Programming C++

Project **div_3_5**

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Summation of specified numbers:
Write a function with input parameter n that adds all those positive integers less or equal n which are a multiples of 3 or of 5 (including or!).

- The easiest approach uses a for-loop.
- Test your function in the main function with various parameters:
  - $n = 15$ results in 60.
  - $n = 1001$ results in 234 168.
  - $n = 1432987$ results in 479 139 074 204.
- Derive a formula for calculating the required sum without executing a loop. Implement it in a second function and test it.
- Compare the run time of your two functions by using the `chrono`[1] functions for time measurement. Run each function at least 1000 times to get some measurable timings.

Hints: `cout`, `cin`, `endl`, `for`, `auto`, `std::chrono::high_resolution_clock::now()`, `std::chrono::duration<double>`, `std::chrono::duration_cast<...>(...)`

Mathematical hints (for the lecturer):
We consider integers from $[1, n]$.

- How many numbers $3 \cdot k$ are in that interval $[1, n]$? Obviously, we have $n_3 := \lfloor \frac{n}{3} \rfloor$ (function `floor`) and the sum of all these numbers is
$$s_3 = 3 \cdot \frac{n_3(n_3+1)}{2} \quad .$$
- Similarly, we get for numbers $5 \cdot k \in [1, n]$ the sum formula
$$s_5 = 5 \cdot \frac{n_5(n_5+1)}{2} \qquad \text{with} \quad n_5 := \left\lfloor \frac{n}{5} \right\rfloor \quad .$$
- Adding the two sum will be wrong because numbers $3 \cdot 5 \cot k$ are counted twice, i.e. we have to correct it with
$$s_{15} = 3 \cdot 5 \cdot \frac{n_{15}(n_{15}+1)}{2} \qquad \text{with} \quad n_{15} := \left\lfloor \frac{n}{3 \cdot 5} \right\rfloor \quad .$$
Finally we achieve the formula
$$s_{3|5} = 3 \cdot \frac{n_3(n_3+1)}{2} + 5 \cdot \frac{n_5(n_5+1)}{2} - 3 \cdot 5 \cdot \frac{n_{15}(n_{15}+1)}{2}$$

[1] `http://www.cplusplus.com/reference/chrono/high_resolution_clock/now/`