Represent the following sentences in first-order predicate calculus. Your representation scheme should be:

- Consistent: the same types of knowledge should be represented the same way
- Correct (a resolution system should be able to infer what we want it to, but not infer things we don’t want it to)
- General and extendable. For example, suppose that actions might have many aspects, such as instruments (e.g., the towel in the first sentence), durations (how long they took), locations, start times, end times, etc.
- Just represents the sentences; you don’t need to separately define your predicates.

Jim cleaned a floor using a towel (a specific floor and a specific towel).

\[
\text{eventType}(e1,\text{clean}) \land \text{thingType}(t1,\text{towel}) \\
\text{thingType}(f1,\text{floor}) \land \text{event}(e1) \\
\text{instrumentOf}(e1,t1) \land \text{agentOf}(e1,\text{Jim}) \\
\text{objectOf}(e1,f1)
\]

It took him 2 hours (i.e., the action had duration of 2 hours).

\[
\text{duration}(e1,\text{2Hours})
\]

Anyone who cleaned anything is ambitious.

\[
\forall X,Y,Z ((\text{eventType}(X,\text{clean}) \land \text{agentOf}(X,Y) \land \text{objectOf}(X,Z)) \rightarrow \text{ambitious}(X))
\]

Sally did something using a towel (a different towel than Jim used).

\[
\text{event}(e2) \land \text{thingType}(t2,\text{towel}) \land \text{instrumentOf}(e2,t2) \land \text{agentOf}(e2,\text{sally})
\]

Everyone cleaned something.

\[
\forall X (\text{person}(X) \rightarrow \exists Y,Z (\text{event}(Y) \land \text{eventType}(Y,\text{clean}) \land \text{thing}(Z) \land \text{objectOf}(Y,Z)))
\]

# There is no way to write this without existentials. It asserts existence. For each person, this rule adds a new event and a new thing to the KB.

# The \rightarrow is needed too!
all X exists Y (person(X) ^ action(X,clean) ^ obj(clean,Y)).

This means that everything is a person!! Events, floors, towels, subways, numbers, ... - each of them is a person, according to this statement.