4a) All pots have lids

"x has a lid"

$\forall x \in P, \overline{L(x)}$

P: set of all pots

Negation: $\sim(\forall x \in P, L(x))$

$\exists x \in P$ s.t. $\sim L(x)$

some pot has no lid

c) Some pigs can fly

"x can fly"

$\exists x \in P$ s.t. $F(x)$

P: set of all pigs

$\sim(\exists x \in P \text{ s.t. } F(x))$

$\forall x \in P, \sim F(x)$

for all pigs x, it is not the case that x can fly

"All pigs can't fly"

$D = \{-48, -14, -8, 0, \underline{1}, \underline{3}, 16, \underline{23}, 32, 36\}$

15 a) $\forall x \in D$, if x is odd then $\underline{x > 0}$

T since "if x is odd then $x > 0$" is T for all $x \in D$:

$x = -48$ if x is odd then $x > 0$

F → F

T

$x = -14$ F → F

⋮

$x \in$ 1 T → T

3 T → T

16 F → T

23 T → T

⋮

c) $\forall x \in D$, x even $\rightarrow x \leq 0$

F

counterexample: 16

x is even T

$x \leq 0$ F

T → F

F

10a) $\forall S \exists D$ S chose D

c) $\exists D \forall S$ S chose D

negation: $\sim(\exists D$ s.t. $\forall S, C(S,D))$

$\forall D, \sim \forall S, C(S,D)$

$\forall D, \exists S$ s.t. $\sim C(S,D)$

For all desserts there is some student such that that student did not choose that dessert.

"Every dessert had some student who didn't choose it"

S: set of students

M: set of movies

$V(s, m)$ = "s has seen m"

15a) $\exists s \in S$ s.t. $V(s, \text{Casablanca})$

"There exist some student who has seen Casablanca"

"Someone has seen Casablanca"

c) $\forall s \in S, \exists m \in M$ s.t. $V(s, m)$

"Everyone has seen some movie"

d) $\exists m \in M$ s.t. $\forall s \in S$, $V(s, m)$

"There is a movie everyone has seen"

negation: $\forall m \in M, \exists s \in S$ s.t. $\sim V(s, m)$

"For every movie, there's someone who hasn't seen it"

Universal instantiation: $\forall x \in D,\ P(x)$

$a \in D$

$\therefore P(a)$

Ex: All pigs like slop $\forall x \in P,\ S(x)$

Wilbur is a pig $Wilbur \in P$

$\therefore$ Wilbur likes slop $\therefore S(Wilbur)$

Universal modus ponens: $\forall x \in D,\ P(x) \rightarrow Q(x)$

$P(a)$

$a \in D$

$\therefore Q(a)$

Ex: All DM students are quiet

Danielle is a DM student

$\therefore$ Danielle is quiet

D = set of all students

$M(x)$ = "x takes DM"

$Q(x)$ = "x is quiet"

$\forall x \in D,\ M(x) \rightarrow Q(x)$

$M(\text{Danielle})$

Danielle is a student

$\therefore$ Danielle is quiet

$M(\text{Danielle}) \rightarrow Q(\text{Danielle})$

$\therefore Q(\text{Danielle})$

All donuts are delicious

$\forall x \in F,\ D(x) \rightarrow E(x)$

F = set of all foods

$D(x)$ = "x is a donut"

$E(x)$ = "x is delicious"

double choc is a donut

$\therefore$ double chocs are delicious

taro cake is not delicious

$\therefore$ taro cake is not a donut

$p \rightarrow q$

$\sim q$

$\therefore \sim p$