WFF Guide

There are three types of cubes in WFF N Proof: Sentence variables, which are the main part of well formed formulas and are similar to (but not exactly like) nouns in English; Connectives, which hold the sentence variables together; and Blanks which are combined with connectives to form words.

Sentence Variables: p, q, r, and s
Connectives: C, A, K, E, and N,
Blanks: R, i, and o

The sentence variables (p, q, r, and s) are all well formed formulas (WFFs) by themselves. Two WFFs joined by a connective (excluding N) **<u>in front</u>** of them is also a WFF.
N is a leech letter. Any WFF with N in front of it is still a WFF. There is no way to take an N out of a WFF or put an N into a WFF, in Basic WFF N' Proof.

Examples of WFFs: p, q, Kpq, Asr, Ars, KArsErp, ECCrpqp, KKKKKKKKAAAAAAppppssssssrrrr, Np, Ns, NNKKpqs, NNNNNNNNKKKrspq

Not WFFs: pq, qps, Eqps, ssEErr, KKKKssqqKs, KKAECKKKsq

The goal of WFF N Proof is to transform a supposition(sometimes known as a "Said-So"), your starting point or given, into the goal, which has to be a WFF. You do this by using rules, which help you change around WFFs. These rules are a connective followed by an i or an o. The rules used in basic WFF are, Ko, Ki, Ai, Co, Eo, Ei, Rp. o stands for out and i stands for in. The R cube can stand for any rule (CAKE letter and blank) and R doesn't have to be the same thing everyplace you use it. R can also stand for the R in Rp.

Ki: Ki says if you have two WFFs, then you can connect those two WFFs with a K. This rule can be stated s, r → Ksr or Krs.
Example proofs and solutions:→

	s, p → Kps		
1	s	s	s, p/Ki
2	p	s	
3	Kps	Ki 1,2	

	p, q, r → KKqpKrp		
1	p	s	
2	q	s	p, q, r/Ki
3	r	s	
4	Kqp	Ki 1,2	
5	Krp	Ki 1,3	
6	KKqpKrp	Ki 4,5	

	p, s → KKKpsKspKps		
1	p	s	
2	s	s	p, s/Ki
3	Kps	Ki 1,2	
4	Ksp	Ki 1,2	
5	KKpsKsp	Ki 3,4	
6	KKKpsKspKps	Ki 3,5	

Practice proofs:
1. p, q → Kpq
2. s, p, q → KKqsKKspKpq
3. s, r, p, q → KKKspqr
4. r, p → KKrpKKrpr
5. s, r, q → KKsrKKqsr

Rp: Repeat. Rp lets you repeat a WFF. The rule can be stated as p → p
Example proofs and solutions:

	r → r		
1	r	s	r/Rp
2	r	Rp 1	

	p, s → KKssp		
1	p	s	
2	s	s	p, s/Rp, Ki
3	s	Rp 2	
4	Kss	Ki 2,3	
5	KKssp	Ki 1,4	

	Ksp, q → KKKspKspq		
1	Ksp	s	
2	q	s	Ksp, q / Rp, Ki
3	Ksp	Rp 1	
4	KKspKsp	Ki 1,3	
5	KKKspKspqKi 2,4		

Practice proofs:
1. s → Kss
2. p → KKKpppKpp
3. s, q → KsKKssKqqq
4. r, p → KKrpKpp
5. s, p, r → KpKKpsKKrrKss

Ko: "When in doubt, Kout." Ko says that if you have a K WFF (any WFF in which K is the left most connective) you can get either of the two smaller WFFs contained in the K WFF. This rule can be stated as Ksr → r or s. Example proofs and solution:

Krs → Ksr

1	Krs	s	
2	s	Ko 1	Krs/Ko, Ki
3	r	Ko 1	
4	Ksr	Ki 1,2	

KKspq → KKKsqKqpKKspq

1	KKspq	s	
2	q	Ko 1	
3	Ksp	Ko 1	KKspq/Ki, Ko
4	s	Ko 3	
5	p	Ko 3	
5	Ksq	Ki 2,3	
6	Kqp	Ki 2,4	
7	KKsqKqp	Ki 5,6	
8	KKKsqKqpKKspq	Ki 1,7	

Ksp, KAprq → KpApr

1	Ksp	s	
2	KAprq	s	
3	p	Ko 1	Ksp, KAprq/Ko, Ki
4	Apr	Ko 2	
5	KpApr	Ki 3,4	

Practice Proofs

1. KsApr → KAprs
2. KCrpq, KEqps → Ksq
3. KECrpsp → KKECrpspp
4. KKpsr → KKrps
5. KpKrs, Kqs → KKpqKsr

Ai: "Buy one, get one free." Ai says if you have a WFF, you can get an A WFF with the WFF you had and a new WFF. Ai can be stated r → Arp or Apr.

Example proofs and solutions:

	KpNs → Arp		
1	KpNs	s	KpNs/Ko, Ai
2	p	Ko 1	
3	Arp	Ai 2	

	p → AKppr		
1	p	s	
2	p	Rp 1	p/Rp, Ki, Ai
3	Kpp	Ki 1,2	
4	AKppr	Ai 3	

	KKsrNCsr → AEprAsr		
1	KKsrNCsr	s	
2	Ksr	Ko 1	
3	s	Ko 2	KKsrNcsr/Ko, Ai
4	Asr	Ai 3	
5	AEprAsr	Ai 4	

Practice Proofs:

1. s → Ars
2. p → ArKKppp
3. Krs → Arp
4. KKprs → AKrsq
5. Kqp → KKppAKpps

Co: "Cancel Out" Co says that if you have a C WFF and the first little WFF of the C WFF, then you can get the second little WFF of the C WFF.
This can be stated as Cqs, q → s
Example proofs and solutions:

	KCrpr → p		
1	KCrpr	s	
2	Crp	Ko 1	KCrpr/Ko, Co
3	r	Ko 1	
4	p	Co 3,4	

	KCCrpsCrp → s		
1	KCCrpsCrp	s	
2	CCrps	Ko 1	KCCrpsCrp/Ko, Co
3	Crp	Ko 1	
4	s	Co 3,4	

	KCKqpsp, Krq → s		
1	KCKqpsp	s	
2	Krq	s	
3	CKqps	Ko 1	KCKqpsp, Krq/Ko, Ki, Co
4	p	Ko 1	
5	q	Ko 2	
6	Kqp	Ki 4,5	
7	s	Co 3,6	

	CArsp, Kqs → Kqp		
1	CArsp	s	
2	Kqs	s	
3	s	Ko 2	CArsp, Kqs/Ko, Ai, Co, Ki
4	Ars	Ai 3	
5	p	Co 1,4	
6	q	Ko 2	
7	Kqp	Ki 5,6	

Practice Proofs:
1. r, CAAssrq → AqNp
2. Krp, CAsKprEps → KEpsp
3. CArps, Cqr, Krq → Ksr
4. Crp, Csr, Ksq → KApEqrq
5. CpCrq, Csp, Ksr → KKsrq

Ei: E in says Cqs, Csq → Eqs or Esq. Some other examples of Ei are CrErq, CErqr → CrErq or CErqr and Cpq, Cqp → Cqp or Cpq.
Both C WFFs are needed to get the E WFF.
Example Proofs and Solutions:

	Cqr, KCrqs → Erq		
1	Cqr	s	
2	KCrqs	s	Cqr, KCrqs/Ko, Ei
3	Crq	Ko 2	
4	Erq	Ei 1,3	

	KCsqq, Cqs → KEsqKsq		
1	KCsqq	s	
2	Cqs	s	
3	Csq	Ko 1	
4	Esq	Ei 2,3	KCsqq, Cqs/Ko, Ki, Co, Ei
5	q	Ko 1	
6	s	Co 2,5	
7	Ksq	Ki 5,6	
8	KEsqKsq	Ki 4,7	

	KCEsqrCsq, p, CpCqs → ANrr		
1	KCEsqrCsq	s	
2	p	s	
3	CpCqs	s	KCEsqrCsq, p, CpCqs/
4	Cqs	Co 2 and 3	Co, Ko, Ki, Ai
5	Csq	Ko 1	
6	Esq	Ei 4 and 5	
7	CEsqr	Ko 1	
8	r	Co 6 and 7	
9	ANrr	Ai 8	

Practice Proofs:
1. KCrrCrr → Err
2. Cps, KpCsp →Esp
3. Cps, KpCsp → KsEps
4. Csr, Crs →Esr
5. KEsrCqp, Cpq → KEqpEsr

Eo: Eo says if you have an E WFF, then you can get a C WFF with the two little WFFs of the E WFF reversed. This rule can be stated as Erp → Cpr or Crp.

Example proofs and solutions:

	Eps, s → p		
1	Eps	s	
2	s	s	Eps, s/Eo, Co
3	Csp	Eo 1	
4	p	Co 2, 3	

	Erp → KCrpCpr		
1	Erp	s	
2	Crp	Eo 1	Erp/Eo, Ki
3	Cpr	Eo 1	
4	KCrpCpr	Ki 2,3	

	KEspp → ANKrps		
1	KEspp	s	KEspp/Ko, Eo, Co, Ai
2	Esp	Ko 1	
3	Cps	Eo 2	
4	p	Ko 1	
5	s	Co 3,4	
6	ANKrps	Ai 5	

	KEsqApr → AKEqsAprKrp		
1	KEsqApr	s	
2	Esq	Ko 1	KEsqApr/Ko, Eo, Ei, Ko, Ki, Ai
3	Csq	Eo 2	
4	Cqs	Eo 2	
5	Eqs	Ei 3, 4	
6	Apr	Ko 1	
7	KEqsApr	Ki 5,6	
8	AKEqsAprKrp	Ai 7	

Practice Proofs:

1. Erp → KCrpCpr
2. Esq → Eqs
3. EqKrs, q → s
4. Erp → KCrpAEprAss
5. KCprEpr → Erp

How To Present A Solution

A solution consists of your proof, and the cubes you used (including the rules). In addition to a solution, you must also write a proof:

	Given → Goal		
1	Given	s	Given/RuleA, RuleB
2	~~~~	RuleA 1	
3	--~~	RuleB 1,2	

When writing a solution you should
1) Number your lines (this will make it easier for the checker to check)
2) Include the line numbers with which you used the rule (Ko uses one line, Ki uses two lines, Ai uses one line, Co uses to lines, Ei uses two lines, and Eo uses one line)
3) Put a line after your given in your proof
4) Put arrows under the cubes in essentials in your solution.

Remember, each proof must have at least one rule, or it's wrong, and if you use a rule twice, you only need to list it once in your solution.

Setting the Goal: You have two minutes to set the goal. The maximum number of cubes in the goal is seven. A goal must be a WFF, or it is a Never.

The Playing Mats:
The Equations playing mat, with Required, Permitted and Forbidden is used to play WFF N Proof. The permitted and forbidden section operate exactly as they do in Equations. The required section, however, is slightly different. When a cube is place in the required section in WFF, it must be an essential part of any acceptable solution. If you can take a cube that is in required out of a solution and the solution still works, that cube is non-essential, and therefore the solution is incorrect. The cube(s) you take out must be a WFF or a rule, not a part of a WFF or part of a rule. You are allowed to take out as many rules and WFFs out of a solution as you want, but you can not add any rules. To prove non-essentiality, you must write a proof showing that the parts you took out are non-essential. If you can prove a cube that is in essentials is non-essential, then the solution is wrong. Here is an example of this:

Someone calls Now on you and presents a solution like this

	Krp → KKrpKrp		
1	Krp	s	
2	r	Ko 1	Krp/Ko, Ki, Rp
3	p	Ko 1	↑ ↑
4	Krp	Ki 2,3	
5	Krp	Rp 1	
6	KKrpKrp	Ki 1,5	

You say that that the K in essentials is non-essential. Here is your proof:

	Krp → KKrpKrp		
1	Krp	s	Krp/Rp, Ki
2	Krp	Rp 1	
3	KKrpKrp	Ki 1,2	

You have proven your opponent is wrong, and they lose the shake.

Regular WFF

In addition to all the basic WFF Rules, regular WFF uses five new rules, No, Ni, Ao, Ci, and R(reiterate). All regular rules require the use of sub proofs, or proofs within a proof. You can start a sub proof with any given that you want to, but you cannot take something that is in a sub proof back out to the regular proof, unless you are using one of the five regular rules.

R(Reiterate)
Reiterate is similar to Repeat in Basic Wff, except that Reiterate allows you to repeat a Wff from the regular proof into a sub proof within that proof.

No(N Out)
N Out states that if you start a sub proof with an N WFF, and within that sub proof you prove a contradiction(p, Np for example), than you can take the N out of the WFF. (Nr→s, Ns)→ r

	r, Nr → KCrqApr				
1	r			s	r, Nr/R, No
2	Nr			s	
3	a	NKCrqApr	s		
	b	r	R, 1		
	c	Nr	R, 2		
4	KCrqApr			No 3	

	Crs, r, Ns →Kpq				
1	Crs			s	Crs, r, Ns/Co, R, No
2	r			s	
3	Ns			s	
4	s			Co 1,2	
5	a	NKpq	s		
	b	s	R,4		
	c	Ns	R,3		
6	Kpq			No 5	

Practice Problems:
1. Eps, Ns, p → Aqr
2. CApsNr, Kpr → NKqq
3. KKEqrCrNqr → Ess
4. NNp → p
5. KsNs → أ (show how that given can lead to any goal)

Using Reiterate and No instead of using Rp

In regular WFF it is not necessary to use the Rp rule if you are also using No in your proof. The following proof accomplishes the same thing as Rp, without using that rule:

```
  | p → p
1 | p                                 s
2 |    a | Np                    s
  |      |    I  | NNp     s
  |      |    II | p       R,R, 1
  |      |   III | Np      R, a
  |    b | Np                    No, a
  |    c |  p                    R, 1
3 | p                                 No 2
```

This proof is especially useful when an opponent uses Rp in their proof and the R or the p cube is in essentials. You can then prove them wrong by using the proof above to show that the p cube is non-essential.

For example, suppose an opponent presents the following solution:

```
  | NNq → q
1 | NNq                               s              NNq/R, Rp, No
2 |    a | Nq                    s                   ↑        ↑↑
  |    b | Nq                    Rp, a
  |    c | NNq                   R, 1
3 | q                                 No 2
```

You could prove the solution wrong by stating the R and p cubes were not essential and providing the following proof:

```
  | NNq →q
1 | NNq                               s              NNq/R, No
2 |    a | Nq                    s
  |    b |    I  | NNq     s
  |      |    II | NNq     R,R, 1
  |      |   III | Nq      R, a
  |    c | Nq                    No, b
  |    d | NNq                   R, 1
3 | q                                 No 2
```

Ni(N in)

N In states that if you start a sub proof with any WFF, and within that sub proof you prove a contradiction(r, Nr for example), than you can put an N in the front of the WFF. (r→s, Ns)→ Nr

r, Nr → NKCrqApr

1		r	s	r, Nr/R, Ni
2		Nr	s	
3	a	KCrqApr s		
	b	r	R, 1	
	c	Nr	R, 2	
4		NKCrqApr	Ni 3	

Krq → NCrNq

1		Krq	s	Krq/Ko, Co, Ni, R
2		r	Ko 1	
3		q	Ko 1	
4	a	CrNq	s	
	b	r	R 2	
	c	Nq	Co a,b	
	d	q	R 3	
5		NCrNq	Ni 4	

Epr, r, Np →NKpq

1		Epr	s	Epr, r, Np/Eo, Co, R, Ni
2		r	s	
3		Np	s	
4		Crp	Eo 1	
5		p	Co 2,4	
6	a	Kpq	s	
	b	p	R 4	
	c	Np	R 3	
7		NKpq	Ni 6	

Practice Problems:

1. p → NNp
2. Cpq, Nq → Np
3. Crs →NKrNs
4. CqKsNs → Nq
5. KqNq → Nأ   (show how that given can lead to any N WFF)

Ci(C in)

C In states that if you start a sub proof with WFF 1, and within that sub proof you prove WFF 2, than you can get C WFF1 WFF2. (r→s)→ Crs

		Krq → Crq			Krq/R, Ci, Ko
1		Krq		s	
2	a	r	s		
	b	Krq	R 1		
	c	q	Ko b		
3		Crq		Ci 2	

		→ CKsrs			/Ci, Ko
1	a	Ksr	s		
	b	s	Ko a		
2		CKsrs		Ci 1	

		Crs, r→ CNNErqs			Crs, r/R, Ci, Co
1		Crs		s	
2		r		s	
3	a	NNErq	s		
	b	Crs	R 1		
	c	r	R 2		
	d	s	Co b,c		
4		CNNErqs		Ci 3	

Practice Problems:

1. Ksq → Eqs
2. → CqCKrpp
3. Crs → CNsNr
4. NKsr → CsNr
5. r → C_r

(show how you can put any WFF as the first WFF in the C WFF)

Ao(A out)

A out states that if you have an A WFF, and you can start one sub proof with the first WFF of the A WFF and prove another WFF, and you can start a second sub proof with the second WFF of the A WFF and prove the same WFF as the first sub proof, than you have proven that WFF.

Arq,(r→s), (q→s)→ s

Asp → Aps

Line		WFF	Justification	
1		Asp	s	Asp/Ai, Ao
2	a	s	s	
	b	Aps	Ai a	
3	a	p	s	
	b	Aps	Ai a	
4		Aps	Ao 1,2,3	

AKqrKpr → r

Line		WFF	Justification	
1		AKqrKpr	s	AKqrKpr/Ko, Ao
2	a	Kqr	s	
	b	r	Ko a	
3	a	Kpr	s	
	b	r	Ko a	
4		r	Ao 1,2,3	

AKpCpqKrq → q

Line		WFF	Justification	
1		AKpCpqKrq	s	AKpCpqKrq/Ko, Co, Ao
2	a	KpCpq	s	
	b	p	Ko a	
	c	Cpq	Ko a	
	d	q	Co b,c	
3	a	Krq	s	
	b	q	Ko a	
4		q	Ao 1,2,3	

Practice Problems:

1. Ars, Ns → r
2. AErpEpr → KCprCrp
3. AKsqKqs → Esq
4. Apr → CNpr
5. Asp → NKNsNp

Additional Practice Problems

1. Cqs → ANqs
2. Krq → NCrNq
3. → ArNr
4. Ksp → NANsNp
5. NKpq → ANpNq
6. NCpr → KpNr
7. NAqs → KNqNs
8. Eps → ENpNs
9. Np, Nq → Epq
10. Epq, Eqr → Epr

Answer Key

No

1) Eps, Ns, p → Aqr

1		Eps	s
2		Ns	s
3		p	s
4	a	NAqr	s
	b	Eps	R 1
	c	Ns	R 2
	d	p	R 3
	e	Cps	Eo b
	f	s	Co d,e
4		Aqr	No 4

Eps, Ns, p /R, Eo, Co, No

2) CApsNr, Kpr → NKqq

1		CApsNr	s
2		Kpr	s
3		p	Ko 2
4		r	Ko 2
5		Aps	Ai 3
6		Nr	Co 1,4
7	a	NNKqq	s
	b	r	R, 4
	c	Nr	R, 6
8		NKqq	No 7

CApsNr, Kpr /
R, No, Co, Ai, Ko

3) KKEqrCrNqr → Ess

1		KKEqrCrNqr	s
2		r	Ko 1
3		KEqrCrNq	Ko 1
4		Eqr	Ko 3
5		CrNq	Ko 3
6		Nq	Co 2,5
7		Crq	Eo 4
8		q	Co 2,7
9	a	NEss	s
	b	q	R, 8
	c	Nq	R, 6
10		Ess	No 9

KKEqrCrNqr /
R, No, Co, Eo, Ko

Answer Key

No

4)

			NNq →q	
1			NNq	s
2	a		Nq	s
	b	I	NNq	s
		II	NNq	R,R, 1
		III	Nq	R, a
	c		Nq	No, b
	d		NNq	R, 1
3			q	No 2

NNq/R, No

5)

		KsNs → __	
1		KsNs	s
2		s	Ko 1
3		Ns	Ko 1
4	a	Nأ	s
	b	s	R, 2
	c	Ns	R, 3
5		__	No 4

KsNs / Ko, R, No

Ni

1)

			p →NNp	
1			p	s
2	a		Np	s
	b	I	p	s
		II	p	R,R 1
		III	Np	R a
	c		Np	Ni b
	d		p	R 1
3			NNp	Ni 2

p/R, Ni

2)

		Cpq, Nq → Np	
1		Nq	s
2		Cpq	s
3	a	p	s
	b	Cpq	R 2
	c	q	Co a,b
	d	Nq	R 1
4		Np	Ni 3

Cpq, Nq /R, Ni, Co

3)

		Crs → NKrNs	
1		Crs	s
2	a	KrNs	s
	b	r	Ko a
	c	Crs	R 1
	d	s	Co b,c
	e	Ns	Ko a
4		NKrNs	Ni 2

Crs/ R, Ni, Co, Ko

Answer Key

Ni

4)

```
   | CqKsNs →Nq
1  | CqKsNs                              s
2  |     a | q                       s
   |     b | CqKsNs                  R 1
   |     c |  KsNs                   Co a,b
   |     d |  s                      Ko c
   |     e |  Ns                     Ko c
3  | Nq                                  Ni 2
```

CqKsNs/
R, Ni, Ko, Co

5)

```
   | KqNq → N_
1  | KsNs                    s
2  | s                       Ko 1
3  | Ns                      Ko 1
4  |     a | أ          s
   |     b | s          R, 2
   |     c | Ns         R, 3
5  | N_                      Ni 4
```

KqNq / Ko, R, Ni

Ci

1)

```
   | Ksq → Eqs
1  | Ksq                                 s
2  |  s                                  Ko 1
3  |  q                                  Ko 1
4  |     a | s             s
   |     b | q             R 3
5  |  Csq                                Ci 4
6  |     a | q             s
   |     b | s             R 2
7  |  Cqs                                Ci 6
8  |  Eqs                                Ei 5,7
```

Ksq/R, Ci, Ei, Ko

2)

```
   | → CqCKrpp
1  |     a | q                           s
   |     b |      I  | Krp        s
   |          II | p          Ko I
   |     c | CKrpp                       Ci b
2  |  CqCKrpp                                    Ci 1
```

/Ko, Ci

3)

```
   | Crs → CNsNr
1  | Crs                                 s
2  |     a | Ns                    s
   |     b |      I   | r     s
   |          II  | Crs   R 1
   |          III | s     Co I,II
   |          IV  | Ns    R a
   |     c | Nr                    Ni
3  |  CNsNr                              Ci 2
```

Crs/ R, Ni, Ci, Co

Answer Key

Ci

4)

NKsr →CsNr

1 NKsr s — NKsr/ R, Ni, Ki, Ci
2 a s s
b I r s
II s R a
III Ksr Ki I,II
IV NKsr R,R 1
c Nr Ni a
3 CsNr Ci 2

5)

r → Cǐr

1 r s — r / R, Ci
2 a ǐ s
b r R, 1
3 Cǐr Ci 2

Ao

1)

Ars, Ns → r

1 Ars s — Ars, Ns/
2 Ns s — R, No, Ao
3 a r s
b I Nr s
II A NNr s
B Nr R I
C r R,R a
III Nr No I
IV r R a
c r No, b
4 a s s
b I Nr s
II s R a
III NS R,R 2
c r No, b
5 r Ao 3,4

2)

AErpEpr → KCprCrp

1 AErpEpr s — AErpEpr / Ao, Eo, Ki
2 a Erp s
b Crp Eo a
c Cpr Eo a
d KCprCrp Ki b,c
3 a Epr s
b Crp Eo a
c Cpr Eo a
d KCprCrp Ki b,c
4 KCprCrp Ao 2,4

Answer Key

Ao

3)

AKsqKqs / Ao, Ei, Ci, Ko

		AKsqKqs → Esq		
1		AKsqKqs		s
2	a	Ksq	s	
	b	s	Ko a	
	c	q	Ko a	
	d	I s	s	
		II q	R c	
	e	Csq	Ci d	
	f	I q	s	
		II s	R b	
	g	Cqs	Ci f	
	h	Esq	Ei e,g	
3	a	Kqs	s	
	b	s	Ko a	
	c	q	Ko a	
	d	I s	s	
		II q	R c	
	e	Csq	Ci d	
	f	I q	s	
		II s	R b	
	g	Cqs	Ci f	
	h	Esq	Ei e,g	
4		Esq		Ao 2,3

4)

Apr / R, No, Ci, Ao

		Apr → CNpr			
1		Apr			s
2	a	Np			s
	b	Aps			R 1
	c	I r			s
		II	A Nr	s	
			B 1 NNr	s	
			2 Nr	R A	
			3 r	R,R I	
			C Nr	No, B	
			D r	R I	
		III r			No, II
	d	I p			s
		II	A Nr	s	
			B Np	R,R a	
			C p	R, I	
		III r			No II
	E	r			Ao b,c,d
3		CNpr			Ci 2

Answer Key

Ao

5)

```
   | Asp → NKNsNp
1  | Asp                                                s          Asp /
2  |     a | KNsNp                                s                Ko, R, No, Ao
   |     b | Np                                   Ko a
   |     c | Ns                                   Ko a
   |     d | Asp                                  R 1
   |     e |      I  | p                  s
   |       |      II |      A | NNp   s
   |       |         |      B | Np    R,R b
   |       |         |      C | p     R I
   |       |      III| p                  No II
   |       |
   |     f |      I  | s                  s
   |       |      II |      A | Np    s
   |       |         |      B | Ns    R,R c
   |       |         |      C | s     R I
   |       |      III| p                  No II
   |     g | p                                    Ao d,e,f
3  | NKNsNp                                             No 2
```

Additional Practice Problems

1)

```
   | Cqs → ANqs
1  | Cqs                                                s          Cqs /
2  |     a | NANqs                                s                Ai, R, No, Co
   |     b |      I  | Nq             s
   |       |      II | ANqs           Ai I
   |       |      III| NANqs          R a
   |     c | q                                    No b
   |     d | Cqs                                  R 1
   |     e | s                                    Co c,d
   |     f | ANqs                                 Ai e
   |     g |      I  | NNANqs         s
   |       |      II | NANqs          R a
   |       |      III| ANqs           R f
   |     h   NANqs                                No g
3  | ANqs                                               No, 2
```

2)

```
   | Krq → NCrNq
1  | Krq                                    s                      Krq/
2  | r                                      Ko 1                   Ko, R, Co, Ni
3  | q                                      Ko 1
4  |     a | CrNq               s
   |     b | r                  R 2
   |     c | Nq                 Co a,b
   |     d | q                  R 3
5  | NCrNq                                  Ni 4
```

Answer Key

Additional Practice Problems

3) → ArNr

/Ai, No, R

1 a NArNr s
b I Nr s
II ArNr Ai I
III NArNr R a
c r No b
d ArNr Ai c
e I NNArNr s
II ArNr R d
III NArNr R a
f NArNr No e
2 ArNr No 1

4) Ksp → NANsNp

Ksp/R, Ko, Ni, Ao

1 Ksp s
2 a ANsNp s
b Ksp R 1
c s Ko b
d p Ko b
e I Ns s
II A s s
B s R,R c
C Ns R I
III Ns Ni II
f I Np s
II A s s
B p R,R d
C Np R I
III Ns Ni II
g Ns Ao a,e,f
3 NANsNp Ni 2

5) NKpq → ANpNq

NKpq/R, Ko, No, Ai

1 NKpq s
2 a NANpNq s
b I Np s
II ANpNq Ai I
III NANpNq R a
c p No b
d I Nq s
II ANpNq Ai I
III NANpNq R a
e q No d
f Kpq Ko c,e
g NKpq R 1
3 ANpNq No 2

Answer Key

Additional Practice Problems

6) NCpr $\rightarrow$ KpNr

NCpr/R, Ki, No, Ci

Line	Formula	Justification
1	NCpr	s
2 a	NKpNr	s
b I	p	s
II A	Nr	s
B	p	R I
C	KpNr	Ki A,B
D	NKpNr	R,R a
III	r	No II
c	Cpr	Ci b
d	NCpr	R 1
3	KpNr	No 2

7) NAqs $\rightarrow$ KNqNs

NAqs/R, Ki, Ni, Ai

Line	Formula	Justification
1	NAqs	s
2 a	q	s
b	Aqs	Ai a
c	NAqs	R 1
3	Nq	Ni 2
4 a	s	s
b	Aqs	Ai a
c	NAqs	R 1
5	Ns	Ni 4
6	KNqNs	Ki 3,5

8) Eps $\rightarrow$ ENpNs

Eps/
R, Eo, Co, Ci, Ei, Ni

Line	Formula	Justification
1	Eps	s
2 a	Np	s
b I	s	s
II	Eps	R,R 1
III	Csp	Eo II
IV	p	Co III
V	Np	R a
c	Ns	Ni b
3	CNpNs	Ci 2
4 a	Ns	s
b I	p	s
II	Eps	R,R 1
III	Cps	Eo II
IV	s	Co III
V	Ns	R a
c	Np	Ni b
5	CNsNp	Ci 4
6	ENpNs	Ei 3,5

Answer Key

Additional Practice Problems

9)

Line	Step	Formula	Justification
		Np, Nq → Epq	
1		Np	s
2		Nq	s
3	a	p	s
	b	I Nq	s
		II Np	R,R 1
		III p	R a
	c	q	No b
4		Cpq	Ci 3
5	a	q	s
	b	I Np	s
		II Nq	R,R 2
		III q	R a
	c	p	No b
6		Cqp	Ci 5
7		Epq	Ei 4,6

Np, Nq/ R, No, Ci, Ei

10)

Line	Step	Formula	Justification
		Epq, Eqr → Epr	
1		Epq	s
2		Eqr	s
3	a	p	s
	b	Epq	R 1
	c	Cpq	Eo b
	d	q	Co a.c
	e	Eqr	R 2
	f	Cqr	Eo e
	g	r	Co d,f
4		Cpr	Ci 3
5	a	r	s
	b	Eqr	R 2
	c	Crq	Eo b
	d	q	Co a.c
	e	Epq	R 1
	f	Cqp	Eo e
	g	p	Co d,f
6		Crp	Ci 3
7		Epr	Ei 4,6

Epq, Eqr/
R, Eo, Co, Ci, Ei