Analyze the sentence below in as much detail as possible. In this case you should identify components that are individual terms, predicates, or functors. Be sure that the unanalyzed components of your answer are independent (in particular, that none contains a pronoun whose antecedent is in another).

5. Adam called Billy's mother and she is the owner of the dog.

answer

Expand the following sentence in all possible ways on each of the terms appearing in it (i.e., you need not use vacuous abstraction).

6. $Rab \rightarrow Rbc$

answer

Use a derivation to show that the entailment below holds. You may use detachment and attachment rules.

7. $a = fb, Ra(fa) \Rightarrow fb = c \rightarrow R(fb)(fc)$

answer

Phi 270 F99 test 3 answers

1. We won't have the material by Thursday unless the order goes in today
 we won't have the material by Thursday $\leftarrow \neg$ the order will go in today
 \neg we will have the material by Thursday $\leftarrow \neg$ the order will go in today

$$\neg H \leftarrow \neg T \text{ [or: } \neg T \rightarrow \neg H \text{]}$$

if not T then not H

H: we will have the material by Thursday; T: the order will go in today

2. If the power went out, they finished the job only if they had a generator
 the power went out \rightarrow they finished the job only if they had a generator
 the power went out $\rightarrow (\neg$ they finished the job $\leftarrow \neg$ they had a generator)

$$O \rightarrow (\neg F \leftarrow \neg G) \text{ [or: } O \rightarrow (\neg G \rightarrow \neg F) \text{]}$$

if O then if not G then not F

F: they finished the job; G: they had a generator; O: the power went out

3.

A $\rightarrow (\neg B \rightarrow C)$	3
C $\rightarrow D$	4
A	(3)
$\neg D$	(4)
$\neg B \rightarrow C$	5
$\neg C$	(5)
B	(6)
•	
B	2
$\neg D \rightarrow B$	1
A $\rightarrow (\neg D \rightarrow B)$	

3 MPP
 4 MTT
 5 MTT
 6 QED
 2 CP
 1 CP

4.

(A \wedge B) \rightarrow (C \vee D)	3
A	(5)
$\neg C$	(8)
•	
A	4
$\neg B$	A, $\neg B$, $\neg C \not\Rightarrow \perp$
○	6
\perp	4
B	3
A \wedge B	8
C \vee D	3
D	A, $\neg C$, D $\not\Rightarrow \perp$
○	6
\perp	3
\perp	2
C	1
A \rightarrow C	
A B C D	(A \wedge B) \rightarrow (C \vee D) / A \rightarrow C
T F F F	F (T) F (F) divides 1st gap
T F F T	F (T) T (F) divides both gaps
T T F T	T (T) T (F) divides 2nd gap

5. Adam called Billy's mother and she is the owner of the dog
Adam called Billy's mother \wedge Billy's mother is the owner of the dog
 [_ called _] Adam Billy's mother \wedge Billy's mother = the owner of the dog
 Ca(Billy's mother) \wedge Billy's mother = the owner of the dog
 Ca([_ 's mother] Billy) \wedge [_ 's mother] Billy = [the owner of _] the dog
 $Ca(mb) \wedge mb = od$
 C: [_ called _]; a: Adam; b: Billy; d: the dog; m: [_ 's mother];
 o: [the owner of _]

6. Apart from the choice of the bound variable, the following are all the possibilities:
- $$[Rxb \rightarrow Rbc]_x a \quad [Rax \rightarrow Rbc]_x b \quad [Rab \rightarrow Rbx]_x c$$
- $$[Rab \rightarrow Rxc]_x b$$
- $$[Rax \rightarrow Rxc]_x b$$

7.

a = fb Ra(fa)	a-fb, b, c, fa, fc (2)
fb = c	a-fb-c, b, fa-fc
•	
2 QED= R(fb)(fc)	1
1 CP	fb = c → R(fb)(fc)

Phi 270 F98 test 3

(questions 1-6 are from quiz 3 and 7-10 are from quiz 4 out of 6 quizzes—these two quizzes addressed the part of the course your test is designed to cover)

Analyze the sentences below in as much detail as possible *without* going below the level of sentences (i.e., without recognizing individual terms and predicates). Be sure that the unanalyzed components of your answer are complete and independent sentences and that you respect any grouping in the English. You may use right-to-left arrows to reflect English word order but you should then also restate your symbolic analysis with arrows running left to right and, in any case, you should restate it using English notation.

1. If our message got there, they should be on their way

answer

2. Unless we make reservations, we'll get a table only if it is a slow night

answer

3. Check the following for validity using derivations; you *may* use attachment rules and detachment rules. If the derivation fails, present a counterexample that divides the premises from the conclusion.

$$A \rightarrow (B \rightarrow (C \vee D))$$

$$\neg C \rightarrow (A \rightarrow \neg B)$$

answer

4. [This question was on a topic not covered in Fo6] Use replacement by equivalence to put the following sentence into disjunctive normal form. Show how you reach your result; you may combine uses of associativity and commutativity with other principles in a single step but there should be no more than one use of De Morgan's laws or distributivity in each step.

$$\neg ((A \vee \neg B) \wedge (C \wedge A))$$

answer

5. Analyze the sentence below in as much detail as possible, continuing the analysis when there are no more connectives by identifying predicates, functors, and individual terms. Be sure that the unanalyzed expressions in your answer are independent and that you respect any grouping in the English. (You need not state the result in English notation.)

If Sam is the winner of the trip, then the winner of the grand prize presented it to him

answer

6. Give two different expansions (using predicate abstracts) of the sentence below as a one-place predicate applied to a term:

$$Pb \wedge Rab$$

answer

7. Draw a diagram which presents the same interpretation as the following tables:

range: 1, 2, 3	a c g	τ Fτ	τ Gτ	R	1	2	3
	2 3 2	1 T	1 F	1	T	F	T
		2 F	2 T	2	T	F	F
		3 T	3 T	3	F	T	T

answer

8. Describe a structure (i.e., an assignment of extensions to the non-logical vocabulary) which makes the following sentences all true. (You may present the structure either using tables or, were possible, using diagrams.)

$$fa = b, b = c, Pb, \neg Pa, Ra(fa), R(fb)(fc), \neg Rbc$$

answer

Check each of the arguments below for validity using derivations. You need *not* present counterexamples to gaps that reach dead ends.

9. $fa = c$
 Rbc

$$\frac{a = b \rightarrow Ra(fa)}{Rbc}$$

answer

10. $Rab \vee Rcb$
 $a = b \wedge gb = gc$

$$\frac{Rbc \rightarrow Rcb}{Rbc \rightarrow Rcb}$$

answer

Phi 270 F98 test 3 answers

1. If our message got there, they should be on their way
our message got there \rightarrow they should be on their way

$$M \rightarrow W$$

if M then W

M: our message got there; W: they should be on their way

2. \neg we will make reservations \rightarrow we'll get a table only if it is a slow night
 \neg we will make reservations \rightarrow (\neg we'll get a table \leftarrow \neg it will be a slow night)

$$\neg R \rightarrow (\neg T \leftarrow \neg S) \text{ or: } \neg R \rightarrow (\neg S \rightarrow \neg T)$$

if not R then if not S then not T

R: we will make reservations; S: it will be a slow night; T: we'll get a table

3.

4	A \rightarrow (B \rightarrow (C \vee D))	4
	\neg C	(6)
	A	(4)
	B	(5)
4 MPP	B \rightarrow (C \vee D)	5
5 MPP	C \vee D	6
6 MTP	D	
	\circ	A, B, \neg C, D $\not\Rightarrow \perp$
	\perp	
3 RAA	\neg B	2
2 CP	A \rightarrow \neg B	1
1 CP	\neg C \rightarrow (A \rightarrow \neg B)	

A B C D	A \rightarrow (B \rightarrow (C \vee D)) / \neg C \rightarrow (A \rightarrow \neg B)
T T F T	Ⓣ T T T Ⓣ F F

4. [This question was on a topic not covered in FO6]

$$\neg ((A \vee \neg B) \wedge (C \wedge A))$$

$$\Leftrightarrow \neg (A \vee \neg B) \vee \neg (C \wedge A)$$

$$\Leftrightarrow (\neg A \wedge B) \vee \neg (C \wedge A)$$

$$\Leftrightarrow (\neg A \wedge B) \vee \neg C \vee \neg A$$

[However, that problem was a typo; I had really intended something along these lines:]

$$\neg ((A \vee \neg B) \vee (C \wedge \neg A))$$

$$\Leftrightarrow \neg (A \vee \neg B) \wedge \neg (C \wedge \neg A)$$

$$\Leftrightarrow (\neg A \wedge B) \wedge \neg (C \wedge \neg A)$$

$$\Leftrightarrow (\neg A \wedge B) \wedge (\neg C \vee A)$$

\Leftrightarrow

$(\neg A \wedge B \wedge \neg C) \vee (\neg A \wedge B \wedge A)$
 [which could, but need not, be continued as follows:

$$\begin{aligned} &\Leftrightarrow (\neg A \wedge B \wedge \neg C) \vee (\neg A \wedge A) \\ &\Leftrightarrow \neg A \wedge B \wedge \neg C \end{aligned}$$

5. If Sam is the winner of the trip, then the winner of the grand prize presented it to him

Sam is the winner of the trip \rightarrow the winner of the grand prize presented the trip to Sam

$s =$ the winner of the trip \rightarrow [_ presented _ to _] the winner of the grand prize the trip Sam

$s =$ [the winner of _] the trip \rightarrow P(the winner of the grand prize)ts

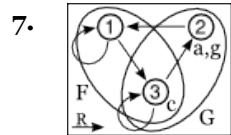
$s = nt \rightarrow P([\text{the winner of } _] \text{ the grand prize})ts$

$s = nt \rightarrow P(ng)ts$

P: [_ presented _ to _]; g: the grand prize; n: [the winner of _]; s: Sam; t: the trip

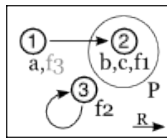
6. The following are the possibilities; in the last, τ may be any term:

$[Pb \wedge Rxb]_x a$, $[Px \wedge Rab]_x b$, $[Pb \wedge Rax]_x b$, $[Px \wedge Rax]_x b$,
 $[Pb \wedge Rab]_x \tau$



7.

range: 1, 2, 3	a b c	τ ft	τ P τ	R 1 2 3
	1 2 2	1 2	1 F	1 F T F
		2 3	2 T	2 F F F
		3 1	3 F	3 F F T



(The diagram above provides a complete answer, and so do the tables to its left. The tables below show a way of arriving at these answers.)

alias	sets	IDs	values
a		1	a: 1
fa		2	f1: 2
b			b: 2
c			c: 2
fb		3	f2: 3
fc			f2: 3

resources	values
Pb	P2: T
$\neg Pa$	P1: F
Ra(fa)	R12: T
R(fb)(fc)	R33: T
$\neg Rbc$	R22: F

9.

	fa = c	a, b, fa-c, fb
	Rbc	(2)
	a = b	a-b, fa-fb-c
	•	
2 QED=	Ra(fa)	1
1 CP	a = b \rightarrow Ra(fa)	

10.

	Rab \vee Rcb	4
	a = b \wedge gb = gc	2
	Rbc	
2 Ext	a = b	a-b, c, gb, gc
2 Ext	gb = gc	a-b, c, gb-gc
	$\neg Rcb$	(4)
4 MTP	Rab	
	o	a=b, gb=gc, Rbc, $\neg Rcb$, Rab $\Rightarrow \perp$
	\perp	3
3 CP	Rcb	1
1 CP	Rbc \rightarrow Rcb	

Phi 270 F97 test 3

(questions 1-6 are from quiz 3 and 7-9 are from quiz 4 out of 6 quizzes—these two quizzes addressed the part of the course your test is designed to cover)

Analyze the sentences below in as much detail as possible *without* going below the level of sentences (i.e., without recognizing individual terms and predicates). Be sure that the unanalyzed components of your answer are complete and independent sentences and that you respect any grouping in the English.

- The creek will be high enough only if it rains.

answer

- Unless you object, Al will show the letter to Barb if she asks to see it.

answer

Check each of the following for validity using the basic system of derivations (i.e., *do not use* attachment rules but *you may use* detachment rules). If a derivation fails, present a counterexample that divides its premises from its conclusion.

$$\frac{A \rightarrow (B \vee C)}{\neg C \rightarrow (A \rightarrow B)}$$

answer

$$\frac{A \rightarrow (B \rightarrow C)}{(C \wedge A) \rightarrow B}$$

answer

- Analyze the sentence below in as much detail as possible, continuing the analysis when there are no more connectives by identifying predicates, functors, and individual terms. Be sure that the unanalyzed expressions in your answer are independent and that you respect any grouping in the English.

If Dan's wife received the message, she is the person who called.

answer

- Give two different expansions (using predicate abstracts) of the sentence: Raba.

answer

- Put the following into reduced form: $[Pxa \wedge Qbx]_x a$.

answer

- Describe a structure (i.e., an assignment of extensions to the non-logical vocabulary) which makes the following sentences all true. (You may present the structure either using tables or, were possible, using diagrams.)

$$a = fb, fa = fb, b = c, Fa, \neg F(gc), Rb(fa), \neg Ra(fb), R(gc)c$$

answer

Use derivations to check each of the claims of entailment below. You need *not* present counterexamples to dead-end gaps.

$$8. Fa \wedge \neg Fb \Rightarrow b = c \rightarrow \neg a = c$$

answer

$$9. fa = c, fb = c, Rc(fa) \rightarrow Ra(fa) \Rightarrow R(fa)(fb) \rightarrow Rb(fb)$$

answer

Phi 270 F97 test 3 answers

- the creek will be high enough only if it rains
 \neg the creek will be high enough $\leftarrow \neg$ it will rain
 $\neg H \leftarrow \neg R$ **or** $\neg R \rightarrow \neg H$
 if not R then not H

H: the creek will be high enough; R: it will rain

- \neg you will object \rightarrow Al will show the letter to Barb if she asks to see it
 \neg you will object \rightarrow (Al will show the letter to Barb \leftarrow Barb will ask to see the letter)
 $\neg O \rightarrow (S \leftarrow A)$ **or** $\neg O \rightarrow (A \rightarrow S)$
 if not O then if A then S

A: Barb will ask to see the letter; O: you will object; S: Al will show the letter to Barb

- | | |
|---|-----|
| A \rightarrow (B \vee C) | 3 |
| \neg C | (4) |
| A | (3) |
| 3 MPP B \vee C | 4 |
| 4 MTP B | (5) |
| • | |
| 5 QED B | 2 |
| 2 CP A \rightarrow B | 1 |
| 1 CP \neg C \rightarrow (A \rightarrow B) | |

4.	$A \rightarrow (B \rightarrow C)$ 3 $C \wedge A$ 2 C A $B \rightarrow C$ (3) $\neg B$ $\neg B$ \circ $A, \neg B, C \Rightarrow \perp$ \perp 6 B 5 C \circ $A, \neg B, C \Rightarrow \perp$ \perp 5 \perp 4 B 1 $(C \wedge A) \rightarrow B$	<table style="border-collapse: collapse; margin-top: 10px;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">A B C</td> <td style="padding-right: 5px;">A \rightarrow (B \rightarrow C) / (C \wedge A) \rightarrow B</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">T F T</td> <td style="padding-right: 5px;">Ⓣ T T Ⓣ Ⓣ</td> </tr> </table>	A B C	A \rightarrow (B \rightarrow C) / (C \wedge A) \rightarrow B	T F T	Ⓣ T T Ⓣ Ⓣ
A B C	A \rightarrow (B \rightarrow C) / (C \wedge A) \rightarrow B					
T F T	Ⓣ T T Ⓣ Ⓣ					

5. Dan's wife received the message \rightarrow Dan's wife is the person who called

[_ received _] Dan's wife the message \rightarrow Dan's wife = the person who called

$R(\text{Dan's wife})m \rightarrow [\text{'s wife}] \text{Dan} = p$
 $R(fd)m \rightarrow fd = p$

R: [_ received _]; d: Dan; f: ['s wife]; m: the message; p: the person who called

6. a. The following are the possibilities; in the last, τ may be any term:

$[Rxbx]_x a, [Rxba]_x a, [Rabx]_x a, [Raxa]_x b, [Raba]_x \tau$

b. $Paa \wedge Qba$

7.	range: 1, 2, 3	a b c	τ ft	τ g τ	τ F τ	R	1	2	3	
		1 2 2	1 1	1 3	1 T	1	F	F	F	
			2 1	2 3	2 F	2	T	F	F	
			3 3	3 3	3 F	3	T	T	F	

(The diagram provides a complete answer, and so do the tables to its left. The tables below show a way of arriving at these answers.)

alias sets IDs values

a	1	a: 1
fa		f1: 1
fb		f2: 1
b	2	b: 2
c		c: 2
gc	3	g2: 3

resources values

Fa	F1: T
$\neg F(gc)$	F3: F
Rb(fa)	R21: T
$\neg Ra(fb)$	R11: F
R(gc)c	R32: T

8.	$Fa \wedge \neg Fb$ 1 Fa (4) $\neg Fb$ (4) $b = c$ a,b-c $a = c$ a-b-c \bullet \perp 3 $\neg a = c$ 2 $b = c \rightarrow \neg a = c$	<table style="border-collapse: collapse; margin-top: 10px;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">1 Ext</td> <td style="padding-right: 5px;">Fa</td> <td style="padding-right: 5px;">(4)</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">1 Ext</td> <td style="padding-right: 5px;">$\neg Fb$</td> <td style="padding-right: 5px;">(4)</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">$b = c$</td> <td style="padding-right: 5px;">a,b-c</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">$a = c$</td> <td style="padding-right: 5px;">a-b-c</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">\bullet</td> <td></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">4 Nc=</td> <td style="padding-right: 5px;">\perp</td> <td style="padding-right: 5px;">3</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">3 RAA</td> <td style="padding-right: 5px;">$\neg a = c$</td> <td style="padding-right: 5px;">2</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">2 CP</td> <td style="padding-right: 5px;">$b = c \rightarrow \neg a = c$</td> <td></td> </tr> </table>	1 Ext	Fa	(4)	1 Ext	$\neg Fb$	(4)		$b = c$	a,b-c		$a = c$	a-b-c		\bullet		4 Nc=	\perp	3	3 RAA	$\neg a = c$	2	2 CP	$b = c \rightarrow \neg a = c$	
1 Ext	Fa	(4)																								
1 Ext	$\neg Fb$	(4)																								
	$b = c$	a,b-c																								
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	\bullet																									
4 Nc=	\perp	3																								
3 RAA	$\neg a = c$	2																								
2 CP	$b = c \rightarrow \neg a = c$																									

9.	$fa = c$ $fb = c$ $Rc(fa) \rightarrow Ra(fa)$ a,b,c-fa-fb 3 $R(fa)(fb)$ (4) $\neg Rb(fb)$ \bullet $Rc(fa)$ 3 $Ra(fa)$ \circ $fa=c, fb=c, R(fa)(fb), \neg Rb(fb), Ra(fa) \Rightarrow \perp$ \perp 3 \perp 2 $Rb(fb)$ 1 $R(fa)(fb) \rightarrow Rb(fb)$	<table style="border-collapse: collapse; margin-top: 10px;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">1 Ext</td> <td style="padding-right: 5px;">$fa = c$</td> <td></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">1 Ext</td> <td style="padding-right: 5px;">$fb = c$</td> <td></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">$Rc(fa) \rightarrow Ra(fa)$</td> <td style="padding-right: 5px;">a,b,c-fa-fb</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">3</td> <td></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">$R(fa)(fb)$</td> <td style="padding-right: 5px;">(4)</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">$\neg Rb(fb)$</td> <td></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">\bullet</td> <td></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">4 QED=</td> <td style="padding-right: 5px;">$Rc(fa)$</td> <td style="padding-right: 5px;">3</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">$Ra(fa)$</td> <td></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">\circ</td> <td style="padding-right: 5px;">$fa=c, fb=c, R(fa)(fb), \neg Rb(fb), Ra(fa) \Rightarrow \perp$</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;"></td> <td style="padding-right: 5px;">\perp</td> <td style="padding-right: 5px;">3</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">3 RC</td> <td style="padding-right: 5px;">\perp</td> <td style="padding-right: 5px;">2</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">2 IP</td> <td style="padding-right: 5px;">$Rb(fb)$</td> <td style="padding-right: 5px;">1</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">1 CP</td> <td style="padding-right: 5px;">$R(fa)(fb) \rightarrow Rb(fb)$</td> <td></td> </tr> </table>	1 Ext	$fa = c$		1 Ext	$fb = c$			$Rc(fa) \rightarrow Ra(fa)$	a,b,c-fa-fb		3			$R(fa)(fb)$	(4)		$\neg Rb(fb)$			\bullet		4 QED=	$Rc(fa)$	3		$Ra(fa)$			\circ	$fa=c, fb=c, R(fa)(fb), \neg Rb(fb), Ra(fa) \Rightarrow \perp$		\perp	3	3 RC	\perp	2	2 IP	$Rb(fb)$	1	1 CP	$R(fa)(fb) \rightarrow Rb(fb)$	
1 Ext	$fa = c$																																											
1 Ext	$fb = c$																																											
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	\circ	$fa=c, fb=c, R(fa)(fb), \neg Rb(fb), Ra(fa) \Rightarrow \perp$																																										
	\perp	3																																										
3 RC	\perp	2																																										
2 IP	$Rb(fb)$	1																																										
1 CP	$R(fa)(fb) \rightarrow Rb(fb)$																																											

Phi 270 F96 test 3

(questions 1-6 are from quiz 3 and 7-9 are from quiz 4 out of 6 quizzes—these two quizzes addressed the part of the course your test is designed to cover)

Analyze the sentences below in as much detail as possible *without* going below the level of sentences (i.e., without recognizing individual terms and predicates). Be sure that the unanalyzed components of your answer are complete and independent sentences and that you respect any grouping in the English.

1. You won't succeed unless you try.

answer

2. If it was after 5, Sam got in only if he had a key.

answer

Check each of the following claims of entailment using the basic system of derivations (i.e., *do not use* attachment rules but *you may use* detachment rules). If a derivation fails, present a counterexample that divides its premises from its conclusion.

3. $(A \wedge B) \rightarrow C \Rightarrow A \rightarrow C$

answer

4. $C \rightarrow (A \rightarrow B) \Rightarrow (A \wedge \neg B) \rightarrow \neg C$

answer

5. Analyze the sentence below in as much detail as possible, continuing the analysis when there are no more connectives by identifying predicates, functors, and individual terms. Be sure that the unanalyzed expressions in your answer are independent and that you respect any grouping in the English.

If Ann's car is the one you saw, she wasn't driving it.

answer

6. a. Give two different expansions (using predicate abstracts) of the reduced form: Raa.

answer

- b. Put the following into reduced form: $[Fx \wedge Pxb]_x c$.

answer

7. Describe a structure (i.e., an assignment of extensions to the non-logical vocabulary) which makes the following sentences all true. (You may present the structure either using tables or, where possible, using diagrams.)

$a = c, ga = gb, Pa, \neg P(ga), Rab, Rbc, \neg Rc(ga)$

answer

Check each of the claims of entailment below using derivations. You need *not* describe structures dividing gaps you leave open.

8. $Ha \wedge c = d, G(fd) \Rightarrow G(fc) \wedge (a = b \rightarrow Hb)$

answer

9. $Ra(fa) \wedge Rb(fb), fa = b \Rightarrow Ra(f(fa))$

answer

Phi 270 F96 test 3 answers

1. You won't succeed unless you try
you won't succeed $\leftarrow \neg$ you will try

\neg you will succeed $\leftarrow \neg$ you will try

$\neg S \leftarrow \neg T$ **or** $\neg T \rightarrow \neg S$

if not T then not S

S: you will succeed; T: you will try

2. If it was after 5, Sam got in only if he had a key
it was after 5 \rightarrow Sam got in only if he had a key
it was after 5 $\rightarrow (\neg$ Sam got in $\leftarrow \neg$ Sam had a key)

$A \rightarrow (\neg G \leftarrow \neg K)$ **or** $A \rightarrow (\neg K \rightarrow \neg G)$

if A then if not K then not G

A: it was after 5; G: Sam got in; K: Sam had a key

- 3.

	$(A \wedge B) \rightarrow C$	3
	A	(4)
	$\neg C$	(3)
3 MTT 4 MPT	$\neg (A \wedge B)$	4
	$\neg B$	
	o	$A, \neg B, \neg C \not\Rightarrow \perp$
	\perp	2
2 IP	C	1
1 CP	A \rightarrow C	
A B C	$(A \wedge B) \rightarrow C / A \rightarrow C$	
T F F	F (T) (F)	

4.	C → (A → B)	4
	A ∧ ¬ B	2
2 Ext	A	(5)
2 Ext	¬ B	(6)
	C	(4)
4 MPP	A → B	5
5 MPP	B	(6)
	•	
6 Nc	⊥	3
3 RAA	¬ C	1
1 CP	(A ∧ ¬ B) → ¬ C	

5. If Ann's car is the one you saw, she wasn't driving it
Ann's car is the one you saw → ¬ Ann was driving Ann's car
Ann's car = the car you saw → ¬ [was driving] Ann (Ann's car)

['s car] Ann = [the car saw] you → ¬ Da(['s car] Ann)
ca = ro → ¬ Da(ca)

[ca = ro → ¬ Da(ro) is also possible]

D: [was driving]; a: Ann; c: ['s car]; o: you; r: [the car saw]

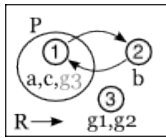
6. a. The following are the possibilities; in the last, τ may be any term:

[Rxx]_xa, [Rxa]_xa, [Rax]_xa, [Raa]_xτ

b. Fc ∧ Pcb

7. range: 1, 2, 3

a	b	c	τ	gτ	τ	Pτ	R	1	2	3
1	2	1	1	3	1	T	1	F	T	F
			2	3	2	F	2	T	F	F
			3	1	3	F	3	F	F	F



(The diagram provides a complete answer, and so do the tables to its left. The tables below show a way of arriving at these answers.)

alias sets IDs values

a	1	a: 1
c		c: 1
b	2	b: 2
ga	3	g1: 3
gb		g2: 3

resources values

Pa	P1: T
¬ P(ga)	P3: F
Rab	R12: T
Rbc	R21: T
¬ Rc(ga)	R13: F

8.	Ha ∧ c = d	(3)
	G(fd)	
1 Ext	Ha	(5)
1 Ext	c = d	a,b,c-d,fc-fd
	•	
3 QED=	G(fc)	2
	a = b	a-b,c-d,fc-fd
	•	
5 QED=	Hb	4
4 CP	a = b → Hb	2
2 Cnj	G(fc) ∧ (a = b → Hb)	

9.	Ra(fa) ∧ Rb(fb)	1
	fa = b	a,b-fa,fb-f(fa)
1 Ext	Ra(fa)	
1 Ext	Rb(fb)	
	¬ Ra(f(fa))	
	o	fa=b,Ra(fa),Rb(fb),¬Ra(f(fa)) ⇒ ⊥
	⊥	2
2 IP	Ra(f(fa))	