Propositional logic (klasyczny rachunek zdań) **KRZ**.

Logical connectives (Stałe logiczne): $\neg$, $\wedge$, $\vee$, $\to$, $\leftrightarrow$

Propositional letters / variables / atomic formulas (zmienne zdaniowe): $p, q, r, \ldots, p_1, p_2, \ldots$

Formulas: Propositional variables are formulas, and if α and β are formulas, then so are $\neg\alpha$, $(\alpha \wedge \beta)$, $(\alpha \vee \beta)$, $(\alpha \to \beta)$, $(\alpha \leftrightarrow \beta)$. There are no other formulas.

Later on we will see that with $\neg$ and $\vee$ we can define the other connectives.

Terminology:

$\wedge$	conjunction, "and"	koniunkcja
$\vee$	disjunction, "or"	alternatywa
$\neg$	negation, "not"	negacja
$\to$	implication, "if...then..."	implikacja
$\wedge$	biconditional, if and only if "and"	równoważność

1. Which of the following strings are formulas **of KRZ**?
   (a) $(p(q) \to r)$, $\quad p \to q$, $\quad (p \to q)$
   (b) $p \wedge q$, $\quad (p \wedge q)$
   (c) $(p \wedge q \wedge r)$, $\quad (p \wedge (q \vee p))$
   (d) $\wedge(p, q)$
   (e) $\neg(p)$, $\quad \neg p$, $\quad \neg(\neg p)$, $\quad \neg\neg p$
   (f) $(p \to (q \wedge (p \vee r)))$, $\quad p \to (q \wedge (p \vee r))$
   (g) $p \to p \to p$, $\quad p \wedge r \to p$
2. Formalize the following sentences in KRZ.
   (a) It is raining and it is not raining.
   (b) If i see a dog and a cat, then i see a dog.
   (c) It is not true that i eat lunch and drink coffee.
   (d) I do not eat lunch or drink coffee.
   (e) If i eat lunch, then i drink coffee.
   (f) If it is not true that (i eat lunch and drink coffee), then (i do not eat lunch or drink coffee).
3. Try to find natural language sentences that can be formalized by the following formulas.
   (a) $(p \to q) \to r$
   (b) $(p \wedge q) \vee r$
4. We have 2 boxes and 3 matches. Let the atomic formula $p_{i,j}$ mean that the i^{th} match is inside the j^{th} box. Write up formulas (of KRZ) that express:
   (a) The first box contains all the matches.
   (b) One of the boxes contains all the matches.
   (c)* Every match is in exactly one box.
   (d)* Every box contains exactly one match.
   (e)* Pigeonhole principle: If every match is inside some box, then there must be a box which contains at least 2 matches.

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