

# Predicate Logic

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## Some Exercises in Semantics

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With my thanks to everyone who has  
taught logic in the Department

# Assume the Universe of integers $\geq 1$

For each of the following decide if it is true or false.

1.  $\exists X$  (X is the product of two odd integers)  
 $\exists X, Y, Z (X=Y*Z \wedge \text{odd}(Y) \wedge \text{odd}(Z))$
2.  $\forall X$  (X is the product of two odd integers)  
 $\forall X \exists Y, Z (X=Y*Z \wedge \text{odd}(Y) \wedge \text{odd}(Z))$
3.  $\forall Y \exists X$  (X is an even factor of Y)  
 $\forall Y \exists X, Z (Y=X*Z \wedge \text{even}(X))$

$$4. \forall X \exists Y (Y > X)$$

$$5. \forall X \forall Y (X * Y \geq X)$$

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$$6. \exists Y \forall X (Y \leq X)$$

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$$7. \exists Y \forall X (X \leq Y)$$

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$$8. \forall X (\exists Y (X = Y^2) \rightarrow \text{even}(X))$$

$$9. \forall X (\forall Y \neg (X = Y^2) \rightarrow \text{odd}(X))$$

$$10. \forall X (\neg \forall Y (X \text{ divides } Y) \rightarrow \neg (X = 1))$$

# Answers

1. True. Take  $15=3*5$ .
2. False. Take 20.
3. False. Take 15.
4. True. For every X take  $X+1$ .
5. True.
6. True.  $Y=1$ .
7. False.

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8. False. Take  $X = 25$ .

$25 = 5^2$ , but 25 is not even.  
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9. False. Take 24.

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10.

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$\forall X (\neg \forall Y (X \text{ divides } Y) \rightarrow \neg (X=1)) \equiv$

$\forall X (X=1 \rightarrow \forall Y (X \text{ divides } Y))$

True.