1. Which of these sentences are propositions? What are the truth values of those that are propositions?
   a) Boston is the capital of Massachusetts. **T**
   b) Miami is the capital of Florida. **F**
   c) $2 + 3 = 5$. **T**
   d) $5 + 7 = 10$. **F**
   e) $x + 2 = 11$. **not Proposition**
   f) Answer this question. **not proposition**

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3. What is the negation of each of these propositions?
   a) Mei has an MP3 player.
   b) There is no pollution in New Jersey.
   c) $2 + 1 = 3$.
   d) The summer in Maine is hot and sunny.

a) Mei does not have an MP3 player.

b) There is pollution in New Jersey.

c) $2 + 1 \neq 3$

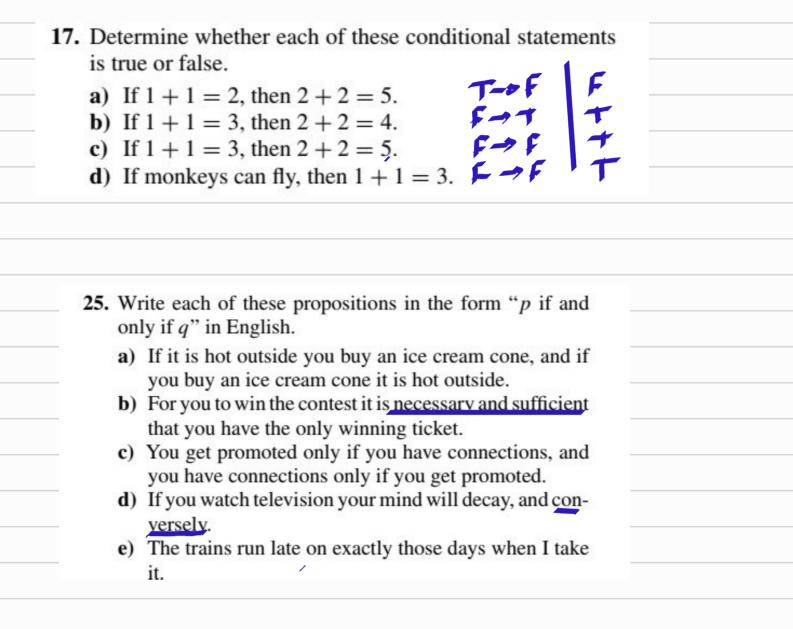d) It is not the case that the summer in Maine is hot and sunny.

10. Let p and q be the propositions "The election is decided" and "The votes have been counted," respectively. Express each of these compound propositions as an English sentence.
   a) $\neg p$ b) $p \vee q$
   c) $\neg p \wedge q$ d) $q \rightarrow p$
   e) $\neg q \rightarrow \neg p$ f) $\neg p \rightarrow \neg q$
   g) $p \leftrightarrow q$ h) $\neg q \vee (\neg p \wedge q)$

a) The election is not decided.

b) The election is decided, or the votes have been counted.

c) The election is not decided, and the votes have been counted.

d) If the votes have been counted, then the election is decided.

e) If the votes have not been counted, then the election is not decided.

f) If the election is not decided, then the votes have not been counted.

g) The election is decided if and only if the votes have been counted.

h) Either the votes have not been counted, or else the election is not decided and the votes have been counted.

11. Let p and q be the propositions

p : It is below freezing.

q : It is snowing.

Write these propositions using p and q and logical connectives (including negations).

a) It is below freezing and snowing. $p \land q$

b) It is below freezing but not snowing. $p \land -q$

c) It is not below freezing and it is not snowing. $-p \land -q$

d) It is either snowing or below freezing (or both). $p \lor q$

e) If it is below freezing, it is also snowing. $p \to q$

f) Either it is below freezing or it is snowing, but it is not snowing if it is below freezing. $(p \lor q) \land (p \to -q)$

g) That it is below freezing is necessary and sufficient for it to be snowing. $p \leftrightarrow q$

13. Let p and q be the propositions

p : You drive over 65 miles per hour.

q : You get a speeding ticket.

Write these propositions using p and q and logical connectives (including negations).

a) You do not drive over 65 miles per hour. $-p$

b) You drive over 65 miles per hour, but you do not get a speeding ticket. $p \land -q$

c) You will get a speeding ticket if you drive over 65 miles per hour. $p \to q$

d) If you do not drive over 65 miles per hour, then you will not get a speeding ticket. $-p \to -q$

e) Driving over 65 miles per hour is sufficient for getting a speeding ticket. $p \to q$

f) You get a speeding ticket, but you do not drive over 65 miles per hour. $q \land -p$

g) Whenever you get a speeding ticket, you are driving over 65 miles per hour. $q \to p$

$p \to q$

if p then q

q if p

17. Determine whether each of these conditional statements is true or false.

a) If $1 + 1 = 2$, then $2 + 2 = 5$.
b) If $1 + 1 = 3$, then $2 + 2 = 4$.
c) If $1 + 1 = 3$, then $2 + 2 = 5$.
d) If monkeys can fly, then $1 + 1 = 3$.

$T \to F$ F
$F \to T$ T
$F \to F$ T
$F \to F$ T

25. Write each of these propositions in the form "p if and only if q" in English.

a) If it is hot outside you buy an ice cream cone, and if you buy an ice cream cone it is hot outside.
b) For you to win the contest it is necessary and sufficient that you have the only winning ticket.
c) You get promoted only if you have connections, and you have connections only if you get promoted.
d) If you watch television your mind will decay, and conversely.
e) The trains run late on exactly those days when I take it.

a) You buy an ice cream cone if and only if it is hot outside.

b) You win the contest if and only if you hold the only winning ticket.

c) You get promoted if and only if you have connections.

d) Your mind will decay if and only if you watch television.

e) The train runs late if and only if it is a day I take the train.

33. Construct a truth table for each of these compound propositions.

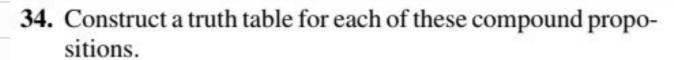a) $(p \vee q) \rightarrow (p \oplus q)$ b) $(p \oplus q) \rightarrow (p \wedge q)$

c) $(p \vee q) \oplus (p \wedge q)$ d) $(p \leftrightarrow q) \oplus (\neg p \leftrightarrow q)$

e) $(p \leftrightarrow q) \oplus (\neg p \leftrightarrow \neg r)$

f) $(p \oplus q) \rightarrow (p \oplus \neg q)$

(أ)   (ب)   (ج)

p	q	$p \vee q$	$p \oplus q$	$(p \vee q) \rightarrow (p \oplus q)$	$p \wedge q$	$(p \oplus q) \rightarrow (p \wedge q)$	$(p \vee q) \oplus (p \wedge q)$
T	T	T	F	F	T	T	F
T	F	T	T	T	F	F	T
F	T	T	T	T	F	F	T
F	F	F	F	T	F	T	F

(د)

p	q	$\neg p$	$p \leftrightarrow q$	$\neg p \leftrightarrow q$	$(p \leftrightarrow q) \oplus (\neg p \leftrightarrow q)$
T	T	F	T	F	T
T	F	F	F	T	T
F	T	T	F	T	T
F	F	T	T	F	T

(هـ)

p	q	r	$\neg p$	$\neg r$	$p \leftrightarrow q$	$\neg p \leftrightarrow \neg r$	$(p \leftrightarrow q) \oplus (\neg p \leftrightarrow \neg r)$
T	T	T	F	F	T	T	F
T	T	F	F	T	T	F	T
T	F	T	F	F	F	T	T
T	F	F	F	T	F	F	F
F	T	T	T	F	F	F	F
F	T	F	T	T	F	T	T
F	F	T	T	F	T	F	T
F	F	F	T	T	T	T	F

f

p	q	$\neg q$	$p \oplus q$	$p \oplus \neg q$	$(p \oplus q) \rightarrow (p \oplus \neg q)$
T	T	F	F	T	T
T	F	T	T	F	F
F	T	F	T	F	F
F	F	T	F	T	T

34. Construct a truth table for each of these compound propositions.

a) $p \oplus p$ **b)** $p \oplus \neg p$

c) $p \oplus \neg q$ **d)** $\neg p \oplus \neg q$

e) $(p \oplus q) \vee (p \oplus \neg q)$ **f)** $(p \oplus q) \wedge (p \oplus \neg q)$

(ب) (أ)

p	$p \oplus p$	$\neg p$	$p \oplus \neg p$
T	F	F	T
F	F	T	T

د (ج)

p	q	$\neg p$	$\neg q$	$p \oplus \neg q$	$\neg p \oplus \neg q$
T	T	F	F	T	F
T	F	F	T	F	T
F	T	T	F	F	T
F	F	T	T	T	F

ه و

p	q	$p \oplus q$	$p \oplus \neg q$	$(p \oplus q) \vee (p \oplus \neg q)$	$(p \oplus q) \wedge (p \oplus \neg q)$
T	T	F	T	T	F
T	F	T	F	T	F
F	T	T	F	T	F
F	F	F	T	T	F