First Order Logic: Conversion to CNF

1. Eliminate biconditionals and implications:
   - Eliminate $\Leftrightarrow$, replacing $\alpha \Leftrightarrow \beta$ with $(\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha)$.
   - Eliminate $\Rightarrow$, replacing $\alpha \Rightarrow \beta$ with $\neg\alpha \vee \beta$.
2. Move $\neg$ inwards:
   - $\neg(\forall x\, p) \equiv \exists x\, \neg p$,
   - $\neg(\exists x\, p) \equiv \forall x\, \neg p$,
   - $\neg(\alpha \vee \beta) \equiv \neg\alpha \wedge \neg\beta$,
   - $\neg(\alpha \wedge \beta) \equiv \neg\alpha \vee \neg\beta$,
   - $\neg\neg\alpha \equiv \alpha$.
3. Standardize variables apart by renaming them: each quantifier should use a different variable.
4. Skolemize: each existential variable is replaced by a *Skolem constant* or *Skolem function* of the enclosing universally quantified variables.
   - For instance, $\exists x Rich(x)$ becomes $Rich(G1)$ where $G1$ is a new Skolem constant.
   - "Everyone has a heart" $\forall x\ Person(x) \Rightarrow \exists y\ Heart(y) \wedge Has(x,y)$ becomes $\forall x\ Person(x) \Rightarrow Heart(H(x)) \wedge Has(x,H(x))$, where H is a new symbol (Skolem function).
5. Drop universal quantifiers
   - For instance, $\forall x\ Person(x)$ becomes $Person(x)$.
6. Distribute $\wedge$ over $\vee$:
   - $(\alpha \wedge \beta) \vee \gamma \equiv (\alpha \vee \gamma) \wedge (\beta \vee \gamma)$.

Output

```
#Test 1
main()
```

```
Enter FOL:
∀x food(x) => likes(John, x)
The CNF form of the given FOL is:
~ food(A) V likes(John, A)
```

```
#Test 2
main()
```

```
Enter FOL:
∀x[∃z[loves(x,z)]]
The CNF form of the given FOL is:
[loves(x,B(x))]
```

```
#Test 3
main()
```

```
Enter FOL:
[american(x)^weapon(y)^sells(x,y,z)^hostile(z)] => criminal(x)
The CNF form of the given FOL is:
[~american(x)V~weapon(y)V~sells(x,y,z)V~hostile(z)] V criminal(x)
```