

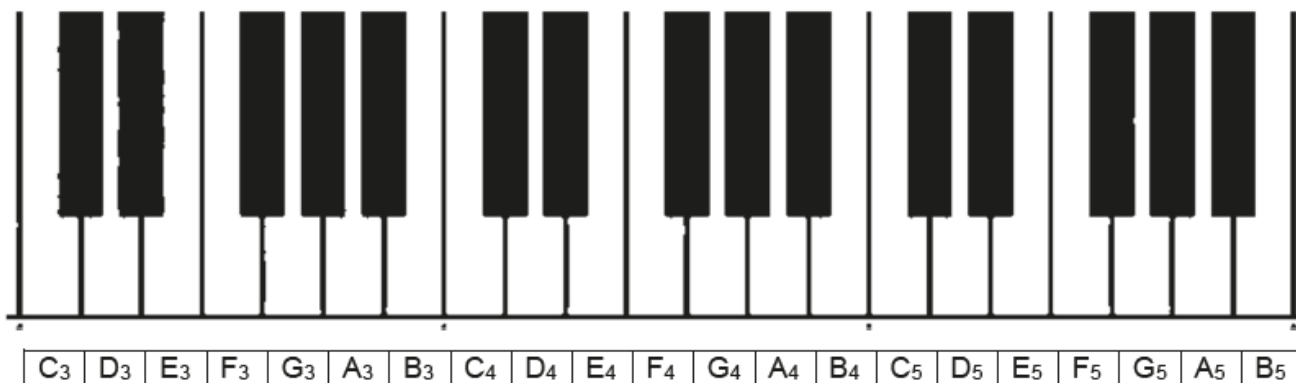
Sujet n°10

Please do not write on this document and do not forget to hand it back to the jury at the end of the exam.

**PROBLEM SOLVING**

*The first part of this page is a summary that can be helpful to do the exercise.*

- Music notes: A, B, C, D, E, F & G.
- The International System (SI) unit for frequency is the Hertz (Hz).

**EXERCISE**

In a modern 88-key standard piano, the keys begin with A0 and go up to C7.

The 49th key, the “central” A (called A<sub>4</sub>), is tuned to 440 Hertz. A jump to one higher octave doubles the frequency.

For example, the frequency of A<sub>5</sub> is  $440 \times 2 = 880\text{Hz}$ .

1. Work out the frequencies of A<sub>6</sub>, A<sub>3</sub>, A<sub>7</sub> and A<sub>0</sub>.
2. Human ear perceives frequencies between 20 Hz to 20 000 Hz. If an instrument could play an A<sub>8</sub>, would it be heard? What about an A<sub>10</sub>?
3. The ratio between A<sub>4</sub> and C<sub>4</sub> is  $1 : 0.595$ . Work out the frequency of C<sub>4</sub>.
4. In 2018, Adam Lopez, an Australian pop musician, held the Guinness World Record for singing a 4 435 Hz note. Is this note located between A<sub>5</sub> and A<sub>6</sub>? Can you locate it on an octave starting with A?
5. Do you like music? Do you play music? Do you know any other connections between mathematics and arts?