I. USE CONDITIONAL PROOF AND THE EIGHTEEN RULES OF INFERENCE TO DERIVE THE CONCLUSIONS OF THE FOLLOWING SYMBOLIZED ARGUMENTS. HAVING DONE SO, ATTEMPT TO DERIVE THE CONCLUSIONS WITHOUT USING CONDITIONAL PROOF.

(5)

1.	$A \supset \sim(A \vee E)$	/ $A \supset F$
2.	A	ACP
3.	$\sim(A \vee E)$	1, 2, MP
4.	$\sim A \cdot \sim E$	3, DM
5.	$\sim A$	4, Simp
6.	$A \vee F$	2, Add
7.	F	5, 6, DS
8.	$A \supset F$	2-7, CP

(6)

1.	$J \supset (K \supset L)$	
2.	$J \supset (M \supset L)$	
3.	$\sim L$	/ $J \supset \sim(K \vee M)$
4.	J	ACP
5.	$K \supset L$	1, 4, MP
6.	$M \supset L$	2, 4, MP
7.	$\sim K$	3, 5, MT
8.	$\sim M$	3, 6, MT

9.	~K ∣ ~M	7, 8, Conj
10.	~(K ∨ M)	9, DM
11.	J ⊃ ~(K ∨ M)	4-10, CP

(7)

1.	M ∨ (N ∣ O)	/ ~N ⊃ M
2.	~M	ACP
3.	N ∣ O	1, 2, DS
4.	N	3, Simp
5.	~M ⊃ N	2-4, CP
6.	~M ⊃ ~~N	5, DN
7.	~N ⊃ M	6, Trans

(8)

1. P ⊃ (Q ∨ R)
2. (P ⊃ R) ⊃ (S ∣ T)

1.	3. Q ⊃ R	/ T
2.	4. P	ACP
3.	5. Q ∨ R	1, 4, MP
4.	6. R ∨ Q	5, Com
5.	7. ~~R ∨ Q	6, DN
6.	8. ~R ⊃ Q	7, Impl
7.	9. ~R ⊃ R	3, 8, HS
8.	10. ~~R ∨ R	9, Impl

9.	11. R ∨ R	10, DN
10.	12. R	11, Taut
11.	13. P ⊃ R	4-12, CP
12.	14. S ∣ T	2, 13, MP
13.	15. T ∣ S	14, Com
14.	16. T	15, Simp

(9)

1. H ⊃ (I ⊃ N)
2. (H ⊃ ~I) ⊃ (M ∨ N)

1.	~N	/ M
2.	H	ACP
3.	I ⊃ N	1, 4, MP
4.	~I	3, 5, MT
5.	H ⊃ ~I	4-6, CP
6.	M ∨ N	2, 7, MP
7.	N ∨ M	8, Com
8.	M	3, 9, DS

(10)

1. C ⊃ (A ∣ D)

1.	2. B ⊃ (A ∣ E)	/ (C ∨ B) ⊃ A
2.	C ∨ B	ACP
3.	[C ⊃ (A ∣ D)] ∣ [B ⊃ (A ∣ E)]	1, 2, Conj

4. (A I D) ∨ (A I E) 3, 4, CD
5. A I (D ∨ E) 5, Dist
6. A 6, Simp
7. (C ∨ B) ⊃ A 3-7, CP

I. USE EITHER INDIRECT PROOF OR CONDITIONAL PROOF (OR BOTH) AND THE EIGHTEEN RULES OF INFERENCE TO DERIVE THE CONCLUSIONS OF THE FOLLOWING SYMBOLIZED ARGUMENTS. HAVING DONE SO, ATTEMPT TO DERIVE THE CONCLUSIONS WITHOUT USING INDIRECT PROOF OR CONDITIONAL PROOF.

(5)

1. S ⊃ (T ∨ ~U)
2. U ⊃ (~T ∨ R)
3. (S U) ⊃ ~R / ~S ∨ ~U
4. ~(~ S V ~U) AIP
5. ~~S I ~~U 4,DM
6. S I ~~U 5, DN
7. S I U 6, DN
8. ~R 3, 7, MP
9. S 7, Simp
10. U I S 7, Com
11. U 10, Simp
12. T ∨ ~U 1, 9, MP

13.	~T ∨ R	2, 11, MP
14.	R ∨ ~T	13, Com
15.	~T	8, 14, DS
16.	~U	12, 15, DS
17.	U ∣ ~U	11, 16, Conj
18.	~~(~S ∨ ~U)	4-17, IP
19.	~S ⋁ ~U	18, DN

(6)

1.	~A ⊃ (B ∣ C)	
2.	D ⊃ ~C	/ D ⊃ A
3.	D	ACP
4.	~C	2, 3, MP
5.	~C ∨ ~B	4, Add
6.	~B ∨ ~C	5, Com
7.	~(B ∣ C)	6, DM
8.	~~A	1, 7, MT
9.	A	8, DN
10.	D ⊃ A	3-9, CP

(7)

1.	(E ∨ F) ⊃ (C ∣ D)	
2.	(D ∨ G) ⊃ H	
3.	E ∨ G	/ H

4.	~H	AIP
5.	~(D ∨ G)	2, 4, MT
6.	~D ∣ ~G	5, DM
7.	~D	6, Simp
8.	~D ∨ ~C	7, Add
9.	~C ∨ ~D	8, Com
10.	~(C ∣ D)	9, DM
11.	~(E ∨ F)	1, 10, MT
12.	~E ∣ ~E	11, DM
13.	~E	12, Simp
14.	G	3, 13, DS
15.	~G ∣ ~D	6, Com
16.	~G	15, Simp
17.	G ∣ ~G	14, 16, Conj
18.	~~H	4-17 IP
19.	H	18, DN

(8)

1.	~M ⊃ (N ∣ O)	
2.	N ⊃ P	
3.	O ⊃	/ M
4.	~M	AIP
5.	N ∣ O	1, 4, MP

6.	N	5, Simp
7.	P	2, 6, MP
8.	O ∣ N	5, Com
9.	O	8, Simp
10.	~P	3, 9, MP
11.	P ∣ ~P	7, 10, Conj
12.	~~M	4-11, IP
13.	M	12, DN

(9)

1.	(R ∨ S) ⊃ T	
2.	(P ∨ Q) ⊃ T	
3.	R ∨ P	/ T
4.	R	ACP
5.	R ∨ S	4, Add
6.	T	1, 5, MP
7.	R ⊃ T	4-6, CP
8.	P	ACP
9.	P ∨ Q	8, Add
10.	T	2, 9, MP
11.	P ⊃ T	8-10, CP
12.	(R ⊃ T) ∣ (P ⊃ T)	7-11, Con
13.	T ∨ T	3, 12, CD

14.	T	Taut

(10)

1.	K	/ S ⊃ (T ⊃ S)
2.	S	ACP
3.	S ∨ ~T	2, Add
4.	~T ∨ S	3, Com
5.	T ⊃ S	4, Impl
6.	S ⊃ (T ⊃ S)	2-5, CP

(11)

1.	(A ∨ B) ⊃ C	
2.	(~A ∨ D) ⊃ E	/ C ∨ E
3.	~C	ACP
4.	~(A ∨ B)	1, 3, MT
5.	~A ∣ ~B	4, DM
6.	~A	5, Simp
7.	~A ∨ B	6, Add
8.	E	2, 7, MP
9.	~C ⊃ E	3-8, CP
10.	~~C ∨ E	9, Impl
11.	C ∨ E	10, DN

(12)

1.	(K ∨ L) ⊃ (M ∣ N)	
2.	(N ∨ O) ⊃ (P ∣ ~ K)	/ ~ K
3.	K	AIP
4.	K ∨ L	2, Add
5.	M ∣ N	1, 4, MP
6.	N ∣ M	5, Com
7.	N	6, Simp
8.	N ∨ O	7, Add
9.	P ∣ ~K	2, 8, MP
10.	~K ∣ P	9, Com
11.	~K	10, Simp
12.	K ∣ ~K	3, 11, Conj
13.	~K	3-12 IP

(13)

1.	[C ⊃ (D ⊃ C)] ⊃ E	/ E
2.	C	ACP
3.	C ∨ ~D	2, Add
4.	~D ∨ C	3, Com
5.	D ⊃ C	4, Impl
6.	C ⊃ (D ⊃ C)	2-5, CP
7.	E	1, 6, MP

(14)

1.	F	/ (G ⊃ H) ∨ (~ G ⊃ J)
2.	G ∣ ~H	ACP
3.	G	2, Simp
4.	G ∨ J	3, Add
5.	~~G ⊃ J	4, DN
6.	~G ⊃ J	5, Impl
7.	(G ∣ ~H) ∨ (~G ⊃ J)	2-6 CP
8.	(~G ∣ ~H) ∨ (~G ⊃ J)	7, Impl
9.	(~G ∨ ~~H) ∨ (~G ⊃ J)	8, DM
10.	(~G ∨ H) ∨ (~G ⊃ J)	9, DN
11.	(G ⊃ H) ∨ (~G ⊃ J)	10, Impl

(15)

1.	B ⊃ (K ∣ M)	
2.	(B ∣ M) ⊃ (P ≡ ~P)	/ ~ B
3.	B	AIP
4.	K ∣ M	1, 3, MP
5.	M ∣ K	4, Com
6.	M	5, Simp
7.	B ∣ M	3, 6, Conj
8.	P ≡ ~ P	2, 7, MP
9.	(P ∣ ~P) ∨ (~P ∣ ~~P)	8, Equiv
10.	(P ∣ ~P) ∨ (~P ∣ P)	9, DN

11.	(P ∣ ~P) ∨ (P ∣ ~P)	10, Com
12.	P ∣ ~P	11, Taut
13.	~B	3-12, IP

II. TRANSLATE THE FOLLOWING ARGUMENTS INTO SYMBOLIC FORM, USING THE LETTERS IN THE ORDER IN WHICH THEY ARE LISTED. THEN USE INDIRECT PROOF AND THE EIGHTEEN RULES OF INFERENCE TO DERIVE THE CONCLUSION OF EACH. HAVING DONE SO, ATTEMPT TO DERIVE THE CONCLUSION WITHOUT USING INDIRECT PROOF

(2)

If either the sea turtle population continues to decrease or rescue efforts are commenced to save the sea turtle from extinction, then nesting sanctuaries will be created and the indiscriminate slaughter of these animals will be halted. If either nesting sanctuaries are created or poachers are arrested, then if the indiscriminate slaughter of these animals is halted, then the sea turtle population will not continue to decrease. Therefore, the sea turtle population will not continue to decrease. (C, R, N, I, P)

C - Continues to decrease.

R - Rescue efforts.

N - Nesting sanctuaries.

I - Indiscriminate slaughter.

P - Poachers are arrested.

P1: If either the sea turtle population continues to decrease or rescue efforts are commenced to save the sea turtle from extinction, then nesting sanctuaries will be created and the indiscriminate slaughter of these animals will be halted.

P2: If either nesting sanctuaries are created or poachers are arrested, then if the indiscriminate slaughter of these animals is halted, then the sea turtle population will not continue to decrease.

C: Therefore, the sea turtle population will not continue to decrease. (C ∨ R) ⊃ (N ∙ I)

1.	(N ∨ P) ⊃ (I ⊃ ~C)	
2.	C	AIP
3.	C ∨ R	3, Add
4.	N ∙ I	1,4 MP
5.	N	5, Simp
6.	N ∨ P	6, Add
7.	I ⊃ ~C	2, 7, MP
8.	I ∙ N	5, Com
9.	I	9, Simp
10.	C	8, 10, MP
11.	C ∙ ~C	3,11, Conj
12.	~C	3-12, IP

(3)

If asbestos workers sue their employers, then if punitive damages are awarded, then their employers will declare bankruptcy. If asbestos workers sue their employers, then punitive damages will be awarded. If asbestos workers contract asbestosis, then either they will sue their employers or their employers will declare bankruptcy. Therefore, either asbestos workers will not contract asbestosis or their employers will declare bankruptcy. (S, P, B, C).

S - Sue their employers.

P - Punitive damages are awarded.

B - Bankruptcy.

C - Punitive damages.

P1: If asbestos workers sue their employers, then if punitive damages are awarded, then their employers will declare bankruptcy.

P2: If asbestos workers sue their employers, then punitive damages will be awarded.

P3: If asbestos workers contract asbestosis, then either they will sue their employers or their employers will declare bankruptcy.

C: Therefore, either asbestos workers will not contract asbestosis or their employers will declare bankruptcy.

1. $S \supset (P \supset B)$

2.	S ⊃ P	
3.	C ⊃ (S ∨ B)	
4.	C ∣ ~B	AIP
5.	C	4, Simp
6.	S ∨ B	3, 5, MP
7.	B ∨ S	6, Com
8.	~B ∣ C	4, Com
9.	~B	8, Simp
10.	S	7, 9, DS
11.	P ⊃ B	1, 10, MP
12.	S ⊃ B	2, 11, HS
13.	B	10, 12, MP
14.	B ∣ ~B	9, 13 , Conj
15.	~C	3-12 IP

(4)

IF ASTRONAUTS SPEND LONG PERIODS IN ZERO GRAVITY ONLY IF CALCIUM IS RESORBED IN THEIR BODIES, THEN ASTRONAUTS ON A MARS VOYAGE WILL ARRIVE WITH BRITTLE BONES. IF ASTRONAUTS ATTEMPT A VOYAGE TO MARS ONLY IF THEY SPEND LONG PERIODS IN ZERO GRAVITY, THEN ASTRONAUTS ON A MARS VOYAGE WILL ARRIVE WITH BRITTLE BONES. THEREFORE, ASTRONAUTS ON A MARS VOYAGE WILL ARRIVE WITH BRITTLE BONES. (Z, C, B, V)

Z - Zero gravity

C - Calcium is reabsorbed in their bodies

B - Brittle bones.

V - Mars voyage.

P1: If astronauts spend long periods in zero gravity only if calcium is resorbed in their bodies, then astronauts on a Mars voyage will arrive with brittle bones.

P2: If astronauts attempt a voyage to Mars only if they spend long periods in zero gravity, then astronauts on a Mars voyage will arrive with brittle bones.

C: Therefore, astronauts on a Mars voyage will arrive with brittle bones.

1.	(Z ⊃ C) ⊃ B	
2.	(V ⊃ Z) ⊃ B	
3.	~B	AIP
4.	~(Z ⊃ C)	1,3, MT
5.	~(~Z ∨ C)	4, Impl
6.	~~Z ∙ ~C	5, DM
7.	~~Z	6, Simp
8.	~(V ⊃ Z)	2, 3, MT
9.	~(~V ∨ Z)	8, Impl
10.	~~V ∙ ~Z	9, DM
11.	~Z ∙ ~~V	10, Com
12.	~Z	11, Simp

13. ~Z I ~~ Z	7, 12 Conj
14. ~~B	3-13 IP
15. B	14, DN