1.(a). $(P \Rightarrow \neg Q) \equiv (\neg P \vee \neg Q)$

$(Q \Rightarrow \neg P) \equiv (\neg Q \vee \neg P)$

P	Q	$\neg P$	$\neg Q$	$\neg P \vee \neg Q$	$\neg Q \vee \neg P$
0	0	1	1	1	1
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	0

The last two columns are equal, thus these two pairs are equivalent.

(b). $P \Leftrightarrow \neg Q \equiv (\neg P \vee \neg Q) \wedge (Q \vee P)$

P	Q	$\neg P$	$\neg Q$	$P \Leftrightarrow \neg Q$	$((P \wedge \neg Q) \vee (\neg P \wedge Q))$
0	0	1	1	0	0
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	0

The last two columns are equal, thus these two pairs are equivalent.

2.(a). $S \Rightarrow F \equiv \neg S \vee F$

$\neg S \Rightarrow \neg F \equiv S \vee \neg F$

$(\neg S \vee F) \Rightarrow (S \vee \neg F) \equiv (\neg(\neg S \vee F)) \vee (S \vee \neg F) \equiv (S \wedge \neg F) \vee (S \vee \neg F)$

S	F	$\neg S$	$\neg F$	$S \wedge \neg F$	$S \vee \neg F$	$(S \wedge \neg F) \vee (S \vee \neg F)$
0	0	1	1	0	1	1
0	1	1	0	0	0	0
1	0	0	1	1	1	1
1	1	0	0	0	1	1

This is Satisfiable(neither) because it contains both 1 and 0.

(b). $S \Rightarrow F \equiv \neg S \vee F$ (A)

$(S \vee H) \Rightarrow \text{Fire} \equiv (\neg(S \vee H)) \vee F \equiv (\neg S \wedge \neg H) \vee F$ (B)

$A \Rightarrow B \equiv \neg A \vee B \equiv (S \wedge \neg F) \vee ((\neg S \wedge \neg H) \vee F)$

S	F	H	$\neg S$	$\neg F$	$\neg H$	$S \wedge \neg F$	$\neg S \wedge \neg H \vee F$	$(S \wedge \neg F) \vee ((\neg S \wedge \neg H) \vee F)$
0	0	0	1	1	1	0	1	1
0	0	1	1	1	0	0	0	0
0	1	0	1	0	1	0	1	1
0	1	1	1	0	0	0	1	1
1	0	0	0	1	1	1	0	1
1	0	1	0	1	0	1	0	1
1	1	0	0	0	1	0	1	1
1	1	1	0	0	0	0	1	1

Since this expression contains both 1 and 0, thus it is satisfiable (neither)

(c).

$(S \wedge H) \Rightarrow F \equiv (\neg(S \wedge H)) \vee F \equiv \neg S \vee \neg H \vee \neg F$ (A)

$S \Rightarrow F \equiv \neg S \vee F$

$H \Rightarrow F \equiv \neg H \vee F$

$(\neg S \vee F) \vee (\neg H \vee F) \equiv \neg S \vee \neg H \vee F$ (B)

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

S	H	F	$\neg S$	$\neg H$	$\neg F$	A	B	$\neg A \vee B$	$\neg B \vee A$	$(\neg A \vee B) \wedge (\neg B \vee A)$
0	0	0	1	1	1	1	1	1	1	1
0	0	1	1	1	0	1	1	1	1	1
0	1	0	1	0	1	1	1	1	1	1
0	1	1	1	0	0	1	1	1	1	1
1	0	0	0	1	1	1	1	1	1	1
1	0	1	0	1	0	1	1	1	1	1
1	1	0	0	0	1	1	1	1	1	1
1	1	1	0	0	0	0	0	1	1	1

Since this expression always evaluates to 1, it's valid

3. a. My: mythical I: Immortal

Mg : magical H : Horned

Mo : mortal mammal

1. $My \Rightarrow I$
2. $\neg My \Rightarrow Mo$
3. $(I \vee Mo) \Rightarrow H$
4. $H \Rightarrow Mg$

b. $My \Rightarrow I$: $\neg My \vee I$

$\neg My \Rightarrow Mo$: $My \vee Mo$

$(I \vee Mo) \Rightarrow H$: $(\neg (I \vee Mo)) \vee H \equiv (\neg I \wedge \neg Mo) \vee H$

$\equiv (\neg I \vee H) \wedge (\neg Mo \vee H)$

$H \Rightarrow Mg$: $\neg H \vee Mg$

c. 1. $\neg My \vee I$

2. $My \vee Mo$

3. $\neg I \vee H$

4. $\neg Mo \vee H$

5. $\neg H \vee Mg$

6. $Mo \vee I$ (1+2)

7. $I \vee H$ (4+6)

8. H (3+7)

9. Mg (8+5)

We can only prove that the unicorn is magical and horned, can't prove that it is mythical.