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1. P=>¬Q, Q=>¬P

P	Q	¬Q	¬P	P=>¬Q	Q=>¬P
T	T	F	F	F	F
T	F	T	F	T	T
F	T	F	T	T	T
F	F	T	T	T	T

From the last two columns P=>¬Q, Q=>¬P are equivalent

P⇔¬Q, ((P^¬Q) ∨ (¬P^Q))

P	Q	¬P	¬Q	P^¬Q	¬P^Q	((P^¬Q) ∨ (¬P^Q))	P⇔¬Q
T	T	F	F	F	F	F	F
T	F	F	T	T	F	T	T
F	T	T	F	F	T	T	T
F	F	T	T	F	F	F	F

From the last two columns P⇔¬Q, ((P^¬Q) ∨ (¬P^Q)) are equivalent

2

In this question, use S for smoke, F for fire, H for heat

(Smoke=>Fire) => (¬Smoke => ¬ Fire)

S	F	¬S	¬F	S=>F	¬S=>¬F	(S=>F) =>(¬S=>¬F)
T	T	F	F	T	T	T
T	F	F	T	F	T	T
F	T	T	F	T	T	T
F	F	T	T	T	F	F

From the last column, I can see the statement is true under certain circumstances. So, the statement is Neither.

(Smoke=>Fire) => ((Smoke ∨ Heat) => Fire)

S	F	H	S ∨ H	S=>F	(S ∨ H) =>F	(S=>F) => ((S ∨ H) =>F)
T	T	T	T	T	T	T
T	F	F	T	F	F	T
T	T	F	T	T	T	T
T	F	T	T	F	F	T
F	T	T	T	T	T	T
F	F	F	F	T	T	T
F	T	F	F	T	T	T
F	F	T	T	T	F	F

From the last column, I can see the statement is true under certain circumstances. So, the statement is Neither.

((Smoke ^ Heat) => Fire) ⇔ ((Smoke=> Fire) ∨ (Heat=>Fire))

S	H	F	S^H	S=>F	H=>F	((S=>F) ∨(H=>F))	(S^H) =>F	Statement
T	T	T	T	T	T	T	T	T
T	T	F	T	F	F	F	F	T
T	F	T	F	T	T	T	T	T
T	F	F	F	F	T	T	T	T
F	T	T	F	T	T	T	T	T
F	T	F	F	T	F	T	T	T
F	F	T	F	T	T	T	T	T
F	F	F	F	T	T	T	T	T

From the last column, I can see the statement is always true.

So, the statement is Valid.

3

In this question use Y for Mythical, I for Immortal, L for Mammal, H for Horned, G for Magical

a) Knowledge base

Y => I

¬ Y => (¬I ^ L)

(I ∨ L) => H

H => G

b) Convert to CNF

Y => I ➜ ¬ Y ∨ I

¬ Y => (¬I ^ L) ➜ Y ∨ (¬I ^ L) ➜ (Y ∨ ¬I) ^ (Y ∨ L)

(I ∨ L) => H ➜ ¬ (I ∨ L) ∨ H ➜ (¬I ^ ¬L) ∨ H ➜ (H ∨ ¬I) ^ (H ∨ ¬L)

H => G ➜ ¬H ∨ G

So, all the CNF are

1) ¬ Y ∨ I
2) Y ∨ ¬I
3) Y ∨ L
4) H ∨ ¬I
5) H ∨ ¬L
6) ¬H ∨ G

c) Find if the unicorn is Mythical? Add ¬Y to the knowledge base

7) ¬Y
8) L (resolve 3 and 7)
9) ¬I (resolve 2 and 7)
   10) H (resolve 5 and 8)
   11) G (resolve 6 and 10)
    12)

From the knowledge base I have, I can't prove the unicorn is Mythical

Find if the unicorn is Magical? Add ¬G to the knowledge base

7) ¬G

8) ¬H (resolve 6 and 7)

9) ¬L (resolve 5 and 8)

10) ¬I (resolve 8 and 4)

11) Y (resolve 3 and 9)

12) I (resolve 1 and 11)

13) contradiction (10 and 12)

So, I proved unicorn is magical.

Find if the unicorn is Horned? Add ¬H to the knowledge base

7) ¬H

8) ¬I (resolve 4 and 7)

9) ¬L (resolve 5 and 7)

10) ¬Y (resolve 1 and 8)

11) Y (resolve 3 and 9)

12) contradiction (10 and 11)

So, I proved unicorn is Horned.