TRUTH TABLE

I. What is truth table?

Mathematicians normally use a **two-valued logic**: Every statement is either **True** or **False**. This is called the **Law of the Excluded Middle**.

A statement in sentential logic is built from simple statements using the logical connectives $\neg$, $\wedge$, $\vee$, $\rightarrow$, and $\leftrightarrow$. The truth or falsity of a statement built with these connective depends on the truth or falsity of its components.

For example, the compound statement $P \rightarrow (Q \vee \neg R)$ is built using the logical connectives $\rightarrow$, $\vee$, and $\neg$. The truth or falsity of $P \rightarrow (Q \vee \neg R)$ depends on the truth or falsity of P, Q, and R.

A **truth table** shows how the truth or falsity of a compound statement depends on the truth or falsity of the simple statements from which it's constructed. So we'll start by looking at truth tables for the five logical connectives.

Here's the table for negation:

P	$\neg P$
T	F
F	T

This table is easy to understand. If P is *true*, its negation $\neg P$ is *false*. If P is *false*, then $\neg P$ is *true*.
$P \wedge Q$ should be *true* when both P and Q are *true*, and *false* otherwise:

P	Q	$P \wedge Q$
T	T	T
T	F	F
F	T	F
F	F	F

$P \vee Q$ is *true* if either P is *true* or Q is *true* (or both — remember that we're using "or" in the inclusive sense). It's only *false* if both P and Q are *false*.

P	Q	$P \vee Q$
T	T	T
T	F	T
F	T	T
F	F	F

II. How to construct a truth table using python?

Example. Find the truth table of $a \wedge b$.

```
truths=[[1,0],[0,1],[1,1],[0,0]]
print("truth table for A and B")
print("A\t B \t A and B")
for item in truths:
```

```
if item[0]==1:
    a=True
else:
    a=False
if item[1]==1:
    b=True
else:
    b=False
print(a,"\t",b,"\t", a and b)
```

III. Exercises

1. Find the truth table of:

   a. $p \wedge q$

   b. $\neg p \vee q$

   c. $p \vee \neg q$

   d. $(p \vee q) \wedge \neg q$

   e. $p \vee \neg q$

   f. $(p \wedge q) \wedge q$

2. Find the truth table of:

   a. $p \Rightarrow q$

   b. $\neg p \Rightarrow q$

   c. $p \Rightarrow \neg q$

3. Use truth table to check whether the following logicals are equivalence

   a. $p \Rightarrow q$; $\neg q \Rightarrow \neg p$

   b. $p \vee q$; p

   c. $p \wedge q$; $\neg(\neg p \vee \neg q)$

   d. $\neg p \Rightarrow q$; $\neg(p \Rightarrow p)$