1.) Since the server asked "Does everybody want coffee?" And the third professor said "No", we can imply that he doesn't want coffee therefore not everybody want coffee. On the other hand, the first and second professor said they don't know, we can imply that they want coffee for themselves but they don't know if everybody want coffee.

$C(x)$: x want coffee.

f = first , s = second , t = third

$$C(f) \wedge C(s) \wedge \neg C(t)$$

Apply negation

$$\neg(C(f) \wedge C(s) \wedge \neg C(t))$$
$$\equiv \neg C(f) \vee \neg C(s) \vee \neg\neg C(t)$$
$$\equiv \neg C(f) \vee \neg C(s) \vee C(t)$$

2) 1) All seals can swim

$S(x)$: x is a seal
$W(x)$: x can swim

$\forall x \, (S(x) \rightarrow W(x))$

2) No fish can fly

$fish(x)$: x is a fish
$fly(x)$: x can fly

$\forall x \, (fish(x) \rightarrow \neg fly(x))$

3) Exactly one fish can fly

$fish(x)$: x is a fish
$fly(x)$: x can fly

$\exists a \forall b \, (fish(a) \rightarrow fly(a) \wedge ((b \neq a) \wedge fish(b)) \rightarrow \neg fly(b))$

4) Exactly two fish can fly

$fish(x)$: x is a fish
$fly(x)$: x can fly

$\exists x \exists y \forall z \, ((fish(x) \rightarrow fly(x)) \wedge (fish(y) \rightarrow fly(y) \wedge (x \neq y) \wedge$
$(fish(z) \wedge (z \neq x) \wedge (z \neq y)) \rightarrow \neg fly(z))$

3) $P(x)$: x is prime
$D(x)$: x is odd

Domain : x is the set of all positive integers.

$\forall x \; ((x<0) \wedge D(x)) \rightarrow P(x))$

False, In the logic expression, it has $(x<0)$ but the domain is the set of all positive integers.

4) $B(g, w)$: group g of 30 people, there were at least w people who were born on same day.

$\forall x \; \exists y \; B(x, y)$

Apply negation

$\neg \forall x \; \exists y (B(x,y) \wedge y \geq 5)$

$\exists x \; \forall y \; \neg(B(x,y) \wedge y \geq 5)$

$\exists x \; \forall y \; (\neg B(x,y) \vee y < 5)$

At least one group of 30 people, there are less than five people who were all born on the same day of the week.