Grade 6 Math Circles
October 18/19/20, 2022
Mathematical Logic - Problem Set

1. Let P stand for the statement "I will eat spaghetti for dinner" and Q for the statement "I will eat spaghetti for lunch." What English sentences are represented by the following expressions?

    a. $\neg(P \wedge \neg Q)$.

    b. $\neg P \wedge \neg Q$.

    c. $\neg P \vee \neg Q$.

2. Identify the premises and conclusions of the following deductive arguments and analyze their logical forms. Do you think the reasoning is valid? (Note: "either" means **exclusive** or.)

    a. Min and Claire won't both win the math prize, Claire will win either the math prize or the science prize. Min will win the math prize. Therefore, Claire will win the science prize.

    b. Either Alex or Claire is telling the truth. Either Min or Claire is lying. Therefore, either Alex is telling the truth or Claire is lying.

3. Find simpler logical formulas equivalent to:

    a. $\neg P \vee \neg(Q \wedge P)$.

    b. $\neg((P \wedge \neg Q) \vee \neg(\neg P \vee Q))$.

4. Make a truth table for $P \vee (Q \vee \neg P)$ and $P \wedge \neg(Q \vee \neg Q)$.

5. Find simpler logical formulas equivalent to:

    (Hint: What are the truth values of $P \vee \neg P, P \wedge \neg P$, (a statement that is always true) $\wedge P$, (a statement that is always false) $\vee P$?)

    a. $P \vee (Q \wedge \neg P)$.

    b. $\neg(\neg(P \wedge (Q \vee \neg Q)) \vee Q)$

    c. $\neg(P \vee (Q \wedge \neg R)) \wedge Q$.

6. Five friends with different ages are side by side wearing different coloured shirts, drinking different juice, and talking about different deals they got during the Black Friday sales. They each got different discount on the deals. Find out who bought the laptop.

    A. The man drinking the Orange juice is exactly to the right of the man who got the 70% discount.

B. Keith is 45 years old.

C. The man who bought the TV is exactly to the left of the man wearing the Red shirt.

D. At the third position is the man who got the 50% discount.

E. Keith is next to the man wearing the White shirt.

F. The 25-year-old man is somewhere between the 35-year-old man and the 40-year-old man, in that order.

G. The man drinking Apple juice bought the Smartphone.

H. The 30-year-old man is exactly to the left of the man that bought the Beard trimmer.

I. Sean is the youngest (25-year-old).

J. The man that got the 40% discount is exactly to the right of the man who bought the Beard trimmer.

K. Keith is next to the 35-year-old man.

L. Eugene is 40 years old.

M. Sean is wearing the Black shirt.

N. At the fourth position is the man who got the biggest discount (80%).

O. Dustin got 60% off.

P. The man drinking the Lemon juice is exactly to the right of the man drinking the Grape juice.

Q. Keith bought a Game console.

R. The man who got the 80% discount is exactly to the left of the man who is wearing the Blue shirt.

S. The man drinking Grape juice bought the Beard trimmer.

T. The man wearing the Black shirt is somewhere to the right of Keith.

U. The man that bought the Smartphone is next to the man wearing the Black shirt.

Taken from brainzilla (https://www.brainzilla.com/)

7. Sudoku - Easy

Taken from PUZZLES.ca (https://www.puzzles.ca/sudoku/)

8. Sudoku - Medium

Taken from PUZZLES.ca (https://www.puzzles.ca/sudoku/)

9. Sudoku - Hard

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Taken from PUZZLES.ca (https://www.puzzles.ca/sudoku/)