**Exercises in Existential Quantification**
PHI 154 (Eliot)

Note: I'm using variables like $x$ and $y$ in the definitions of predicates to show how many places they have—whether they are one-place (e.g., $O(x)$) or two-place (e.g., $O(x, y)$) or more. In actual FOL sentences, you could never leave variables unbound like that. When you do these on a test, you'll need to

**domain** = people
$F(x)$ = $x$ is famous
$P(x)$ = $x$ is a professor
$T(x)$ = $x$ has a television
$K(x, y)$ = $x$ knows who $y$ is
$j$ = the President (of the United States)
$k$ = Kim Kardashian
$d$ = Doris (who cooks at Bits & Bytes)

Translate these from First-order Logic into English using the provided key. For this exercise, if you want to write shorter versions of the names and singular terms that's fine. Think about them literally first, and then think whether there is a more natural way to express an equivalent sentence in English:

1. $F(k) \land F(j)$
2. $T(k) \land F(k)$
3. $\neg P(k) \land K(k, j)$
4. $K(j, k) \to \neg P(k)$
5. $K(k, k) \land \neg K(j, j)$
6. $\neg F(d) \land \neg [K(j, d) \lor K(k, d)]$
7. $K(j, k) \leftrightarrow T(j)$
8. $\exists x \neg F(x)$
9. $\neg \exists x F(x)$
10. $\neg \exists y \neg T(y)$
11. $\exists z(P(z) \land \neg F(z))$
12. $\exists z \neg (P(z) \land F(z))$
13. $\neg \exists z(P(z) \land F(z))$
14. $\exists y F(y) \land \exists x P(x)$
15. $\exists x K(x, j) \to K(d, j)$
16. $\exists x \neg K(d, x) \land K(d, k)$
17. $\exists x(P(x) \land \neg K(x, k))$
18. $\exists x(\neg K(x, k) \land P(x))$
19. $\neg \exists y(P(y) \land [\neg T(y) \land \neg K(y, k)])$
20. $\neg \exists z \neg (P(z) \lor T(z))$

21. $[\exists x \neg T(x) \rightarrow \exists y \neg K(y, j)] \wedge [\exists y \neg K(y, j) \rightarrow \exists z \neg K(z, k)]$
22. $\neg \exists x \neg T(x) \rightarrow \neg \exists y(\neg K(y, j) \wedge \neg K(y, k))$
23. $\neg \exists x \neg K(x, j) \vee [\exists x \neg K(x, j) \rightarrow \neg \exists y T(y)]$
24. $\exists y[P(y) \wedge (K(y, k) \leftrightarrow T(y))]$
25. $\exists y[(F(y) \wedge P(y)) \wedge [(T(y) \vee \neg T(y)) \rightarrow K(y, k)]]$
26. $\exists z(K(z, d) \wedge K(z, k)) \rightarrow \exists y(P(y) \wedge T(y))$

Symbolize the following in First-order Logic using the symbolization key above:

1. Doris isn't famous, but Kim Kardashian is.
2. Kim Kardashian is famous, but she is not a famous professor.
3. Kim Kardashian is famous if and only if the President is.
4. Though Doris isn't famous, someone is.
5. Someone is famous and they have a TV.
6. Kim Kardashian is famous only if someone has a TV.
7. Nobody is famous.
8. Somebody is not famous.
9. No one isn't famous.
10. Someone is neither famous nor a professor.
11. Someone is a non-famous professor only if someone is not famous.
12. There are no non-famous professors who own televisions.
13. Someone isn't a professor and isn't famous, but knows Kim Kardashian.
14. If Kim Kardashian doesn't know who she is, she doesn't have a TV or she's not famous.
15. If no one is famous and no one owns a TV, no one knows who Kim Kardashian is.
16. Someone who doesn't have a TV is a famous professor.
17. If there's a professor who doesn't have a TV, there's someone who doesn't know who Kim Kardashian is.
18. If the President doesn't know who Doris is, then at least some professors do.
19. There are no professors who don't know who the President is.
20. Some professors don't know who Kim Kardashian is just in case some professors neither have televisions nor know who the President is.
21. If the President knows who Kim Kardashian is, then there's nobody who doesn't know who Kim Kardashian is.
22. There's a famous professor who knows who both Kim Kardashian and the President are if and only if there's a famous professor who has a television.