Q1.

a)

Smoke	Fire	① Smoke $\Rightarrow$ Fire	② $\neg$Smoke $\Rightarrow$ $\neg$Fire	(a) ① $\Rightarrow$ ②
T	T	T	T	T
T	F	F	T	T
F	T	T	F	F
F	F	T	T	T

Thus, (a) is $\boxed{\text{neither}}$ valid or satisfiable

b)

S	F	H	① $S \Rightarrow F$	② $S \vee H$	③ $(S \vee H) \Rightarrow F$	(b) ① $\Rightarrow$ ③
F	F	F	T	F	T	T
F	F	T	T	T	F	F
F	T	F	T	F	T	T
F	T	T	T	T	T	T
T	F	F	F	T	F	T
T	F	T	F	T	F	T
T	T	F	T	T	T	T
T	T	T	T	T	T	T

(b) is $\boxed{\text{neither}}$.

c)

S	H	F	① $S \wedge H$	② $(S \wedge H) \Rightarrow F$	③ $S \Rightarrow F$	④ $H \Rightarrow F$	⑤ = ③ $\vee$ ④	(c) = ② $\Leftrightarrow$ ⑤
F	F	F	F	T	T	T	T	T
F	F	T	F	T	T	T	T	T
F	T	F	F	T	T	F	T	T
F	T	T	F	T	T	T	T	T
T	F	F	F	T	F	T	T	T
T	F	T	F	T	T	T	T	T
T	T	F	T	F	F	F	F	T
T	T	T	T	T	T	T	T	T

(c) is $\boxed{\text{valid}}$

Q2

a) mythical ⇒ immortal

¬mythical ⇒ (¬immortal ∧ mammal)

(immortal ∨ mammal) ⇒ horned

horned ⇒ magical

b) ① (¬mythical ∨ immortal)

② mythical ∨ (¬immortal ∧ mammal)

(mythical ∨ ¬immortal) ∧ (mythical ∨ mammal)

③ ¬(immortal ∨ mammal) ∨ horned

(¬immortal ∧ ¬mammal) ∨ horned

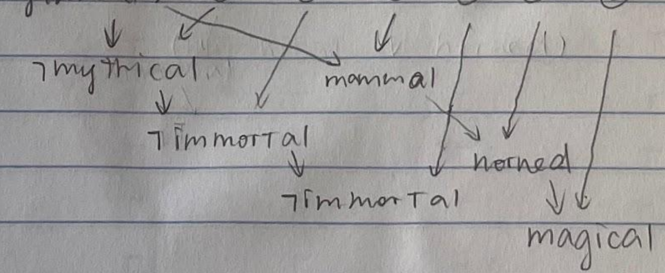
(¬immortal ∨ horned) ∧ (¬mammal ∨ horned)

④ (¬horned ∨ magical)

Answer: (¬mythical ∨ immortal) ∧ (mythical ∨ ¬immortal) ∧ (mythical ∨ mammal) ∧ (¬immortal ∨ horned) ∧ (¬mammal ∨ horned) ∧ (¬horned ∨ magical)

c) ① KB ⊨ ¬mythical, prove (KB ∧ ¬mythical) unsatisfiable

(¬mythical) ① ② ③ ④ ⑤ ⑥ (corresponding to sequence in (b

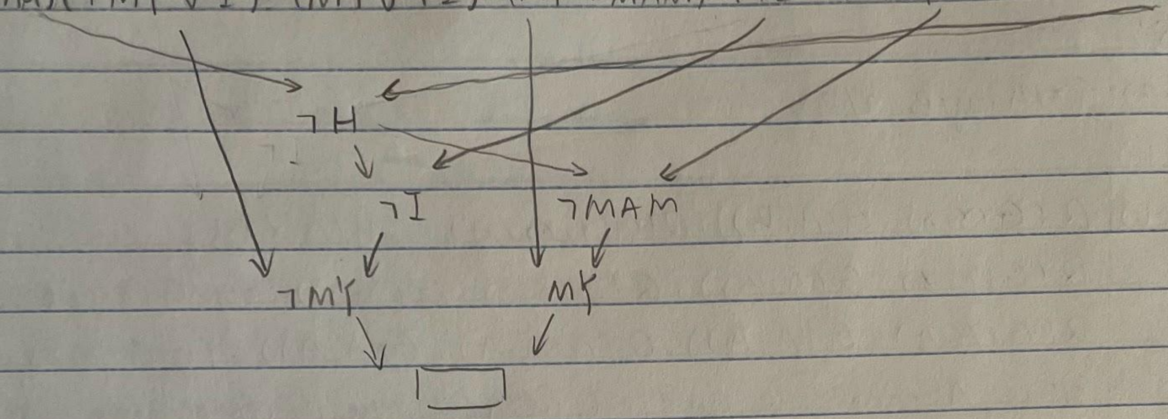


¬mythical ∧ ¬immortal ∧ mamal ∧ horned ∧ magical is satisfiable.

Thus, we can't prove that unicorn is mythical

Magical: (MAG)

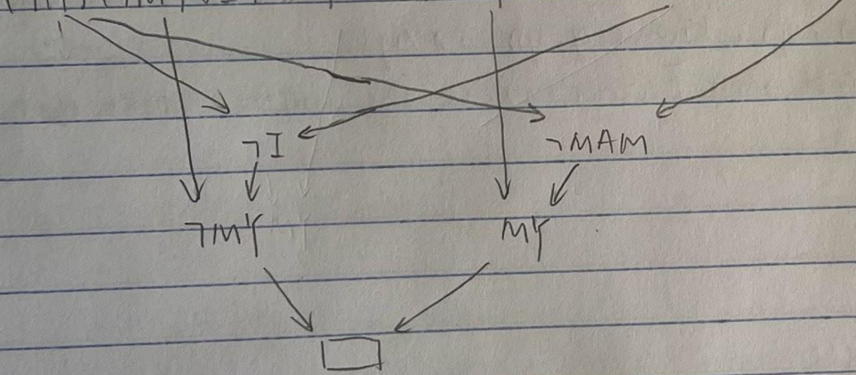
② $(\neg MAG)(\neg MY \vee I)\ (MY \vee \neg I)\ (MY \vee MAM)\ (\neg I \vee H)\ (\neg MAM \vee H)\ (\neg H \vee MAG)$



Since there is an empty clause, $KB \wedge \neg Magical$ is unsatisfiable, so $KB \models magical$, the unicorn is magical

③ horned (H)

$(\neg H)\ (\neg MY \vee I)\ (MY \vee \neg I)\ (MY \vee MAM)\ (\neg I \vee H)\ (\neg MAM \vee H)\ (\neg H \vee MAG)$



Similarly, $KB \wedge \neg horned$ is unsatisfiable. $KB \models horned$, the unicorn is horned.

Q3.

a) $\{x/A, y/B, z/B\}$

b) $Q(G(x,x), G(A,B)), Q(G(x,x), y) : \{y/G(x,x)\}$
$Q(G(x,x), G(A,B)), Q(G(x,x), G(x,x)) : \{y/G(x,x)\}$
$Q(G(A,A), G(A,B)), Q(G(A,A), G(A,A)) : \{y/G(x,x), x/A\}$
since A cannot be unified with B, the unifier does not exist

c) Older (Father (John), John), Older (Father (x), John) : {y/ John}
Older (Father (John), John), Older (Father (John), John) : {x / John, y / John}
{x / John, y / John}

d) Knows (Father (y), y), Knows (y, y) : {x / y}
y cannot be unified with Father (y), so the unifier does not exist.

Q4

a) $\forall x, \text{isfood}(x) \Rightarrow \text{like}(\text{John}, x)$

$\text{isfood}(\text{Apples})$

$\text{isfood}(\text{Chicken})$

$\forall x, y\ \text{eat}(y, x) \,\&\, \neg\text{kill}(x, y) \Rightarrow \text{isfood}(x)$

$\forall x, y, \text{kill}(x, y) \Rightarrow \neg\text{alive}(y)$

$\text{eat}(\text{Bill}, \text{peanuts}) \wedge \neg\text{kill}(\text{peanuts}, \text{Bill})$

$\forall x, \text{eat}(\text{Bill}, x) \Rightarrow \text{eat}(\text{Sue}, x)$

b) $\neg\text{isfood}(x) \vee \text{like}(\text{John}, x)$

$\text{isfood}(\text{Apples})$

$\text{isfood}(\text{Chicken})$

$\neg\text{eat}(y, x) \vee \text{kill}(x, y) \vee \text{isfood}(x)$

$\text{eat}(\text{Bill}, \text{peanuts})$

$\neg\text{kill}(\text{peanuts}, \text{Bill})$

$\neg\text{eat}(\text{Bill}, x) \vee \text{eat}(\text{Susan}, x)$

c) prove $KB \wedge \neg\text{like}(\text{John}, \text{peanuts})$

$(\neg\text{eat}(y, x) \vee \text{kill}(x, y) \vee \text{isfood}(x))$ $(\text{eat}(\text{Bill}, \text{peanuts}))$ $(\neg\text{kill}(\text{peanuts}, \text{Bill}))$

$(\text{kill}(\text{peanuts}, \text{Bill}) \vee \text{isfood}(\text{peanuts}))$

$(\text{isfood}(\text{peanuts}))$

$(\neg\text{isfood}(x) \vee \text{like}(\text{John}, x))$

$\text{like}(\text{John}, \text{peanuts})$

$(\neg\text{like}(\text{John}, \text{peanuts}))$

$\boxed{}$

$KB \wedge \neg\text{like}(\text{John}, \text{peanuts})$ results in an empty clause,

Thus, $KB \wedge \neg\text{like}(\text{John}, \text{peanuts})$ is unsatisfiable.

$KB \models \text{like}(\text{John}, \text{peanuts})$

d) $KB \wedge \neg eat(Sue, x)$

$(\neg eat(Sue, x))$ $(\neg eat(Bill, x) \vee eat(Sue, x))$

$(\neg eat(Bill, x))$ $(eat(Bill, peanuts))$

$x / peanuts$

$\square$

Sue eats peanuts

e) $\forall x, y, \neg eat(x, y) \Rightarrow die(x)$ $eat(x, y) \vee die(x)$

$\forall x, die(x) \Rightarrow \neg alive(x)$ $\neg die(x) \vee \neg alive(x)$

$alive(Bill)$ $alive(Bill)$

$kill(x, y) \Rightarrow \neg alive(y)$ $\neg kill(x, y) \vee \neg alive(y)$

$KB \wedge \neg eat(Sue, f)$

$(eat(x, y) \vee die(x))$ $(\neg die(x) \vee \neg alive(x))$

$(eat(x, y) \vee \neg alive(x))$

$(\neg kill(x, y) \vee \neg alive(y))$ $(alive(Bill))$

$(\neg kill(x, Bill))$ $(eat(x, y) \vee kill(y, x) \vee isfood(y))$

$(\neg eat(Bill, y) \vee isfood(y))$

$(\neg eat(Bill, x) \vee eat(Sue, x))$ $(\neg eat(Sue, f))$

$(\neg eat(Bill, f))$ $(eat(x, y) \vee \neg alive(x))$

$(\neg alive(Bill))$ $(alive(Bill))$

$\square$

$KB \wedge \neg eat(Sue, f) = KB \models eat(Sue, f)$ is true without unifying f.

Thus, Sue eats everything.